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Radio Broadcasting in Great Britain.

THE delay which has arisen in connexion with the inauguration of the proposed provision of a comprehensive radio broadcasting scheme in the British Isles has caused questions affecting the policy the Government should pursue in relation to broadcasting to be widely ventilated, and has, at the same time, directed attention to the great variety of interests that are involved in this matter. In view of the immense importance of radio-telegraphy to-day in connexion with measures affecting national defence, and of the fact that this means of communication is easily susceptible of interference from accidental causes as well as those of wilful design, it is the duty of the Government to ensure that the radio interests in its own care shall be properly safeguarded in the new situation which has come into existence in the wireless field.

Hitherto the authority and powers under which the Government has exercised control in relation to radio-telegraphy are those which it has derived under the Wireless Telegraphy Act, 1904 (4 Ed. 7, c. 24)—hereinafter referred to as the principal Act—a temporary Act which was placed on our Statute Roll a very few years after the practical utility of radio-telegraphy was first demonstrated, and has since been re-enacted in its original form from time to time as required. With the progress of time the need for governmental control in this field has in no way abated. Early in this year, about the same time that broadcasting first prominently attracted public attention, the Government took steps to strengthen its position by introducing the Wireless Telegraphy and Signalling Bill (12 & 13 Geo. 5—No. 148) in the House of Commons: therein provision is included for placing the principal Act permanently on the Statute Roll and, at the same time, for greatly enlarging the powers hitherto enjoyed by the Postmaster General. Under these new provisions the Government will undoubtedly possess extremely large powers, but probably not larger than are required to enable it effectively to cope, in the general interest of the public, with the wireless situation in this country. It is unfortunate, then, that a suspicion should have arisen in some quarters that the new powers may possibly be misused by the Government in their application to broadcasting: particularly is this so as many conflicting interests are involved in connexion with the putting into operation of broadcasting services, and therefore, in pursuing its policy, the Government needs to secure the fullest confidence of the several groups affected.

Indications have already been given as to the policy

which the Government intends to follow with regard to certain aspects of broadcasting. The decision of the Government to leave this branch of wireless activity in the hands of private enterprise to develop, has been widely welcomed: however, fears have been expressed lest, in giving effect to its policy under a licensing system, the Government may allow an industrial monopoly to grow up. It has to be borne in mind that the situation under discussion is altogether an exceptional one, and that although a complete monopoly cannot be tolerated, on the other hand, as is the case with ordinary telegraphy and telephony, and, indeed, with many other public utility services, so in the case of radio broadcasting, the field is not one which lends itself to unlimited competition; for, on purely technical grounds, a limitation has to be placed on the liberty of free competition in those cases where the radiation through space of electro-magnetic waves for signalling purposes is involved.

This latter point requires to be emphasised, as a proposal has been seriously put forward that, in spite of the grave risks of mutual interference incurred thereby, full liberty of action should be permitted to those whose wish it is to develop and trade in radio broadcasting, rather than that a complicated system of licences and supervision should be introduced. But full liberty of action is not feasible here: radio broadcasting cannot, on the transmission side, be conducted untrammelled by bureaucratic restrictions. The removal of such restrictions would not only defeat the aims of those who are seeking to establish useful, efficient and continuous broadcasting services in the British Isles, but would also, at the same time, put in serious jeopardy the radio communication services established in connexion with our national defence arrangements, as also the commercial services already in existence. For practical reasons, it is found necessary to lay down a definite upper limit to the number of radio transmitting stations which may be erected within a particular region. In the British Isles, the number of radio services of the several kinds connected with the fighting services and required for commercial purposes are already so great, that a central governmental authority has had to be created in order effectively to regulate the situation: it determines and allocates the radio wave-lengths that shall be utilised for particular purposes.

It is on the advice of this authority that the Government will, so far as the technical aspects of the situation are concerned, be obliged to act. In the matter of competition there are, of course, apart from the technical considerations referred to, financial aspects also which have to be brought under review. Normally it certainly is not the function of the Government to attempt to control the financial side of a private enterprise. However, so far as broadcasting is concerned, the Government is committed, *nolens volens*, to a certain measure of control of the organisations about to be licensed for this purpose; therefore, so long as everything is done to allow of the fullest amount of competition permissible in this field at the present time, and to admit of an increase of this competition in the future should technical and other considerations permit this safely to be done, it would not be unreasonable, at the present juncture, for the Government to exercise such further control as may be required to prevent anything being done the inevitable result of which would be the almost immediate destruction of a part of the capital of the investing public. On the other hand, by playing a part, as is proposed to be done by the Postmaster General, in the framing of the articles of association of the companies which it is intended to license for providing broadcasting services, the Government is likely, at some future date, to be deprived, wholly or partially, of its liberty to modify its policy in relation to competition should this be feasible, and desirable in the public interest, and it may thus lay itself open later to the charge of having allowed a monopoly to come into existence. It is at this stage that care should be taken by the Government to guard against entanglements which may afterwards prove embarrassing.

In the case of receiving apparatus the technical situation is relatively a simple one, and there is every reason for permitting the fullest competition in dealings connected therewith. It is desirable, therefore, that individuals wishing to possess such apparatus should have the greatest latitude allowed them in procuring what they want. Announcements have appeared that the types of apparatus to be used in connexion with broadcasting must conform to certain technical standards approved by the Post Office: if this merely means that the Post Office will issue a general specification, no objection can be taken. However, if it is intended that manufacturers must submit to the Post Office for its approval the designs of the apparatus they propose to put on the market for broadcasting, a serious mistake is being made alike from the manufacturers' point of view as of that of the Post Office, which will thus be saddling itself with a responsibility that it should seek to avoid. In the interests of all parties, it would seem best that the sale and purchase of wireless receiving apparatus should be carried on in these islands on the customary commercial lines free from restrictions of all kinds. It follows, therefore, that whoever may so desire should be permitted to make use in his or her broadcasting receiving installation of any home-made apparatus, provided that the same complies with the general technical requirements laid down officially.

It has been announced that the Postmaster-General is in favour of subsidising the organisations which are to be licensed for broadcasting purposes out of fees to be collected on the licences issued in connexion with wireless receiving stations. The situation is one which requires to be carefully handled, if mischief is not to be done. The authority given to the Postmaster-General to grant and renew licences in connexion with radio receiving apparatus exists primarily, not for revenue-raising purposes, but for that of effecting the registration of wireless installations of every kind; a step which is necessary as a measure of police precaution and also for facilitating control over all individuals using radio receiving sets. Since the law requires every person with a wireless installation to take out a licence, the charge for the same should be kept as low as possible. At the same time, it is reasonable that those who desire habitually to avail themselves, for one reason or another, of broadcasting services should be expected to contribute towards the cost of the same: strictly, this contribution should depend upon the extent of the user. The situation is one that lends itself to treatment by the grouping of the licences, on some practical basis, into two easily distinguishable categories, and by a differentiation in the charges to be levied on the licences in these two categories.

Now, broadcasting is essentially a luxury demand, and it has to be borne in mind that there are to-day, and will always be, many owners of licensed wireless installations who are not desirous, as a practice, of making use of broadcasting services. For this reason, anything in the nature of a general levy on all wireless receiving stations must be avoided. On its merits, broadcasting is deserving of the fullest encouragement and the greatest assistance which the Government can give it, alike in the interests of those who seek amusement therefrom, of the research workers in this field, and of the electrical industry. It seems improbable that any sum likely to be raised at the present time by fees on the grant and renewal of licences will go anywhere near providing the contemplated annual outlay on the broadcasting scheme which has been projected. It has been estimated that an outlay of 180,000*l.* per annum [2] will be involved in connexion with the proposed broadcasting stations. Now, there are at the present time in this country some 10,000 holders of licences for wireless receiving installations. In view of the relatively high cost of providing complete receiving installations, an increase in the number of licences may, in these days of trade depression, be a slow matter; but assuming that an immediate increase may multiply their number tenfold, even so, approximately 2*l.* per annum would, on a flat-rate basis, have to be levied on every licence, in addition to the registration fee, if the whole annual cost of the broadcasting stations is to be met in this way. There is, however, a serious risk that an annual contribution on this scale may have the effect of retarding materially the rate of the growth in the number of private wireless installations.

In these circumstances, it would seem that the licensed organisations will be well advised to endeavour to raise the annual revenue they require largely from audiences attracted to public entertainments promoted and run under their auspices: evidence exists tending to show that large audiences can be attracted to broadcasting entertainments of a high class. The licensed organisations can, of course, at the same time, raise additional revenue by hiring out wireless receiving installations for entertainment purposes, by sales of apparatus outright, and by other means. It is in relation to the carrying out of this wider policy, which caters for the needs of all classes interested in radio-telegraphy, that the Government can best help in popularising broadcasting and aid in promoting the commercial success of licensed organisations rather than in the attempt to subsidise them out of moneys raised by means of fees charged on licences, the amount of which may, more than likely, prove extremely disappointing. For example, the Government can, on the technical side, help the licensed organisations materially by allotting to them the necessary number of suitable radio wave-lengths to enable them to carry out their programmes, and in many other incidental ways: it can also to some extent afford them assistance on the commercial side by causing all applications for entertainment licences to be collected by them for transmission to the Postmaster General, a course the adoption of which would provide the licensed organisations with opportunities for selling broadcasting services, whilst at the same time promoting genuine competition in this field.

In connexion with broadcasting, other rights are threatened, such, for example, as copyright and patent right. In all the circumstances of the present situation, it behoves the Government then to keep itself as free as possible from responsibility in connexion with the details of the radio broadcasting services. This it will do so long as it confines its rôle to that of a licensing authority exercising general control and supervision over the purely wireless situation, and by allowing, in collateral matters, the old doctrine to prevail, that where the likelihood of the invasion of the legal rights of others is involved, every subject in the realm acts at his own peril and must be held personally answerable for his own deeds to him who establishes in due course of law that he has suffered an injury from an actionable wrong at the hands of another.

[2] See NATURE for August 5, p. 197.

University Education in London.

The University of London (History, Present Resources and Future Possibilities). By Sir Gregory Foster. Pp. 48. (London: University of London Press, Ltd., 1922.) 1*s.* 6*d.* net.

THE Provost of University College has been well advised to publish in the form of a pamphlet, attractively printed and illustrated, the two lectures delivered at the College in February last, together with the speech of the president of the Board of Education (Mr. Fisher) at the conclusion of the second lecture. A less ambitious title might perhaps have been chosen, for in effect the lectures are a closely reasoned apology for the Bloomsbury site and for the University policy which it represents. At the outset, the popular illusion that University education in London is to be concentrated entirely in one quarter is examined and dismissed. The sites alone of the thirty-six Colleges of the University occupy no less than 212 acres and their students number 21,600. Their halls of residence account for 7½ acres and their playing fields for another 215 acres, making a grand total of 434½ acres. To bring together these vast educational resources would be a prodigious undertaking—extravagant (a "wanton waste" as the Provost says), impracticable by reason of the necessary contiguity of the medical schools to their hospitals, and undesirable in an educational sense. Other less fortunate Universities have discovered that it is impossible to educate in crowds. The Provost's arguments against carrying the "concentration" idea too far are complete and unanswerable.

One asks at once why if a large dose of the medicine is fatal, a homœopathic dose should be beneficial—in other words, why the Government should urge so strongly the removal of King's College to the Bloomsbury site. "It is," says the Provost, "for the obvious reason that King's College on its present site, delightful as it is from many points of view, cannot grow and extend according to its needs." This argument is hardly relevant, for there are other parts of London than Bloomsbury where King's College could grow if that is what it wishes to do. The question of the *optimum* size for a college is involved; and there are other ways of growing, it may be suggested, than in size and numbers—in efficiency, for example, or by planting out part of its work as King's has done already in the case of its Household Science Department at Campden Hill. The impression left on the mind of the reader of these discourses must be that the King's College question is not discussed with force or conviction.

There is a peculiar habit in University circles in London of continuing the argument after a conclusion has been reached. From this point of view the Provost's carefully compiled statistics in favour of the Bloomsbury site will fortify the loyal forces in the guerilla warfare which is now being waged with vigour and persistence. Of the total of 21,634 students in the Colleges of the University, no less than 16,764 are in Colleges within two miles of the Bloomsbury site, whereas the corresponding figure for the rival Holland Park site is only 1520. The number outside the two-mile radius of either site is 3306. Whether the two-mile radius was chosen because of the distance covered by the 1*d.* bus fare of a happier generation, we cannot determine; but we may fairly ask why the University quarter should be within this reasonable distance of the students, seeing that except for compulsory attendance at examinations they have in recent years found no pleasure in visiting the University headquarters. On the only occasion on which the present writer remembers to have seen a thousand London students in one room, their object in coming together was to denounce the existing constitution of the University!

On this question the Provost maintains a strange silence. He fails to stress the need which exists in London for the active encouragement of all those social, athletic, and extra-academic influences which make for the development of students' personality as distinct from intellect. The Bloomsbury site should provide these facilities as far as practicable in the form of dining-halls, clubs, hostels, accommodation for debates and meetings of extra-academic societies, theatres, concert-rooms, art galleries, museums, gymnasia, fives courts, swimming baths, churches, and mosques! Unless something can be done on these lines, the whole discussion is meaningless from the point of view of the students regarded as human beings and not merely as statistical units.

For administrative purposes and for ceremonial and public meetings of all kinds, the need for a central position is paramount and incontestable. Busy public men, administrators, and teachers who do voluntary work as members of University Committees may reasonably demand that their sacrifice of time and money in travelling shall be reduced to a minimum. A few weeks ago some five hundred graduates attended a meeting of Convocation at South Kensington for the purpose of electing a new chairman. At the lowest computation 10*l.* extra was spent in travelling to South Kensington as compared with, say, Bloomsbury; more important and serious, the meeting must have been less representative because of the inability of graduates living or working on the remote side of London to attend. How any person of common sense or knowledge of London can argue that South Kensing-

ton or Holland Park is conveniently situated for a University quarter passes comprehension.

It would be unfair to expect in the course of two lectures a full exposition of University policy; but there appears to be some lack of consistency, possibly more apparent than real, between the criticism of pre-1900 higher education in London when "each college made its own plans and did its own work in the best way it could" and the current demand that, a teaching University having at last been established, certain Colleges shall be given the status of "Dominions" enjoying Home Rule within the University. If University and King's Colleges were set up cheek by jowl on the Bloomsbury site, the need for co-ordination by some independent and impartial authority would cry out to heaven. The Provost is on surer ground in pleading for "as much concentration in the University Quarter as is practicable," especially in respect of "all the new post-graduate institutes," and our only criticism of this proposal is that a more comprehensive term than "post-graduate institutes" should be used. In addition to post-graduate institutes, there is need for a number of schools or institutes of a specialised character, *e.g.* for law, music, drama, journalism, and military science, to specify only a few subjects for which at present provision is not made or is inadequately made within the University. As an instance of a post-graduate institute, the new scheme for an Institute of Public Health is cited, and it is gratifying to find that the demand for Collegiate Home Rule is not in this case interpreted by the Provost in the sense of "what we have we hold." "We have a department [of Hygiene] in this College, the oldest in the country, but it is inadequate to meet the needs of London; and we should be prepared to see that department, and all the still smaller departments in the other Colleges, merged into one great institute. That is the kind of development which will be helped by the concentration in Bloomsbury."

Towards the conclusion of the lectures, the Provost pleads for "the necessary spirit to pull and work together" in order to substantiate the vision of a great University of London which he has somewhat faintly adumbrated. These wise words should not be received in a derisive spirit. No one will suppose that University College has attained its present great prestige without a struggle, or that on certain occasions its rivalry with other Colleges may not have taken a combative form. The important thing to ensure, as the Provost suggests, is that this rivalry, unavoidable and even desirable within limits, shall be as free as possible from selfishness—"particularism" is the polite academic word—with the greater glory of the University always in view, magnanimous, void of envy, malice, and intrigue, and of that perverted form of academic freemasonry which suspends private judgment and exalts College loyalty. The alternative is constant suspicion and bitter, often unreasonable, opposition to progress.

A brief reference must be made in conclusion to Mr. Fisher's speech delivered at the end of the second lecture. He found himself in "full agreement with the admirable doctrine contained in the address." The University of London was a species by itself.

"The Government, four years ago, made an offer of the Bloomsbury Site to the University of London. That offer has been accepted by the University. The Government do not propose to make another offer, and if the University does not like the site, well, it can return it to the source from which it came. I have no doubt the Chancellor of the Exchequer will appreciate its generosity."

The limit to the number of students who could be educated at Oxford and Cambridge had been reached, and London must be prepared to receive a great influx of students, particularly

"from the Dominions, from India, from the Crown Colonies, from the United States of America, and from the allied Powers of the Continent." You must concentrate in one part of London "not *all* the teaching power, but an impressive proportion of the teaching power," and that was "the principal object which the Government had in view in suggesting an arrangement under which King's College could be brought into close proximity with University College." And as last words he said: "Let those who are anxious for the future of London University, from whatever angle they may have hitherto viewed London University problems, let them concentrate on the endeavour to create upon the site a noble series of buildings, worthy of the reputation of the University, worthy of its past, and adequate to the great destinies which await it."

T. LL. H.

Antarctic Foraminifera.

British Museum (Natural History). British Antarctic ("Terra Nova") Expedition, 1910. *Natural History Report. Zoology*, Vol. 6, No. 2. *Protozoa*, Part 2: *Foraminifera*. By Edward Heron-Allen and Arthur Earland. Pp. 25-268 + 8 plates. (London: British Museum (Natural History), 1922.) 30*s*.

STUDENTS of natural history in its wider aspects will welcome the appearance of this memoir on the Antarctic Foraminifera of the second Scott Expedition—a notable contribution to the series of reports which have resulted from the *Terra Nova* Expedition. The authors state that the material collected during the expedition was placed in their hands seven years ago, and that the delay in publication has been due, not

only to the difficulties of biological research in war-time, but also to the method of preservation adopted for most of the dredgings containing foraminiferal specimens. The collectors appear to have put unwarranted confidence in formalin, "than which no more unsatisfactory medium for . . . Foraminifera can be imagined." Messrs. Heron-Allen and Earland have been compelled, therefore, to expend much time and trouble in cleaning the material entrusted to them so as to render it at all suitable for study, and they "can only review the results as a tantalising sketch of the possibilities which would have attended upon an ample supply of properly collected Antarctic material." Nevertheless, the authors are able to record 650 species and varieties of these fascinating Protozoa, of which 46 are new to science.

In looking through the systematic list, which occupies by far the greater part of the memoir, the student of distribution cannot but be impressed by the wide range of many of the types. Species recorded here from the far south are identical with those, already enumerated in lists by the same authors, of Foraminifera from the North Sea, and from the Atlantic waters around the shores of Conacht. Several types are common to Arctic and Antarctic regions, but these are almost all pelagic forms, and capable of the most extensive migrations. The only exception, *Globigerina pachyderma*, Ehrenberg, with its "curiously thick-walled" shell, is "the typical Globigerina of Arctic deposits," reaching its southern limit about the Faeroe Channel. Nevertheless, the authors do not consider that its presence in the Antarctic Ocean affords any support to the once-popular "bipolarity" theory of specific origins. Apparently *G. pachyderma* is "a local variation" of *G. dutertrei*, d'Orbigny, a transition from the one form to the other being clearly demonstrable as dredgings from more southerly stations are examined. This transition is supposed to be "induced by conditions of temperature," and the authors believe that "the same gradual transition [from *G. dutertrei* to *G. pachyderma*] which we have described in the Antarctic could be traced in the Arctic and temperate seas."

Systematic students of the Foraminifera will be especially interested in the number of hyaline species of which arenaceous isomorphs are described—for example, *Bifarina porrecta* (Brady), *Bolivina punctata*, d'Orbigny, and *Rotalia soldanii*, d'Orbigny. The authors express their agreement with Bütschli, Fauré-Fremiet, and other recent workers at the order, in considering that the existence of such isomorphs—the formation of an arenaceous instead of a calcareous test due to some obscure physiological reaction—may necessitateu ltimately a revision in the classification of the Foraminifera. "We do not think the time has yet arrived to abandon the generally accepted, if artificial, system of Brady, which, with some modifications, is followed in this Report. But we have endeavoured to clear the way towards a proper zoological allocation of the Lituolidæ by refraining wherever possible from the creation of new arenaceous species, and retaining our new arenaceous forms in the genera to which they naturally belong."

Among the newly described forms the genus Dendronina, referred to the Astrorhizidæ, comprising two New Zealand and two Antarctic species, is noteworthy. The test is built of fine mud, sand-grains, and sponge-spicules, and the sessile *D. arborescens* assumes a complex branching habit, attaining a height of 5 to 6 millimetres. The authors believe that the genus may be represented also in tropical seas (Indian Ocean). *Polytrema miniaceum* (Pallas) was found in great abundance in the New Zealand area, at one station "practically every solid organism" being "more or less covered with it." It is a sessile foraminifer of very wide range, and the authors have made a special journey to Corsica so as to study the species in life in Mediterranean waters. The organism in its early free stage settles on some object, wherewith it gains connexion by thrusting out protoplasm from its under surface and forming "a thin layer of incrusting chambers." The protoplasm subsequently streams out from these, surrounds the young spherical test, and constructs a wall of small chambers which overgrow and envelop the latter. Finally the characteristic branching, arm-like processes grow out. The occurrence of siliceous sponge-spicules inside the chambers of the Polytrema has given rise to much discussion; the authors have observed sponge and foraminifer "close together and approximately the same size," and do not altogether reject the possibility of a true symbiosis.

In order to reduce the cost of publication, the authors have restricted to a minimum their synonymic references. The eight plates illustrating the memoir have been admirably drawn by Mr. M. H. Brooks and are excellently reproduced. All the workers concerned may be heartily congratulated on the results made known in this most recent outcome of Antarctic exploration and research. G. H. C.

Water Underground.

Nouveau Traité des eaux souterraines. Par E.-A. Martel. Pp. 838. (Paris: G. Doin, 1921.) 50 francs.

IN M. Martel's treatise, stress is naturally laid on what he has styled "spelæology." For him, subterranean water moves in a fascinating world of caves. The conception of a general water-table in

permeable rocks does not appeal. His conclusions as a follower of water by sheer hard climbing and exploration underground are supported by the very varied results of borings made near one another in beds regarded as porous by the engineer. M. Martel believes, with much justice, that subterranean rivers do not etch out their own way; they are determined by pre-existing crevices, the *diaclases* of Daubrée. In the case of limestone, solution obviously widens the original fissure; but it must have been generally recognised that the long-continued dominance of the joint-system is again and again revealed in the plans of sinuous caves.

M. Martel, however, does not give geologists much credit for observing a relation between the direction of surface-streams and the fissured structure of a country; but we cannot help remembering the account of the Drava and Gail system in the first volume of Suess's "Antlitz der Erde," and the exposition by Molyneux and Lamplugh of the Batoka Gorge of the Zambezi. In the case of Mosi-oa-tunya, however, M. Martel seems satisfied with the somewhat catastrophic views of Livingstone. We must admit that an examination of our ordinary text-books reveals an unfortunate silence on this question of fissures and stream-erosion; but surely M. Martel is inclined to exaggerate (p. 42) the differences between his views and those of colleagues like Lugeon, Kilian, and de Martonne. He is accustomed to move adventurously in narrow rift-like ways, along the floors of ravines and their counterparts underground; but he cannot wish us to return to the antique view of valleys as gaping fissures in the crust. On a tilted peneplain the courses of streams are at first uncertain; they are controlled merely by the general slope. When they have worked down into the surface of solid rock, they at once begin to be guided by the joints, the lines of weakness. The walls of the ultimate valleys are due to erosion; the general ground-plan is often determined by that of the joints, the walls of which are practically in contact until the streams begin to work.

The surface-waters then cut downwards. By seepage they become subterranean, and the *diaclases* prove still more effective in the underworld. The details of caves and of disappearing and reappearing streams are never monotonous to M. Martel; but the frequent photographic representation of them may pall a little on the geological or engineering reader. We must admit that the pictures here given, to the number of three hundred, are fascinating and often very impressive. In some cases, as in those of the cañon of Olhadibie in the Basses-Pyrénées, they result from very recent exploration.

The discussion of the origin of water in the Chalk (p. 366) raises important engineering considerations. Mr. R. L. Cole has recently dealt with this matter as regards the south of England ("The Power User," June 1922, p. 97), and he treats the body of the Chalk as providing little opportunity for flow. M. Martel, in his descriptions of "lapiaz" or "lapiés" (p. 531), shows well how water penetrates a limestone surface and how it proceeds to ramify below. His remarks on the use of the divining-rod (p. 749) are philosophic and reserved; he looks for a very extended series of trials made on a consistent plan. The power of divination, if it exists, resides in the operator and not in the instrument used. He shows, among other interesting matters, how the sinking of artesian wells was known to dwellers on the edge of the Sahara centuries before Moorish engineers were invited to find water in Artois. The ease with which subterranean water may be contaminated is attested by grim instances (p. 767) of the slow decomposition of corpses interred on the battlefields of 1914–18, and by the infection during a whole year of the spring of Gerbéviller in Lorraine.

GRENVILLE A. J. COLE.

Statics, Dynamics, and Hydrodynamics.

(1) *Elementary Statics of Two and Three Dimensions.* By R. J. A. Barnard. Pp. vii+254. (London: Macmillan and Co., Ltd., 1921.) 7*s.* 6*d.*

(2) *Theoretical Mechanics: An Introductory Treatise on the Principles of Dynamics, with Applications and Numerous Examples.* By Prof. A. E. H. Love. Third Edition. Pp. xv+310. (Cambridge: At the University Press, 1921.) 30*s.* net.

(3) and (4) *Idromeccanica Piana.* By Prof. Umberto Cisotti. Parte Prima. Pp. xii+152. Parte Seconda. Pp. viii+155-373. (Milano: Libreria Editrice Politecnica, 1921.) Lire 24 and 32 respectively.

(1) PROF. BARNARD'S new book makes an excellent text-book for the higher years in pass degree courses and for the first part of honours courses in applied mathematics. The scope is that generally expected, a chapter on forces in three dimensions being included. In treatment the book is orthodox and safe, so orthodox in fact that centres of gravity are left to quite a late chapter, as if the finding of centres of gravity were an aim in itself. The proof of the vector property of couples is very effective.

A chapter is added on vectors in space, use being made of the vector notation, and the student is referred to the author's "Dynamics" for a fuller treatment. The modern student of mechanics and physics cannot afford to be quite ignorant of vector methods and notation, and Prof. Barnard is performing a useful

service by including them in his books, even if only in the form of an afterthought.

(2) Prof. Love's "Theoretical Mechanics" is a book that serious students of dynamics cannot be without: the discussions of the principles are illuminating, and the collections of examples are useful to both teacher and pupil. Only a few changes have been made in the recently issued third edition. Perhaps it is permissible to suggest that the book would be immensely more useful if it partook of the nature of a text-book, and included a much larger number of worked examples. The student's main difficulty in dynamics is not in learning the comparatively restricted number of ideas and methods given in the usual honours courses, but rather in obtaining the necessary experience for using these ideas and methods successfully in the problems presented by nature. By far the most effective help that can be given him is that contained in a judiciously selected and carefully graduated series of worked problems, where the efficiency value of each process is made evident.

As the author emphasises the importance of the fundamental principles, the volume would be the right place for a brief account of relativity in dynamics. To leave this latest phase of modern scientific reform to the physicist and the philosopher is a mistake that applied mathematicians should endeavour to counteract.

Publishers no doubt know their business and do not need the advice of academic men. A protest must nevertheless be raised against excessive prices. The price of this new edition will prevent its sale among just those young students whose mechanical ideas the author wishes to influence.

(3) and (4) The study of two-dimensional problems is of great interest in several branches of applied mathematics, as, for instance, in potential theory, electricity, and hydrodynamics. It often happens that when a three-dimensional problem of importance cannot be solved, the two-dimensional case is amenable to modern mathematical methods and its solution sheds much light on the general problem. This has been the case particularly in hydrodynamics.

The present volumes are the first two parts of a treatise on two-dimensional hydrodynamics. Part I. gives the theory of the complex variable and conformal representation, which is followed by a statement of the equations of motion of a fluid in two dimensions. Problems with boundaries consisting of free stream lines only, and with boundaries consisting of fixed barriers only, are then discussed. Part II. deals with jets and other problems, involving both fixed and free boundaries, while Part III. will deal with wave-motion.

Of the different types of problems discussed by Prof. Cisotti, perhaps the most interesting is that of discontinuous motion of fluid past a fixed barrier—a problem that has some bearing on the modern subject of aerodynamics. When the barrier is plane, and the motion is assumed to be irrotational, with free stream lines, the problem has been solved by the use of what constitutes one of the most elegant processes of mathematical reasoning. Curved barriers, however, have so far defied solution, except in the sense that when a solution is suggested one can obtain equations which define the barrier appropriate to the solution. The problem of the curved barrier may almost be described as one of the classical problems of hydrodynamics. Several interesting cases have been discussed, in particular by Prof. Cisotti himself, Villat, and others.

The ordinary text-book process of solving two-dimensional problems in hydrodynamics is to seek a relation between the complex variable that represents the geometry of the actual motion and the complex variable involving the velocity potential and the stream-line function. An intermediary variable, which is essentially representative of the velocity vector, is often useful. In dealing with discontinuous motion past barriers consisting of plane surfaces, a further intermediary variable is needed, based on the Schwartz-Christoffel transformation: the problem is then reduced to quadratures.

For curved barriers, however, this is insufficient, and a new type of transformation has been found necessary. The essential idea of this transformation is to make the barrier correspond to a semicircle in a new Argand diagram. The general solution of the problem is then defined in terms of a Taylor expansion, and the choice of the coefficients in this expansion determines any particular curved barrier. Elegant formulæ exist for finding the pressure components on the barrier, and the line of action of the resultant pressure, but an explicit statement for the latter has not yet been published.

This process, due to Levi-Civita and others, can be made to yield numerical results of considerable interest. Brillouin has given the working for a set of barriers defined by a certain choice of the coefficients in the above-mentioned series. Further, by a process of approximation, circular and elliptic barriers admit of numerical solution.

Prof. Cisotti's résumé of the progress in this problem during the last fifteen years is masterly, and of great use to researchers in the subject. It seems, however, that the footnote on p. 179 is based on a misapprehension. Brillouin has given the conditions that must be satisfied if the free stream lines are to have finite curvature where they leave the barrier. The author urges that these conditions are not necessary. He is right, but Brillouin does not mean that these conditions

are to be satisfied always. As a matter of fact, the problems in which Brillouin's conditions are satisfied are those which have the greatest bearing on aerodynamical research. Further, Brillouin's conditions can be used to elucidate the rather puzzling question of the difference between barriers which are defined by the same mathematical curves, but of different extents, as *e.g.* circular barriers of different angular extents.

These two volumes can be highly recommended to all who are interested in recent developments in the mathematics of two-dimensional hydrodynamics.

S. BRODETSKY.

Our Bookshelf.

Register zum Zoologischen Anzeiger. Begründet von J. Victor Carus. Herausgegeben von Prof. Eugen Korschelt. Band xxxvi.-xl., und *Bibliographia Zoologica*, vol. xviii.-xxii. Pp. iv+695. (Leipzig: Wilhelm Engelmann, 1922.) 280 marks.

ALL who have had occasion to use the bibliography which is issued with the "Zoologischer Anzeiger" know that much trouble and loss of time are involved in consulting the volumes not yet indexed in one of the five-yearly "Registers." They will welcome, therefore, this belated volume, which indexes, mainly, the papers published from 1909 to 1911, including also a few from 1912 and a good many of earlier date which had previously escaped notice. It is compiled according to the same plan as its predecessors. Each paper is indexed under its author's name, with an abbreviated title and a citation of the volume and page of the bibliography where the full reference will be found. There are also cross-references under systematic names where these are mentioned in the title, or in the brief notice appended to the entries in the bibliography, and all new generic names are separately entered.

It was the opinion of Herr Heinrich in Mr. H. G. Wells's story of "Mr. Britling" that "the English do not understand indexing." It may be only because of this national defect that we find the plan of the "Bibliographia Zoologica" cumbersome and inconvenient as compared with that of our own "Zoological Record." The volume before us is only an index to an index. It requires us to take down at least one other volume from the shelf before we can find the reference we want. It includes neither a subject index nor a geographical index, and the systematic references are far from adequate for the needs of the systematist. All bibliographies, however, are useful, if only because none of them is perfect, and certainly no zoologist can afford to neglect the "Bibliographia Zoologica." At the present time, when the obstacles to the international diffusion of knowledge are only slowly being removed, the need for such works and the difficulties in the way of compiling and publishing them are alike great. It is to be hoped, therefore, that this volume will soon be followed by others cataloguing the literature of more recent date.

W. T. C.

Report of the Canadian Arctic Expedition, 1913–18. Vol. xii.: *The Life of the Copper Eskimos.* By D. Jenness. (Southern Party, 1913–16.) Pp. 277. (Ottawa: Department of the Naval Service, 1922.) 50 cents.

THE report of the Canadian Arctic Expedition, 1913–18, is planned to include at least sixteen volumes. This, the ethnographical volume, is the work of Mr. D. Jenness, a graduate of the University of New Zealand, who received his anthropological training at Oxford, and is already known as the author of an important book entitled "The Northern D'Entrecasteaux." Mr. Jenness lived for some years in the tents and snow-houses of the Eskimo, and though he says little of his personal difficulties, the companionship of his Eskimo hosts and their strange food must have been a trying experience. With the help of a devoted missionary, the Rev. H. Girling, who unfortunately died of pneumonia at Ottawa in 1920, he has been able to prepare a singularly valuable account of life in all its phases among the Copper Eskimos, whose headquarters are on the Coppermine River. Fortunately for them, this land lies in the track of the Great Caribou migration when the herds move northward in the spring. They are then able to collect stores of meat and skins, and from this and the seals and fish, which are abundant, their wants are supplied. Formerly their hunting was done with bows and arrows, but these are now replaced by rifles, and it would be well for the Canadian Government to consider whether the use of improved weapons should not be controlled in the interests of game preservation.

The book is full of curious facts and is illustrated by photographs and maps. "With the influx of traders and missionaries into the country the conditions of life are fast changing. Famine looms less in the foreground, but in its place European diseases are threatening the health of the communities, and bid fair to rival all other causes in their effect on the death-rate." The suggestion that a period of quarantine and medical examination should be enforced on all strangers entering the Eskimo territory certainly deserves serious consideration.

The Scope of School Geography. By Dr. R. N. Rudmose Brown, O. J. R. Howarth, and J. Macfarlane. Pp. 158. (Oxford: Clarendon Press, 1922.) 5*s.* 6*d.* net.

THE authors have briefly reviewed the scope of school geography, maintaining two dominant themes throughout, one the essential unity of the subject, the other the scientific character of its data and its methods. "Geography, properly speaking, has a definite viewpoint of its own and is not a mosaic of loans from other subjects." "The teaching of geography is no less the work of a specialist than the teaching of chemistry or history."

The authors have adhered, and for school purposes perhaps correctly, to the statement that geography may be regarded as the interaction between man and his environment; but even for the purpose of this book it might have been desirable rather to have stated the broader and deeper truth that geography has as its field the distribution of the interrelations of many phenomena of which human activities form but one.

In the chapters dealing with meteorology, biology, oceanography, and economics the relations of these subjects to geography and the material which geography can and must derive from them for its own study is fully discussed. On the subject of maps and map-reading the book contains excellent advice. "The practical study of maps must entail the art of map-reading." "The map must be interpreted."

Many will disagree with the authors' application of the term historical geography. Some historical events depend for their complete interpretation on a knowledge of geography, but this is not historical geography; it is merely history fully understood. It is possible, however, in theory at least, to reconstruct for each region the geography of past epochs and to see for that area not merely the evolution of its history, but what is much more comprehensive, the evolution of its geography. This is historical geography.

The book should do much to remove the many anomalies which exist in the school study of the subject.

Within the Atom: A Popular View of Electrons and Quanta. By John Mills. Pp. xiii+215. (London: G. Routledge and Sons, Ltd., n.d.) 6*s.* net.

WHAT can a scientific reviewer say about books like this on "popular science"? Mr. Mills, who has quite a competent knowledge of his subject, sets out to initiate those who have no knowledge of physics and chemistry (and apparently no intention of acquiring it) into the mysteries of modern atomic theory. Of course the task is utterly impossible. Scientific theories serve mainly to explain facts, and those who have no knowledge of those facts can grasp little of their real meaning. Such satisfaction as they can obtain must be wholly different from that of the earnest student, who, even if he admits the morality of an attempt to delude the laity into the belief that they can appreciate scientific work without serious study, can never be in a position to judge whether an author has been successful in tickling the palates of his readers in the manner they desire.

However, from the sale of similar works we imagine that there are some who will appreciate the mixed fare set before them. Very mixed it is, ranging from a conversation (in the spirit, but not the style, of the celestial dialogues of Faust) between the author, an electron, energy and the reader to a more or less sober discussion of the difficulties of interpreting X-ray spectra. Indeed we find a certain inconsistency in our author's attitude; if he is prepared to make such a concession to sensationalism as to assert that the nucleus is smaller than the electrons which it contains, he need not have boggled over many quite minor difficulties which seem to us to occupy a disproportionate space. But then, as we said, we are clearly not in a position to judge.

Süd-Bayern. Von R. H. Francé. (Junk's Natur-Führer.) Pp. v+423. (Berlin: W. Junk, 1922.) M. 32 and 150 per cent "Valutazuschlag."

IT is pleasant to think that the State of Bavaria was not dismembered by the great European peace, and we regret that Dr. Francé's scientific guide-book could not extend a little northward, so as to include the palæontological treasures of Eichstätt and the cauldron-subsidence of the Ries. But the finest landscapes of the country await the traveller across the southern glacial plain. There is much, indeed, to detain him on the "Niederterrassenschotter" itself. Dr. Francé calls attention, for example, to the forest of Ebersberg, within easy reach for any botanist who visits Munich. Here the climatic change in modern Germany may be traced in the decay of the giant oaks in the eighteenth century, in the subsequent dwindling of the beeches, and in the present predominance of conifers, under which wild tulips grow. The site of Munich raises the puzzle of its apparent extinction in Roman times, though Roman roads run through it, based on predecessors built by Celtic engineers. The rapid rivers are themselves worth watching, as they stream from the Alps across the glacial deltas of the plainland. With this book as a companion, the naturalist will finally cross the old lake-floor to Partenkirchen, and will stand under the crags of the Wetterstein well content. G. A. J. C.

In the Heart of Bantuland. By Dugald Campbell. Pp. 313. (London: Seeley, Service and Co., Ltd., 1922.) 21*s.* net.

MR. CAMPBELL provides his readers with an abundance of good stories of big-game hunting, slave traders, and natives and Europeans whom he has met in his twenty-nine years of experience as a missionary. His travels range from the Katanga and Angola to the shores of Lake Nyassa. His use of the word "Bantuland," not merely in his title but in the text, may be misleading to the uninitiated, as he does not deal with all Bantu peoples, but only with those within the limits mentioned. Even thus he is not always sufficiently explicit in mentioning the tribe to which a particular custom or belief appertains. Many of the peoples with whom he deals are but little known, and his careful description of their culture is a useful addition to our knowledge. His account of secret societies of various types is worthy of note. Mr. Campbell gives to native character a tribute of admiration which is well deserved, as is shown by instances of self-sacrifice and bravery, while he has much to say of the political sagacity and instinct for government displayed by some of the tribes and their chiefs.

The Technique of Psycho-Analysis. By Dr. David Forsyth. Pp. viii+133. (London: Kegan Paul, Trench, Trübner and Co., Ltd., 1922.) 5*s.* net.

IN his book on the technique of psycho-analysis Dr. Forsyth deals, from the practical viewpoint, with a subject which is full of difficulties for the beginner in analytical work. The first chapter is devoted to a consideration of the analyst himself; the second deals with the conditions under which the treatment should proceed; the remaining four chapters discuss the actual analysis. Dream analysis is excluded as being too big a subject for discussion in such a book, and the reader is referred to Freud's "Interpretation of Dreams" for the study of this side of analytical treatment.

Dr. Forsyth gives much practical advice which is frequently omitted from literature on the theory and practice of psycho-analysis.

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.*]

The Acoustics of Enclosed Spaces.

THE acoustics of enclosed spaces intended to hold large audiences is now receiving attention, and it is recognised that good conditions for distinct hearing can be obtained only by eliminating the reverberation due to reflection from the walls. Owing to the high velocity of the transmission of sound in nearly all solid bodies, the angle at which total reflection begins is small; for oak wood it is about 6°, and for glass as low as 3°. Unless the wave-front is therefore very nearly parallel to a wall it cannot penetrate and is sent back into the room. The simple and partially effective method of deadening the reverberation by covering the walls with a highly porous material, or woven stuffs, is difficult to apply in large spaces, and a more hopeful solution of the problem seems to me to lie in the discovery of a substance that can be used for the exterior lining of walls and has a velocity of transmission not far different from that in air.

Unfortunately our knowledge of the velocity of sound in different materials is very scanty. I am not aware that the acoustical properties of the substances most commonly used in buildings, such as stones, brick, and mortar or plaster of Paris, have ever been examined. My suggestion is to look for a suitable material which is transparent to sound and can be backed by highly porous matter which will absorb the transmitted vibration. If necessary, a series of alternate layers may be introduced. In referring to the tables of Landoldt-Börnstein I find that the substance which has a velocity of transmission for sound nearest to that of air is cork. This might be taken as a starting point for further investigation, but there are great gaps and inconsistencies in the tables.

It is to be remarked that at nearly normal incidence, so long as no total reflection takes place, the posterior surface of the wall diminishes very considerably the intensity of the reflected sound. This is illustrated by the analogous problem in the theory of light. Applying the relevant equations (A. Schuster, "Optics," p. 71) to normal incidence we find for the reciprocal of the intensity of a wave transmitted through a wall: $1+\pi^2(1-\mu^2)^2e^2/\lambda^2$, where e is the thickness of the wall, λ the wave-length in air, and μ the refractive index. It is here assumed that the thickness of the wall is small compared with the wave-length measured inside the wall, which will nearly always be the case. For wood the refractive index is about ·1, and for stone it will probably be of the same order of magnitude. Applying the equations and assuming the wave-length to be 250 cm. in air, representing a frequency of 130, we find that a wall one metre thick would transmit 86 per cent. of the incident sound at normal incidence, and this would be increased to 98·5 per cent. if the thickness be reduced to 10 cm. Apart from absorption, it is to be expected that stone walls are fairly transparent to sound falling normally upon them. But, as has been said at the beginning, sound incident at angles slightly inclined to the normal is totally reflected.

Some interest attaches to the cognate problem of avoiding the transmission of sound from one room to another. I am not referring to the construction of sound-proof spaces of comparatively small dimensions, such as telephone boxes, where the use of absorbing materials is permissible. But we are all familiar with rooms, more especially in hotels, where everything that is said in one room can be overheard next door. This is generally ascribed to the thinness of the walls. Apart from absorption, which is not likely to be very appreciable in a homogeneous material, no large diminution of the intensity of the transmitted sound should be expected from a moderate increase in the thickness of the walls. The above example shows what may be expected from theory. When we deal with bricks and mortar, or lath and plaster, the want of homogeneity may cause a considerable amount of scattering, and this would help in making the increased thickness more effective.

Unless my information as to our present knowledge is insufficient, it would appear that experimental investigation of the acoustical properties of materials, with regard to absorption, scattering, and the rate of transmission, are much needed at the present time. Such investigations may also have a theoretical interest, as they would include experiments on sheets, the thickness of which bears a much smaller ratio to the wave-length than we are accustomed to deal with in optics. ARTHUR SCHUSTER.

Some Spectrum Lines of Neutral Helium derived theoretically.

IT is well known that, owing to the prohibitive nature of the general problem of three (or more) bodies, Bohr's quantum theory has proved so far to be unable to account for any spectrum lines but those forming a series of the simple Balmerian type, *i.e.*

$$\nu=\kappa^2N\left(\frac{1}{n^2}-\frac{1}{m^2}\right),$$

where N is the familiar Rydberg constant given by $2\pi^2me^4/ch^3$, and κ the number of unit charges contained in the nucleus, or the atomic number. Apart from X-ray spectra of the higher atoms, for which κ is replaced empirically by a smaller and not necessarily a whole number (Moseley, Sommerfeld), and where the requirements of precision are not high, this simple type of formula covers, as a matter of fact, only the spectra of atomic hydrogen ($\kappa=1$) and of ionised helium ($\kappa=2$), which, having been deprived of one of its electrons, presents again the same problem of two bodies as the hydrogen atom. Accordingly, the known spectrum series of He^+, the ultraviolet Lyman series, the principal or Fowler's series, and the Pickering series, are all of the simple Balmer type, with $n=2$, 3, 4 respectively.

The neutral helium atom, however, with its two electrons, emits an entirely different spectrum consisting in all of more than a hundred lines (Prof. Fowler's latest report contains, pp. 93-94, a list of 105 lines), some apparently "stray" lines, others arrayed empirically into series strongly deviating from the Balmer type, but all alike baffling modern theoretical spectroscopists. In fact, not a single one of these one hundred or so observed lines has, to my knowledge, been accounted for theoretically, the mere desire of attempting this being paralysed by the insuperable difficulty of the three-bodies problem. This is particularly so in the case of lithium ($\kappa=3$) and the higher atoms.

Now, it has occurred to me that, in the absence of a general solution (in finite form, of course), it may be worth while to try some special solution of that classical problem.

At first a sub-case of Lagrange's famous solution of 1772 suggested itself, namely, the collinear type of motions, in which the three bodies, in our case

the nucleus and the two electrons, are always collinear with each other, the latter describing two equal and oppositely situated ellipses around the former. But the corresponding spectrum formula, which is again of the simple Balmer type, namely, $\nu = \frac{49N}{8}\left(\frac{1}{n^2} - \frac{1}{m^2}\right)$, proved to be entirely useless, as (to judge from one's numerous trials extended up to $n=8$) it does not cover, even within 1·5Å, a single observed line of He. This tends to show that such extremely special (collinear) states of motion, or at least passages between them, do not occur within the He-atoms, or if they do, then only so sporadically as to give no light of observable intensity.

What next suggested itself was the apparently trivial class of motions in which *the mutual perturbation of the two electrons is negligible*. Though approximate only, this class of solutions, being much broader than that of the collinear motions, would seem more likely to cover some actual spectrum lines. In fact, the very first trials gave encouraging results, as will be shown presently.

The energy of the system being for such states of motion equal to the sum of the energies due to the nucleus and each of the electrons taken separately, the corresponding spectrum formula for neutral helium is, obviously,

$$\nu = 4N\left(\frac{1}{n_1^2} + \frac{1}{n_2^2} - \frac{1}{m_1^2} - \frac{1}{m_2^2}\right),$$

or $\nu = \nu_1 + \nu_2$, where ν_1 and ν_2 are any two frequencies belonging to ionised helium, and thus represents a "combination principle" of a new kind. The resulting line of He, due to the passage of the two electrons from stationary orbits determined by m_1, m_2 to a pair of orbits determined by n_1, n_2, may conveniently be denoted by $\left(\frac{m_1 \cdot m_2}{n_1 \cdot n_2}\right)$.

This simple spectrum formula, the sum of two Balmerian ones, has yielded so far ten or eleven remarkably well-fitting lines, of which it will be enough to quote here a few.

Thus, to start with lines of the type $\left(\frac{m_1 \cdot m_2}{4 \cdot 4}\right)$, *i.e.* derivable from the Pickering series $\left(\frac{m}{4}\right)$ of He^+, we have the frequencies (ν_1, ν_2)

$$\left(\frac{5}{4}\right) \ldots 9875{\cdot}1,$$

$$\left(\frac{14}{4}\right) \ldots 25191{\cdot}8,$$

the sum of which gives for the frequency of the theoretical line $\left(\frac{5 \cdot 14}{4 \cdot 4}\right)$

$$\nu = 35067.$$

This agrees very closely with the nearest observed line at λ (air) 2851 or $\nu = 35065$, which is tabulated among the combination lines of neutral helium (Fowler, p. 94). Similarly the members $\left(\frac{5}{4}\right)$ and $\left(\frac{20}{4}\right)$ of the Pickering series of He^+ give $\left(\frac{5 \cdot 20}{4 \cdot 4}\right)$ with the frequency

$$\nu = 9875{\cdot}1 + 26333{\cdot}6 = 36209,$$

which is in striking coincidence with the observed He-line at $\lambda = 2761$ or $\nu = 36208$.

In these examples both ν_1 and ν_2 are frequencies actually observed in He^+. But not less interesting are lines of the type $\left(\frac{m_1 \cdot m_2}{4 \cdot 5}\right)$, *i.e.* combinations of Pickering lines with those of a purely theoretical He^+ series $\nu = 4N\left(\frac{1}{5^2} - \frac{1}{m^2}\right)$, and yet covering some observed lines of neutral helium very closely. Thus, we have (with $N = 109723$) :—

$$\left(\frac{6 \cdot 9}{4 \cdot 5}\right),\ \nu = 27377,\ \lambda = 3651{\cdot}8,$$

$$\left(\frac{6 \cdot 17}{4 \cdot 5}\right),\ \nu = 31276,\ \lambda = 3196{\cdot}4,$$

$$\left(\frac{6 \cdot 19}{4 \cdot 5}\right),\ \nu = 31579,\ \lambda = 3165{\cdot}7,$$

the nearest observed lines of neutral helium being λ3652·0, 3196·7, and 3166 respectively.

Finally, an example in which both of the combined frequencies are purely theoretical is

$$\left(\frac{6 \cdot 28}{5 \cdot 5}\right),\ \nu = 22360,\ \lambda = 4471{\cdot}00,$$

with the nearest observed He-line at $\lambda = 4471{\cdot}48$, tabulated (*l.c.*, p. 93) among the diffuse doublets.

Other examples of well-fitting lines and some further details are being given in a paper on this subject to appear in the September issue of the *Astrophysical Journal*.

Similarly one could try to cover some Li-lines by three pairs of terms, *i.e.* by $\nu = 9N\left(\frac{1}{n_1^2} + \frac{1}{n_2^2} + \frac{1}{n_3^2} - \frac{1}{m_1^2} - \frac{1}{m_2^2} - \frac{1}{m_3^2}\right)$, and some spectrum lines of the higher atoms by four and more pairs of terms. But since, with increasing number of independent term-pairs, even a thorough agreement would appear more and more likely as the work of chance, it does not seem worth while to push the procedure much beyond lithium. For the latter element I have thus far found (with $N = 109730$) eight well-fitting lines, of which the most interesting lines are $\left(\frac{5 \cdot 14 \cdot 18}{4 \cdot 13 \cdot 17}\right)$, $\nu = 23394{\cdot}4$ and $\left(\frac{5 \cdot 12 \cdot 21}{4 \cdot 10 \cdot 18}\right)$, $\nu = 26046{\cdot}6$, which are remarkably close to the lithium lines observed at $\nu = 23394{\cdot}7$ and 26046·9. But by far more interesting seem, for the present at least, the coincidences obtained for neutral helium. These would seem to justify the conclusion that there is a good deal of independence between its electrons.

LUDWIK SILBERSTEIN.

July 18.

In my letter of July 18 I considered the formula :

$$\nu = 4N\left[\frac{1}{n_1^2} + \frac{1}{n_2^2} - \frac{1}{m_1^2} - \frac{1}{m_2^2}\right],$$

constructed as if the two electrons did not influence each other at all, and I mentioned that this spectrum formula had yielded ten or eleven well-fitting lines, of which six were actually quoted, the remaining lines being given in the full paper appearing in the *Astrophysical Journal*.

I now write to say that, to my own surprise, the same formula has since covered more than thirty further lines of neutral helium, and that when the whole ground is swept (by means of an auxiliary arithmetical table), almost the whole observed spectrum of helium is likely to be thus represented. While a complete list will be found in the paper referred to, some of these further lines may be quoted here so as to give an idea of the closeness of the agreement. Using the short symbol $\left(\frac{m_1 \cdot m_2}{n_1 \cdot n_2}\right)$ as already explained, we have, to five figures :—

Line.	$\nu_{calc.}$	$\nu_{obs.}$	Line.	$\nu_{calc.}$	$\nu_{obs.}$
$\left(\frac{9\cdot24}{6\cdot7}\right)$	14968	14970	$\left(\frac{22\cdot24}{5\cdot7}\right)$	24843·9	24843·96
$\left(\frac{9\cdot15}{6\cdot6}\right)$	17014·0	17014·3	$\left(\frac{7\cdot19}{5\cdot5}\right)$	24939	24935
$\left(\frac{6\cdot10}{4\cdot7}\right)$	19807	19805	$\left(\frac{7\cdot21}{5\cdot5}\right)$	25159	25157
$\left(\frac{14\cdot14}{5\cdot8}\right)$	19935	19932	$\left(\frac{11\cdot22}{5\cdot6}\right)$	25213	25215
$\left(\frac{7\cdot11}{5\cdot5}\right)$	22527	22529	$\left(\frac{9\cdot18}{4\cdot8}\right)$	25822	25820
$\left(\frac{7\cdot18}{4\cdot8}\right)$	23977	23980	$\left(\frac{15\cdot15}{5\cdot6}\right)$	25846	25849
$\left(\frac{10\cdot20}{5\cdot6}\right)$	24261	24260	$\left(\frac{13\cdot20}{5\cdot6}\right)$	26053	26047

The ν-region beyond 26047 has thus far not been swept systematically. When this is done, I have but little doubt that ninety or more of the one hundred and five lines of helium will be accounted for. In these circumstances one would feel justified in asserting that the absence of mutual repulsion between the electrons is not (as I first thought) an exception but rather the rule. A simple estimate will show that if the usual Coulomb repulsion law were valid in any of the considered stationary states, the mutual energy of the electrons would contribute several thousand units to ν. Since it is hard to explain away so many coincidences as due to chance, we are driven to the belief that the electrons within the atom do not repel each other even with a small fraction of the force usually attributed to them. In other words, the field of force of a bound electron seems to be entirely engaged by the nucleus, at least in the case of helium and probably of lithium, but possibly also in that of the higher atoms. LUDWIK SILBERSTEIN.

129 Seneca Parkway, Rochester, New York,
July 26.

The Primitive Crust of the Earth.

IN reference to the letter of Dr. Harold Jeffreys (NATURE, July 29, 1922), I wish at once to say that nothing in my letter published on July 8 was intended to express my adhesion or non-adhesion to those who support the planetesimal hypothesis. Even if we think that the earth originated in a rain and concentration of solid planetesimals, we may, with Prof. R. A. Daly, regard its complete fusion at a later stage as a very probable event. At some time or other, the earth may well have possessed a crust consolidated from "igneous" fusion. Prof. J. Joly now suggests to us, with his unfailing brilliance of outlook, the recurrence of such a crust after successive meltings of the globe. What I have urged, however, is that the oldest rocks traceable by geologists must not be regarded as a record of a primitive crust. They are sediments, invaded again and again by igneous matter from below. We cannot conclude from our Archæan schists, which are so often converted into composite gneiss, that there was ever a crust formed of crystalline rocks about the globe. The "extent of the crust accessible to geologists" is, of course, much more than the film 2·5 km. thick stated by Dr. Harold Jeffreys. Owing to the great movements that bring up antique masses from the depths, rocks that consolidated finally under several miles of sediments now form a large part of the surface. But so far no planetesimal sediment has come to light, although matter of the mineral composition demanded by the hypothesis is associated with many igneous upwellings.

In support of the concluding remarks of Dr. Harold Jeffreys, attention may be directed to "A Critical Review of Chambertin's Groundwork for the Study of Megadiastrophism," by W. F. Jones, published in the *American Journal of Science* for June of the present year. GRENVILLE A. J. COLE.

Carrickmines, Co. Dublin, July 29, 1922.

Peculiarities of the Electric Discharge in Oxygen.

SEVERAL years ago I described (*Phil. Mag.*, April 1908) a discontinuity in the electric discharge in oxygen at pressures near to 0·8 mm. Namely, when a current (0·0025 amp.) was passed in a discharge tube (diam. 2·4 cm.), the electric force in the positive column suddenly changed on slightly lowering the pressure from about 11 volts per cm. to about 20, an effect which could be reversed by raising the pressure.

Some experiments which I have made recently, with the assistance of Mr. E. P. Cardew, have shown that at pressures in the same neighbourhood, with a fixed circuit (battery and resistance), the discharge is not uniquely determined, but can be one or the other of two distinct types, distinguished by a remarkable difference in the values of the electric force within the positive column, one of these values being about twice the other. The magnitude of the current with the higher electric force in its positive column is less than the other, since the potential difference of the electrodes is greater in its case; but the currents tend to equality when the electrodes are so near that the positive column tends to disappear. The two discharges differ only slightly in appearance: the positive column of the smaller one with the higher electric force being somewhat shorter and a trifle paler than the other—both being without striæ in general.

To give an example. With a battery of 990 volts and external resistance 363,000 ohms, electrodes 21·8 cm. apart in a tube of 27 mm. diameter, and pressure 0·75 mm., the currents observed were 1·19 and 0·883 milliamperes; their positive columns were nearly 15 and 14 cm. long, and the electric force within them about 9 and 18·5 volts per cm. respectively. In this and in many other cases, by means of a certain arrangement, the discharge could be made to change from one form to the other without stopping the current or altering the circuit.

The region of pressures within which alternative currents have been so far observed are from 0·64 to 0·91 mm. The two types of discharge differ in stability according to the pressure and the magnitude of the currents, so that the discharge tends to assume one type rather than the other. But the one having the high electric force in the positive column is much more definite and invariable than the other for a given pressure, being in this respect similar to discharges in other gases, so that that electric force can be determined with much more precision, and is in fact nearly the same as in hydrogen.

Since these effects hold good for a large range of current, it is obviously possible, by adjusting the external circuit, to make two discharges of the same arbitrary magnitude (of the necessary order) pass through oxygen, between electrodes at a given distance apart, at any given pressure within the range in question, one of which will have the high electric force in its positive column and the other the low. P. J. KIRKBY.

Saham Toney Rectory, Watton, Norfolk,
July 26.

Defoliation of Oaks.

A REFERENCE to the defoliation of oaks, particularly on the borders of Surrey and Hampshire, by the larvæ of *Tortrix viridana*, was made in NATURE on June 10. It concludes with the remark that the effect of the defoliation is to check "the growth of the trees to some extent for the time being, but is rarely more serious."

At Haslemere, in the south-west corner of Surrey, infestation by the Tortrix larvæ was sufficiently marked fifteen years ago to be the subject of comment, and it has continued ever since. In some years the attacks were very severe. For a long time infested trees did not appear to suffer any serious harm. In recent years, however, the American White Mildew, *Oidium alphitoides*—which in the early years of its appearance in this country infested the leaves of pollard and sapling oaks only—has invaded the new leaves which the trees put forth after defoliation by the caterpillars. The effect of the combined attack is already becoming very serious. In the tract of country lying between the towns of Haslemere, Petersfield, Midhurst, Petworth, Horsham, and Godalming, many oaks have been killed outright, and large numbers are slowly dying. It seems very desirable that these dead and dying trees be removed and destroyed, or they may become centres for the spread of beetles destructive to timber.

E. W. SWANTON.

Educational Museum, Haslemere,
August 1.

Scorpions and their Venom.

PHYSALIA in "Animaux Venimeux," p. 252, says that in all venomous animals their immunity to their own venom is limited, and announces that in an experiment a scorpion, *Bulteus australis*, was killed by an injection of the same venom as its own. I should like to add further observations from personal experience, bearing on this very interesting subject.

Until very recently, by many, and even now by some, the accepted opinion of men of science was that each venomous animal carried its own antidote, *i.e.* was immune to the effects of its own venom.

So long ago as 1900, when for some weeks during the Boer War I was stationed with my company in the Blue River mountains opposite the Metrosberg Peak in Cape Colony, I witnessed numerous fights between the different species of scorpions. In more than a hundred fights between two scorpions, each of the same species, whether black, red or yellow, the result was always the same, the one that was stung by its opponent dying almost immediately, 10 seconds being the longest interval between receiving the sting and death.

The result when *different* species were pitted against each other was the same, but that was to be expected.

C. E. F. MOUAT-BIGGS.

Hampden Club, Hampden Street, N.W.1,
July 7, 1922.

Bloomsbury.

IT is to be regretted that in his interesting article on Bloomsbury and the University of London, Mr. Humberstone repeats the erroneous statement that Bloomsbury was originally Lomesbury. That statement was made by John Stow, London's first historian, but one can only suppose that he was misled by the mistake of some early copyist. The earliest form of the name known to me is Blemidesberie. I am writing away from references, but that form is at least as old as the fourteenth century. Like other place-names ending in *-sbury* it must be derived from the personal name of its owner, possibly Blemund.

The further statement that the Royal Mews, at Bloomsbury, were burnt down in 1537, is also not quite accurate. The royal stables were burnt then, but the Mews (*i.e.* falconry) were situate at Charing Cross, on the site of the present Trafalgar Square, at least as early as 1443 (the earliest reference verifiable at the moment). It was the transference of the royal stables to Charing Cross that led to the change in the meaning of the word "mews" to that which it still bears.

A. MORLEY DAVIES.

Amersham, July 29.

I REGRET that my article should have contained the errors to which Dr. Morley Davies draws attention. Stow wrote: "But in the yeare of Christ 1534. the 26. of H. the 8. the king hauing faire stabling at Lomsbery (a Manor in the farthest west part of Oldborne) the same was fiered and burnt, with many great horses, and great store of Hay. After which time, the forenamed house called the Mewse by Charing Cross was new builded, and prepared for the stabling of the kings horses. . . ." H. B. Wheatley in "London Past and Present" states that Bloomsbury is a corruption of Blemundsbury, the manor of the De Blemontes, Blemunds, or Blemmots. Blemund's Dyche, which was afterwards Bloomsbury Great Ditch, and Southampton Sewer divided the two manors of St. Giles and Bloomsbury. He adds: "There is an absurd statement, taken from Stow's Survey, that the name of Bloomsbury was originally Lomsbery. This could only have occurred by a misprint, in which the B was inadvertently dropped."

T. LL. HUMBERSTONE.

Absorption of Potassium Vapour in the Associated Series.

IN our investigations on the optical properties of potassium vapour we found that there were some traces of absorption in the above series at about 1100° C., the results of which were embodied in a note to appear shortly in the *Phil. Mag.* As a result of further experiments conducted in the Physical Laboratory of this college, we now feel fairly sure that we have detected distinct traces of absorption in the diffuse series; the bands 5780, 5340, 5300, and 5100 surely correspond to 5782, 5340, 5323, and 5100 of (*2p–m.d*).

The well-defined dark line 4640 previously observed by us at about 900° C. is confirmed to be the combination line (*1s–2d*) recently observed by Datta in the vacuum arc spectrum of potassium (Proc. Roy. Soc., 99, April 1921) and by J. K. Robertson on "Electrodeless Discharge in certain Vapours" (*Physical Review*, May 1922).

At these high temperatures the chemical difficulties are so great, and the conditions in the experimental tube so unstable, that, in spite of many attempts, we found it difficult to obtain a good negative, on account of the tube giving way owing to the chemical action of potassium vapour on its walls. Further experiments are in progress, and we hope to confirm these observations by photography, as these experiments lend weight to Saha's theory of temperature radiation.

A. L. NARAYANA.
D. GUNNAIYA.

Maharajah's College, Vizianagram, July 10.

A Recording and Integrating Gas Calorimeter.

By Dr. J. S. G. THOMAS, Senior Physicist, South Metropolitan Gas Company.

UNDERTAKINGS operating under the provisions of the Gas Regulation Act 1920, are required to deliver gas of a declared calorific value to consumers, and charges to individual consumers are to be based upon the value of the total thermal energy supplied to each. By calorific value is to be understood the number of B.Th.U. produced by the combustion of 1 cubic foot of gas measured at 60° F. under a pressure of 30 inches of mercury and saturated with water vapour. Under the Act, penalties are to be inflicted upon the gas undertaking, if on any day for a period of two hours or more the calorific value of the gas supplied is more than 6 per cent. below the declared calorific value, or if in any quarter the average calorific value is less than the declared calorific value. Embodied in Orders under the Act are clauses governing the price per therm (100,000 B.Th.U.) to be charged by individual gas undertakings, and the amount of dividend to be paid to proprietors, as regulated by this price. Such, in brief, are the main thermal clauses of the Gas Regulation Act 1920—the Charter of Liberty of the gas industry in this country, and the consumers' guarantee that gas undertakings must and will "deliver the goods."

Accurate gas calorimetry has long been of importance for scientific purposes; *extremely* accurate gas calorimetry is now of consequence industrially and socially. The accuracy of determination desirable will be realised when it is understood that, in terms of money, an error of 1 per cent. in respect of the thermal value of the annual gas supply of England, Scotland, and Wales represents about 500,000*l*.

Prof. C. V. Boys, at the annual meeting of the Institution of Gas Engineers on June 22, exhibited and described a recording and integrating calorimeter (Fig. 1) which he has designed and constructed primarily to meet the requirements of the Act in the matter of continuously recording the calorific value of towns' gas. The instrument is, however, immediately applicable to the determination and recording of the calorific value and percentage variation with time of the calorific value of *any* gas. It is of the water-flow type, the same water being circulated continuously through the apparatus and cooled to atmospheric temperature, by the hot-air engine and cooling coil seen at the bottom left-hand side of the figure. This is an important consideration in continuous calorimetry, as with another form of recording gas calorimeter at present available the cost of water amounts to about 20*l*. per annum. The fundamental features of the instrument are: water and gas are doled out positively at the correct respective rates, and the correction for gas volume as affected by temperature, pressure, and humidity are likewise effected by a positive operation.

Water Measurement and General.—Water flows from a tank, seen in the top right-hand corner of Fig. 1, where the level is maintained constant, through a nozzle into a celluloid bucket pivotted eccentrically and so proportioned that it overbalances and empties into the celluloid water-box shown in Fig. 1. After emptying and draining, the bucket is released by a clock every half-minute, and the operation is repeated. The quantity of water delivered to the bucket can be adjusted by a stop, so that if the gas is of the declared calorific value, the rise of temperature of the water flowing in the calorimeter is exactly 10° C. On the record sheet, therefore, corresponding percentage

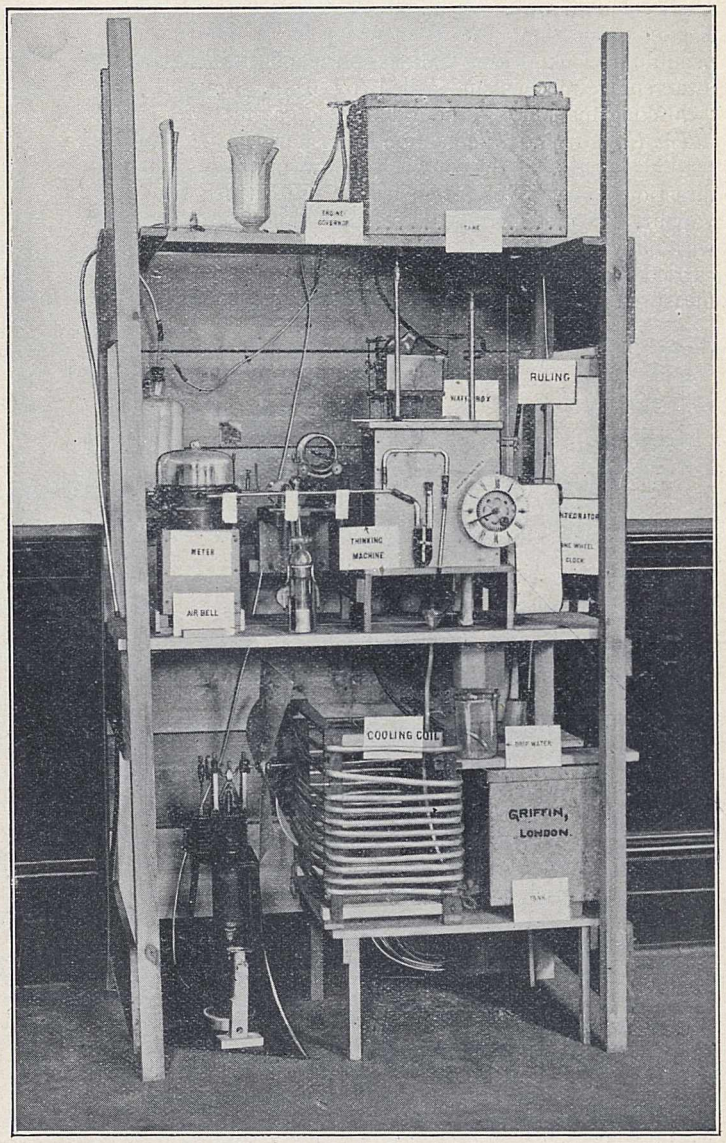

FIG. 1.

departures from the declared calorific value are strictly comparable, being represented by equal displacements of the recording point, whatever the declared calorific value.

The water doled out passes through a small hole into a second compartment of the water-box, and thence to the calorimeter proper. When the bucket is overturned, the jet of water misses the bucket and enters a third compartment of the water-box, whence it passes to a fourth compartment, to be delivered to a small celluloid water-wheel, which drives, through an elastic connection, the escapement of a one-wheel pendulum clock ticking half-seconds, and through an intervening mechanism—called by Prof. Boys the "thinking machine"—the axle of the gas meter.

The Gas Meter.—The gas meter is shown in vertical section in Fig. 2, the smallest arrow indicating the direction of entry of gas previously saturated with water vapour. The meter drum is of celluloid, and is provided with buoyancy chambers A, so that the drum is largely carried by the water and not by the axle. The gas measured in any compartment is therefore contained

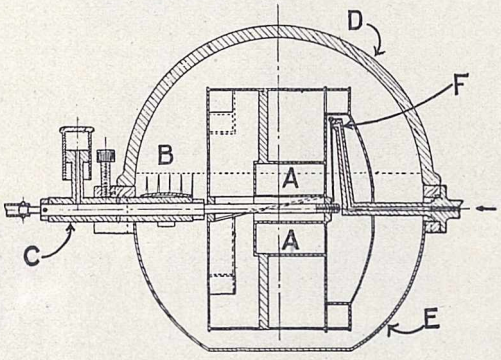

FIG. 2.

in a chamber of which the sides, ends, roof, and about two-thirds of the floor are independent of the water-level, which can be adjusted to $\frac{1}{10000}$th inch by reference to the upturned points, B. Changes of water-level, even if they should occur, would clearly have little effect on the capacity of the meter. The meter drum rests loosely on the axle, which is screwed, so that if meter and axle turn at the same rate there is no endlong movement of the drum. The axle works in a long sleeve, C, screwed into a brass ring, and vaseline is forced in to make axle and sleeve water-tight. No stuffing boxes are employed, and the inlet and outlet aprons of the usual wet-meter drum are replaced by discs closing the front and back of the usual four compartments. The meter is enclosed gas-tight within a glass bell D above, and a spun copper bowl, E, below. The pressure in the meter is about $\frac{1}{8}$ inch of water in excess of atmospheric, such excess being due to the inclusion in the gas circuit of a pin-hole burner to prevent the calorimeter burner being extinguished by the sudden slamming to of a door, etc.

The "Thinking Machine."—This device, already referred to, is shown in plan in Fig. 3A. It consists of a small ball-disc-cylinder integrator, a vertical section of which is shown in Fig. 3B, coupled with epicyclic double reduction gear, as shown at A in Fig. 3A, inserted between the clock and the meter axle so as to control the rate of revolution of the meter drum. The epicyclic device gears down the motion of the disc of the integrator in the ratio 3 : 2, the disc itself being geared down from the water-wheel in the ratio 4 : 1. The motion of the cylinder of the integrator is geared down in the ratio 15 : 1.

Temperature and pressure corrections to the gas volume are automatically and positively effected in the following way. It is clear that if the ball, B (Fig. 3B), makes contact with the rotating disc, C,

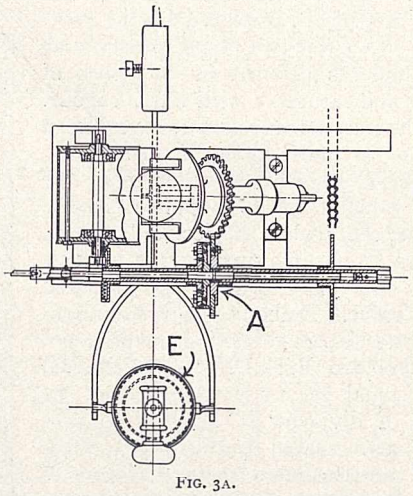

FIG. 3A.

exactly at the centre of the disc, no rotary motion will be communicated by the disc to the ball and consequently none to the cylinder D. Such a position of the ball corresponds to normal conditions of temperature (60° F.) and pressure (30 ins. of mercury) of the gas, and may be conveniently referred to as its N.T.P. position. The radial displacement of the ball from the centre of the disc is made to depend upon atmospheric temperature and pressure as follows: E (Fig. 3A) shows in plan a glass bell filled with air floating

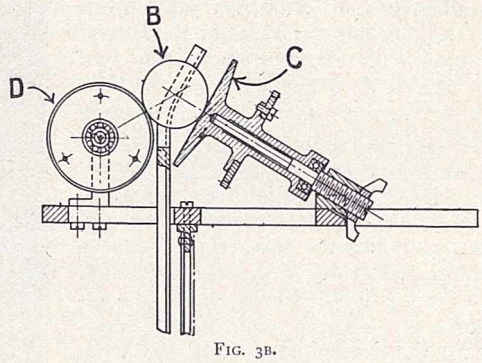

FIG. 3B.

in a mercury and water seal, and connected by a lever system with a fork which displaces the ball to one side or other of the centre of the disc, according as the bell rises or falls with change of atmospheric conditions. The lever system is such that the ball moves 1 inch, equal to the radius of the cylinder, when the gas volume correction is 10 per cent. Such displacement of the ball is accompanied by its rotation, producing rotation of the cylinder, D, whereby endlong motion is communicated to the meter drum, resulting in the gas inlet to the meter, F, Fig. 2, being further closed or opened as required, so that the rate of gas delivery

reduced to standard conditions is maintained constant to within $\frac{1}{10}$ per cent. The corrections effected over a period of a month are automatically recorded on a drum revolving above the device. The method of mounting the meter drum loose on a screwed axle also prevents the occurrence of accidents should the gas supply be temporarily cut off and resumed later, or should the water flow cease. The possible interference of a mouse with the righting of the bucket after emptying is also ingeniously provided for.

The Calorimeter Proper.—This is shown in vertical section in Fig. 4. A and B are the hot and cold water chambers respectively; C is the heat interchanger, in which the heat of the products of combustion derived from gas burning at the fused-silica burner, D, is communicated to the stream of water. A silica dome is disposed above the flame. The interchanger is made of sheet-lead closely folded into fifteen zig-zags round the central combustion space. Narrow up-cast water-ways are then formed on one side of the sheet, and down-cast gas-ways on the other side. The heated water passes to B through the narrow neck in the double partition, E, a device introduced by Prof. Boys to prevent the calorimeter indicating more heat than is produced by the gas. The copper cylinder, F, fixed to the brass ring, G, is so proportioned, that loss of heat from the upper part of the hot-water compartment is compensated by the equal gain from the cylinder lower down by the heat interchanger.

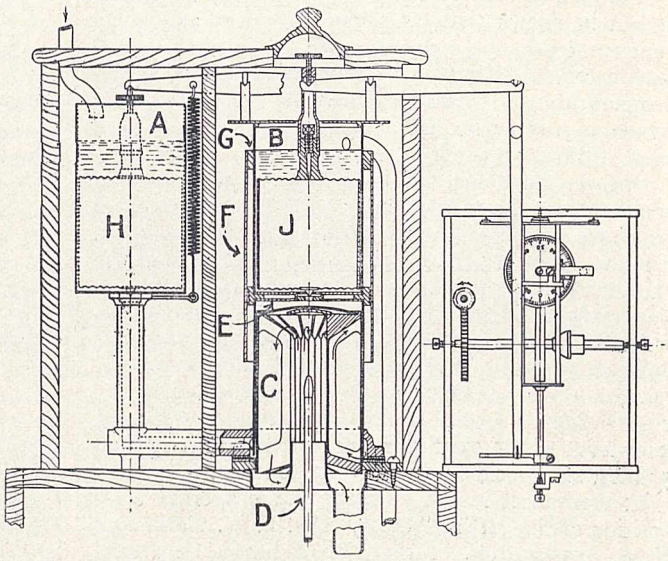

FIG. 4.

The operative thermometers, H and J, are of brass, and are filled with amyl alcohol. They are closed with corrugated brass covers. A lever system utilising the third dimension of space, magnifies the deformation of the respective covers occurring with change of temperature, and the net difference of temperature of the two thermometers, due to heating, controls the position of an inked pen recording on a roll of paper, seen on the right of Fig. 1, kept in motion by the clock. On the paper parallel lines are ruled during the rotation, indicating definite percentage departures of the actual measured calorific value of the gas from the declared calorific value. Time indications are in like manner impressed upon the record. An integrating device shown on the right of Fig. 4, operating after the manner of the Amsler planimeter and controlled by the position of the recording pen, averages the departures of the calorific value of the gas from the declared calorific value since the indicator was last set to zero, *i.e.*, since the beginning of the quarter, so that, for example, the integrator indicating +5 would signify a 5-day 1 per cent. excess of calorific value, or a 1-day 5 per cent. excess, etc.

The writer is extremely obliged to Prof. Boys for the kind manner in which he has afforded information concerning the instrument, and to Messrs. Griffin and Sons for providing the illustrations reproduced in this article.

The Earth's "Crust" and its Composition.

By THOMAS CROOK.

THE term "crust" is frequently used in dealing with the constitution of the earth, but is seldom defined. It is a convenient scientific term to apply to the earth's outermost shell, the only portion of which geologists have much positive knowledge, and if it is put to scientific use, it should be defined, although a definition of it may involve some hypothesis as to the physical condition of the earth's interior.

According to Arrhenius, who assumes that the temperature-gradient observed in continental areas is persistent in depth, the temperature of the earth's interior greatly exceeds that of the critical temperature of the materials occurring there. He infers therefore that the interior is for the most part gaseous though rigid, and that this gaseous core is separated by a molten layer from an outer solid shell about 40 miles thick. Osmond Fisher assumed a molten condition at a depth of 25 miles. To those who accept this view, the term "crust" has a very real and simple significance: it is the thin, solid, outer shell of the earth, underlain by molten magma.

At the present time, however, this hypothesis appears not to be widely held among geophysicists, most of whom follow Lord Kelvin, Sir George Darwin, and other eminent authorities who have shown good reasons for rejecting the hypothesis of a molten interior at such depths as postulated by Fisher and Arrhenius, and who claim that the earth is solid throughout. For those who adopt this view the definition of the earth's "crust" is a more difficult matter.

The prevalent view at the present day as regards the constitution of the earth's interior is that it consists of an inner core of nickel-iron about 6200 miles in

diameter, surrounding which is a silicate shell some 900 miles in thickness. The silicate shell is largely ultra-basic and basic. Lying on the thick shell of basaltic rock, which girdles the whole earth, is a comparatively thin and discontinuous layer of more siliceous rock-matter (granite and gneiss), on which the sedimentary rocks have been formed in and around the continental areas. According to the conception of a solid earth so constituted, we clearly have no satisfactory basis for defining the earth's "crust" in terms of the kind of rock of which it is made up, and unless it can be shown that, at some convenient and fairly uniform depth, the rock-substance of the earth undergoes a critical change in its physical condition at the temperature and pressure prevailing there, the only available alternative is to define the "crust" in a more arbitrary manner in terms of depth.

One way of doing this is to limit its thickness, as some authors do, to that outer portion of the earth of which we may be said to have observational knowledge. The maximum depth at which rocks observable at the surface of the earth have been formed is quite an important geological problem from the economic as well as from the scientific viewpoint, and one that appears never to have been treated adequately. It may, however, perhaps safely be inferred that, by observation of surface geological features, we have a knowledge of the earth down to a depth of more than 5 miles, but considerably less than 10 miles.

In their most recent estimate of the average composition of the earth's "crust," Drs. F. W. Clarke and H. S. Washington, of the United States Geological Survey, give its average composition down to depths of 10 and 20 miles. The detailed statement of their results has not yet been published, but is to be issued as a Professional Paper by the U.S. Geological Survey. Pending the publication of the detailed report, however, they have given a brief account of their results in the Proceedings of the National Academy of Science (1922, vol. 8, p. 108).

The method adopted by them for ascertaining the average composition of the lithosphere is to take the average of trustworthy analyses of igneous rock specimens collected from various parts of the earth's surface. They have included 5159 analyses. Averages are given separately for the igneous rocks of the United States; North America other than the United States, including Greenland; Central and South America; Europe; Africa and Asia; Australasia, Polynesia and Antarctica. In computing the averages for these various regions the sum total of each constituent was divided by the total number of analyses of specimens from the region dealt with. In calculating the composition of the earth's "crust" as a whole, the proportions of the lithosphere, hydrosphere and atmosphere for a depth of ten miles were taken as follows:—lithosphere 93 per cent., hydrosphere 7 per cent., and atmosphere 0·03 per cent. The lithosphere is assumed to be made up as follows:—igneous rocks, 95 per cent.; shale, 4 per cent.; sandstone, 0·75 per cent.; and limestone, 0·25 per cent. Figures are given for the rarer as well as for the commoner elements.

The following is the result obtained for the average chemical composition of the igneous rocks of the earth:—

Average Igneous Rock.

	Per cent.		Per cent.
SiO_2	59·12	F	0·030
Al_2O_3	15·34	S	0·052
Fe_2O_3	3·08	$(Ce,Y)_2O_3$	0·020
FeO	3·80	Cr_2O_3	0·055
MgO	3·49	V_2O_3	0·026
CaO	5·08	MnO	0·124
Na_2O	3·84	NiO	0·025
K_2O	3·13	BaO	0·055
H_2O+	1·15	SrO	0·022
CO_2	0·101	Li_2O	0·008
TiO_2	1·050	Cu	0·010
ZrO_2	0·039	Zn	0·004
P_2O_5	0·299	Pb	0·002
Cl	0·048		100·000

The following table shows the estimated percentages of the commoner elements in the lithosphere, hydrosphere and atmosphere:—

Elements in the Lithosphere, Hydrosphere, and Atmosphere.

	1	2	3	4
Oxygen	49·19	47·80	46·68	46·41
Silicon	25·71	26·65	27·60	27·58
Aluminium	7·50	7·79	8·05	8·08
Iron	4·68	4·88	5·03	5·08
Calcium	3·37	3·49	3·63	3·61
Sodium	2·61	2·72	2·72	2·83
Potassium	2·38	2·48	2·56	2·58
Magnesium	1·94	2·01	2·07	2·09
Hydrogen	0·872	0·497	0·145	0·129
Titanium	0·648	0·684	0·696	0·720
Chlorine	0·228	0·162	0·095	0·096
Phosphorus	0·142	0·150	0·152	0·157
Carbon	0·139	0·095	0·149	0·051
Manganese	0·108	0·116	0·116	0·124
Sulphur	0·093	0·086	0·100	0·080
Barium	0·075	0·078	0·079	0·081
Chromium	0·062	0·065	0·066	0·068
Zirconium	0·048	0·050	0·052	0·052
Vanadium	0·038	0·040	0·041	0·041
Strontium	0·032	0·034	0·034	0·034
Fluorine	0·030	0·030	0·030	0·030
Nickel	0·030	0·031	0·031	0·031
Nitrogen	0·030	0·016	..	..
Cerium, Yttrium	0·019	0·020	0·020	0·020
Copper	0·010	0·010	0·010	0·010
Lithium	0·005	0·005	0·005	0·005
Zinc	0·004	0·004	0·004	0·004
Cobalt	0·003	0·003	0·003	0·003
Lead	0·002	0·002	0·002	0·002
Boron	0·001	0·001	0·001	0·001
Glucinum	0·001	0·001	0·001	0·001
	100·000	100·000	100·000	100·000

1. Average composition. Ten-mile crust, hydrosphere, and atmosphere.
2. Average composition. Twenty-mile crust, hydrosphere, atmosphere.
3. Average composition. Ten-mile crust, igneous and sedimentary rocks.
4. Average composition. Ten-mile crust. Igneous rocks.

A serious defect in the method of procedure on which the above estimates by Clarke and Washington are based is that it makes no allowance for the relative magnitude of the different kinds of rock of which the lithosphere is composed. They admit this defect, but claim that any errors involved are likely to be compensating (*Journ. Franklin Inst.*, 1920, vol. 190, p. 770). Their claim can scarcely be allowed, however, even for the outer 10 miles of the "crust," and still less can it be allowed down to a depth of 20 miles.

As to the relative proportions of the rocks composing

the lithosphere at this depth, even at 10 miles, we have as yet no positive knowledge, but the distribution of igneous rocks at the surface of the earth, and a comparison of oceanic and continental regions, give us some important facts to guide our reasoning on this matter. We are probably not far from the truth if we assume that the granitic portion of the lithosphere is largely restricted to the continental regions of the earth, and its thickness may not exceed an average of about 5 miles. If so, assuming this granite layer in continental regions to contain on an average 70 per cent. of silica, and assuming that it is underlain to a depth of 10 miles from the surface by basalt containing on an average 48 per cent. of silica, this would give us a silica percentage of about 59 for the average igneous rock of the lithosphere in continental regions down to a depth of 10 miles, which is in agreement with the average of the igneous rock of the "crust" as estimated by Clarke and Washington.

It should be noted that this takes no account of the "crust" of the oceanic regions, which is probably in large part basaltic. We may for the purpose of this argument assume that the granite shell of continental regions covers half the earth. This is an extravagant assumption, but as it doubtless errs substantially in exaggerating the acidity of the "crust," the error is on the right side so far as the present argument is concerned. If we further assume the sub-oceanic "crust" down to a depth of 10 miles to be basaltic, and to contain on an average 48 per cent. of silica, this would give us an average igneous rock containing about 53½ per cent. of silica for the outer 10 miles of the lithosphere all round the earth.

Extending our considerations to a depth of 20 miles, there can be little doubt that we should regard the deeper 10 miles as on the whole more basic than the basaltic material of the outer 10 miles, and it is reasonable to assume that this deeper layer of basalt does not contain on the average more than 46 per cent. of silica. If we make this assumption, then the average rock of the earth's "crust" as a whole down to a depth of 20 miles would contain not more than about 50 per cent. of silica.

Comparing these with the figures given above by Clarke and Washington, the inference we draw is that they have probably much understated the basicity of the earth's "crust." Their average down to a depth of 10 miles is, as we have seen, only acceptable for continental regions, and cannot be admitted for the earth as a whole. Still less can their average for the lithosphere down to a depth of 20 miles be admitted, for, as we have seen, there is good reason for believing that the average rock down to this depth probably corresponds to a gabbro, containing about 50 per cent. of silica, rather than, as they infer, to a granodiorite containing 59 per cent. of silica.

This question of the average composition of the earth's "crust" has important bearings on many scientific and economic problems. It is quite commonly assumed that the average igneous rock is intermediate in composition, and that granitic and basaltic eruptives are products of differentiation derived from intermediate magmas. It seems highly probable, however, that the average igneous rock of the earth's crust is basic; and although differentiation does undoubtedly play an important part in the formation of igneous rocks, the claim that granites and basalts are in general differentiates from magmas of intermediate composition has no adequate foundation in the facts known to us concerning the petrology of the earth.

Centenary of the Death of William Herschel.

ON August 25, 1822—a hundred years ago—William Herschel died at Slough, aged eighty-three years and nine months. His scientific activity had continued almost to the end of his long life. His last published paper was read before the Royal Astronomical Society (of which he was the first President) in June 1821. It is the only one of his seventy memoirs which was not published in the Philosophical Transactions, of the yearly volumes of which for the years 1780 to 1818 inclusive only those for 1813 and 1816 contain nothing by him, while not a few volumes include several papers from his hand. Even in the last year of his life, when his son, under his continual guidance, made and figured the 18¾-inch mirror, which was afterwards used by Sir John Herschel at Slough and at the Cape, it is recorded that "the interest he took in this work and the clearness and precision of his directions showed a mind unbroken by age and still capable of turning all the resources of former experience to the best account."

When Herschel, on March 1, 1774, began to keep a record of what he saw in the heavens with telescopes made by himself, it was natural that he should for some years show no decided preference for any particular branch of astronomy. At first he paid some attention to the planets, and determined the rotation-periods of Jupiter and Mars. But it did not escape his clear perception very long that what was urgently required at that time was a systematic study of the vast number of celestial bodies outside the solar system. If Herschel had not early grasped this fact, and persevered all the rest of his life in his devotion to sidereal astronomy, he would never have become a great astronomer, but would merely, like his contemporary, Schröter, have been known as an indefatigable observer who occasionally did some good work. But on his way from the solar system out into space beyond it Herschel found a new planet (Uranus), about twice as far from the sun as what had up to then been considered the outermost planet. This was not a lucky accident, but a discovery which was bound to be made sooner or later by an observer who searched the heavens as systematically as he did. It was the first time since the prehistoric ages that a new planet was discovered. Herschel afterwards found two satellites of Uranus and two of Saturn, but his principal work was always on subjects connected with sidereal astronomy.

"A knowledge of the construction of the heavens has always been the ultimate object of my observations." This was the opening sentence of his paper of 1811, and as he had said much the same in the concluding words of his first paper (of 1784) on that subject, we see how faithful he remained to the plan of work he had adopted early in his scientific career.

Speculations on the construction of the universe had been made before Herschel's time: by Thomas Wright in 1750, by an anonymous writer in 1755 (who afterwards turned out to be Immanuel Kant, and adopted most of Wright's conclusions), by Lambert, and by Michell. None of these writers had made any observations on which to found their theories. But Herschel would build on observed facts so far as possible. He began by attempting to find the distance of the fixed stars by measuring double stars. This turned out to be impossible; but the work done was not wasted, as hundreds of double stars had been found and measured. When many of these measures were repeated some twenty years later, the great discovery was made that not a few of these pairs of stars were revolving round their common centre of gravity. The nebulæ and clusters of stars were next systematically searched for; 2500 were found and their places determined. Herschel started with the idea that all nebulæ were composed of stars, and he therefore included clusters, even rather scattered ones, in his observations, as representing with dense clusters and nebulæ the different stages of the same class of bodies. But the discovery of some indubitably nebulous stars, or stars with atmospheres, made him recognise that there must be here and there in space some kind of "shining fluid" of which diffused nebulæ and planetary nebulæ were formed. This idea found very little favour among astronomers for many years, particularly after the completion of Lord Rosse's 6-foot reflector, the maker of which was inclined to think every nebula "resolvable." Yet Herschel was found to be right when Huggins proved many nebulæ to have a gaseous spectrum.

Another discovery of Herschel's, which was doubted or denied until confirmed elsewhere, was the proper motion of the sun through space. Here there was perhaps some excuse for the doubters, as the material available for the investigation was rather scanty.

In order to get some idea of the distribution of the stars Herschel for some years took observations of the star-density in various parts of the sky by counting the stars seen in the field of his telescope. Making two assumptions—that his telescope could reach the boundaries of the Milky Way, and that the stars of the system were tolerably uniformly distributed—he was able to construct a rough diagram of the shape of the Milky Way system to which our sun belongs. This is the well-known disc or grindstone theory, according to which the stars are scattered between two planes, roughly parallel to the belt of the visible Milky Way, with a stratum running out to one side to represent the bifurcation from Cygnus to Scorpio. Near the centre of this system (also spoken of as "our nebula") Herschel placed our sun. In after years, in two papers of 1817 and 1818, Herschel, as a result of his observations, was obliged to abandon the idea of uniform distribution, and also to recognise that his telescope could not reach the boundaries of the Milky Way system. But that the system extended very much further in the plane of the Milky Way than at right angles to it, remained his opinion, though the conception of the system being a nebula—that is, a star cluster—had been given up.

Here again there was, towards the end of the nineteenth century, a tendency to abandon Herschel's results, and the opinion was set forth in more than one quarter, that the Milky Way is really what it looks like—a huge ring-shaped cluster. It has even been suggested that it is a gigantic spiral nebula inside which our sun is situated—at first sight a rather tempting proposal. But recent researches by Shapley have shown these hypotheses to be untenable; and his work on the distribution of globular clusters, showing the enormous distances of many thousands of light-years which separate them from us, agrees in a remarkable manner with the ideas worked out by the old astronomer at Slough exactly a hundred years earlier, in the last paper he sent to the Royal Society. J. L. E. D.

Obituary.

Dr. Arthur Ransome, F.R.S.

THE death of Dr. Ransome at Bournemouth in his eighty-ninth year recalls the memory of a Manchester physician who was a pioneer in the training of female health visitors, and in the investigation of tuberculosis and of the cyclical waves of epidemic diseases. He died on July 25; and by a striking coincidence, at the first meeting earlier in the same day of Section I.—that of Preventive Medicine—of the Congress of the Royal Sanitary Institute then being held in Bournemouth, a message of appreciation of Dr. Ransome's past work had been authorised, which never reached him.

Dr. Ransome was born in Manchester in 1834. He became an honorary fellow of Gonville and Caius College, Cambridge, and for many years was consulting physician of the Manchester Hospital for Consumption, as well as Professor of Hygiene and Public Health at Owen's College, 1880–95.

Dr. Ransome's chief writings related to tuberculosis, on which he published several books, as well as special contributions to the Epidemiological and other Societies. He gave the Milroy lectures to the Royal College of Physicians on the causes of phthisis, and received the Parkes Weber prize for special researches on tuberculosis. From his experiments he concluded that finely divided tuberculous matter is rapidly deprived of virulence in daylight and in free currents of air; that even in the dark, fresh air has some, though a retarded disinfecting influence, and that in the absence of currents of air the tubercle bacillus retains its infectivity for long periods of time. The general effect of his work was to emphasise the importance of disinfection of rooms occupied by tuberculous patients. At the same time Dr. Ransome attached greater importance to sanitary and social improvements in the prevention of tuberculosis than to direct attack on the bacillus.

In epidemiology Dr. Ransome was one of the first to investigate the influence of cyclical waves in producing the intermittent prevalence of epidemic diseases, apparently independent of the accumulation of unprotected persons. The Swedish tables of mortality,

of unique historical duration, furnished him, as they did other investigators, with the data for the construction of charts, which showed, for example in scarlet fever, not only a short cycle for that country of four to six years, but also a long undulation of from fifteen to twenty years or more, which, as he said, might "be likened to a vast wave of disease upon which the lesser epidemics show like ripples upon the surface of an ocean swell" (Epidemiological Society's Transactions, 1881–82).

Dr. Ransome wrote much also on general public health subjects, always with a keen appreciation of the value of vital statistics and of the pitfalls to be avoided. Thus, in any population, except that of a life-table, in which births equal deaths and migration is absent, a death-rate of 10 per 1000 does not mean an average duration of life of 100 years. As he put it: "under present conditions such figures . . . can only be looked for in the millennium, when, as Isaiah says, the child shall die an hundred years old."

Dr. Ransome taught at an early date that "preventible" mortality extended far beyond epidemic diseases; and was singularly accurate in his forecast that infant mortality, which "had not yet received full attention from the sanitary administrators of the country," would hereafter prove largely controllable.

In a paper contributed to the *Lancet*, July 11, 1896, Dr. Ransome drew a striking comparison between leprosy and tuberculosis, arguing that in view of the close analogy between the two diseases there is reason to hope for a diminution of tuberculosis as striking as that already experienced in leprosy. The subject is too large to be expanded in this column, but this paper deserves to be consulted.

The above illustrations of some portions of Dr. Ransome's life-work show how wide were his studies and how prescient his teaching. A special shelf will always be reserved for his writings by students of tuberculosis and of general epidemiology. Many years ago Dr. Ransome retired to Bournemouth, where, until a few weeks before his death,—when the present writer received a letter from him on an epidemiological point,—he maintained his interest in his life-studies.

Prof. Gisbert Kapp.

By the death on August 10 of Prof. Gisbert Kapp, the country loses one of the few remaining pioneers of electrical engineering. Prof. Kapp was born at Mauer near Vienna in 1852, his father being German and his mother Scottish. At the Zürich Polytechnic he was a pupil of Zeuner and Kohlrausch. In 1875 he came to England, but spent several years afterwards in travelling on the Continent and in North Africa. He was appointed engineer to the Chelmsford Works of Messrs. Crompton and Co. in 1882, and in conjunction with Mr. (now Colonel) Crompton he invented a system of compound winding for dynamos. At this period England was the leading country in the world in electrical engineering. In 1886—the year in which John and Edward Hopkinson published their classical paper on dynamo design—Kapp read a paper on a similar subject to the Institution of Electrical Engineers. He pointed out clearly the analogy between the magnetic circuit of a dynamo and an ordinary electric circuit. In this year also he published his book on the transmission of electrical energy which gave a very clear introduction to the whole problem. In the autumn of 1894 he accepted the post of secretary to the German Association of Electrical Engineers. He was also a lecturer to the Technical School at Charlottenburg and was editor of the *Elektrotechnische Zeitschrift*. In 1904 he was appointed the first professor of electrical engineering to Birmingham University.

As an inventor Kapp was in the front rank. The Kapp dynamos were very useful in their day. The Oerlikon Company, of Switzerland, built many large Kapp machines. But like all the other early types they are now superseded by machines with revolving fields and armature windings embedded in slots. Kapp also invented many types of measuring instruments, a method of making dynamos self-regulating, several types of transformer, a high-speed steam-engine, a system of distributing alternating currents, and a method of boosting the return feeders on electric railways. This last method has still considerable vogue in this country and in Germany.

Kapp was an excellent teacher. Many of the present-day electricians acquired their first ideas of the working of electric machinery from his books. His mathematical theorems were original and in several cases strikingly simple—for example, his formulæ for the free period of coupled alternators. He invented many laboratory methods of testing machines. His test for the efficiency of dynamos and his method of getting the moment of inertia of the rotor of a machine are particularly valuable. He also invented a method of getting the insulation resistance of a three-wire network without the necessity of shutting down the supply. He was one of the earliest to recognise the importance of the phase difference between the alternating current and the alternating potential difference. Developing the theory of the power factor he gave a very simple geometrical explanation of electrical resonance. In recent years he invented a vibratory type of phase advancer and pointed out that considerable economies might be effected by using these machines in everyday supply.

Kapp was a past president of the Institution of Electrical Engineers and was president of the Engineering Section of the British Association in 1913. Personally he was of a very kindly disposition and was always pleased to give his colleagues the benefit of his great engineering experience. He was most hospitable, and was learned in many branches of study outside his professional work. A. R.

Mrs. J. A. Owen Visger.

Readers of natural history works at the end of the last century were somewhat mystified as to the authorship of a number of books published under the pen-name of "A Son of the Marshes," with the editorship of "J. A. Owen." The latter was the name under which Mrs. Jean A. Owen Visger preferred to be known, whose death at Ealing on July 30, in her eighty-first

year, we much regret to have to record. Mrs. Visger was a woman of considerable attainments, with a good deal of masculinity in her character, both mental and physical. She had an absorbing interest in anything appertaining to Nature, and her mind was a storehouse of material acquired during her long life. Her powers of observation were great, and she used to the full in her literary work the excellent memory which Nature had given her, and the many opportunities which travel afforded her.

The real "Son of the Marshes" was understood to have been a working naturalist in Surrey, but it is probable that J. A. Owen's editorship went a good deal further than mere editing. One might say, in effect, that the books were practically written by her. They contained much interesting natural history gossip, following the Richard Jefferies style, but, as a rule, the information was quite unlocalised, and so lost much of its scientific value. The books followed rapidly on one another, and amongst them may be mentioned, "From Spring to Fall," "With the Woodlanders and by the Tide," "Annals of a Fishing Village," "Within an Hour of London Town," "Forest Tithes," and "On Surrey Hills."

Mrs. Visger was twice married, first in 1863, in which year she went to live in New Zealand. There she remained for five years, visiting Tahiti and the Sandwich Islands. She returned to reside in England in 1876, and married again in 1883, afterwards travelling considerably in Europe and in the Pacific. She finally returned to England in 1913. Beside a few books of travel, Mrs. Visger wrote, "Forest, Field, and Fell," "Birds in a Garden," "Birds Useful and Birds Harmful," and in collaboration with the late Prof. G. S. Boulger, "The Country Month by Month." Her books are not now read, perhaps, so much as they deserve to be.

Prof. H. Battermann.

Hans Battermann, who died in Blankenburg, Harz, on June 15, at the age of sixty-two, has left a record of much useful work in astronomy. In his youth he studied at Berlin University under Förster and Tietjen, gaining the degree of doctor in 1881 for a dissertation on aberration. After a short period at Hamburg Observatory he returned to Berlin as a member of the Commission which was appointed, under the direction of Auwers, for the discussion of the results obtained at the transits of Venus in 1874 and 1882. During this period he observed a long series of occultations of stars by the moon, utilising them to obtain a value of the moon's parallactic inequality, and hence of the solar parallax; the value that he found for the latter was 8·789″, which is a good approximation to the accepted value; a still longer series of occultations, observed near the first and last quarters of the moon, should give a very accurate solar parallax. Battermann also conducted two other useful investigations at this time, one on the nature of the images in a heliometer, the other a triangulation of the Pleiades with that instrument. In 1888 he observed for nine months at the Göttingen Observatory; on his return to Berlin he took the chief part in the star observations with the transit circle, and in their reduction to a Catalogue, including the discussion of proper motions.

In 1904 Battermann was appointed professor and director of the University Observatory at Königsberg; he continued there his researches on proper motion, and also observed further occultations with the 13-inch refractor. He was compelled to resign his professorship in 1919 through a complete breakdown in health, brought on by overwork; he retired to Blankenburg, where he died three years later, after much suffering.

A. C. D. C.

Current Topics and Events.

Dr. M. O. Forster, who, since November 1918, has been director of the Salters' Institute of Industrial Chemistry, is relinquishing this post at the end of next month, having been appointed director of the Indian Institute of Science, Bangalore. He expects to take up his new duties early in November.

A new biological station for the study of limnological problems and for research on the development of fresh-water fishes has been established at the Lake of Trasimeno, in Umbria. The University of Perugia has assumed responsibility, and the director of the station is the professor of physiology, Dr. Osvaldo Polimanti. Further details of the equipment are promised at an early date.

The excavations at the Meare Lake Village, near Glastonbury (Shapwick and Ashcott are the nearest stations), will be resumed by the Somersetshire Archæological and Natural History Society on August 25, and continued until September 9 (exclusive of the filling-in). As in previous years, the work will be under the personal direction of Dr. Arthur Bulleid and Mr. H. St. George Gray. The antiquities discovered in past years at Meare are exhibited in the Somerset County Museum at the society's headquarters, Taunton Castle, while those from the Glastonbury Lake Village (described in two royal quarto volumes) are to be seen, for the most part, in the Museum at Glastonbury. Donations are needed and will gladly be received by Mr. St. George Gray, at the Somerset County Museum, Taunton.

One of the oldest organised scientific societies, the "Schweizerische Naturforschende Gesellschaft," is holding its 103rd Annual Meeting at Berne on August 24-27. In addition to the usual business of the society, there will be scientific discussions, and a number of important papers will be read, including: "The Trend of Modern Physics," Dr. C. E. Guye (Geneva); "The Nature of the so-called General Neuroses," Prof. Sahli (Berne); "The Aar Massif—an Example of Alpine Granitic Intrusion," Dr. E. Hugi (Berne); "The Natural Form of Substances as a Physical Problem," Dr. V. Kohlschütter (Berne); "Experimental Genetics in regard to the Law of Variation" (illustrated by lantern slides), Dr. A. Pictet (Geneva); and "Investigations into the Physiology of Alpine Plants," Dr. G. Senn (Bâle). Banquets will be held at the end of each session, and there will be concerts

and other social functions. Those wishing to take part in the meetings may do so on payment of a fee of thirty francs, payable to the "Postcheckkonto No. III. 1546" of the "Naturforschende Gesellschaft," Berne.

AMONG the Civil List Pensions granted during the year ended March 31, 1922, and announced in Parliamentary Paper, No. 137, just published, we notice the following:—Lady Fletcher, in recognition of the services rendered by her late husband (Sir Lazarus Fletcher) to science, and in consideration of her circumstances, 60*l.*; Dr. Francis Warner, in recognition of the services rendered by him in his investigations into the mental and physical condition of defective children, and in consideration of his circumstances, 100*l.*; Sir George Greenhill, F.R.S., in recognition of his services to science and his ballistic work, and in consideration of his circumstances, 125*l.*; Mrs. J. M. Miller, in recognition of the services rendered by her late husband (Dr. N. H. J. Miller) to agricultural science, and in consideration of her circumstances, 50*l.*; Mrs. Alice Mabel Ussher, in recognition of the services rendered by her late husband (Mr. W. A. E. Ussher) to geological science, and in consideration of her circumstances, 50*l.*; Mrs. Agnes E. Walker, in recognition of the services rendered by her late husband (Mr. George W. Walker, F.R.S.) to science, and in consideration of her circumstances, 75*l.*; The Misses Ellen C., Gertrude M., Alice B., Katherine E. and Mary L. Woodward, in recognition of the services rendered by their late father (Dr. Henry Woodward, F.R.S.) to geological science, and in consideration of their circumstances, 125*l.*

ON August 19, 1822, a hundred years ago, died Jean Baptiste Joseph Delambre, the illustrious astronomer and permanent secretary to the Paris Academy of Sciences. Born in Amiens, September 19, 1749, Delambre became a student in Paris and first gained a livelihood as a translator and a tutor. A friendship with Lalande led him to astronomy, and among his earlier work was the formation of tables of Herschel's newly-discovered planet Uranus. With the revolution came the proposal for a rational system of weights and measures, and on the formation of a commission to carry the scheme through, Delambre and Méchain were instructed to measure an arc of meridian from Dunkirk to Barcelona. Often interrupted, this great work occupied the years 1792 to 1799, while the results were given fully in Delambre's "Base du Système métrique decimal," published in 1806–10. Various appointments fell to Delambre; in 1807 he succeeded Lalande at the Collège de France, and as secretary to the Academy of Sciences he wrote many *éloges* and reports. His later years were largely devoted to the writing of his great history of astronomy, five volumes of which appeared during 1817–1821, while the final volume was published five years after Delambre's death. Delambre is buried in the Père la Chaise Cemetery.

MR. H. G. SMITH, formerly assistant curator and economic chemist at the Sydney Technological Museum, has been awarded the David Syme Research prize of the University of Melbourne. The prize, which consists of a medal and a sum of 100*l.*, is awarded for the best thesis based upon original scientific research connected with the material and industrial development of Australia. Mr. Smith is the leading authority upon the chemistry of the essential oils of the eucalypts. Working largely in collaboration with his botanical colleague, Mr. R. T. Baker, and as a result of nearly thirty years' assiduous research, he has been able to establish a remarkable correlation between chemical and botanical characteristics in this complex genus, and an evolutionary theory accounting for the formation of the various species of Eucalyptus has been advanced by him and Mr. Baker. Since his retirement from the Sydney Technological Museum, Mr. Smith, although in his seventieth year, has been actively engaged in further work in the Organic Chemistry Department of the University of Sydney, in association with Prof. Read.

IN accordance with its policy of promoting scientific investigation in Australia, the Australian National Research Council has decided to publish a quarterly catalogue, comprising a list of titles, authors, and journals of publication of scientific research papers of Australian origin, whether appearing in Australian or other journals. The catalogue, which will also contain a brief abstract supplied by the author of each paper concerned, will be entitled *Australian Science Abstracts*, and will be under the control of an editorial committee representing the various branches of science corresponding with the sectional arrangement. The personnel of the editorial committee is as follows: Prof. H. G. Chapman, Dr. L. A. Cotton, Mr. J. J. Fletcher, Mr. A. Gibson, Prof. J. Read, Prof. O. U. Vonwiller, Mr. G. A. Waterhouse, and Prof. R. D. Watt, with Dr. A. B. Walkom as editor-in-chief. The catalogue will be published in Sydney; it will be issued free of charge to members and associates of the Australian National Research Council, and a number of copies will be used for exchange purposes. It is hoped to issue the first number this month.

EXCEPTIONALLY heavy rains fell in many parts of England during the August Bank-holiday week-end and the following days, causing not only discomfort but doing also a large amount of damage in several districts. The primary cause of the rainfall was the arrival of a cyclonic disturbance from the Atlantic, the core or centre of the storm being situated near the Land's End at 8 A.M. on Sunday, August 6, reaching Portland by 2 o'clock in the afternoon, and passing over the Isle of Wight at 7 o'clock in the evening. It was a few miles to the north-west of London at 8 A.M. on August 7, and passed over Cambridge at 2 o'clock in the afternoon, reaching Spurn Head by 7 o'clock in the evening. The disturbance had arrived near Flamborough Head at 2 A.M. on August 8 and afterwards passed away over the North Sea, but the arrival of another disturbance occasioned a renewal

of the rains. During the 12 hours ending 6 P.M. on August 6 the fall of rain at Bournemouth was about $1\frac{3}{4}$ inches. At Harrogate the aggregate rainfall was nearly 5 inches for the three days ending Wednesday, August 9. Nottingham registered 3·4 inches of rain for the 24 hours ending 7 P.M. on August 7. Sheffield experienced exceptionally heavy rain on this date, which occasioned floods, and there was a renewal of the floods in the late evening of the following day. At Leeds, between the morning of August 7 and midday of August 9 the rainfall measured 3·44 inches, which is said to be the highest ever recorded in the city. At Melton Mowbray the rain measured 4·83 inches for the 24 hours ending 9 P.M. on August 7, and at Doncaster the measurement was 4·08 inches between midnight on August 6 and 6.30 P.M. on August 7. Violent thunderstorms occurred generally in the south and east of England, and in London on the afternoon of August 9 a storm was accompanied by a heavy fall of hail. At Hampstead the hailstones remained unmelted on the ground for several hours.

SWATOW, situated on the China coast at the mouth of the river Han and in the Formosa Strait, was visited by a typhoon of terrific violence during the night of August 2-3; the storm lasted about six hours, starting at 10 P.M. on August 2. The pre-war population of Swatow is given as 60,000, and an estimate, made a week after the disaster, of the loss of life at Swatow and the surrounding district is said to be probably 50,000. Six other towns besides Swatow are said to be destroyed. The water rose quite suddenly, partly submerging houses and buildings. Trees were uprooted and telegraph poles blown down. Sampans and native craft were blown hundreds of yards inshore, most of the occupants being drowned, and many large vessels were driven ashore. More than 2000 vessels annually enter the port. The occurrence and characteristics of typhoons in the China Seas have long been studied and are comparatively well understood. The recent storm was probably one of the type shown in the "Barometer Manual for the use of Seamen" published by the Meteorological Office. The period of occurrence is from June to September. These storms usually originate in the neighbourhood of the Philippines and travel northward or north-eastward, striking or skirting the China coast and afterwards passing near to Korea and Japan. The typhoons are commonly warned from Manila or Hong-kong, but the warning can, at the best, only lessen the amount of damage. The Hong-kong Government has greatly aided in relieving the distress occasioned, and the British have been helped in this by the Japanese. In the Backergunge, Bay of Bengal, cyclone, in October 1876, the loss of life by drowning was estimated at 100,000, and the deaths afterwards from disease directly due to the inundation added another 100,000 to the number.

Our Astronomical Column.

CONJUNCTION OF VENUS AND JUPITER.—A conjunction of these brilliant planets will occur on August 26 at 18h. G.M.T., when Venus will be 2° 29′ south of Jupiter. Venus will set at 8h. 11m., and Jupiter will set at 8h. 24m. G.M.T. Sunset occurs at 7h. G.M.T., so that the two planets will set about $1\frac{1}{4}$ hours after the sun. Twilight will be very strong in the western sky just before the setting of the two planets, and in order to observe them it will be necessary to look from a position which commands a clear open view of the western sky near the horizon.

On August 25 Venus and Jupiter will be in conjunction with the moon soon after midnight following the date mentioned, and on August 30 will be in conjunction with Mars in the evening. The western sky during the last week of August will be extremely interesting, the new moon being there and Venus, Jupiter, and Saturn also visible in the same region.

THE ORBITAL DISTANCES OF SATELLITES AND MINOR PLANETS.—Prof. G. Armellini in 1918 published a law of planetary distances in the form $1{\cdot}53^n$, where n is given successive integral values from -2 for Mercury to $+8$ for Neptune. The two integers $+2$ and $+3$ are assigned to the asteroids, while $+6$ is left unused. It can scarcely be claimed that (except in the case of Neptune) it shows great superiority over the law of Bode. However, in a further paper (*Scientia*, August 1922) he notes that his colleague Prof. Burgatti has applied the law to the satellite systems of Jupiter, Saturn, and Uranus, the formulæ being $1{\cdot}80^n$, $1{\cdot}34^n$, and $1{\cdot}31^n$ respectively. In the case of the Jupiter family the indices are -3, -2, -1, 0, $+1$ for V and the four bright satellites; $+2$, $+3$ are unused, $+4$ is assigned to the two satellites VI, VII, while $+5$, $+6$ are given to VIII, IX respectively. The author erroneously gives a distance to IX half as great again as that of VIII. The two in reality form a twin pair like VI, VII. Since the law gives no explanation of vacant spaces or of pairs of satellites, its claims to rest on a physical basis are not convincing.

The remainder of the paper deals with the asteroidorbits. The gaps at the distances where the periods are half and one-third of Jupiter's are not ascribed to the direct action of that planet, but to some primitive agency which determined both its distance and theirs. It is, indeed, likely that the asteroids will play an important part in future discussions on the cosmogony of the solar system.

Prof. Armellini cites an interesting point about planet 434 Hungaria. Its distance from the sun, 1·95, is the precise distance at which Leverrier stated that enormous perturbations in inclination would develop, causing oscillations of 53°. Charlier, however, pointed out that Leverrier had included only first-order perturbations; he estimated that the inclusion of higher terms would diminish the oscillation to 17° or less. Finally, Prof. Armellini himself has effected the complete integration of the expressions, using elliptic functions, and finds that the oscillation of the inclination is only $3\frac{1}{3}°$, a quantity of the same order as that of the major planets.

Research Items.

COLOUR SYMBOLISM.—In the June issue of *Folk-lore* (vol. xxxiii. No. 2) Mr. D. A. Mackenzie contributes a paper on colour symbolism, which contains a mass of interesting facts. Egyptian colour symbolism was already old at the dawn of the Dynastic period. In ancient Europe it was restricted by the conventions of Cave art, and the range of colours used by the Cro-Magnon artists was limited and confined to earth colours only. There is clear evidence, however, that people in Aurignacian, Solutrean, and Magdalenian times attached a symbolic value to certain, if not to all, colours. Small green stones were placed between the teeth of some of the Cro-Magnon dead interred in the Grimaldi caves near Mentone—an interesting fact in connexion with the ancient Egyptian belief in the magico-religious value of green stones. The writer is, however, mistaken in extending the analogy to China, where, it is said, green jade was placed in the mouths of the dead; on the contrary, the use of green jade for this purpose was exceptional.

JURASSIC BIRDS.—Dr. Branislav Petronievics, who has published several papers on fossil vertebrates in the Annals and Magazine of Natural History, now states the results of his examination of the original specimen of *Archæopteryx macrura* preserved in the British Museum (Natural History) in a paper ("Über das Becken, den Schultergürtel und einige andere Teile der Londoner Archaeopteryx") published separately by Georg and Co. of Geneva. His most important conclusion is stated so modestly on p. 10 that it might easily escape recognition. He feels that the differences between the Berlin and London specimens referred to Archæopteryx, which caused Dames to separate the Berlin bird as *A. Siemensii*, are sufficiently increased by his recent researches to allow of the formation of two genera. He proposes therefore to include in the established order Archæornithes, Archæornis, the Berlin specimen, and Archæopteryx, the London specimen. The latter (p. 18) is held to be the more primitive type, and the shoulder-girdle (p. 24) even suggests that the two genera should fall into different families. The author perceives an early carinate type in Archæornis and an early ratite type in Archæopteryx, and indicates that a convergence of the two important divisions of birds should be found farther back in some descendant of the Lacertilia. The dinosaurs lie on a separate branch, converging with the bird-branch in some ancestral reptile. We should like to have Dr. Petronievics's views on Compsognathus and Podokesaurus (NATURE, vol. 109, p. 757).

MOSQUITO CONTROL.—Apart from certain war-time measures in the neighbourhood of a few military camps, scarcely anything has been attempted in this country in the way of the reduction of mosquitoes, but an example has recently been set by the Hayling Mosquito Control, which, under the direction of Mr. John F. Marshall, is doing very useful work, both practically and experimentally. The Report just issued by this body summarises what has been done since its foundation in the autumn of 1920. It was found that in Hayling Island the two common domestic species (*Culex pipiens* and *Theobaldia annulata*) were almost negligible as pests, by far the greater part of the annoyance being caused by the salt-marsh species (*Ochlerotatus detritus*). So numerous was this species that it was roughly calculated that two million larvæ were destroyed by paraffining in a single afternoon. Although last year's drought did not seriously restrict the breeding-places of *O. detritus*, the control measures adopted proved very effective, as was shown by comparison with other places along the south coast. The very successful use of soluble cresol in small quantities as a larvicide has already been described in NATURE by Mr. Marshall (June 10, 1922, p. 746). Important experiments are now being carried out to ascertain if possible the range of flight of *O. detritus*. Some kinds of salt-marsh mosquitoes, especially in North America, have been shown to make large migrations for distances of many miles. If *O. detritus* shares these habits local control work may be rendered largely unavailing, though the comparative immunity already obtained by the control goes far to show that this is not the case.

PHILIPPINE FORAMINIFERA.—Mr. J. A. Cushman has published (Bull. 100, Smithsonian Institution, U.S. Nat. Mus.) a monograph on the Foraminifera of the Philippine and adjacent seas, based on material from shallow water and from nearly 600 dredgings. The shallow water examples—from less than 30 fathoms—are characteristically tropical, most of the genera being those of similar areas in the general Indo-Pacific region, many of the species being, however, distinct. In the deeper water, 100-300 fathoms, there is an exceptional development of the Lagenidæ, and in the colder deeper parts of the region a great development of arenaceous forms, especially Astrorhizidæ and Lituolidæ—many of the characteristic genera and species of cold waters in high latitudes being represented. This supports the view that the wide distribution of these arenaceous forms in cold waters is dependent more on temperature than on depth. The largest of the living calcareous Foraminifera, *Cycloclypeus carpenteri*, of which specimens about 2½ inches in diameter were obtained, was dredged in quantity in parts of the area. The systematic part of the work records 568 species and gives notes on their characters and distribution; figures of the more important species are given in 100 plates.

THE MICROSCOPIC DETERMINATION OF THE NON-OPAQUE MINERALS.—The method of identifying minerals by determining their indices of refraction by immersing or embedding their powders in media of known refractive index receives immense extension through Esper S. Larsen's memoir bearing the above title (U.S. Geol. Survey, Bull. 679, 1921). The tables given contain data for about 950 mineral species, and the methods of determination are adequately described.

PRE-DEVONIAN GEOLOGY OF GREAT BRITAIN.—The Quarterly Journal of the Geological Society, vol. lxxviii. pt. 2, 1922, shows how much work has remained to be done on the stratigraphy of our older British areas. Mr. E. B. Bailey develops his theory of *nappes* in the south-west highlands of Scotland, arousing thereby a healthy and critical discussion. Dr. Gertrude L. Elles gives in detail the results of her zoning of the rock-succession in the Bala district; and Dr. J. Wills and Mr. Bernard Smith have greatly extended our knowledge of the country round Llangollen.

NEW RADIOLITES AND A NEW CRINOID FROM THE UPPER CRETACEOUS OF MEXICO.—Examples of those strange aberrant bivalves the Radiolitidæ from the Upper Cretaceous of Tamaulipas, Mexico, where they appear to be scarce, have been described and figured by L. W. Stephenson (Proc. U.S. Nat. Mus., lxi. art. 1), who, however, favours Lamarck's later name in his title and refers to them as belonging to the "Rudistid Group." A new genus, Tampsia, with two new

species; three species, of which two are new, of Sauvagesia; and a new species of Durania complete the series. Among the associated fossils cited is *Balanocrinus mexicanus*, n.sp., which forms the subject of a separate paper by F. Springer (tom. cit., art. 5). This is the first known occurrence of the genus in America.

THE FLOTATION OF CONTINENTS.—M. E. Gagnebin, of the University of Lausanne, has provided a masterly review of Wegener's hypothesis of the movement of continental masses over the general surface of the globe. In ten pages of the *Revue générale des Sciences naturelles*, vol. xxiii. p. 293, 1922, he states the main features of the argument, discusses the problems raised, and furnishes references and footnotes that make his lucid essay an almost essential introduction to Wegener's "Entstehung der Continente" (see NATURE, vol. 109, pp. 202 and 757). It is interesting to notice that the relations of folded zones to those of subsidence on the earth is one of the subjects discussed at the International Geological Congress in Brussels in August 1922.

THE MATRIX OF DIAMOND.—The question of whether diamond separates out from ultrabasic igneous magmas, or is carried up in these exceptional magmas because they have traversed deep-seated metamorphic rocks, is once more raised by the description of the diamond-bearing gravels of the Somabula Forest in Southern Rhodesia (A. M. MacGregor, Geol. Surv. S. Rhodesia, Bull 3, 1921). These fluriatile beds form part of the Karroo systems, and the kimberlite pipes of S. Africa are of later date. The author suggests that the diamonds were washed from a kimberlite of unusually early age, since he favours the view of their igneous origin. New interest is given to the kimberlite pipes of Africa by H. S. Harger's discovery (Trans. Geol. Soc., S. Africa, vol. xxiv. p. 1, 1922) that an example in the Riversdale district of the Cape Province cuts strata of Uitenhage (Cretaceous) age.

CRITICAL RESEARCH ON FOSSIL BRACHIOPODA.—The transference of well-known species to new genera as investigation becomes more precise often leaves little to be said for an original genus the name of which has become known throughout the world. This is sadly the case with Rhynchonella, to which Mr. S. S. Buckman (Mem. Geol. Surv. India, Palæontologia Indica, New Ser., vol. 3, Mem. 2, "The Brachiopoda of the Namyan Beds, Northern Shan States, Burma") now assigns only two species, *R. loxia* Fischer of the Portlandian, and *R. variabilis* Davidson of the Kimmeridgian (p. 57). The author quotes (p. 91) his previous conclusion that no Mesozoic species can be assigned to Terebratula Müller, 1776. On pp. 8 to 11 he describes his method of "burning" specimens of fossil brachiopods; when the shell is heated and dropped into water, it commonly flakes off from the internal cast, and the characteristic muscular scars are clearly traceable on the mould. Much, of course, depends on the infilling material, and oolitic limestone yields poor results. The method has been elaborated by Mr. Buckman from an observation by Mr. T. H. D. La Touche (p. 2), who noticed that the fossils fell out easily from material that had passed through Burmese lime-kilns, and who proceeded to treat his rocks in a big fire "with very satisfactory results."

EVOLUTION OF THE GRAPTOLITES.—The numerous geologists who wish to keep abreast of progress in the classification of Older Palæozoic strata will find much guidance in a paper by Dr. Gertrude Elles on "The Graptolitic Faunas of the British Isles" (Proc. Geol. Assoc. vol. 33, part 3, 1922; price 5*s*.). Since it seems uncertain if hydrozoan, or even cœlenterate, affinities can be maintained for graptolites and their allies, a separate class of organisms, the Graptolithina, has been established, subdivided into two orders, the rapidly changing Graptoloidea and the almost stationary Dendroidea. In the same prudent spirit the term rhabdosome replaces polypary, and theca hydrotheca. The virgula of older descriptions of graptolites disappears. Attention is well directed to the nema, the hollow thread-like prolongation of the apical portion of the sicula, as being the organ of attachment essential to the welfare of the rhabdosome. In the earlier pendent graptolites the nema is unprotected; but in forms regarded as scandent, such as Diplograptus, and also in some uniserial genera, it is protected, and is sometimes wrapped round the bases of the thecæ. Many of the points mentioned are quoted from work published by the author and other investigators, and recognised by modern writers, such as A. M. Davies; but the present summary, the clear diagrams of types successively evolved, and the stratigraphical table, render this paper by Dr. Elles valuable in all colleges as a supplement to established text-books of palæontology.

VERTICAL CIRCULATION IN THE ATLANTIC.—A. Merz and G. Wüst (*Zeitschrift der Gesellschaft für Erdkunde*, Berlin, 1922, No. 1-2) discuss the nature and causes of the vertical circulation of the water of the Atlantic Ocean, reviewing the various descriptions and explanations so far published. It has been known, in a general way, that water which is relatively warm and fresh flows on the surface from the region of equatorial rains and calms north and south to the sub-tropical zones, while water which is relatively cold and dense flows in the opposite directions as under-currents. This system of drifts now appears to be of very limited depth. The superficial warm currents extend to about 50 metres while the under-currents have their main stratum at a depth of 75-150 metres from the surface. The cause is differences of density rather than differences of temperature.

DUST-RAISING WINDS.—This subject is dealt with in the Memoirs of the Indian Meteorological Department, vol. 22, part 7, by Dr. C. W. B. Normand. Observations were made on dust phenomena in Mesopotamia in 1918, and these, together with Dr. Hankin's observations in a preceding memoir, are correlated with those of other observers in other countries. The camp in Mesopotamia was situated at Samarrah, near the edge of the vast low plateau known as Jezireh, where the dust in places lay knee-deep. With even light winds in August and September it was no uncommon occurrence to see three or four dust-devils of great height meandering with the breeze on the plain. The base of many of these was only about 5 metres in diameter and the height was at least 300 metres. For the origin of dust-devils a highly unstable vertical distribution of temperature is said to be a necessity. At Samarrah the author attributes the impetus to be often due to the incinerators at the various camps for burning refuse. The "primary" dust-storm in Mesopotamia occurs principally between 4 P.M. and midnight in the months of March, April, May, and September; they are always associated with cloud, and were often followed by rain, thunder, and a marked fall in air temperature. The dust-storms in spring are almost always associated with thunderstorms and are said to be undoubtedly due to the descending currents which are known to occur in front of thunderstorms. Interesting information is given on the cause of dust-raising by wind, and on turbulence and the density of dust at various heights.

The Hull Meeting of the British Association.

PROGRAMMES OF THE SECTIONS.

THE programmes of the various Sections of the British Association for the forthcoming meeting at Hull have now been provisionally completed, and it is possible to state what are the chief subjects to be brought forward. We are indebted to the Recorders of the Sections for the subjoined outline of arrangements made for the meeting.

SECTION A (MATHEMATICS AND PHYSICS).—The proceedings of Section A this year promise to be of more than usual interest. The Section is fortunate in having secured the attendance of three very distinguished foreign guests, Prof. P. Langevin, Prof. P. Weiss, and M. le Duc de Broglie. The two former will take part in a discussion which has been arranged on the origin of magnetism, to which Sir J. A. Ewing and Dr. A. E. Oxley have also promised to contribute. M. de Broglie will read a paper, which cannot fail to attract great interest, on X-rays and Beta rays, and as Prof. R. Whiddington will make a communication on the same subject, a valuable discussion on this aspect of physics may be expected. Prof. G. H. Hardy has chosen as the subject of his presidential address "The Theory of Numbers," and it may be confidently anticipated that he will make it of that fascinating interest which is an attribute of all his lectures. An important and somewhat novel joint discussion will take place under the auspices of Sections A and I on physical instruments for biological purposes. Prof. A. V. Hill will open this discussion, and several biologists and physicists have promised to take part. In connexion with this discussion there will be an extensive exhibition of appropriate apparatus by Major W. S. Tucker, Mr. F. E. Smith, Dr. G. Wilkinson, and The Cambridge and Paul Scientific Instrument Company. In view of the success attending the experiment at Edinburgh last year, the Committee of Section A has arranged several lectures of a semi-popular character. Sir William Bragg will lecture on "The Significance of Crystal Analysis"; Prof. J. Proudman has chosen a subject especially appropriate to Hull, namely, "Tides, with Special Reference to the North Sea"; and Prof. H. H. Turner will delight the children with the topic, "The Telescope and what it tells us."

SECTION B (CHEMISTRY).—The programme of Section B will include several discussions. Principal Irvine has selected research problems in the sugar group as the subject of his presidential address, and this will be followed by several papers on carbohydrates from the St. Andrews laboratories. Photosynthesis will be discussed jointly with Section K (Botany), the recent work from the Liverpool laboratories on the synthesis of the more complex plant products being well represented. Sir William Bragg will describe his researches on the crystalline structure of organic compounds; and the recent theories of organic structure will be considered in a discussion on valency and polarity, to be opened by Prof. Robinson, and in a paper by Prof. Holleman on substitution in the benzene nucleus. Other separate papers include an account of the recent work on compressibilities under high pressures conducted in the Geophysical Laboratory at Washington, and a study of the properties of soap solutions by Prof. McBain. Two discussions of industrial questions have been arranged. One of these concerns the local industry of the hydrogenation of fats, which will be considered from the scientific and the industrial side, and the other is the industry of synthetic nitrogen compounds. Several of the modern processes of synthesis will be described. The city is an important centre of chemical manufactures, and visits of the Section to some of the principal works, including the fat and oil and the cement industries, have been arranged.

SECTION C (GEOLOGY).—As a part of the series of discussions on questions connected with the North Sea to be held in various Sections, the first item in the programme will be an account by Prof. Kendall of the geological history of the North Sea Basin from Permian times to the present day. This will be followed by an account of the floor deposits of the North Sea and by a general discussion of these topics. The geology of the Hull district will be described by Mr. T. Sheppard, whose lecture will be illustrated by lantern slides. Other communications on local geology are the erosion of the Holderness Coast, by Mr. C. Thompson; a new section in the Oolites and Glacial deposits at South Cave, by Mr. J. W. Stather; and a new section in the Oolites at North Ferriby, by Mr. W. S. Bisat. Pleistocene and Recent ice conditions in North-eastern Labrador will be described by Prof. Coleman of Toronto. The subject of the presidential address by Prof. P. F. Kendall is the physiography of the coal swamps. The address will be followed by Prof. Gilligan on sandstone dykes in the Cumberland coalfield and the subjects raised in the two communications will be discussed. A discussion on Wegener's hypothesis of continental drift, in which both the geological and astronomical sides will receive attention, has been arranged, and the relation of early man to the phases of the ice age in Britain will form the subject of a joint meeting between the anthropological, geological, and geographical sections. Papers dealing with the zoning of Carboniferous rocks will be read by Mr. W. S. Bisat and Mr. R. G. Hudson, and Dr. H. L. Hawkins will describe the relation of the Thames to the London Basin. Numerous excursions will be held during the meeting.

SECTION D (ZOOLOGY).—The organising committee of Section D, the president of which is Dr. E. J. Allen, has shaped its programme for the forthcoming meeting at Hull with the view of relating it so far as possible to local interests. Four of the eight sessions will be devoted to marine biological and fisheries problems; the remaining four to matters of a wide variety of interest. One whole day will be given to discussion with representatives of the fishing industry, when members of the industry will propound difficulties and questions which the biologist will endeavour to answer to the limits of his knowledge, and which he will, it may be hoped, take to heart against the planning of further investigations. Another feature of the meeting will be the number of distinguished foreign marine biologists who will attend. Dr. Hjort, of Norway, will give an evening lecture at Grimsby, Dr. C. J. Joh. Petersen will come from Denmark to open a discussion on the fauna of the sea bottom, of the quantitative study of which he is the pioneer, Dr. Johs. Schmidt will give an account of his recent explorations in the Atlantic, and there will be eleven other distinguished oceanographers, including representatives from Belgium, Denmark, France, Holland, Norway, and Sweden. It is anticipated that a representative gathering of research vessels will also attend, including, in addition to our British vessels, the Danish *Dana*, the French *Pourquoi Pas*, and the Swedish *Skagerak*. Of items other than those concerned with marine biology one will be a discussion

with Section K (Botany) on the present position of Darwinism, when the views of Dr. Willis and Mr. Yule, as put forward by themselves at the meeting, will come under review and criticism. Among the individual contributions it is difficult to particularise; they will deal with problems relative to hormones, hydrogen ion concentration, forestry, geographical distribution, hereditary transmission of small variations, adaptation, periodicity of pond protozoa, and the effect of lead pollution. The final but not the least important item on the programme is a discussion with the Hull naturalists on the possible work of natural history societies in relation to faunal surveys.

SECTION E (GEOGRAPHY).—The presidential address by Dr. M. I. Newbigin will be on Human geography: first principles and some applications. On the same day Miss E. C. Semple will speak on the influence of geographical conditions upon ancient Mediterranean agriculture. Several speakers will deal with current problems in Europe, including Prof. J. F. Unstead on the belt of political change in Europe, and Mrs. H. Ormby on the Danube as a waterway. Prof. P. M. Roxby will lecture on the place of Peking in the life of modern China, and Dr. Vaughan Cornish, in a paper entitled the isothermal frontier of ancient cities, will develop the interesting thesis that from the North Sea to the Sea of Japan the separation between city life and that of forest and prairie people is marked by the same mean annual isotherm. Local geography will be treated by Mr. L. Rodwell Jones, Mr. C. B. Fawcett, and others. There will be a number of papers on cartography and survey, including survey in polar regions, by Mr. F. Debenham; the mapping of Latin America, by Mr. A. G. Ogilvie; early maps of Malta, by Dr. T. Ashby; and a discussion on the use of Mercator's projection for air-maps, which, it is hoped, will be opened by Col. E. M. Jack. A joint discussion, with the cosmical subsection of Section A, on the monsoons, will be opened by Dr. G. C. Simpson. Section E will also take part in a joint discussion with Sections C and H on relations of early man to phases of the ice age in Britain. Travel will be represented by Sir P. Brocklehurst on his recent journeys through Wadai, Mr. R. R. Walls on his extensive wanderings in Portuguese Nyasaland, and Mr. R. A. Frazer on some work in Spitsbergen. In economic geography Mr. H. M. Spink will speak of some geographical aspects of recent developments of water power, Mr. A. V. Williamson on irrigation in the Indo-Gangetic alluvium, and Mr. D. C. T. Meckie on the trend of world commerce. An excursion to Spurn Head and Sunk Island is being arranged.

SECTION F (ECONOMIC SCIENCE AND STATISTICS).—The influence which the war has had upon our economic life is again the subject of several of the papers which are to be read in this section. Prof. A. L. Bowley will continue his studies of post-war prices in a paper comparing wholesale and retail prices since the Armistice; and Mr. W. H. Whyte is contributing a paper on the war and its influence on stock markets. The questions of unemployment and of out-door relief are to be dealt with by Mr. J. L. Cohen in a paper on the future of unemployment insurance; and by Miss Anne Ashley, who has had considerable experience of social work in Edinburgh, and is contributing a paper on the English and Scottish Poor Law in relation to the able-bodied. The measurement of productivity in agriculture and industry is to be dealt with by Mr. R. B. Forrester; human motive in industry by Miss H. Reynard; and modern municipal markets and their economic significance, by Prof. J. G. Smith. The president of the section is Prof. F. Y. Edgeworth, and his address will deal with the question of equal pay to men and women for equal work. In addition to the papers there are to be two important discussions with other sections—the first with the Sections of Agriculture and Physics (Meteorology) on weather cycles in relation to agriculture and industrial fluctuation. It will be opened by Sir William Beveridge and Mr. R. A. Fisher. The second discussion is with the Agriculture Section, and is to discuss the possibility of increasing the food supply of this country. Sir Henry Rew, Sir John Russell, Mr. C. S. Orwin, Sir Thomas Middleton, Prof. Somerville, and Prof. Cannan have promised to speak. Both these discussions deal with very urgent problems at the present time, and they should prove of considerable interest not only to members of the Association but to the general public.

SECTION H (ANTHROPOLOGY).—This Section has a varied programme, in which matters relating to archæology predominate. It includes two organised discussions—one dealing with the antiquity of man in relation to the ice age in Britain, which will take place in a joint session with the Geological and Geographical Sections, and one, to be held in a joint session with the Psychological Section, on mental characters and race, which will be opened by Prof. J. L. Myres. One morning session will be devoted to questions relating to the archæology and anthropology of the north-east coastal area of England, when Mr. Leslie Armstrong will discuss the Maglemose remains of Holderness and their Baltic counterparts, Mr. W. G. Collingwood will deal with the influence of Scandinavia on the art of the Danelaw in the tenth century, and Prof. A. Mawer will consider the place-names of the East Riding. In connexion with this group of subjects Prof. A. W. Brøgger of Christiania will describe the burial found in a Viking ship at Oseberg, which is of great importance for our knowledge of Scandinavian art and culture in the ninth century. Lord Dunsany will describe recent finds of palæolithic implements in North Africa, and Mr. Seton-Karr will deal with aspects of the same subject; Miss Nina F. Layard will discuss prehistoric cooking places, and the excavations carried out by the Spelæological Society of Bristol University in caves in the Mendips, which have brought to light remains of the late Palæolithic and Iron Ages, will be described by Mr. E. K. Tratman and Mr. J. A. Davies. A communication by Mr. Cyril Fox, which is likely to give rise to an interesting discussion, deals with the distribution of population in the Cambridge region with special reference to the bronze age. Dr. T. Ashby will give an account of archæological investigations carried out in Italy during the last twelve months, as well as of certain supplementary investigations made by himself at the megalithic temple of Hal Tarxien in Malta. Miss Murray also will describe the excavations which she is now carrying on in the same island. Mr. Stanley Casson will give an account of his recent excavations in Macedonia, and discuss their bearing upon certain general problems. This communication, in conjunction with one from Mr. J. Whatmough on inscribed fragments of stagshorn from North Italy, of which the inscriptions are in an unknown language, should give rise to fruitful discussion on racial movements in Europe in late prehistoric times. In physical anthropology Prof. W. J. Sollas will discuss comparative craniometric methods, with special reference to Neanderthal Man; and in ethnography the two most important communications will be a description of rock-paintings from New Guinea by Dr. W. M. Strong, and an account of certain peoples of the Congo area by Mr. E. Torday. The latter will deal incidentally with the question of the decay of custom among primitive peoples.

SECTION I (PHYSIOLOGY).—The section of physi-

ology can congratulate itself on an exceptionally good programme. Local effort is well represented, for the first morning session, as well as parts of other sessions, are occupied by papers contributed by Hull members of the medical profession. The meeting will open with a paper by Dr. F. C. Eve, senior physician to the Hull Infirmary, on "Life and Energy: an Interpretation." Dr. T. Ritchie Rodger is to follow with a paper on "The Effect of Loud Noises on the Cochlea," in which he will discuss the consequences of the boiler-making industry in causing damage to the organ of hearing. A demonstration of a model of the cochlea, by Dr. G. Wilkinson of Sheffield, is also of interest in this connexion. The investigation of the movements of the alimentary canal by means of the X-rays will be described and demonstrated by Dr. J. E. Bannen. Prof. A. V. Hill will read a paper on athletics and oxygen supply, in which he will show what a large debt of oxygen becomes due to the body in severe exertion, to be called in during the succeeding period of rest. The presidential address, by Prof. E. P. Cathcart, on the "Efficiency of Man and the Factors which Influence It," will deal with another aspect of muscular work which Prof. Cathcart has studied, in America with Dr. Benedict, and at home in connexion with the energy requirements of recruits. There are two interesting joint discussions with other sections. With the section of physics there is to be a discussion on the application of physical methods to biological investigations, to be opened by Prof. A. V. Hill; while with the section of agriculture there will be a discussion of the popular topic of the vitamins, to be opened by Prof. J. C. Drummond. In this discussion we welcome a paper by Dr. Atherton Seidell of Washington, who has done outstanding work on the isolation of vitamins. The foreign guest of the section, Prof. W. Storm van Leeuwen of Leyden, will contribute two interesting papers on hypersensitiveness, a subject of considerable importance in relation to the causation of asthma, hay fever, and serum sickness. The section is fortunate in securing two eminent physiologists to deliver popular lectures —Mr. J. Barcroft on the expedition which he recently led to Peru for the study of mountain sickness in the Andes, and Prof. W. D. Halliburton, who will lecture on "Our Bones and Teeth." Dr. F. W. Edridge-Green will give two papers on colour vision, Dr. P. M. Tolmie of Hull one on the cytology of the blood, and Dr. J. H. Burn a contribution to the physiology of sweating, in which he shows how certain clinical facts can be explained on physiological lines.

SECTION J (PSYCHOLOGY).—The new psychological section of the British Association met for the first time last year at the meeting held at Edinburgh. Judging by the programme announced, it should have an equally successful session this year at Hull. Unfortunately, however, it has already sustained a grave and lamentable loss by the death of Dr. W. H. R. Rivers, the elected president. Dr. C. S. Myers, who has just given up his Cambridge post to become director of the new National Institute of Industrial Psychology, is taking the chair in Dr. Rivers' place, and his presidential address will deal with the influence of Dr. Rivers' work on the development of psychology in Great Britain. The first important feature in the programme will be the opening discussion upon industrial psychology. In this Dr. Myers, Dr. Miles, Mr. J. Seebohm Rowntree, and Mr. Eric Farmer are taking part. The two first speakers will doubtless describe the work proposed, and the work hitherto carried out, by the National Institute, in the establishment of which they have had so prominent a share. Mr. Farmer is reporting an investigation on "Output Curves as Measures of Fatigue"—an inquiry carried out under the Industrial Fatigue Research Board—and Mr. Rowntree is describing the results of some group-tests of intelligence applied to the employees at the big factory at York. Friday morning, September 8, will be devoted to a joint discussion with the Section of Educational Science upon psychoanalysis and the School. In this the chief speakers will be Dr. Kimmins, Dr. Crichton Miller, Prof. Pear and Dr. R. G. Gordon. The other joint discussion will be that held in conjunction with the Anthropological Section on Tuesday morning, September 12, when Prof. J. L. Myres, Prof. A. A. Fleure, and Dr. C. S. Myers are holding a symposium on mental characteristics and race. On the same afternoon there will be a similar symposium on mental deficiency, in which Dr. Auden (the School Medical Officer for Birmingham) and Dr. Shrubsall (the Assistant School Medical Officer for London) will both take part.

SECTION K (BOTANY).—Under the presidency of Prof. H. H. Dixon, Section K has a very full and varied programme for the Hull meeting. The president's address will deal with "The Transport of Organic Substances in Plants." An interesting feature of the programme will be the joint discussions on photosynthesis (with Section B) and on the present position of Darwinism (with Section D). The discussion on photosynthesis will be opened by Dr. F. F. Blackman with a paper on the biochemical problem of chloroplastic photosynthesis, which will be followed by Profs. Baly and Heilbron with accounts of their recent important researches upon carbon and nitrogen metabolism in green leaves. Contributions to this discussion will also be made by several other botanists and chemists. An animated discussion is expected upon the present position of Darwinism, which will be opened by Dr. J. C. Willis, who will treat of "The Inadequacy of the Theory of Natural Selection as an Explanation of the Facts of Geographical Distribution and Evolution." He will be followed by Mr. Udny Yule, with a paper on "A Mathematical Concept of Evolution based on the Theory of Age, Size, and Space." Mr. C. Tate Regan will then enter the arena, and, it is understood, will attack the Willis-Yule position from the zoological point of view. Other speakers will include Prof. Johannsen (Denmark), Dr. J. T. Cunningham, and Dr. H. Wager. Persons interested in forestry are again linked with Section K as at Edinburgh, and a morning is to be devoted to papers on forestry, the most important of which is one by the Right Hon. Lord Lovat (Vice-President of the section) on the position of British forestry today. The popular lecture is to be given this year by Prof. Dame Helen Gwynne-Vaughan, who will take "Moulds" as her subject. The remainder of the programme is representative of many different branches of botany, including plant physiology, genetics, cytology, mycology, anatomy, and ecology. Thanks to the local botanical committee, a fine excursion programme has been arranged, including visits to Spurn Head, Skipwith and Riccal Commons, and Brantingham Dale. In addition, permission has been given to members interested in forestry to visit Lord Yarborough's woods by the kindness of the owner.

SECTION L (EDUCATIONAL SCIENCE).—The proceedings of this section will open at 10 A.M. on Thursday, September 7, with an address on "Educational and School Science" by the president, Sir Richard Gregory. The address will be used to open discussion upon what should be the character and content of school science courses in the general education of all up to about sixteen years of age. Prof. J. Arthur Thomson will be one of the speakers on this subject. After the discussion there will be a paper on advanced instruction in elementary schools by Mr. R. C. Moore.

Lord Haldane had arranged to give an address in the afternoon, but unfortunately he has had to cancel all public engagements for reasons of health. Two important meetings will be held on Friday, September 8. In the morning there will be a joint meeting with the Psychological section for the discussion of psycho-analysis in relation to the school. The opening speakers will be Dr. C. W. Kimmins, Dr. Crichton Miller, Prof. Pear, and Dr. R. G. Gordon. In the afternoon, addresses on Imperial Citizenship will be given by the Rt. Hon. Lord Meston and the Rt. Hon. Sir Joseph Cook (High Commissioner for Australia). Bishop Welldon will also speak. On Monday, September 11, there will be a paper on international students' organisations, by Mr. Iveson S. Macadam (President of the National Union of Students), and a discussion on English as the basis of national education, at which the speakers will include Mr. G. R. Pocock (Dartmouth College), Prof. Edith Morley, and Dr. F. S. Boas. The morning of Tuesday, September 12, will be devoted to local educational work, and the papers will be on the movement towards individual work in schools, with special reference to experiments in Hull, by Miss F. Sayer; and on the Dalton Plan, by Miss C. T. Cumberbirch. In the afternoon there will be a joint discussion with the engineering section on the effect of reformed methods in teaching mathematics, to be opened by Prof. P. T. Nunn and Mr. R. C. Fawdry (Clifton College).

The Imperial Cancer Research Fund.

THE executive of the Imperial Cancer Research Fund can look with satisfaction on twenty years of steady progress towards the understanding of the nature of tumours. In the twentieth annual report, lately issued, the director, Dr. J. A. Murray, records once again a tale of sound and solid work in a field which is rather particularly liable to be overrun with hasty and slipshod frontal attacks and premature attempts to find a cure for cancer.

Of chief interest perhaps are Dr. Drew's experiments on the growth of normal and malignant tissues *in vitro*. Observations on the transplantable tumours of mice have shown that malignant tissue has no natural duration of life, the same tumour growing continuously under favourable conditions for a period far longer than the normal life of the animal in which it arises. Similarly, experiments on the continuous culture of normal tissue *in vitro* show, with a certainty which will increase with further lapse of time, that they too may achieve an analogous immortality. The fundamental functional characteristic of tumours is their independence of, and dissociation from, the rest of the body in which they grow. If normal tissues are subjected to the same dissociation by isolation in artificial cultures, they too appear to be capable of continuous life without the intervention of sexual regeneration.

Dr. Drew has now analysed this question of the influence of different tissues on one another to a further point. He finds that epithelial cells when growing in pure culture remain undifferentiated. When connective tissue cells are added to such cultures, differentiation sets in with little delay, squamous epithelium producing keratin in the familiar form of the concentric corpuscles so well known in human epitheliomata and mammary epithelium growing into branching acinous structures. The form of the cells depends, then, more on where they are than on their origin, and the facts form an interesting commentary from the experimental side on the views of Dr. G. W. Nicholson on heteromorphosis in tumours put forward in his essays in recent numbers of the Guy's Hospital Reports. Dr. Drew has discovered also the curious point that malignant cells quickly make the fluid in which they grow unsuitable for further multiplication, though normal tissue will still grow in it readily. Continuous culture of malignant cells requires more frequent transplantation than do normal tissues, exemplifying the observational fact that human tumours are less resistant than normal tissues to all sorts of harmful influences—infections, poisons such as arsenic, radiation of different kinds, and so forth. They are superior to normal tissues only in their capacity to override the rules governing normal growth differentiation and morphology.

Drs. Cramer Drew and Mottram have continued their studies of vitamin deficiencies. Defect of vitamin A produces characteristically a diminution in the blood platelets, just as absence of vitamin B leads to almost complete disappearance of lymphoid cells. Similar changes in the blood elements may be induced by X-rays and radium. No success was obtained in attempts to influence the growth of transplanted tumours by vitamin deficiencies. In continuation of the production of malignant epithelial tumours by the repeated irritation of the skin by tar and similar substances, Dr. Russell now records the generation of malignant tumours of connective tissue by its subcutaneous administration. He also records further progress in his study of the respiratory exchange of tumours.

European Fish in New Zealand Waters.

A VERY useful account of the Marine Biological Station and Fish Hatchery at Portobello in New Zealand has been prepared by the Hon. G. M. Thomson and the late Mr. Thos. Anderton, and is published as Bulletin No. 2 of the Board of Science and Art of the Dominion. There is an appreciative note about Mr. Anderton, a man of great practical ability, who began life as a mercantile marine officer and then became a marine zoologist: he organised the Portobello Station with conspicuous success. The work of this institution is remarkable for the very original experiments carried out in connexion with it, having in view the naturalisation of European fishes and other marine edible animals in New Zealand waters. These attempts are well known in a general way, but it is well to have detailed records of their methods and results.

The main object was to introduce the European herring, turbot, edible crab and lobster. The herring was taken over in the form of large numbers of fertilised ova and the turbot in the form of small immature fishes. Undismayed by unfavourable reports by various ichthyologists, a number of preliminary experiments were made in order to discover whether the rate of development of herring ova could be retarded by the employment of low

temperatures so that the eggs could be carried through the tropics and would hatch at about the end of the journey to New Zealand.

Prof. J. Cossar Ewart and Dr. H. C. Williamson made the preliminary experiments and Mr. Anderton devised the water-cooling and circulating apparatus, which was fitted up in a cold room on an ordinary commercial vessel. As fishery zoologists well know, it is not easy to collect large numbers of healthy, fertilised herring eggs, but this was successfully done at Lowestoft by Mr. Anderton, and the ova were made to adhere to glass plates, which were then transferred to the apparatus on board ship. The water was kept at a temperature a little above 0° C. and was circulated over the eggs. The experiment would have been quite successful but for a breakdown in the tank arrangements of the ship. It has not been repeated, though it is now evident that the method presents no insuperable difficulties. The young turbots and the pregnant edible crabs and lobsters were taken out to New Zealand without any difficulty and were successfully " planted " there.

So far there is no proof, however, that these species have established themselves in their new environment. The ingenuity displayed in these experiments and the eminently practical methods employed are of much interest and well deserve permanent record.

University and Educational Intelligence.

EDUCATIONAL legislation in America in 1919 and 1920 is reviewed by one of the specialists of the Washington Bureau of Education in Bulletin No. 13 of 1922. Of the many problems connected with education which have been dealt with by the State Legislatures since the war, several are, or have lately been, subjects of controversy in this country. The proportions in which the cost of supporting schools is shared between the general tax-payer and the rate-payer have been changing at the expense of the former throughout the States, " including the South, where the State, as such, is already relatively a very large contributor and where the need is rather for the further development of local educational spirit." In the State of New York the increase in appropriations for schools amounted to over twenty million dollars, which was added for the purpose of raising teachers' salaries. Texas appropriated four million dollars for the same purpose. Many of the States passed salary laws more or less on the lines of the " Burnham scales." Under an Iowa act, for example, a schedule of minima is prescribed, the lowest being 50 dollars a month, while a teacher who has received a degree upon completion of a four-year college course and holds a State certificate must be paid not less than a hundred dollars a month, and after two years of successful experience not less than a hundred and twenty. Teachers' superannuation systems are of recent origin in the United States, very few having been established earlier than the beginning of the present century. Nearly half of the States now have systems established by law for the entire State, and nearly a third have laws for certain cities only. Tendencies in recent pension laws are in general towards a larger participation of public funds in the support of the system, a more thorough application of scientific actuarial data, and more business-like administration. Extensions of the age limits of compulsory education have been effected recently in many States, the upper limit being in many cases raised to sixteen, while the lower limit is commonly seven or eight years.

Calendar of Industrial Pioneers.

August 20, 1769. Gabriel Jars died.—A native of Lyons and born in 1732, Jars acquired a practical knowledge of mining under his father, and after studying at the École des ponts et chaussées, made a long tour of inspection of the mines of England, Scotland, Sweden, Holland, Austria, and other countries, the results of his observations appearing in his " Voyages métallurgiques " published after his death.

August 21, 1884. Henry Wimshurst died.—For many years a shipbuilder at Millwall, Wimshurst was an ardent supporter of Pettit Smith in his endeavours to introduce screw propulsion, and, with the aid of friends, in 1838 he built the *Archimedes*, the vessel which first demonstrated the value of the screw for propelling ships in the open sea, and in 1839 he built the *Novelty*, the first screw steamer to make a commercial voyage.

August 23, 1836. Louis Marie Henri Navier died.—A distinguished professor of engineering, known for his mathematical investigations, Navier was an engineer in the Corps des ponts et chaussées, and at the time of his death was professor of analysis and mechanics in the École Polytechnique.

August 24, 1860. Jesse Hartley died.—The son of the master bridge-builder to the county of York, Hartley succeeded to his father's position, and in 1824 became engineer to the Liverpool docks, in which capacity he planned and executed with complete success the most extensive dock works in the world.

August 25, 1819. James Watt died.—Acknowledged to be the greatest engineer of modern times, Watt made his great discovery of the separate condenser in 1765, while engaged on the repair of a model of a Newcomen atmospheric steam engine for Glasgow University. This improvement in the steam engine was followed by his patents of 1769, 1781, 1782, and 1784, which collectively transformed a rude and imperfect contrivance into an efficient and powerful machine, providing the miner with his pump, the smelter with his blast, and the weaver with his power-house. From his early boyhood Watt was given to scientific pursuits, and all his work was the result of the application of scientific principles to practical problems. Born in Greenock, he became instrument maker to Glasgow University, and after some years of civil engineering, in 1775 entered into partnership with Matthew Boulton, the founder of the Soho Manufactory. Watt died at Heathfield House, close by Soho, and was buried in Handsworth Church.

August 25, 1862. James John Berkley died.—Trained under Bidder and Robert Stephenson, Berkley in 1849 was appointed Chief Resident Engineer of the Great Indian Peninsular Railway, and as such projected and carried through with the highest skill the line of railway from Bombay to Calcutta.

August 26, 1845. Philippe Henri de Girard died.—Famous as a chemist, a mechanician, and technologist, Girard was born on February 1, 1775, and after the French Revolution had soda factories at Marseilles and Paris. The offer by Napoleon in 1810 of a prize of a million francs for flax machinery led Girard to devise new machinery and establish flax mills, but he received no prize. After the Restoration he lived mainly in Austria and Poland, promoting steam navigation on the Danube, and carrying out extensive operations in manufactures, metallurgy, and practical engineering at Warsaw. E. C. S.

Societies and Academies.

PARIS.

Academy of Sciences, July 17.—M. Emile Bertin in the chair.—H. **Deslandres** and V. **Burson**: Researches on the atmosphere of the stars. Properties of stars which have the same radiations and the same chromospheric layers as the sun: a list of twelve stars is given, all of which show bright lines: eleven of these are yellow stars of types G and K (Harvard classification), one only is of the M_a type. These stars possess chromospheres relatively more luminous and more important than those of the sun.—Charles **Moureu** and Charles **Dufraisse**: Auto-oxidation. Anti-oxygenic power. Various phenomena relating to anti-oxygenic action. It has been shown in an earlier communication that certain substances, of which hydroquinone is the type, can prevent oxidation. The reaction between acrolein and oxygen has been studied quantitatively, when the proportion of hydroquinone present has been varied between $\frac{1}{10}$th and $\frac{1}{1\,000\,000}$th of the acrolein present; and the results given in graphical form. Various phenols are classified according to their power of retarding oxidation ("anti-oxygenic power"). A summary is given of earlier work bearing on the subject.—Maurice **Leblanc**: Lamps with three electrodes, anode, cathode, and intermediate grid where the current is carried by ions, and their applications. It is shown how these lamps can be used to transform a continuous current in an alternating current of high frequency or to transform high-frequency currents into alternating currents of low frequency.—Jules **Andrade**: Mechanical determinism and the notion of the medium; pseudo-elliptic orbits and circular orbits.—Paul **Vuillemin**: The legitimacy of the genera Laverania and Nocardia.—Jules **Baillaud**: The co-ordinates of the galactic pole, deduced from the distribution of the stars in the zone of the Paris astrophotographic catalogue.—M. **Bedeau**: The determination of the specific inductive capacity of mercury vapour. The measurements were made at a temperature of 400° C., under atmospheric pressure, utilising the method described in an earlier communication for air. Mercury vapour shows none of the anomalies proved for steam, ammonia, etc., and its specific inductive capacity is in agreement with 1·00074 deduced from Maxwell's formula.—Jean G. **Popesco**: The variation of the surface tension of mercury in gases. Employing a kinematographic method, the variation of the surface tension of mercury with time of exposure to various gases has been measured. Results are given for air, ammonia, sulphur dioxide, hydrogen, carbon dioxide, and nitrogen. In all cases there is a rapid fall in the surface tension, and the variation is of the same order of magnitude in all the gases, about 5 per cent. reduction in 10 seconds, increasing to about 24 per cent. after 24 hours' exposure.—M. **Lindsay**: The limits of the L absorption of elements Ba, Cs, I, Te, Sb.—R. de **Mallemann**: Rotatory polarisation and molecular orientation.—Pierre **Lambert** and A. **Andant**: An arrangement for depositing films of metal on large surfaces by cathodic projection. The use of greased ground joints is avoided by using a double bell jar. Both jars are exhausted down to about 10 mm., and the evacuation of the inner jar, containing the cathode and object to be silvered, is completed by a Gaede pump.—Ch. **Fabry** and H. **Buisson**: The curve of the distribution of energy in the ultraviolet part of the solar spectrum.—M. **Duffieux**: The mass of the particles which give the spectrum of carbon monoxide. The bands are emitted by particles the masses of which are in the ratio of 16 : 12, and hence are not due to the molecule CO but to its decomposition products, the free atoms of carbon and oxygen.—Paul **Mondain-Monval**: The preparation of ammonium chloride at a low temperature.—A. Ch. **Vournazos**: Mixed complex antimoniodobromides. Several complex salts have been isolated, of which the sodium salt $Na(SbBrI_3)$ may be taken as the type.—L. J. **Simon**: The chromic oxidation of the homologues of acetic acid. A comparison of the oxidising effects of the two mixtures, sulphuric acid, chromic acid, and sulphuric acid, silver chromate upon eleven fatty acids. These acids are only partially converted into carbon dioxide and water by the chromic acid mixture, but are completely burnt when silver chromate replaces chromic acid.—Maurice **François** and Louis Gaston **Blanc**: A method of preparing the iodomercurates of the alkaloids in a crystallised condition.—A. **Wahl** and R. **Lantz**: The 2-oxy-1-arylnaphthylamines.—Louis **Longchambon**: The rotatory power of crystals and molecular rotatory power.—René **Abrard**: The presence of *Nummulites variolarius* in the Cresnes, Marines, and Ruel sands and their signification.—P. **Lavialle** and J. **Delacroix**: The wall of the pistil and fruit in the genus Euphorbia.—J. **Athanasiu** and L. **Bull**: The registration of the longitudinal vibrations of muscle during voluntary contraction.—Pierre **Girard**, W. **Mestrezat**, and **Li-Shou-Houa**: A physical view of the selective permeability of living cells for different ions.—Mlle. Marthe **Giroud**, Gaston **Giroud**, and L. **Parès**: Experimental researches on the genesis of the hæmoclasic crisis of intensive irradiations.—L. **Panisset**, J. **Verge**, and E. **Grasset**: The fixation-reaction in the diagnosis of tuberculosis in cattle. The Bordet-Gengou method may be applied to the diagnosis of tuberculosis of milch cows.—M. **Denucé**: The treatment of congenital dislocation of the hip.

Official Publications Received.

Abisko Naturvetenskapliga Station. Observations Météorologiques à Abisko. Situé par 68°20′,5 Lat. Nord et par 18° 49′,3 Long. Est. By Bruno Rolf. En 1913. Pp. xvi+76. En 1918. Pp. ii+74. En 1919. Pp. ii+75. En 1920. Pp. iii+76. (Uppsala: Almquist and Wiksells Boktryckeri A.-B.)

Department of the Interior: Bureau of Education. Bulletin, 1921, No. 27: Training for Foreign Service. Compiled by Glen Levin Swiggett. Pp. vi+154. (Washington: Government Printing Office.) 15 cents.

Memoirs of the Bernice Pauahi Bishop Museum. Vol. 8, No. 3: The Grasses of Hawaii. By A. S. Hitchcock. Pp. 132+5 plates. Vol. 8, No. 4: Bayard Dominick Expedition, Publication No. 2: A Contribution to Tongan Somatology. By Louis R. Sullivan. Pp. 30+4 plates. (Honolulu: Bishop Museum Press.)

Occasional Papers of the Bernice Pauahi Bishop Museum of Polynesian Ethnology and Natural History. Vol. 7, No. 12: Notes on Hawaiian Zonitidæ and Succineidæ. By C. Montague Cooke, Jr. Pp. 17+2 plates. Vol. 7, No. 13: Stomatopoda in the Bernice P. Bishop Museum. By Chas. H. Edmondson. Pp. 24. Vol. 7, No. 14: Dermaptera and Orthoptera of Hawaii. By Morgan Hebard. Pp. 76+2 plates. Vol. 8, No. 2: Hawaiian Dromiidæ. By Chas. H. Edmondson. Pp. 10+2 plates. Vol. 8, No. 3: Proverbial Sayings of the Tongans. By E. E. V. Collocott and John Havea. Pp. 118. Vol. 8, No. 5: Report of the Director for 1921. Pp. 39. (Honolulu: Bishop Museum Press.)

Union of South Africa: Department of Agriculture. Bulletin No. 2: Pear Scab in the Western Province. Experiments and Facts relating to its Control. By V. A. Putterill. Pp. 31. (Pretoria: Government Printing and Stationery Office.) 3*d*.

Department of Statistics, India. Agricultural Statistics of India, 1919–20. Vol. 2: Area, Classification of Area, Area under Irrigation, Area under Crops, Live-Stock, and Land Revenue Assessment in Certain Indian States. Pp. iv+v+192. (Calcutta: Government Printing Office.) 1·8 rupees.

Bihang till Meteorologiska Iakttagelser i Sverige, Band 60, 1918: Termosynkroner och Termosokroner på den Skandinaviska Halvön. By H. E. Hamberg. Pp. 39+15 plates. (Stockholm: Almquist and Wiksells Boktryckeri A.-B.)

U. S. Department of Agriculture: Weather Bureau. Monthly Weather Review. Supplement No. 20: An Aerological Survey of the United States. Part 1: Results of Observations by Means of Kites. By Willis Ray Gregg. Pp. iv+78. (Washington: Government Printing Office.)