THURSDAY, SEPTEMBER 25, 1913.

ELECTRICAL STANDARDS.

Reports of the Committee on Electrical Standards appointed by the British Association. Pp. xxiv + 783 + 10 plates. (Cambridge: University Press, 1913.) Price 12*s.* 6*d.* net.

THE reissue by the Cambridge University Press of the annual Reports of the Committee on Electrical Standards, with Mr. F. E. Smith as editor, has placed in our hands in a convenient form an extremely interesting chapter of the history of scientific research in this country. The committee was first appointed in 1861, as the outcome of a paper on the subject by the late Sir Charles Bright and Mr. Latimer Clark. At that time no generally recognised system of electrical units existed, and its initial object was to decide on the most convenient unit of resistance and embody it in a material standard. Its first members were Profs. W. Thomson, Williamson, Wheatstone, and Miller, Dr. Mattiessen, and Mr. Jenkin. Seven other members, including Profs. Maxwell, Stewart, and Dr. Joule, were added in 1863, and four others, including Prof. C. Foster and Mr. Hoskin, in 1867.

During the first eight years of its existence the committee displayed great activity, its first six annual reports covering 290 pages of the book, the contributions of the members named being especially prominent. As a result a unit equal to 10^9 cm. per second had been adopted, and named at first the Ohmad and subsequently the Ohm. This had been embodied in wires of several materials, and in a column of mercury of a square millimetre section and 104·85 cm. long. In its seventh report in 1870 the committee complained of the difficulty of getting its many members together, and of the remissness of its subcommittees, and suggested that the further problems of selecting units of capacity, difference of potential and current, and the construction of standards, be dealt with by new committees. Neither the old committee nor the suggested new committees were appointed, however, until 1880, when other measurements had cast doubt on the accuracy of the committee's ohm, and four of its original members, and nine others, were constituted the re-appointed committee charged with the construction of standards of resistance, capacity, and electromotive force.

For the next twenty years the activities of the committee centred round the Cavendish Laboratory at Cambridge, where under Lord Rayleigh the value of the old ohm was shown to be more than 1 per cent. too low, and under Dr. Glazebrook a systematic comparison of the various copies of the ohm was kept up for many years as a test of their relative permanency. Standard capacities were also constructed, but the middle years of this period were chiefly occupied with the Clark cell as the standard of electromotive force. The end of the period brought the question of the measurement of current by the "current balance" to the fore, and for the next decade the work of the committee was centred in the National Physical Laboratory, and fell largely on the shoulders of Mr. F. E. Smith. Under the new conditions the order of accuracy of the results obtained was rapidly increased, and at the present time measurements of electrical resistance, current, and electromotive force can be made in terms of the international units with an accuracy of about five parts in 100,000.

The work of constructing practical electrical standards for which the committee was appointed fifty years ago has therefore been achieved, and each of the twenty-two members who formed the committee last year when it dissolved, may look back with satisfaction to his share in an advance of national and international importance.

The book is well printed, the type used is larger than that of the British Association Reports, and the spacing between the lines is somewhat greater. The index covers ten pages, and much facilitates the use of the work. A list of the whole of the members of the committee, with their years of service, is given in the introduction, but the familiar headings to the reports with the names of the members, and the specification of the chairman and secretary, have been omitted, much to the present writer's regret. C. H. L.

TRADE WASTE WATERS.

A Text-book on Trade Waste Waters: their Nature and Disposal. By Dr. H. Maclean Wilson and Dr. H. T. Calvert. Pp. xii + 340. (London: C. Griffin and Co., Ltd., 1913.) Price 18*s.* net.

MANUFACTURING prosperity implies the increasing production of trade waste waters, and the increased pollution of our rivers unless the greatest care is taken to utilise or minimise such waste, or processes of purification more efficient than many of those in general use are adopted.

In north and central England the problems attendant upon the utilisation or purification of waste liquors are numerous and of special importance, but there are few districts in this country where difficulties do not occasionally arise. The authors of this work, as chief officials of the West Riding

of Yorkshire Rivers Board, have had ample opportunity of gaining experience, and they have turned this to good account, having placed the results of their labours and observation at the disposal of all who are interested in the subject. The trades dealt with are so numerous and so varied in character that it has been apparently impossible to describe any process of purification of wide applicability, hence the trades are dealt with separately, and in most cases exhaustively.

The detailed illustrations of different kinds of purification plants are numerous, and greatly enhance the utility of the work. Wherever it has been found possible to utilise a waste liquor, and such cases will become more and more numerous as greater care is taken to improve the condition of our rivers, the results actually obtained are given. Upon occasions it is found that one waste liquor may be used for purifying another, in itself a process of utilisation, and upon others that by modifying a process or improving a plant the amount of waste could be markedly decreased. The authors' experience, moreover, is not limited to this country, since they have visited Germany and France to see processes actually at work, and they have availed themselves of the evidence given before Royal and other Commissions.

The book is therefore thoroughly up to date, but excellent as it is it does not solve, nor does it pretend to solve, all the difficulties with which local authorities have to deal. For example, the writer is now attempting to deal with the waste liquor from a "producer" gas plant, in which gas is made from sawdust and wood-shavings. He naturally hoped to obtain assistance by consulting this work, but the information available is too meagre. An excellent feature of the book is that it describes the origin and nature of the polluting waste liquors dealt with, and then sets out the means which have in actual practice been found most successful in dealing therewith. At the end of each section is a bibliography, which is particularly useful.

The authors are to be congratulated upon having produced a work which was urgently required, and will be as useful to the manufacturers as to sanitary authorities and their officials. It becomes increasingly obvious as our knowledge of trade processes is broadened that a great deal of the river pollution which now takes place is easily preventible, and it is to be hoped that one of the results of making this special knowledge more accessible will be to encourage both manufacturers and local authorities in their endeavours to take such steps as will tend to restore our rivers and streams to something like their pristine condition of purity.

ENGINEERING MANUALS AND TEXT-BOOKS.

(1) *A Course of Elementary Workshop Drawing.* By H. A. Darling. Pp. 172. (London: Blackie and Son, Ltd., 1913.) Price 1*s.* 6*d.*

(2) *A Text-book on Field Fortification.* By Colonel G. J. Fiebeger. Third edition. Pp. ix + 155 + xxvii plates. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1913.) Price 8*s.* 6*d.* net.

(3) *Machine Construction and Drawing.* By A. E. Ingham. Pp. xii + 143. (London: George Routledge and Sons, Ltd., 1913.) Price 1*s.* 6*d.* net.

(4) *Earthwork Haul and Overhaul, including Economic Distribution.* By Prof. J. C. L. Fish. Pp. xiv + 165. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1913.) Price 6*s.* 6*d.* net.

(5) *Continuous Beams in Reinforced Concrete.* By Burnard Geen. Pp. iv + 210. (London: Chapman and Hall, Ltd., 1913.) Price 9*s.* net.

(1) THIS work on elementary drawing is well arranged and concisely written. It takes the student up to (but not including) intersection of solids, and leaves him there with a crop of good ideas regarding the use of familiar drawing instruments, and the elements of orthographic projection and isometric drawing. The catechisms in the form of elementary exercises throughout the book are a useful addition. Works on this subject are seldom charged with a sufficient supply of such examples. The chapter on "full-size drawing" is a commendable innovation, for much work is laid out on a floor full size in a workshop, and a knowledge of how to lay out designs in this manner forms a part of the work in a structural iron works or boiler shop, while for a moulding loft it is especially necessary. It would have been preferable if more space had been devoted to orthographic projection, and less to isometric projection. Moreover, the student finds it easier to proceed to the latter from the former, and too much time cannot be spent in assisting the learner to think in three dimensions. This little book should commend itself to teachers in elementary mechanical drawing.

(2) This edition is entirely re-written to bring it up to date, the more necessary as the science of field fortification expands with the experience derived from modern wars. The precision and penetrating power of the firearm to-day have raised the duty of the sapper to an importance now fully recognised, and instruction in the rapid construction of shelters for an army is one of the principal features of military science and engineering. The

author, who is professor of civil and military engineering at the Westpoint Military Academy, draws extensively upon the experience gained in recent wars, as far back as the American Civil War, and up to the Russo-Japanese war. In this period much has taken place to modify field works and entrenchments, and the art of concealment due to the use of smokeless powder becomes one of the characteristic features of military field work. It would be impossible to follow the author through the various types of entrenchments, breastworks, embankments, stockades, palisades, revetments, blockhouses, and buildings, that he describes and illustrates. It is all clearly set forth in short, if somewhat disjointed, sentences. The chapters on passage of rivers and military demolitions contain little that is new, but there is quite enough new material in the book without expecting something fresh on every page. The work should prove to be valuable to the student of military science.

(3) In the preface the author states his intention of providing a course of training in machine construction and drawing, not only to conform to the requirements of actual workshop practice, but to provide approximately a year's work in the evening technical school. This he has done by rendering numerous examples of parts of machines, reserving for each general type a separate chapter, the first four chapters being devoted to such elementary matters as nuts, bolts, screws, and riveted joints. The student is supposed to have a fair acquaintance with mechanical drawing before entering on the subjects in this book. The machine details and examples are of the usual pattern.

(4) Perhaps a more descriptive title for this book would be one which conveyed the impression of economical operations in excavations and fillings for railways, for such is the matter of which it treats. The term "overhaul" is employed to describe a distance of hauling excavated materials in excess of a specified distance on the basis of which the contract is let. Overhaul is the product of the number of cubic yards hauled by the average overhaul distance. The unit of haul used throughout the work is the station-yard, the station being a distance of 100 ft., and the volume the cubic yard. By taking cross-sections of cuts and fills mass curves are drawn, due allowance being made for the "swell ratio," or the increase in bulk resulting from moving the material from its initial position to a fill. The engineer and contractor would derive much condensed information from the examples that are worked out, showing for different cross-sections the most economical way of handling the material. Such problems are, however, capable of indefinite variations, but the author has covered the ground by illustrative types which point the way to solutions in special cases.

(5) In the form of diagrams information is set forth for the rapid calculation of the maximum possible bending moments, vertical and horizontal shearing forces, and stirrups or binding for any number of equal continuous spans with any possible arrangement of loading of complete spans for all types of loading generally met with in practice. The work contains sixty-nine diagrams besides tables, and the bending moments and shear for continuous girders up to five spans are shown. It would have added considerably to the value of the work if scales had been put to all the diagrams; as it is, some of them are bare, without any scales or reference marks. They are very instructive as showing the variation of bending moment and shear in continuous beams, and are capable of wide application.

DIET AND HEALTH.

(1) *Health Through Diet: A Practical Guide to the Uric-Acid-Free Diet.* By Kenneth G. Haig. With the Advice and Assistance of Dr. Alexander Haig. Pp. x+227. (London: Methuen and Co., Ltd., n.d.) Price 3*s.* 6*d.* net.

(2) *The Elements of Heating and Ventilation.* A Text-book for Students, Engineers, and Architects. By Prof. A. M. Greene, jun. Pp. vi+324. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1913.) Price 10*s.* 6*d.* net.

(3) *Chloride of Lime in Sanitation.* By A. H. Hooker. Pp. v+231. (New York: John Wiley and Sons; London: Chapman and Hall, Ltd., 1913.)

(1) THIS little volume is most practical in its treatment of problems of diet. The author approaches the subject with such wholehearted enthusiasm that he equals, if not excels, that of his father, whose work he continues and extends. The rules emphasised as to selection of food are to secure ample proteid, and a preferential position for this in making up a dietary, so that digestion shall not be previously weakened by any less valuable constituent.

Four classes of food are given, the above coming first, then the cereals, then a mixed group of fruits and vegetables with the vegetable and animal fats. Lastly foods containing no nourishment (proteid)—tapioca, arrowroot, and commercial cornflour. Two meals a day are recommended, the optima being 11.30 a.m. and 7.30 p.m., though the author admits practical difficulty in the former.

An interesting claim made is that the use of hard water causes visceral retention of uric acid. The rheumatism of peasants using but little meat in certain districts of Ireland, Wales, and Scotland he attributes to the abuse of tea, and in a lesser degree to exposure to cold. In referring to the "frugivorous teeth" of man it is suggested that the proneness to decay may be in the nature of a penalty for attempting to use these as "carnivorous" organs. No mention is made here of the dentists' opinion that the essentially decay-producing foods are those "claggy" with local acid fermentation to follow, *e.g.* the bun and glass of milk at night.

(2) This work will appeal especially to the engineer, as the author has endeavoured throughout to give the data and laws required in designing to any specification. Following American practice, very low outer temperatures are reckoned with, such as 0° F. as lasting some days.

The temperatures set forth as optima for various kinds of room are higher than those in use in this country. Thus a hospital ward is taken at 72° F., and rooms, offices, and laboratories at 70° F. Chimneys—other than furnace-flues—appear to be unknown, implicit reliance being placed on a combination of air warming with induction or exhaustion methods.

The section dealing with the flow of air in ducts is well considered, and the anemometer is recommended for velocities not exceeding 1500 ft. per minute. After reviewing the Pitot, Venturi, and orifice devices the author mentions a novel and ingenious method depending on the increased temperature found after using a known amount of electrical energy, and so from this arriving at the mass of the air so warmed.

The criterion adopted for purity of the air is the old chemical standard of carbonic acid, where, taking 4 per 10,000 as low, 11 as causing oppression, 7 is taken for those ill, and 15 permissible in a group of healthy persons. An estimation apparatus in portable form, adapted for accurate work with small amounts of air, is illustrated and described, and appears likely to give good results as the pressure correction is simple and delicate.

Humidity has to be considered where air is artificially warmed, and various forms of apparatus are shown, though the hot-air system outlined at the commencement appears to have none. Prof. Greene points out the objectionable features of both extremes, but does not realise how, to English ways of thinking, the dryness is usually overdone. He points out a weak point in Mason's hygrometer, namely, its inaccuracy in still air, but the sling instrument shown does not impress one as practicable for average observers.

The discussion of the wet-bulb temperature and its cause for exceeding the dew-point is lucid and interesting. Carrier's work showing the mode of warming the wet bulb by heat rendered sensible is quoted briefly. After alluding to the disturbance of the mucous membranes by exposure to air itself too dry, no reference is made to the well-known feelings of malaise and depression brought about by life in a system of manipulated air monotonous in character. No matter what may be the carbonic-acid content, the normal cutaneous stimulus is lost.

(3) The author of this monograph is the technical director of a large American electrochemical company. The work falls into two portions: (1) The text—in which is a general description of the substance and its mode of action. This is continued by accounts of six main applications to public health work, thus: Water purification, sewage disinfection, street flushing, medical and surgical uses, agricultural, house-fly campaign (68 pp.). (2) A series of summarised references and reports dealing very fully with American practice, but which also includes many quotations from English publications (154 pp.).

The mode of its action being essentially that of oxidation is well stated, and the confusion with chlorine preparations pointed out.

The relative unsuitability of copper sulphate additions to polluted water destined for animal consumption is well brought out in the account of the Chicago stockyard and the sewage-contaminated waters of Babbly Creek. The animals were found to thrive less than when allowed to drink city water. The change was made to hypochlorite treatment, with the result that a purer water organically was obtained than from the city mains by some thirty-seven times less *B. coli* frequency.

Limits to the powers of hypochlorite are given on pp. 22 and 23. But though small in quantity, it should be clearly shown that some increase in hardness is inevitable in the water treated by it.

The volume concludes with an admirable index arranged separately under subjects and names.

OUR BOOKSHELF.

The Under Dog: a Series of Papers by Various Authors on the Wrongs Suffered by Animals at the Hand of Man. Edited by S. Trist. Pp. xv+203+v. (London: *Animals' Guardian* Office, 1913.) Cloth, 3*s.* 6*d.*; paper, 1*s.*

APART from the main title, which is much more suitable for a novel, and utterly fails to convey the faintest inkling as to the nature of its subject, the editor and authors of this volume are to be con-

gratulated on the fair and temperate manner in which they have brought their case before the court of public opinion. Pain and suffering are unfortunately inseparable from the lot of many kinds of domesticated animals, as well as of those wild species which are hunted for sport or for their spoils; but it is the bounden and paramount duty of all civilised nations to see that these are reduced to the smallest possible minimum. Those who read this book—and it is, for the most part, at any rate, very painful reading—will, however, be convinced that even in our own country matters too often are by no means as they should be in this respect. In fact the authors have, unhappily, in many instances, a very strong, and in almost every instance a very sad, case; and it is sincerely to be hoped that their book may be the means of bringing to pass a better state of affairs in regard to our treatment of the lower animals in such cases as amendment and amelioration are most urgent and at the same time practicable. Apart from the ruthless slaughter of birds for their plumage—accompanied too frequently by the lingering starvation of their helpless young—one of the worst and most pitiable cases in the whole sad story is the treatment meted out to worn-out horses; and it must indeed be a hardened heart which is not rent by the illustrations depicting these wretched animals on their last journeys. Fortunately, several European Governments are already awake to the need of stringent measures to remedy this crying evil, and we trust the present volume may give a further stimulus to their efforts. R. L.

Les Moteurs Thermiques dans leurs Rapports avec la Thermodynamique. Moteurs à explosion et à Combustion. Machines Alternatives à Vapeur. Turbines à Vapeur. By F. Moritz. Pp. vi+297. (Paris: Gauthier-Villars, 1913.) Price 13 francs.

In writing this book on heat engines the author has divided very unequally the space given to engines operating with external combustion and those in which combustion takes place inside the cylinder. By far the larger part is given up to the steam engine, and particularly the steam turbine. As is usual in French books, mathematical analysis is the natural line of approach to any difficult problem, however obscure the relationship of theory and practice. The book is divided into six chapters, of which the first two relate to the laws of thermodynamics—and a very careful and complete statement of them is given—to gaseous cycles and to a concise explanation of what is meant by entropy.

The twenty-five pages of chapter iii. are made to suffice for the application of preceding theory to the gas engine, and as a natural consequence of such compression the conclusions reached are incomplete. The gaseous mixture used in the gas engine is throughout assumed to have a specific heat quite independent of all temperature changes—an assumption which naturally removes almost all practical value from any conclusions which may be arrived at on theoretical grounds. The chapter concludes with the following quaint suggestion:—"On peut en tirer des conclusions practiques intéressantes, par example, sur l'influence de la circulation d'eau autour des cylindres. Nous laissons au lecteur le soin de faire cette comparison pour tous les cas qui peuvent se présenter à lui."

Chapters iv., v., and vi. (some two hundred pages) are given up to piston steam engines and steam turbines. The author shows much skill in his analysis of the theory of jets and of turbine flow; he treats very fully also of turbine leakage, and uses freely the entropy diagram to illustrate his meaning. Students of the steam turbine will find M. Moritz' book both interesting and stimulating.

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 Spectra of Helium and Hydrogen.

With regard to Mr. Evans's communication to Nature, September 4, p. 5, I should like to remark that while I have for some time recognised that the experimental evidence, on the whole, seems to be in favour of helium as the origin of the new lines 4686, &c., it should not be too hastily concluded that they are not due to hydrogen. Mr. Evans appears to have succeeded in eliminating the ordinary spectroscopic indications of hydrogen from his helium tubes, but is it not possible that, under the special conditions of the strongly disruptive discharge, with helium also present, residual hydrogen may be represented only by the new lines? This would not be the only known case in which the presence of helium aids the development of the spectrum of another gas with which it is mixed. I have observed this effect in the case of the series of bands of carbonic oxide which are characteristic of the tails of comets; these bands are of very feeble intensity at the low pressures necessary for their approximate isolation in the spectrum of the pure gas, but I have seen them greatly intensified when carbonic oxide was present as an impurity in helium. Also, the Ritz series of infra-red hydrogen lines was found by Paschen to be brighter in a mixture of hydrogen and helium than in hydrogen alone. Apart from this, I find it difficult to believe that the close agreement of one set of lines with the principal series calculated for hydrogen by Rydberg is merely accidental.

Dr. Bohr's theory (*Phil. Mag.*, July, 1913) does not at present seem to me to give much evidence for helium, in preference to hydrogen, as the origin of the lines in question. The formula derived from the theory gives no better agreement with the observations than that of Rydberg, so far as the two are comparable, and apparently requires that the seven observed lines, beginning with 4686, should be capable of arrangement in a single series. I think, however, that the lines cannot be so united within the limits of error of observation, though very nearly so, and I believe that my separation into two series converging to the same limit is correct. The necessity for two series is rather more clearly indicated in the case of the analogous series of magnesium spark lines

which I have lately described (Proc. Roy. Soc., vol. lxxxix., p. 133). Moreover, the merging of two such series into one formula is open to the objection that it involves multiplication by 4 of the series constant, which would otherwise be universal. It may be possible, however, to test this point by observations of the Zeeman effects on the lines, and I shall make this experiment at the first opportunity.

I may add that experiments made by Prof. Strutt and myself are in harmony with those of Mr. Evans in showing that the lines under consideration do not occur in mixtures of hydrogen with neon or argon.

A. FOWLER.

Imperial College of Science and Technology, South Kensington, September 13.

The Elephant Trench at Dewlish—Was it Dug?

THE Rev. Osmond Fisher makes the interesting suggestion that the curious trough at Dewlish, in which numerous remains of *Elephas meridionalis* were found, was an artificial trench, dug as a sort of pitfall to intercept and disable wild animals driven across it. Perhaps, as having seen the excavations made by Mr. Mansel-Pleydell, I may say a word on this point.

Open trenches in the soft chalk are unknown elsewhere, though they are common enough in the hard mountain limestone. I therefore examined this trench most carefully, in order to find out how it had originated, and whether man had had anything to do with it. I am still much puzzled as to its exact mode of excavation; but certain peculiarities convinced me that it was due to natural agencies, and that it was probably cut by the swirl of the fine dust-like quartz-sand which, mixed with polished flints, now fills its lower part. I could find no implements, and could nowhere see traces of pick marks. The sides of the trench, where not damaged by the workmen who had just cleared it, were curiously smooth; but the flint-nodules projected into the cavity from either side, as though the softer chalk had been scoured away. The abrupt rounded end of the trench was most peculiar, and as I cleaned this out myself, dusting away the sand from the smoothed face of the chalk, I am sure that there were here neither tool-marks nor rubbings such as might be made by a man working in the trench, or by wild beasts. In short, the smooth, rounded contours suggested the eddying of wind, and the absence of any crack or joint showed that here at any rate the rounding was not likely to be due to percolating water.

Beneath the elephant bones, which occurred in a layer a few feet down, the infilling of the trench seems to be a fine dust-like, unfossiliferous sand, which was not bottomed, as Mr. Mansel-Pleydell's excavations were made primarily to obtain elephant remains, and these were in such a soft condition as to make removal almost impossible. If this sand-filled fissure is found to continue downward, but is too narrow for a man to work in, it will show that the trench is not artificial. I could only just squeeze past in one or two places; but the upper part of the trench was passable; I think, however, that it tended to narrow downward, but at the time of my visit the bones had not been removed, and I could not excavate below them.

Perhaps someone acquainted with plateaus of soft limestone under desert conditions can say whether there is any tendency for the wind to cut trenches with rounded blind ends, such as the Dewlish trench has. In this connection, it is worth noting that our newer Pliocene land-faunas show distinct indications of drier and more sunny conditions than we have at present. A gazelle, an antelope, and several land and fresh-water mollusca point in that direction. Under dry conditions, and before the loose flints were swept away during the glacial period, our chalk-downs would probably be stony deserts, quite unlike the green hills we now see.

CLEMENT REID.

Milford-on-Sea.

Red-water Phenomenon due to Euglena.

THE red-water phenomenon due to a Euglena described by Prof. Dendy in NATURE of August 7 has been observed by me in Pretoria. In this case, however, the Euglena swims freely about in the water, and also forms a red gelatinous scum on the surface of the damp mud on the side of the pond. In swimming they seldom show euglenoid movement. A flagellum longer than the body can be easily seen under the microscope at the anterior end of the body, but it always trails along the body with lashing movements. If they become stranded on the mud at the edge of the pond, they soon become spherical and encysted in a mucilaginous covering much wider than the body and showing a layered formation. I have not observed any bubbles of gas given off, although I have kept large quantities of them under observation for long periods. They appear to prefer the encysted form, as they always swim to the edge of the vessel towards the light and form a deep red line along the edge, which gradually becomes dry. If more water is added and the vessel turned round, they will leave their cysts and again swim towards the light side. They are of a fairly large size, and have a cylindrical body tapering to a sharp point at the posterior end, where the last portion is free from pigment. Chlorophyll is present, and is easily seen amongst the red in those that have just come out of the encysted stage, but later on it entirely disappears.

HORACE A. WAGER.

Transvaal University College, Pretoria.
August 30.

Distance of the Visible Horizon.

MR. W. MOSS's account in NATURE for August 7, p. 583, as to how to get the area of a sphere theoretically visible at any altitude is interesting; but can he, or any of your readers, say what the formula is for obtaining the distance actually visible with an average amount of refraction? So far as I can discover, all ordinary books of tables ignore this, although such a table would be very useful.

A table is given in Chamber's Mathematical Tables, p. 436, for the distance of the visible horizon, but the explanation, p. xl., states that this is theoretical, and that a correction for refraction should be made, although nowhere is any table or formula given for such correction.

T. W. BACKHOUSE.

West Hendon House, Sunderland.
September 6, 1913.

ATMOSPHERIC refraction is such a varying quantity that no rule respecting it can be laid down applicable in all circumstances; as in cases of mirage, for instance, where vessels below the horizon are seen standing above it, and turned upside down. The refraction of the sea horizon is the great difficulty in obtaining correctly the position of vessels at sea. This can be eliminated in most cases by taking observations of the heavenly bodies to opposite sides of the horizon; for latitude in a north as well as in a south direction; for longitude in an east as well as in a west direction. When only one heavenly object is available this is not always practicable, but it can be done when the altitude is 60° or upwards.

In the appendix to Captain Parry's "Arctic Voyage, 1821–3," p. 187, some observations of the sea horizon by Mr. Fisher are given. He found a variation of 18° in the Arctic region, the ice horizon being elevated in summer and depressed in winter. The variation of the place of the apparent horizon, as a question of unequal temperature, was discussed generally by M. Biot in 1809. But no detailed observations on the subject have, so far as I am aware, been yet made.

The correction for refraction in obtaining the heights of mountains by angles of depression to the water-line of points or lighthouses, or by angles of elevation from points the height of which has been ascertained, is taken empirically, in nautical surveying, as $\frac{1}{12}$th the distance of the object observed. The results thus obtained are fairly accurate. For instance, when surveying the Gulf of Suez in 1871, the observations from the summit of Jebel Hooswah gave the results shown in the accompanying table.

T. H. TIZARD.

Place of observation	Object observed	Angle of elevation	Angle of depression	Refraction + or − ½ dist.	Corrected angle	Dist.	Diff. of level	Height of: Object observed	Height of: Theod.	Dip.	Corrected height: Place of observer	Corrected height: Object observed
			° ′ ″	′ ″	° ′ ″	′						
Summit of Jebel Hooswah	Water line of Tur point...	—	1 27 30	+1 21	1 28 51	16·38	2573	0	5 ft.	237	2331	0
	,, at Tur	—	1 20 0	+1 31	1 21 31	18·24	2633	0	,,	292	2336	0
	,, Marabut point	—	3 57 0	+0 27	3 57 27	5·48	2303	0	,,	26	2272	0
	,, point this side of Marabut	—	4 1 0	+0 26	4 1 26	5·35	228-	0	,,	24	2258	0
	Water line to the right ...	—	4 49 0	+0 23	4 49 23	4·60	2358	0	,,	19	2334	0
	,, of station point	—	16 12 0	+0 6	16 12 6	1·30	2295	0	,,	1	2289	0
	,, of another point with station ...	—	11 18 0	+0 9	11 18 9	1·85	2246	0	,,	3	2238	0
	Water line of another point	—	8 54 40	+0 12	8 54 52	2·40	2287	0	,,	5	2277	0
	,, by Asses ears..	—	6 14 0	+0 17	6 14 17	3·48	2311	0	,,	11	2295	0

Mean height 2292 ft. Max. height observations 2336. Minimum 2238. Range 98 ft.

For greater distances and heights the angles from and to Jebel Serbal may be given as follows:—

Summit of Jebel Serbal	Water line of Gharib lighthouse	—	2 6 0	+2 47	2 8 47	33·48	7623	0	,,	989	6629	0
	Water line of Zaffarana lighthouse	—	1 28 0	+4 53	1 32 53	58·55	9613	0	,,	3025	6583	0
	Point to south-east of Zaffarana lighthouse ..	—	2 25 0	+2 24	2 27 24	28·9	7533	0	,,	737	6791	0
	Abu Zenina point	—	1 58 0	+3 07	2 1 7	37·33	7994	0	,,	1230	6758	0
	Water line Tur Spit ...	—	2 42 0	+2 4	2 44 4	24·90	7225	0	,,	551	6669	0
	Summit of Jebel Hooswah	—	2 30 0	+1 29	2 31 29	17·92	4801	2292	,,	285	6803	2292

Mean height 6706 ft. Max. 6803. Min. 6583. Extreme range 220 ft.

The Undagraph.

LAST week the Dominion Astronomical Observatory installed at Chebucto, near Halifax, Nova Scotia, a wave-counter, which I have called an "undagraph." The site, a granite cliff 110 ft. high, on which is a lighthouse, faces the broad waters of the Atlantic. The coast hereabouts is bold and rocky.

Modern seismographs record tremors of the earth—microseisms—not attributable to earthquakes, and investigators have traced them to the action of the sea during storms. These microseisms manifest themselves particularly markedly in Ottawa and in Europe from autumn to spring, *i.e.* during the winter or stormy season. Their period ranges, say, from four to seven seconds, and the greater the storm or steeper the gradient of the "low" on the water along the coast, the greater is the amplitude of the microseisms.

In order to correlate the period of the waves of the ocean which pound upon the coast with the period of the microsiesms, the above instrument has been installed. It may be mentioned that a trial instrument was made for the International Seismological Association by the Cambridge Instrument Company, and installed on the pier at Newcastle-on-Tyne. It did its work, but the position is not suitable for the purposes of correlation. The west coast of Ireland or of Norway would have been better. However, practical difficulties stood in the way for utilising either for the trial instrument. The present instrument, made by the same company, has been improved on the former, but has as yet no contrivance for registering the height or magnitude of the waves, which is so very desirable.

The principle of the instrument is very simple. It is based on Boyle's law, PV = constant. An iron pipe —in our case 625 ft. long—is led from the instrument, the diaphragm part, to and into the ocean to a depth beneath the trough of the assumed highest waves at low tide, say 15 ft. The sea-end of the pipe is open. The wave passing over it causes the water to rise in the pipe and compress the air beyond, whereby the leather diaphragm is raised, and electric contact is made. By means of the armature of an electro-magnet a toothed wheel is pushed forward, one tooth for every wave, and with one revolution, or 120 waves, the recording pen returns to its zero. The record presents a series of finely serrated oblique lines, each representing 120 waves. Clockwork with pen traces at the edge of the paper a time scale, making a break every hour, the linear measure of which is 6 cm. A fresh roll of paper is put on once a week. A small leak is provided in the diaphragm chamber, to cut out the effect of the slowly rising and ebbing tide, which, however, does not affect the rapid action by the waves.

The sea-end of the pipe gives the most anxiety, as it has to resist the immense force of the waves during storms. The greater part of the 625 ft. is of half-inch galvanised iron pipe, while the ocean end, about 100 ft., is of four-inch pipe, with reducing pipes between the preceding two. The bedding of the submerged part will be in about four tons of concrete

with iron girders surrounding the pipe. The whole subject is so new that we have to feel our way in this investigation. Here in Ottawa, three hundred miles from the nearest sea-coast, we have in a general way correlated microseisms recorded by the seismograph with the storms along the Atlantic coast from Cape Hatteras to St. John's, Newfoundland, a distance of 1500 miles, so that for an exhaustive study there should be quite a number of undagraphs installed. However, a beginning has been made at Chebucto, distant in an air-line about 620 miles from Ottawa, and the results will be published as soon as available.

OTTO KLOTZ.

Dominion Astronomical Observatory,
Ottawa, September 5.

Geographical Distribution of Phreatoicus.

THE occurrence of the isopod Phreatoicus in a fresh-water stream near Cape Town, in South Africa, as recorded in your issue of June 12 by Mr. Keppel H. Barnard, is of very considerable interest from the point of view of the geographical distribution of the group. Since I described the first species of the genus in 1884 our knowledge of this group has grown very rapidly, and there are now known three species of Phreatoicus in New Zealand, two subterranean and one from surface waters, and several species grouped under allied genera from Australia and Tasmania. The genus is shown both by its generalised character and by its distribution to be an ancient one. I have long considered that it is probably a fresh-water form that has developed in subantarctic lands, and its discovery in South Africa seems to confirm this. In New Zealand it appears to be confined to the more southerly portion, but it was not found in the subantarctic islands to the south of New Zealand when these were visited in 1907. It should, however, be looked for in other subantarctic islands, particularly St. Paul and Amsterdam Islands in the Indian Ocean, and the Falkland Islands and adjoining parts of South America.

CHAS. CHILTON.

Biological Laboratory, Canterbury College, N.Z.,
August 7.

The Characters of Hybrid Larvæ obtained by Crossing Different Species of the Genus Echinus.

I HAVE carried out this summer hybridisation experiments on certain species of echinoids, and, in view of the interesting condition in which this inquiry was left last year by other workers, I venture to think that my results may be worth recording.

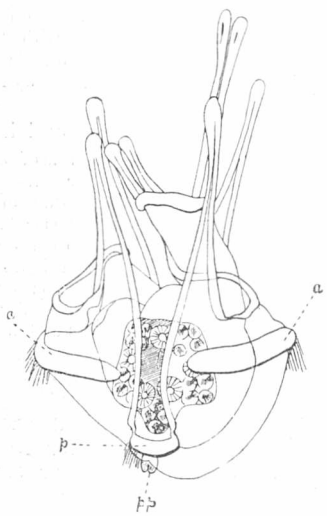
In 1911, Shearer, De Morgan, and Fuchs, as the result of three seasons' crossing experiments at Plymouth, stated (Journal M.B.A., ix., 2) that the hybrids between *Echinus miliaris*, on the one hand, and *E. esculentus* or *E. acutus*, on the other, showed, in respect of certain larval characters, a purely maternal inheritance. In 1912 the same workers, in a letter to NATURE, and later in *The Quarterly Journal of Microscopical Science*, published the result of their latest experiments, which was, briefly, that when *E. miliaris* was mother the inheritance was *paternal*. They found one culture which was exceptional. Debaisieux, working at the same time, and independently, first in London upon Plymouth material, and afterwards at Millport, obtained substantially identical results. These results he expressed in terms of dominant and recessive characters in the larvæ.

This disparity between the results of 1912 and those of former years raised a number of interesting questions, and made urgent a repetition of the experiments—a work that at the suggestion of Prof. E. W. MacBride (whose encouragement and advice I gratefully acknowledge) I undertook to perform.

The species used by me were those mentioned above, and the symbols, **M** and **m**, **E** and **e**, **A** and **a**, may be used to represent the ♀ and ♂ gametes respectively of each of them, the zygotes being then written **Mm**, **me**, **Em**, **Ee**, &c. The larval characters, the inheritance of which was studied, were the green pigment masses of **Mm** plutei, on one hand, and, on the other, the posterior pair of ciliated epaulettes and the posterior pedicellaria of **Ee** and **Aa** plutei. Debaisieux found the first of these "recessive," the other two "dominant."

In London I succeeded in raising cultures of **Mm**, **Em**, and **Am** plutei only, the reciprocal crosses failing for want of ripe males. Plymouth sea-urchins were used, and sea-water from Lowestoft. The hybrids, without exception, showed maternal characters. But in these crosses the dominant characters of Debaisieux were also maternal characters. I accordingly made further experiments at the Millport Marine Biological Station during July and August, using *E. miliaris* and *E. esculentus* only for my crosses.

After many failures, four healthy cultures of the **Me** cross were reared, one culture to a stage at which the anterior epaulettes were formed, the other three to the stage of metamorphosis. In the first culture green pigment was absent from all the larvæ examined; in the other three cultures all the individuals (132) had posterior epaulettes, eighty-one had the posterior pedicellaria, none had green pigment. The reciprocal cross agreed in its characters with the one made in London.



There was a very notable difficulty in making the **Me** cross—a difficulty which would seem to be intrinsic, and unconnected with any defect in the egg, because it has occurred again and again in experiments in which the **Mm** and **Ee** controls have both yielded good cultures of plutei. The *E. miliaris* used as parents were small, and the ovaries contained a large proportion of unripe eggs; but a majority of the apparently ripe eggs developed, when fertilised with sperm of their own species, while only a small proportion developed when *E. esculentus* sperm was used.

The mortality in the **Me** cultures finally examined was unusually low after the blastula stage, and could be assessed with considerable accuracy on account of the small number of individuals in a culture. Differential mortality would seem then to be improbable as accounting for the final character of a culture.

The sketch shows a hybrid pluteus (**Em**) as seen from the left side: *a*, anterior epaulettes; *p* posterior epaulette; *pp*, posterior pedicellaria.

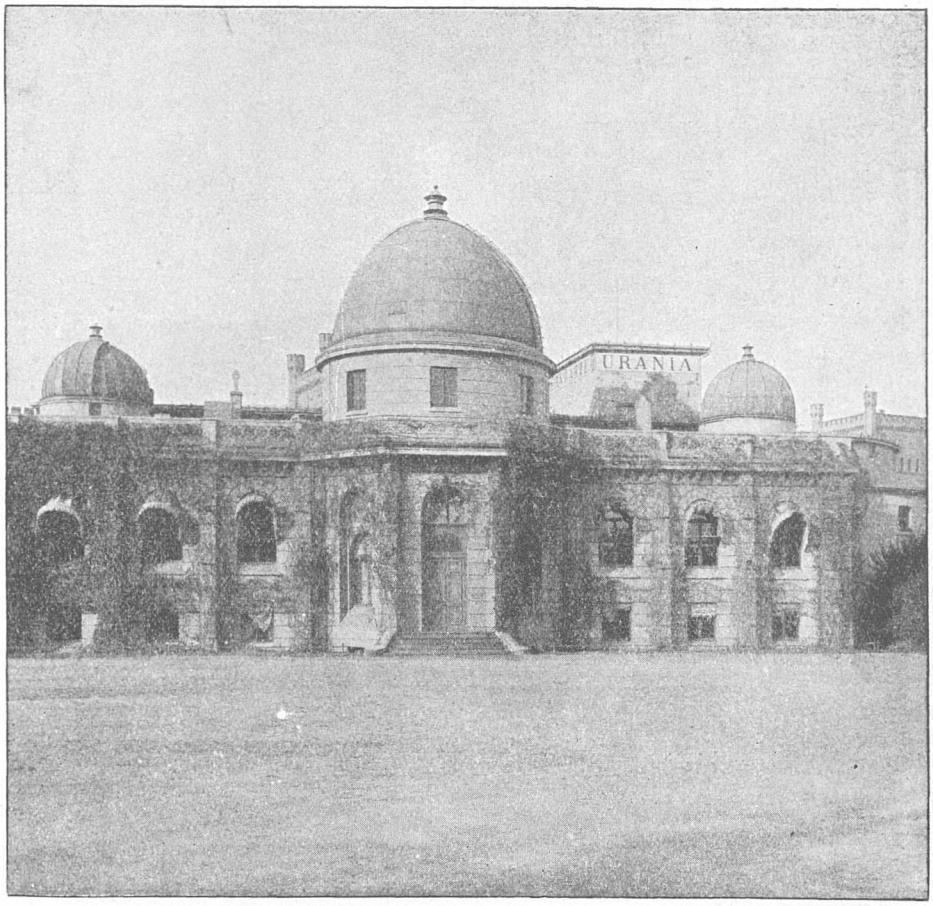
H. G. NEWTH.

Zoological Department, Imperial College of
Science and Technology.

THE "GESELLSCHAFT URANIA" OF BERLIN.

AN illustrated article on the "Gesellschaft Urania" of Berlin, by Dr. P. Schwahn, appeared in the June issue of *Himmel und Erde*.

On April 29 the society celebrated its twenty-fifth anniversary, when a distinguished audience gathered in the large theatre of the Urania building in the Tauben-strasse. Among those present were representatives from the various state departments of Germany and from the municipality of Berlin; members of the professorial staff of the University and the Charlottenburg Technical Institute; representatives of the various learned societies of Germany and many members of the leading technical and manufacturing firms of Germany. During the course of the evening a congratulatory telegram was read from the Kaiser. The proceedings were opened by Prof. Foerster, who gave a brief historical survey of the origin and work of the society during the last twenty-five years, and a lecture was delivered by Prof. Donath, the director of the physics department of the institution, in the course of which some of the most recent results and applications which have arisen from the classical discoveries of Hertz and of Röntgen were demonstrated.



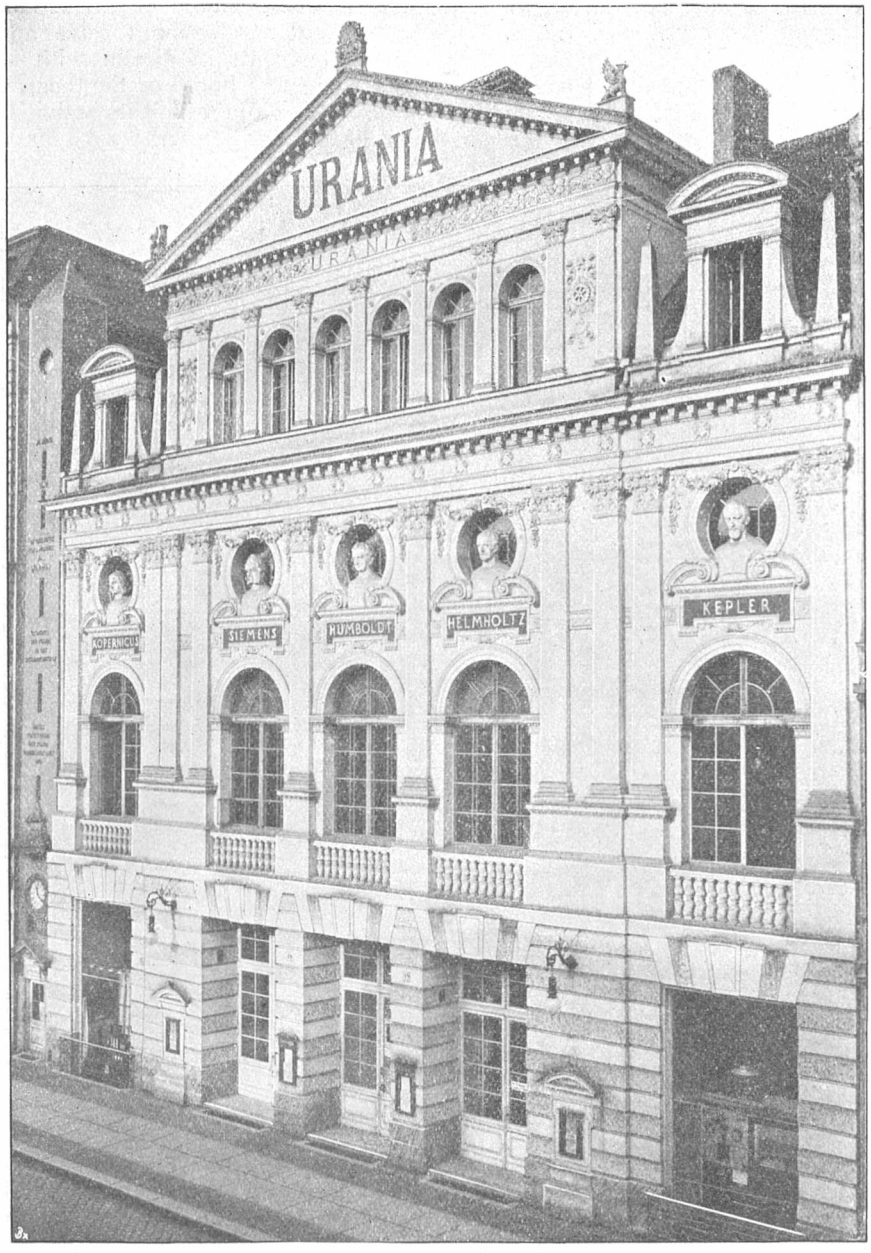
The "Urania" Observatory, in the Ausstellungs Park.

The society was formed in 1888, at a time when the applications of electrical science were beginning to excite the interest of the general public. Its object was the foundation of an educational institution which should foster and stimulate the interest of the people in scientific knowledge and acquaint them with the more important advances and applications of science. Among the originators of the scheme were Werner von Siemens and Prof. Wilhelm Foerster, the director of the Royal Observatory of Berlin. The Minister of Education expressed his sympathy with the scheme and through his kindly interest a suitable building site was obtained in the Ausstellungs Park, near the Lehrte Bahnhof. By the aid of public subscriptions the building "Urania" was erected and equipped. The building contained a lecture theatre, galleries for the exhibition of scientific apparatus, and an astronomical platform.

The first director of the institution was Dr. Wilhelm Meyer, and the popular lectures on astronomical and geological subjects which he organised proved a great source of attraction. Urania became a popular scientific theatre and was visited by the residents of Berlin with as much eagerness as the opera house or the theatre. The institution, however, did not limit its activities to the provision of popular lectures; systematic evening courses in physics, electrotechnics, chemistry, biology, and astronomy were arranged, and from time to time eminent men of science both of Germany and other countries were invited to lecture on special subjects.

The need of more extended premises was soon felt, and as the Ausstellungs Park was somewhat difficult of access, it was thought desirable to obtain a site in the centre of the town. Consequently, in 1896, the operations of the society were transferred to a much larger edifice in the Tauben-strasse and designated "Urania." The old building in the Ausstellungs Park, now known as the "Urania Sternwarte," passed into the hands

of the Government, and with the removal of the Royal Observatory from the Encke Platz in Berlin to Neubabelsberg is now being utilised with its equipment as an astronomical institute in connection with the Berlin University. Lectures on astronomy are still given at the Observatory by the society during the winter months, but only a portion of the building is open on special days in the week to visitors. The large refracting telescope, which has a focal length of five metres and an aperture of 314 millimetres, and other smaller telescopes and instruments may still be inspected by the public, and on the appearance of comets and occurrence of eclipses the Observatory is visited by large numbers of the general public.

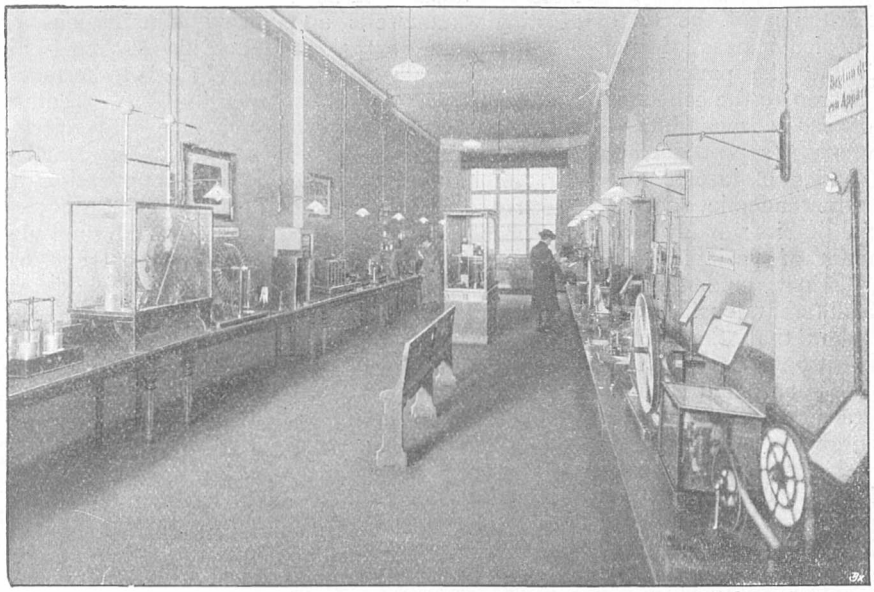


The "Urania" building, Tauben-strasse, Berlin.

The new institute in the Tauben-strasse, which is under the direction of Dr. Schwahn and Franz Goerke, contains a large lecture theatre with seating accommodation for 700 people and a smaller lecture room to hold 200. It is also provided with library and reading-room, workshop and preparation rooms. The scientific exhibits are placed in six galleries, two being allotted to physics, two to natural science, one to chemical technology, and one to machinery. The apparatus exhibited in the physics section has been arranged to illustrate an ordinary college course in experimental physics. It is possible for the visitor to perform for himself many of the experiments he would see demonstrated in a lecture or carry out in a laboratory. Thus, he may verify the ordinary laws of optics, measure a resistance with a metre bridge, excite the kathode rays and deflect them with a magnet, and so on. This idea was due to Prof. Goldstein, who had the arrangement of the physics apparatus in the smaller building in the Ausstellungs Park. A similar plan, wherever possible, has been followed in the other departments, and no doubt has proved extremely beneficial to many earnest students who prosecute their studies in their spare time or lack the opportunity of a college training.

During the last sixteen years the average annual number of visitors to Urania has been 200,000, and the society has arranged on an average 700 lectures yearly. Urania has welcomed the members of the various scientific congresses which have held their conferences in Berlin during the past few years, and the institution numbers among its visitors many of the world's leading men of science. From many of these the society has received gifts of various objects of scientific interest.

The popular scientific lectures have been given in many of the larger German towns, and in 1903 the society was invited by the Russian Government to conduct a series in St. Petersburg. Urania took part in the organisation of the German educational section at the Brussels Exhibition of 1909, and was granted a premier award by the Commissioners of the exhibition. With the advent of the kinematograph the popularity of the institution is still further ensured, and at the present time great interest is being displayed in the exhibitions in the domain of hygiene and the laws of health. Urania is undoubtedly fulfilling the wishes of its founders and has become an established factor in the educational life of Germany.



Magnetism and electricity gallery of the Urania Society, Berlin.

THE FAUNA OF THE SANDWICH ISLANDS.[1]

IN 1890 a Joint Committee of the Royal Society and of the British Association was formed "to report on the present state of our knowledge of the Sandwich Islands," and it at once entered into relationship with the Trustees of the Bernice P. Bishop Museum at Honolulu. It wisely decided to restrict its investigations to the land fauna, and it recently issued the last part of its "Fauna Hawaiiensis." Its chairmen have been Sir W. H. Flower, Prof. Alfred Newton, and Dr. F. D. Godman, while Dr. D. Sharp and Prof. S. J. Hickson have respectively been secretary and treasurer during the twenty-three years of its existence. A number of the greatest authorities collaborate in the production of the "Fauna," which throughout has the high standard usually associated with the name of Dr. Sharp. Dr. R. C. L. Perkins was the collector and naturalist, and in both lines he is pre-eminent.

Hawaiia has about the area of Yorkshire, and consists of eight main islands, of which the fauna of six has been collected. California is their nearest continental land, being 2100 miles distant, while Samoa and Fiji are 30°–40° S. and Tahiti is still further away, intervening islands being mostly of coral-reef origin. These groups are not sufficiently well-known to make a comparison with their fauna of much value, but Fiji is usually regarded as continental. The islands of Hawaiia are of volcanic origin and vary up to 14,000 feet in height. They present great diversities of climate, some coastal parts subtropical, the mountain summits snow-capped in winter, some parts relatively dry, even parched up, and others with more than 200 inches of rain. Probably all was at one time covered with forest, relatively tropical by the coasts, dense rain-forest above, more open on the much drier higher slopes. Most of the lower forest has long been cleared away, but parts of the rain-forest persist as well as great stretches of the higher woods.

The fauna may be said to be a function of the flora, and this flora has only 860 known species, of which 653 are endemic with 40 endemic genera, the rest being introduced weeds or common littoral forms. Geographically this flora must take precedence, for the first animals must not only be able to land, but to find suitable vegetation on which to feed. These animals must flourish or carnivorous beasts will never become regular components of the fauna. Again, most immigrants to oceanic islands must be supposed to be best adapted to the conditions of the low country, where later man's ravages by axe and fire will be most felt. In any case most of those that survive the passage will be unproductive, since, even if they do find suitable climate and food, few indeed will find mates.

For a small insect to become widespread round the coast of one of these islands would take many generations. A still longer time would be required to take each step up the mountains, because either each step would mean the adaptation of the needs of the animal to fresh environments, resulting later in the production of new forms, or each step would be taken as the result of some variant of its physical organisation resulting in a new need. Each beast in each step must take a mate with him, and the time required for

[1] "Fauna Hawaiiensis; or, the Zoology of the Sandwich (Hawaiian) Isles." Being Results of the Explorations instituted by the Joint Committee appointed by the Royal Society of London for Promoting Natural Knowledge and the British Association for the Advancement of Science, and carried on with the assistance of those Bodies and of the Trustees of the Bernice Pauahi Bishop Museum at Honolulu. In three volumes. Edited by David Sharp, F.R.S. (Cambridge University Press.)

the production of new forms by either physiological or morphological variation becomes still more considerable.

Dr. Perkins, and apparently all the contributors to the "Fauna" agree that Hawaiia is oceanic. Dr. Perkins summarises the evidence in his "Review of the Land-Fauna," the last published part. He further points out that nineteen-twentieths of the endemic species are found in the forest belt. This is in accordance with theory, for the isolation as varieties leave the coast land is to be expected to be helpful to species formation, though the largeness of the proportion is doubtless helped by the destruction of the low-land vegetation. The inconspicuousness of the fauna and flowers is noted, but the paucity of individuals—some parts are barren to the collector owing to the devastation of carnivorous ants—is doubted, as is interbreeding as producing diminished fertility. 3325 species of insects are known, and practically all the endemic species are of small size and special habits; many are flightless. Their large amount of variability is interesting as well as a distinct tendency to specialisation in variation in different localities.

Dr. Perkins clearly considers that the fauna arose from a very few immigrants, which have varied to form the present large genera and groups of allied genera. Some genera are confined to one of the six forest-clad islands, and in large genera few species from different islands are identical. Isolation even without selection is supposed to have brought about change, and the extreme difficulty that the systematist has in limiting his species is ascribed to the absence of agencies by which natural selection works. On every theoretical point Dr. Perkins has some fertile suggestion, but the writer hesitates to quote more because such might be misconceived by the reader, who had not the altogether unique facts before him.

J. STANLEY GARDINER.

SIR W. N. HARTLEY, F.R.S.

BY the death of Sir Walter Noel Hartley, the scientific world has lost a man who undoubtedly has enriched it in very many ways. Although perhaps his name is more intimately connected with work upon absorption spectra and their relation to the constitution of organic compounds, yet Hartley also carried out most important investigations in many other branches of spectroscopy.

Sir Walter Hartley was born on February 2, 1846, and was appointed professor of chemistry in the Royal College of Science, Dublin, in 1879, a position he held until his retirement under Civil Service regulations in 1911. One of the founders of the Institute of Chemistry, he was a vice-president from 1900 to 1903. He was elected a Fellow of the Royal Society in 1884, and was awarded the Longstaff medal by the Chemical Society in 1906. He received his knighthood on the occasion of the opening of the new buildings of the Royal College of Science, Dublin, by the King and Queen in 1911. His death, which occurred on September 11, at Braemar, was due to heart failure following on bronchitis.

Hartley's investigations were almost entirely connected with spectroscopy, and his published papers deal with three of its principal branches, namely, flame spectra, spark spectra, and absorption spectra. Perhaps the most striking thing in connection with all his work is the singular interest which he instilled into it. To many, spectroscopy may appear as a somewhat dry statistical study of the wave-lengths of emission lines and absorption bands, but no one on reading Hartley's numerous and varied contributions to the literature of the subject could lay such an accusation against his work. There is to be found there no mere dull compilation of accurate measurements, but copious evidence of wonderful insight and keenness. In all his work, Hartley showed himself a pioneer in the application of spectroscopic methods to the study of the nature and properties of the chemical atom and molecule, and it is from this that the great interest of his work arises.

In 1872 Hartley became the possessor of Dr. W. A. Miller's spectroscope, and he not only showed that it was possible to obtain the whole spectrum in focus upon a flat plate with the use of quartz prisms and unachromatised quartz lenses, but he was the first to use dry plates in the photography of spectra. The original apparatus was modified considerably, and amongst other improvements it was so devised that a number of photographs could be taken on the same plate. This in itself marked a great advance in technique. Hartley in the early days almost entirely restricted himself to the use and study of spark spectra. In 1883 he published a series of photographs of spark spectra, and in 1884 he put forward, in conjunction with Dr. W. E. Adeney the wave-lengths of the lines in these spectra. This later paper also contained the wave-lengths of the lines due to air which are of such importance in all spark spectra observations. The publication of these wave-lengths marked a very important advance in spectroscopy.

Later, Hartley turned his attention to the spark spectra of solutions of metallic salts, and it is to him that we owe almost the whole of our knowledge of the nature and character of the lines in these spectra. From a study of the effect of concentration it was soon noted that all the lines do not disappear at the same dilution. Hartley found that there exists a constant relation between the dilution and the appearance or disappearance of certain lines of each metal, and based on this he was able to found a system of quantitative analysis. The value of this method he proved by applying it with perfect success to the analysis of an Egyptian coin. Similarly, from his knowledge of the relative persistence of spectrum lines, he was the first to prove the presence of gallium in the sun and many of the stars. In the same way he showed the remarkably extensive distribution of the rare earth metals,

and also the great prevalence of lithium in very small quantities. He pointed out that the latter fact is of considerable interest with reference to recent work on radioactivity.

Again, Hartley was the first to discover the relation between the wave-lengths of lines in the spectra of analogous elements. He explained the fact by saying that analogous elements do not consist of different kinds of matter, but of different quantities of the same kind of matter. This relation possesses a fundamental significance in connection with modern views on the electronic nature of the atom; and, moreover, the deduction Hartley himself made affords support to the theories recently put forward as to the evolution of the elements.

In his work on flame spectra, Hartley showed the value of the oxy-hydrogen flame. In conjunction with Dr. H. Ramage, he discovered the existence of the bands in the flame spectra of many metals, and from a study of these he was able to draw important conclusions about the relation between the band and line spectra of the same element. Further, both alone and with Ramage, he made an exhaustive study of the spectroscopy of the Bessemer process, and was able to contribute largely to the knowledge of the thermochemistry of that process.

With Hartley's work on absorption spectra it is not possible adequately to deal in a brief epitome. In this direction he has undoubtedly founded a field of research which is of great importance and promise, as Prof. von Baeyer has recognised. Hartley was the first to establish a scientific method of observation and recording of absorption spectra, and was the first to show that they may be applied to the problems of chemical constitution. In a series of nearly fifty papers he dealt with the absorption exerted by both inorganic and organic compounds. In the first-named, he showed how the spectroscopic evidence was antagonistic to the ionic hypothesis in its earlier development. In the second, he showed, among many other fundamentally important facts, that the colour of all dyestuffs and similar compounds is to be traced to the absorptive power of the hydrocarbons from which they are derived. In fact, he gave the scientific explanation of the chromophore theory. Also may be mentioned his investigation of the absorption exerted by the alkaloids, and his record of facts that are of great importance to the synthetic chemist, and also from the medico-legal point of view. The application of the method to the elucidation of the constitution of carbostyril, *o*-oxycarbanil, isatin, and other compounds is perhaps too well known to need emphasis. It is impossible to specify the many lines of work Hartley successfully carried on in absorption spectra. He has left accurate records of the absorption curves of a vast number of substances, and he discovered a series of fundamental laws governing the relation between absorption and chemical constitution with which his name always will be associated.

In conclusion, it may well be said of Hartley that whatever research he undertook, his results were always most valuable, and he conferred distinction upon everything to which he put his hand. E. C. C. B.

DR. ALEXANDER MACFARLANE.

DR. ALEXANDER MACFARLANE, whose name is well known to workers in vector algebras, died at his home in Chatham, Ontario, on August 28. He was born in Blairgowrie on April 21, 1851, and was trained as a pupil teacher. As a student in Edinburgh University he soon impressed his contemporaries with his mental capacity. He gained high distinctions in the class of logic and philosophy as well as in mathematics and natural philosophy. After graduating with first class mathematical honours, he proceeded to study for the science degree, gaining his doctorate in 1878 with a thesis on the conditions governing the sparking of electricity between electrodes in air and in paraffin. The experimental work was carried out in Prof. Tait's laboratory, but the idea of the research was entirely Dr. Macfarlane's own. Some of these early results are referred to by Clerk Maxwell in his "Electricity and Magnetism."

Dr. Macfarlane did not, however, pursue experimental research, but turned his mind to the application of mathematical symbols in somewhat unusual directions. His "Algebra of Logic" was published in the late 'seventies, and he read before the Royal Society of Edinburgh a series of papers on the algebra of the relationships of consanguinity and affinity. In 1885 he was appointed professor of physics in Texas University, and was of great service in developing that institution as a centre of scientific teaching. About this time he published a book on physical arithmetic, which was the first sustained systematic treatment of methods of calculation useful in physical reductions. He was also the compiler of a compact and well-arranged book of mathematical tables.

He retired from active teaching in 1894, and some years later settled in Canada on a large farm which had been bequeathed to him by an uncle. Here and subsequently in the neighbouring town of Chatham, he turned his attention to the study of vector algebras. Already he had taken part in the controversy which appeared in NATURE (1893–4) as to the rival merits of quaternionic and non-quaternionic vector analysis. Prof. Tait, Prof. Willard Gibbs, and Dr. Heaviside were among the disputants. Dr. Macfarlane agreed with none of these, but took a line of his own, which he has worked out with ingenuity in many later papers. Last year, for example, he read a short paper on the subject before the Mathematical Congress at Cambridge. It was, however, as the devoted secretary of the Association for the Study of Quaternions and Allied Systems of Mathematics that he found his chief opportunity. This association, which was started by Dr. Kimura, of Japan, is now a fairly strong

body of mathematicians representing all countries of the civilised world. Much of the success attending its labours must be attributed to the zeal and energy of the secretary, whose last letter to me, written just a fortnight before his death, anticipated a new departure which would increase the efficiency of the association.

Throughout his life Dr. Macfarlane was keenly interested in educational methods, and at the time of his death was Chairman of the Board of Education in Chatham, Ontario. C. G. KNOTT.

DR. JULIUS LEWKOWITSCH.

WE regret to announce that Dr. Julius Lewkowitsch, the well-known authority on fats and oils, died at Chamonix on September 16, after a short illness. He was born at Ostrovo, in Prussian Silesia in 1857, and had a brilliant university career at Breslau. After graduating as doctor of philosophy at Breslau, Lewkowitsch devoted himself to an academic career; he carried out a considerable quantity of original investigation under Prof. Victor von Richter at Breslau, and subsequently took a position under Prof. Hans Landolt in the chemical laboratory of the Berlin Agricultural High School. At a later date he became assistant to Prof. Victor von Meyer in the University of Heidelberg.

Lewkowitch's first published work consisted in the study of the action of nitric acid on fatty acids, but he soon applied himself to experimental work on stereochemistry, which was at that time a new and undeveloped subject, and was far from assuming the commanding position which it now holds. He was the first to develop the method given by Pasteur for the resolution of externally compensated substances by the action of living organisms, and in 1882 and 1883 prepared the optically active modifications of tartaric, lactic, glyceric, and mandelic acids from the corresponding racemic substances by the action of penicillium glaucum, aspergillus mucor, yeasts, and a schizomycetes. At a later date he attacked the problem presented by the optical inactivity of benzene derivatives, and made many experimental attempts to obtain such substances in optically active modifications.

The brilliance of Lewkowitsch's early experimental work indicates that, had he continued to devote himself to pure science, he would rapidly have achieved a foremost place as a teacher and investigator. About twenty-five years ago, however, he came to this country, became naturalised, and, abandoning his aspirations towards a purely scientific career, entered upon what proved to be his life-work, the development of the industrial technology of fats and oils. At the time of his death he was the first living authority on the vegetable and animal fats and oils; a large number of processes which are widely employed in the utilisation and valuation of these important raw materials were devised by him. His treatise on the "Chemical Technology and Analysis of Oils and Fats" is now in its fifth English edition, and has been published also in French and German; his "Laboratory Companion to Fats and Oils Industries" has a wide sphere of usefulness in English and in its German translation. Lewkowitsch wrote the article on oils and fats in the "Encyclopædia Britannica" and the articles on oils in the last and the current editions of Thorpe's "Dictionary of Applied Chemistry"; his writings on his own subject have set a standard of precise treatment which has been accepted and adopted in later works by others upon this great branch of chemical industry.

Dr. Lewkowitsch served in many capacities upon the Councils of the Chemical Society, the Society of Chemical Industry, the Institute of Chemistry, and the Society of Public Analysts; at the time of his death he was the honorary foreign secretary of the Society of Chemical Industry, and had held the chairmanship of the London Section of the society. In 1909 he received the Lavoisier medal as conférencier of the Société chimique de France; as a Cantor lecturer of the Royal Society of Arts he delivered a course of lectures on fats and oils which, in their published form, are of considerable value, and exhibit the great mastery which he had acquired over our language.

Lewkowitsch was a keen mountaineer; few men possessed so intimate and complete a knowledge as he had gained of the French and Swiss Alps, in sight of which he passed away. He married in 1902, and his widow, with a son and daughter, survives him. W. J. P.

NOTES.

DR. ROUX, director of the Paris Pasteur Institute, has been made a grand officer of the Legion of Honour.

THE death occurred on September 15, at the age of fifty-nine, of Dr. Louis Merck, senior partner of the firm of E. Merck, Darmstadt.

IT is stated in *The Lancet* that Mr. W. F. Fiske has been asked by the Tropical Diseases Committee of the Royal Society to investigate the life-history of the tsetse flies in Uganda.

THE *Chemist and Druggist* for September 20 contains the reproduction of a photograph of the bronze statue of Dr. Ludwig Mond, which was unveiled by Sir John Brunner, Bart., on September 13, and was alluded to in our issue of September 11 (p. 48).

THE death is reported, in his sixty-eighth year, of Prof. Lucien A. Wait. On graduating at Harvard in 1870 he was appointed assistant professor of mathematics at Cornell University. In 1877 he became associate professor, and in 1890 full professor. From 1895 to 1910 he was head of the department of mathematics.

ACCORDING to *Science*, a national museum is to be established in the city of Santo Domingo for the purpose of retaining and preserving in the country objects and relics of historical character connected with the discovery and development of the country.

The museum is to occupy the old palace known as the house of Don Diego Colon. The sum of 20,000 dollars has been appropriated by the National Congress for repairing the building.

THERE is no doubt as to the efficiency of the radium emanations in the cure of certain forms of superficial cancer, ulcers, &c. It is now stated that the emanations of mesothorium, derived from the waste in the manufacture of incandescent gas mantles, possess similar properties, but in an enhanced degree, and efforts are being made to prepare a sufficient supply of the material so that a thorough trial of it may be made.

WE notice with regret the death, on September 18, at eighty-five years of age, of Mr. Samuel Roberts, F.R.S., president of the London Mathematical Society from 1880 to 1882, and De Morgan medallist in 1896. Another well-known mathematician whose death, on September 19, is announced is Mr. John Greaves, bursar and senior mathematical lecturer at Christ's College, Cambridge, and author of "A Treatise on Elementary Statics."

THE death is announced, at the age of sixty-seven, of the eminent French surgeon, Prof. Antonin Poncet, who in 1882 was appointed to the chair of operative medicine at Lyons, and in 1895 was elected to the Academy of Medicine. He was the author of many medical works dealing with diseases of the bones, and was well known for his investigations into the cause of death of Napoleon, Richelieu, Rousseau, and many other famous men.

IT was briefly announced in our issue for September 11, that the importation into the United States of the plumage of wild birds, raw or manufactured, save for scientific or educational purposes, is by the new Tariff Bill prohibited. We now learn from Mr. W. T. Hornaday, of the New York Zoological Park, that the prohibition movement was inaugurated and carried through by the New York Zoological Society and the National Association of Audubon Societies. It would be well if their example were copied in this and other countries.

WE learn from *The Pioneer Mail* that Sir Aurel Stein, K.C.I.E., has been deputed by the Government of India, with the sanction of the Secretary of State, to resume his archæological and geographical explorations in Central Asia and westernmost China. For his journey to the border of Chinese Turkestan on the Pamirs Sir Aurel Stein is taking on this occasion a route which offers special interest to the student of the geography and history of the Hindu Kush regions. It leads through the Darel and Tangir territories which have not been previously visited by a European, and which only recent political developments have brought under British influence. The Survey of India Department has deputed with Sir Aurel Stein his old travel companion Rai Bahadur Lal Singh, and a second surveyor to assist him by topographical work.

As was announced in NATURE of September 11, the eminent entomologist, Dr. Odo Morannal Reuter, of Abo, Finland, Emeritus professor of zoology at Helsingfors University, died on September 2 in his sixty-fourth year. As an entomologist Prof. Reuter's name was known throughout the world as a leading authority on the Hemiptera-Heteroptera, whilst he was also a worker in the more obscure groups, the Collembola (spring-tails), Psocidæ and Thysanoptera (thrips). About five years ago it was learned from Prof. Sahlberg that his colleague, O. M. Reuter, had been sadly stricken with blindness, yet, despite this great affliction, he plodded on with the aid of a secretary, and shortly before his death a work—so written—on the habits and instincts of solitary insects saw light at Stockholm. His work was characteristically thorough, and though his contribution to zoological literature numbered about 480 publications, large and small, and included a number of works on animal psychology and practical entomology, he was also a writer on literary subjects and a poet of high attainments and merit. In this country he will be missed by many, and it is pleasing to know that the highest honour British entomologists can bestow—the honorary fellowship of the Entomological Society of London—was conferred upon him in 1906.

IN vol. iii. of the publications of the Babylonian section of the University Museum of Pennsylvania Mr. J. A. Montgomery contributes an elaborate memoir on a collection of Aramaic incantation texts from Nippur. These bowls were found above the stratum of the Parthian temple, which was destroyed and became covered with sand, and was occupied by small ascetic communities of Jews and Mandæans, probably attracted to this deserted place by motives of religious community life. They appear to date from approximately 600 A.D. The importance of the present discovery lies in the fact that this bowl magic is in part the lineal descendant of ancient Babylonian sorcery, while at the same time the unexpected result is arrived at that it takes its place in the great field of Hellenistic magic which pervaded the whole of the western world at the beginning of the Christian era. The monograph is a scholarly piece of work, and will be indispensable to all students of Oriental magic.

THE *Reading University College Review* for August, an attractive volume, includes an article on bovine tuberculosis in man, by Dr. Stenhouse Williams, which gives a good summary of the subject. He concludes that the bovine type of tubercle bacillus is the cause of one-third of the cases of tuberculous disease other than the pulmonary at ages 0–16 years, which corresponds to about 4000 deaths per annum in this country.

To the July-August issue of *Naturen* Mr. P. A. Øyen contributes an illustrated article on remains of the mammoth and the musk-ox in Norway, with a discussion as to the horizons in which they respectively occur.

WE have received a copy of a fifth edition of the late Mr. T. Southwell's admirable guide to the Norwich Castle Museum, brought up to date by Mr. F. Leney, the curator. Among the illustrations are

figures of the stuffed skin and egg of the great auk, which form two of the chief treasures of the museum. To Prof. McIntosh we are indebted for a copy of a reprint of his sketch of the Natural History Museum of the University of St. Andrew's, originally published in the Museum's Journal.

ACCORDING to the report of the Madras Museum for the past year (issued by the Educational Department), a large collection of marine organisms has been obtained from the coral reef at Kilaharai, in the Ramnad district, the examination and classification of which are expected to occupy a considerable period. The superintendent also records the third or fourth specimen (it is not quite clear which) of the great snipe (*Gallinago major*) killed in India; all these appear to have been obtained since the publication, in 1898, of the fourth volume on birds in the "Fauna of British India," as the species is not mentioned in that work.

IN an article on the ancestry of Edentate mammals published in a recent issue of the American Museum Journal (vol. xii., pp. 300–303), Dr. Matthew, after mentioning that armadillos are probably the most primitive existing members of the group, and that "armadillos without armour" occur in the early N. American Tertiary, observes that although the latter and the tæniodonts of the N. American Eocene cannot be regarded as direct ancestors of the typical S. American edentates, yet they suggest the possibility that the group originally came from N. America, and penetrated to S. America about the beginning of the Tertiary, where it developed into a host of new forms.

GREAT interest attaches to the description by Dr. W. D. Matthew in vol. xxxii., art. 17 (pp. 307–314), of the Bulletin of the American Museum of Natural History, the imperfect skull of a new genus and species (*Palaeoryctes puercensis*) of the so-called zalamdodont insectivorous mammals from the Puerco, or Basal, Eocene of New Mexico. At the present day that group is represented by the Solenodontidæ of Haiti and Cuba, the Potamogalidæ of Equatorial (Dr. Matthew, judging from his map, seems to be unaware that the "otter-shrew" occurs in the eastern as well as in the western part of the forest-zone) and the Chrysochloridæ, or golden moles, of southern, eastern, and central Africa, and the Centetidæ, or tenrecs, of Madagascar. In 1891 the extinct genus Necrolestes, more or less nearly related to the Chrysochloridæ, was described from the Patagonian Miocene. At that time fossil forms were unknown from the northern hemisphere, which led to the suggestion that the group was essentially southern; but between 1903 and 1907 five extinct genera were recorded from the N. American Tertiary. The new genus now described serves to show the great antiquity of the tritubercular type of molar characteristic of the zalamdodonts; and also, if rightly associated with that family, indicates that the Centitidæ are the oldest existing group of placental mammals.

AMONGST the familiar sporozoan parasites known as gregarines, one genus, Porospora, has always stood apart from all others by reason of the possession of peculiar and anomalous characteristics. The genus comprises species parasitic in Crustacea, and *P. gigantea*, parasite of the lobster, is the largest gregarine known. Recent researches have shown that the peculiar "gymnospores," so-called, of these gregarines are not true spores at all, but clusters of merozoites, and that the apparent sporogony of these parasites in their crustacean hosts is really a process of non-sexual schizogony, different from that of all other gregarines. The question then arose: Where and under what circumstances does the true sporogony take place? The answer has now been given by the distinguished French investigators, Messrs. Léger and Duboscq, who have discovered that the sexual cycle and sporogony of Porospora takes place in bivalve molluscs, and is no other than that of the curious parasite described many years ago by Aimé Schneider under the generic name Nematopsis, a genus of which the systematic position has been hitherto quite uncertain. Thus *Porospora portunidarum*, parasitic in crabs, has its Nematopsis-phase in *Cardium edule*, the common cockle, in which host the parasite produces a single spore, containing a single vermiform sporozoite, in the gills of the mollusc. A preliminary account of the development of this species, illustrated by nineteen text-figures, is published in the *Comptes rendus des séances de la Société de Biologie* (vol. lxxv., p. 95).

WE have received the concluding numbers of the sixteenth volume (for 1912) of the *Bollettino* of the Italian Seismological Society. The complete volume contains eleven papers, the more important of which deal with the recent eruption of Etna, the luminous phenomena associated with the Valparaiso earthquake of 1906 (NATURE, vol. xc., p. 550), and the sea-waves of the Calabrian earthquake of 1907 (vol. xci., p. 327). The greater part of the volume, however, consists of the notices of earthquakes observed in Italy during the year 1909, compiled by Dr. G. Martinelli. These notices occupy more than six hundred pages, and their value has been increased by several improvements recently made. The constants of the seismographs used in twenty-nine Italian observatories are given in an appendix; the notices relating to different earthquakes are separated by a space (it would be still more useful if they were numbered); the earthquakes, with the exception of those recorded by a single instrument or from one place only, are named according to the districts chiefly affected by them, and of these an alphabetical index is added.

A RECENTLY issued Bulletin (No. 54) of the Bureau of American Ethnology, by Messrs. Hewett, Henderson, and Robbins, deals with the Rio Grande valley, an arid region in New Mexico. The bulletin contains three papers; the first two, on the physiography and general geology respectively, are more or less introductory to the third, which deals with the climate and climatic changes. The evidence for the latter is (1) archæological, (2) botanical, and (3) geological. (1) There are great numbers of ruins in the country, many of them far from present known sources of water, and even as late as the coming of the Spaniards the population seems to have been denser than now. (2) Study of the trees shows that the rock pine and the piñon pine are the most widespread, the latter

occupying the drier situations. The boundary between these two species is shifting towards the moister regions, indicating that the area which is too dry for the rock pine to inhabit is increasing. (3) Geologically, the authors have to take a wider field. Of chief importance is the evidence that the whole of the south-west States have suffered a great diminution of their mountain glaciers and enclosed lakes, commencing several thousand years ago, and probably still in progress, as shown by measurements in the last few decades. No single line of evidence is conclusive, but the convergence of so many, coupled with the experience of observers in other lands, renders dessication in this region in human times very probable. In connection with the authors' suggestion for the careful measurement of the fluctuations of land-locked lakes, it may be noted that such records are now being kept in the British colonies in tropical Africa. The work is illustrated with a number of very clear photographs, but the omission of the names of the months and the scales of units in the diagrams of monthly rainfall and temperature is unfortunate.

We have received the "Pilot Chart" of the North Atlantic Ocean for September, published by the United States Hydrographic Office, containing similar useful information relating to winds, currents, &c., to that included in the "Meteorological Charts" formerly published by the Weather Bureau, but now discontinued (NATURE, September 11). An interesting account is given of observations on ocean temperatures in the vicinity of icebergs and in other parts of the ocean by officers of the U.S. Bureau of Standards, with illustrations of the temperature equipment and of samples of the records obtained. Practically continuous temperature readings were obtained from June 4 to July 10, 1912, and these show that the variations in parts of the ocean far removed from ice are often as great and sudden as in the vicinity of icebergs. The authors consider that the question is still in doubt whether these influence to any considerable extent the temperature of sea-water at a mile or so distant.

An interesting article on evaporation in the great plains and intermountain districts as influenced by the haze of 1912, by Messrs. L. J. Briggs and J. O. Belz, of the Bureau of Plant Industry, appeared in the Journal of the Washington Academy of Sciences of August 19. The haze was presumably due to the eruption of Mount Katmai (Aleutian Islands) on June 6–7 of that year, during which volcanic ashes fell at Sitka, 700 miles distant, and the sun was obscured for a time. It gave rise to a marked diminution in the intensity of solar radiation, which was particularly noticed in subsequent months at the Mount Wilson, Mount Weather, and Madison observatories in the United States. The authors, who had been engaged in evaporation measurements during the last five years, deemed it desirable to determine to what extent this reduction of solar intensity affected the evaporation (not forgetting that this is also greatly influenced by other factors). Tables of monthly normal evaporation for fifteen stations show that during four months following the eruption the average reduction was about 10 per cent. This reduction in the mean evaporation, although somewhat less than the observed reduction in solar intensity, appears to afford an approximate measure of the reduction of the latter at the earth's surface.

The *Scientific American* (vol. cix., No. 5) contains two illustrated articles on the modern developments of the electric furnace. In the first (p. 84) an account is given of recent patents covering improvements in the electric arc as used in the purification of steel and iron and in the production of compounds of nitrogen from the air; whilst in the second a special account is given of the electrical production of steel, from the early experiments of Siemens to the thirty-ton furnace of to-day. Illustrations are given of the Stassano arc furnace in use at Turin, of the Kjellin and the Röchling-Rodenhausen induction furnaces, and of the Heroult 15-ton arc furnace in use at the works of the U.S. Steel Corporation.

Aëronautical science in America receives fresh recognition in the decision of the Smithsonian Institution to reopen the Langley Aërodynamical Laboratory. The first serious contribution from the scientific side of aëronautics is to be found in the work of Langley, the necessary funds being provided by a Governmental grant; had the light petrol motor come into existence twenty years ago, it is probable that the Langley Laboratory would never have been closed, and would now be the leading aëronautical laboratory in the world. The Smithsonian Institution is a private concern, although closely connected with the U.S. Government departments. For the present it will be dependent on private donations for its income for aëronautical research, though in time it is hoped to receive a Governmental grant in aid. Apparatus useful in aëronautics already exists in the U.S. Bureau of Standards, and the U.S. Weather Bureau, with which the Langley Laboratory will be closely connected, and financial support is primarily needed for the construction of two wind tunnels and the necessary model-making apparatus. In addition to experiments on models an aircraft field laboratory is proposed, for measurements of stress, moments of inertia, &c., and for the adjustment and repair of several full-scale land and water aëroplanes.

In the July number of *The Biochemical Journal* (vol. vii., No. 4) Mr. Egerton C. Grey demonstrates the production of acetaldehyde during the anaerobic fermentation of glucose by *Bacillus coli communis*, and states that, by artificial selection by means of growth on sodium chloracetate, strains of the original organism can be obtained which produce either a greatly diminished amount of the aldehyde or none at all. As this diminution is accompanied by a falling-off of the production of alcohol and carbon dioxide, it is probable that the aldehyde is a primary, not a secondary, product of fermentation, and that the process of alcohol formation by *B. coli communis* is analogous to the alcoholic fermentation set up by the zymase of yeast.

In the current number of the *Berichte* (No. 11, p. 2401), Prof. Willstätter and L. Zechmeister publish

an important communication on the quantitative conversion of cellulose into dextrose by means of cold, fuming hydrochloric acid of sp. gr. 1·204° to 1·212°, containing from 40 to 41·4 per cent. of hydrogen chloride. A problem has thus been solved which for more than one hundred years has been vainly attempted by the use of hot mineral acids and other means. Although ordinary concentrated hydrochloric acid containing 37·6 per cent. of hydrogen chloride does not dissolve cellulose but merely disintegrates the fibre and causes gelatinisation, the more concentrated acid containing 40 per cent. rapidly dissolves it, and after twenty-four to forty-eight hours 95 to 96 per cent. of the theoretical quantity of dextrose is present in the solution. The course of the hydrolysis has been followed by observing the specific rotatory power and copper-reducing value of the solution in successive intervals of time. In this way it was found that the cellulose at first dissolves in an optically inactive form, thus differing entirely from starch, which gives a highly dextro-rotatory modification from the start. Only after one hour is a slight dextro-rotation to be observed, which progressively increases; in the early stages the product, which can be precipitated from solution by water or alcohol, is of a dextrin-like character, but without either reducing power or specific rotation. The solution gradually develops reducing properties as the specific rotation increases, but during the first six hours the amount of "dextrose" calculated from the reducing power is much less than that calculated from the change of rotation. It is thus probable that a complex, optically active, but non-reducing sugar is formed first, and that this is later further resolved into dextrose. One of the most striking observations recorded in the paper is the very high specific rotation shown by dextrose when dissolved in concentrated hydrochloric acid. In 41·4 per cent. hydrochloric acid $[\alpha]_D^{16°}$ was found to be 106°, which approximates to that of the so-called α-form of dextrose (110°), the ordinary value observed in aqueous solution for the equilibrium mixture of α- and β-forms being 52·5°. In 44·5 per cent. hydrochloric acid, however, the extraordinarily high value of 164·6° was observed for $[\alpha]_D$ at 5° C.

No. 29 of *Scientia* contains a number of articles of general scientific interest. Dr. E. E. Fournier d'Albe writes on interstellar space, Dr. A. Findlay gives a short account of the phase rule and its applications, and Mr. Léon Fredericq contributes an interesting summary of the methods by which animals utilise chemical and physical forces as means of defence. Mr. E. Rignano discusses the problem of the evolution of reason, and G. Cardinali traces the influence of Hellenic culture on the development of Roman civilisation.

OUR ASTRONOMICAL COLUMN.

VARIABLE NEBULÆ.—M. Borrelly's recent announcement in the *Comptes rendus* that Hind's nebula appeared to be passing through a period of maximum is now followed (No. 9, *Comptes rendus*) by a note from M. G. Bigourdan incorporating a list of the dates of published measures together with the names of the observers dating from Schönfield's observations, July 26, 1861. Attention is directed to the importance of confirming M. Borrelly's observation.

COMET (1913*b*) METCALF.—The following is the ephemeris of Metcalf's comet as taken from the *Astronomische Nachrichten*, No. 4682 :—

12h. M.T. Berlin.

	R.A. h. m. s.	Dec.	Mag.
Sept. 25 ...	3 41 54 ...	+76° 44′·2	—
26 ...	3 6 0 ...	77 17·7	—
27 ...	2 25 33 ...	77 31·4	8·4
28 ...	1 42 38 ...	77 16·6	—
29 ...	1 0 15 ...	76 40·9	—
30 ...	0 21 36 ...	75 33·3	—
Oct. 1 ...	23 47 1 ...	74 1·0	8·2
2 ...	23 18 26 ...	72 6·0	—

The above ephemeris has been calculated by Prof. Kobold from the observations on September 2, 6, and 10, which gives quite a new set of parabolic elements and makes the places of the comet very different from those calculated from his previous elements.

The present elements are as follows :—

$$T = 1913 \text{ Sept. } 13{\cdot}9168 \text{ M.T. Berlin.}$$
$$\left.\begin{aligned} \omega &= 117° \ 7′ \ 51″ \\ \Omega &= 157° \ 9′ \ 59″ \\ i &= 143° \ 24′ \ 25″ \end{aligned}\right\} 1913{\cdot}0.$$
$$\log q = 0{\cdot}133805$$

As this comet is getting brighter and higher up in the sky, it should be observable with telescopes of small aperture.

COMET 1913*c* (NEUJMIN).—This comet, discovered by Neujmin, is becoming fainter, being now nearly of the 12th magnitude. For the sake of those who wish to follow it further with larger telescopes, the following ephemeris by Herr M. Ebell, taken from a supplement to the *Astronomische Nachrichten*, No. 4680, is given :—

12h. M.T. Berlin.

	R.A. (true) h. m. s.	Dec. (true)	Mag.
Sept. 25 ...	23 39 58 ...	+6° 4′·7 ...	11·8
,, 26 ...	23 39 35 ...	6 18·8	
,, 27 ...	23 39 14 ...	6 32·4	
,, 28 ...	23 38 54 ...	6 45·4	
,, 29 ...	23 38 36 ...	6 57·9	
,, 30 ...	23 38 19 ...	7 10·0	
Oct. 1 ...	23 38 3 ...	7 21·6	
,, 2 ...	23 37 49 ...	7 32·7 ...	12·1

ANNALS OF THE BUREAU OF LONGITUDES.—Containing accounts of the inception, organisation, programmes, and transactions of two international conferences which have led to results of the highest practical importance in applied astronomy, the ninth volume of the Annals of the Bureau of Longitudes attains the distinction of being not only a valuable document in the history of that science, but also of marking a stage in the growth of international cooperation in scientific work. Of the successful issue of the Congrès des Ephémérides, let us recall only the sixth of the seven general resolutions adopted, namely, that the names of stars should be accompanied by designations of their spectral type after the notations of Pickering. The work last autumn of the Conférence Internationale de l'Heure, of course, chiefly centred around the employment of wireless telegraphy not only in the distribution of time, but also in the service of meteorology. The value of these applications is attested both by the rapidly increasing numbers using the time-signals, especially on land, and by the fact that it has recently been found necessary to add more than a dozen stations to the original six for which the meteorological elements were distributed on the resolution of the conference.

In addition to the reports just mentioned, the volume also contains a detailed account of the determination by wireless telegraphy of the difference in longitude between Paris and Bizerta.

SPECTRUM OF WOLF-RAYET STAR D.M. +30° 3639.—Mr. Paul W. Merrill records in the Lick Bulletin, No. 230, the result of the examination of the red end of the spectrum of the Wolf-Rayet star D.M. +30° 3639, the photographic magnitude of which is 10·0, and position for 1900·0 R.A. 19h. 30m. 8s., Dec. +30° 18′. The following previously observed bright lines appear:—λ4652 broad; Hβ monochromatic, strong; λ5694 broad; λ581 broad, trace; D_3 doubtful; Hα monochromatic, strong. In addition to the above, the following two bright lines appear:—λ6548·5 monochromatic, 0·4 as strong as Hα; λ6583·4 monochromatic, slightly stronger than Hα. The chief nebular lines are not seen in the star's spectrum. It is pointed out that these two nebular lines were observed by Wright in the nebula N.G.C. 7027, but are otherwise unidentified. While the two lines appear together it does not necessarily follow that their origins are identical.

THE BERLIN MEETING OF THE INTERNATIONAL ELECTROTECHNICAL COMMISSION.

THE meeting of the International Electrotechnical Commission was held in Berlin at the Kunstlerhaus from September 1 to September 6. It was well attended, twenty-four nations being represented by seventy delegates. In addition to the voting delegates sent by the local committees of the countries represented, some of the Governments also nominated their official representatives, those representing England being Dr. Glazebrook, who was unfortunately not able to attend, Dr. Gisbert Kapp, Dr. Silvanus P. Thompson, and Mr. Duddell, the president of the Institution of Electrical Engineers. The German Government was represented by Dr. Jaegar, Geheimrat Dr. Strecker, and several others. Unfortunately, Dr. E. Budde, the president of the International Electrotechnical Commission, was absent through illness, but his place was very efficiently filled by Dr. Warburg, the president of the Reichsanstalt.

The commission was welcomed on behalf of the German Government by Dr. Lewald, Director of the Ministry of the Interior. Prof. Paul Janet, of the Laboratoire Centrale, Paris, replied on behalf of the commission.

The proceedings were opened by the reading of the report of the honorary secretary, Col. Crompton, on the work which had been accomplished up to date and confirmed by the last plenary meetings held two years previously at Brussels; he also briefly described the new work which had been prepared during the two years' interval by the various national committees, and by the four special committees which had been appointed to bring forward the four main subjects requiring international treatment; and which required confirmation at this the second plenary meeting, to ensure final acceptance by all the national committees.

The first two days were occupied by the final meetings of the special committees. The first, and certainly the most difficult, question to be decided internationally, was that of providing a means of international rating of electrical machinery. This matter, touching closely as it does on industrial questions, was naturally very warmly debated, both in the meetings of the special committee, which was presided over by Huber Stockar, the well-known Swiss engineer, and at the full meeting, but although much valuable evidence was brought forward on the test methods to be adopted for international rating, the only figures that were unanimously agreed to were the final temperatures permissible in the hottest parts of working generators, motors, and transformers, but the remaining very necessary factors, namely agreement as to temperature-rise and as to the standard temperature of the ambient air from which the temperature-rise must be calculated, were not considered to be sufficiently settled to allow of unanimity.

On the latter point the English and American engineers insisted on taking the ambient air temperature at a figure of 40° C., which is very frequently obtained at certain times of the year in all tropical and in many temperate climates, especially in engine-rooms, stokeholds, and similar places. It will be noted that the choice of this high temperature is greatly to the advantage of a purchaser, as it ensures that a machine ordered on standard international rating will be a somewhat large machine capable of a larger overload in cool weather than was hitherto considered necessary by manufacturers. The majority of the meeting was apparently in favour of adopting this high figure so favourable to the consumer; but the German and Swedish engineers thought that the matter was too important to be decided off-hand, so the filling in of these two figures is left for further consideration by the national committees. It is hoped that an agreement may be arrived at in the course of this year, or at any rate before the next plenary meeting, which is to be held at San Francisco two years hence.

The reports and the recommendations of the three other special committees, first that on nomenclature, second on the international standardisation of symbols in use for formulæ, and third on the definitions and terminology for prime-movers used for electrical generating plant, were all unanimously adopted. It is needless to point out that the unification of symbols is of immense benefit to the engineering student, and the unanimity arrived at by a number of delegates who, in the majority of cases, are largely interested in other branches, and particularly mechanical engineering, makes it probable that this unification of symbols will extend to all branches of engineering science, and perhaps eventually to all branches of physical investigation.

As regards nomenclature, although the work done is undoubtedly good and useful, at first sight it seems small in amount, as a list of only eighty terms with the expressions defining them was adopted. It has been found necessary to modify the original arrangements by which there should be two official languages, English and French, to which others should be referred, but the inconvenience of having two languages of reference was so marked that the English agreed to forego their claim that English should continue to be one of the official languages, French now remains as the one language of reference from which all words and expressions must be translated, but it was decided that the vocabulary which has now been prepared should contain the official corresponding words now agreed to, in four languages—French, English, German, and Spanish. The delegates from five countries using the Spanish language informed the meeting that this unification of terms in the Spanish language would be of great service to them, for already misunderstandings had arisen, as some of the South American countries using the Spanish language had shown a tendency to adopt different Spanish words for one and the same expression.

Another matter satisfactorily settled was the copper standard, which had long been discussed between the four National Physical Laboratories of England, France, Germany, and America, and the ultimate figures were agreed to, so that the tables of copper conductors based on this standard will be common to all the countries.

Mr. Maurice Leblanc, of Paris, was unanimously elected to succeed Dr. Budde, as president of the I.E.C., for a term of two years, and he will therefore preside at San Francisco.

Colonel Crompton was re-elected honorary secretary for the third time.

The Spanish delegates invited the special committees to hold their next meetings in April next in Madrid, and the Russian delegate, Prof. de Chatelain, on behalf of the Russian Committee, invited the I.E.C. to hold the plenary meeting of 1917 in St. Petersburg.

BUDGETS OF CERTAIN UNIVERSITIES AND UNIVERSITY COLLEGES IN ENGLAND AND WALES.

THE reports for the year 1911–12 from those universities and university colleges in Great Britain which are in receipt of grant from the Board of Education have been issued in two bulky volumes (Cd. 7008 and Cd. 7009). The first volume contains reports from the provincial universities and university colleges in England, and the second reports from the London college, including the medical schools, the Welsh colleges, and Dundee University College.

The tabular matter which precedes the separate reports from the various universities contains detailed information as to the income and expenditure of the places of higher education concerned. The following summaries have been compiled from the tables, and show at a glance the amount available for education and research in the universities and colleges receiving Treasury grants and how the income is expended.

UNIVERSITIES AND UNIVERSITY COLLEGES.

(1) ENGLAND.

(*a*) *Income.*

	Amount £	Percentage of total
Fees	180,371	29·0
Endowments	85,435	13·7
Donations and Subscriptions	22,437	3·6
Annual Grants from Local Authorities	95,875	15·4
Parliamentary Grants	215,003	34·5
Contributions from Hospitals, &c., for services rendered	659	0·1
Other Income	22,694	3·7
Total	622,474	100·0

(*b*) *Expenditure.*

	Amount £	Percentage of total
Administration	64,528	10·7
Provision and Alteration of Buildings	6,785	1·1
Maintenance	63,714	10·6
Educational Expenses	400,001	66·4
Superannuation	13,575	2·3
Scholarships, &c., from sources other than Trust Funds	9,187	1·5
Other Expenses	44,228	7·4
Total	602,028	100·0

(2) WALES.

(*a*) *Income.*

	Amount £	Percentage of total
Fees	18,117	28·2
Endowments	4,191	6·5
Donations and Subscriptions	1,911	3·0
Annual Grants from Local Authorities	5,283	8·2
Parliamentary Grants	33,805	52·7
Other Income	890	1·4
Total	64,197	100·0

(*b*) *Expenditure.*

	Amount £	Percentage of total
Administration	8,104	12·7
Maintenance	4,659	7·3
Educational Expenses	46,399	72·6
Superannuation	1,640	2·6
Scholarships, &c., from other than Trust Funds	395	0·6
Other Expenses	2,670	4·2
Total	63,867	100·0

The total income from endowments in England has increased by about 4500*l.*, due chiefly to new endowments for Reading University College, which bring in about 4000*l.* a year, and the increased income of about 1600*l.* a year available for East London College. On the other hand, the income from Welsh endowments has fallen by nearly 300*l.* The total income from donations and subscriptions shows some falling-off, both in England and Wales, owing in part at least to the exclusion of donations specially earmarked for scholarship purposes. The net annual grants from local education authorities show an increase of about 10,000*l.* in England and about 800*l.* in Wales. The income received from Parliamentary grants increased during the year by about 58,000*l.*

The expenditure during 1911–12 out of income upon the provision and alteration of buildings in England was more than 4000*l.* greater than in the previous year, owing in the main to heavy expenses at Leeds largely due to the provision of a hostel for women and to alterations and equipment at University College, London.

THE PILTDOWN SKULL.

IN his evening lecture to the British Association at Birmingham on September 16, Dr. Smith Woodward took the opportunity of replying to Prof. Arthur Keith's recent criticisms on his reconstruction of the Piltdown skull. It will be remembered that Dr. Woodward regarded the mandible as essentially that of an ape, and restored it with ape-like front teeth, while he determined the brain-capacity of the skull to approach closely the lowest human limit. Prof. Keith, on the other hand, modified the curves of the mandible to accommodate typically human teeth, and reconstructed the skull with a brain-capacity exceeding that of the average civilised European.

Fortunately, Mr. Charles Dawson has continued his diggings at Piltdown this summer with some success, and on August 30, Father P. Teilhard, who was working with him, picked up the canine tooth which obviously belongs to the half of the mandible originally discovered. This tooth corresponds exactly in shape with the lower canine of an ape, and its worn face shows that it worked upon the upper canine in the true ape fashion. It only differs from the canine of Dr. Woodward's published restoration in being slightly smaller, more pointed, and a little more up-

right in the mouth. Hence, there seems now to be definite proof that the front teeth of Eoanthropus resembled those of an ape, and its recognition as a genus distinct from Homo is apparently justified.

The association of such a mandible with a skull of large brain-capacity is considered by Dr. Woodward most improbable, and he has made further studies of the brain-case with the help of Mr. W. P. Pycraft, who has attempted a careful reconstruction of the missing base. Dr. Woodward now concludes that the only alteration necessary in his original model is a very slight widening of the back of the parietal region to remedy a defect which was pointed out to him by Prof. Elliot Smith when he first studied the brain-cast. The capacity of the brain-case thus remains much the same as he originally stated, and he maintains that Prof. Keith has arrived at a different result by failing to recognise the mark of the superior longitudinal sinus on the frontal region and by unduly widening that on the parietal region.

It is understood that Mr. Dawson and Dr. Woodward will offer an account of the season's work to the Geological Society at an early meeting, and Prof. Elliot Smith will include a detailed study of the brain-cast of Eoanthropus in a memoir on primitive human brains which he is preparing for the Royal Society.

THE BRITISH ASSOCIATION AT BIRMINGHAM.

SECTION C.

GEOLOGY.

OPENING ADDRESS BY PROF. E. J. GARWOOD, PRESIDENT OF THE SECTION.

ON the last occasion when members of the British Association met in Birmingham, in 1886, this section was under the able presidency of my friend Prof. T. G. Bonney, who at that time occupied the chair of geology at University College, London. Fifteen years later I succeeded him on his retirement from that post, and to-day I succeed him as president of this section, at the second meeting of the Association at Birmingham; and again I feel the same diffidence in following him as I did on the former occasion.

In his address in 1886 Prof. Bonney discussed the "Application of Microscopic Analysis to Discovering the Physical Geography of Bygone Ages."

Strangely enough, this title might apply almost equally well to the subject of my address to-day; but whereas Prof. Bonney employed for his purpose the evidence obtained from observations on mechanical sediments, I propose to deal with certain organically formed deposits with the same object.

More than twenty years ago, whilst engaged in the study of the lower carboniferous rocks of Westmorland, I noticed the occurrence of certain small concretionary nodules of very compact texture, in the dolomites near the base of the succession in the neighbourhood of Shap.

Shortly afterwards, when examining the Bernician rocks of Northumberland, I again met with similar compact nodular structures. It was obvious, however, even at that time, that the Northumberland specimens occurred here at a much higher horizon than those which I had observed in Westmorland.

More recently, whilst studying the lithological characters of the lower carboniferous rocks of the North of England and the Border country, I have been still further impressed by the abundance of these nodular structures at several horizons, and the large tracts of country over which they extend. An examination of these nodules in thin sections showed their obvious organic character, and I was at first inclined to refer them to the Stromatoporoids. Dr. G. J. Hinde, who was kind enough to examine my specimens from the Shap district, reported, however, that they were probably not Stromatoporoids, but calcareous algæ, and referred me to the descriptions of Solenopora published by the late Prof. Nicholson and Dr. Brown.

Since then I have examined a large number of nodules collected from different horizons in the lower carboniferous rocks of Britain and Belgium; and the examination has convinced me that the remains of calcareous algæ play a very much more important part in the formation of these rocks than has hitherto been generally realised.

The majority of geologists in this country have been slow to recognise the importance of these interesting organisms, and, with the notable exception of Sir Archibald Geikie's text-book, we find but scant allusion in English geological works of reference to the important part played by calcareous algæ in the formation of limestone deposits.[1]

From the more strictly botanical standpoint, however, we are indebted to Prof. Seward for an admirable account of the forms recognised as belonging to this group, up to the date of the publication of his text-book on fossil plants in 1898; while in an article in *Science Progress*, in 1894, he has also dealt with their importance from a geological point of view.

Since these publications, not only have several new and important genera been discovered in this country and abroad, but the forms previously known have also been found to have a very much wider geological and geographical range than was formerly suspected. For these reasons I venture to hope that a summary of our knowledge of the part they play as rock builders, more especially in British deposits, will serve to stimulate an interest among geological workers in this country in these somewhat neglected organisms.

Previous to 1894, in which year Dr. Brown first referred Solenopora to the Nullipores, with the exception of the Jurassic and Tertiary Characeæ, we meet with little, if any, reference to the occurrence of fossil calcareous algæ in British deposits.

Indeed, in this country the subject has attracted but few workers, and they can almost be counted on the fingers of one hand. When we have mentioned the late Prof. H. A. Nicholson and Mr. Etheridge, jun., Mr. E. Wethered, Dr. Brown, Dr. Hinde, and Prof. Seward, we have practically exhausted the list of those who have contributed to our knowledge of the subject. To these we may add the name of Mrs. Robert Gray, whose magnificent collection of fossils from the Ordovician rocks of the Girvan district has always been freely placed at the disposal of geological workers, and has furnished numerous examples of these organisms to Prof. Nicholson and the officers of the Geological Survey.

It was Nicholson and Wethered who first recognised the important part played in the formation of limestones by certain organisms, which, though referred at the time to the animal kingdom, are now generally considered to represent the remains of calcareous algæ.

The presence of these organisms in a fossil state, especially in the older geological formations, has only been recognised in comparatively recent years; though it was suggested as long ago as 1844 by Forchhammer[2] that fucoids, by abstracting lime from seawater, probably contributed to the formation of Palæozoic deposits. When we remember that it was

[1] Geikie. "Text-book of Geology." 4th ed., vol. i, pp. 605 and 611. 1903.

[2] British Association, 1844, p. 155.

not until the researches of Phillipi were published in 1837 that certain calcareous deposits were discovered to be directly due to the growth of living forms of lime-secreting algæ, it is not surprising that, only in comparatively recent years, has the importance of the fossil forms as rock-builders in past geological formations been recognised.

The original genera established by Phillipi—namely, Lithothamnion and Lithophyllum—are known now to have a wide distribution in the present seas, and it is therefore natural that it was members of these groups which were the first to be recognised in a fossil state in Tertiary and, subsequently, in upper cretaceous rocks.

Thus in 1858, Prof. Unger of Vienna showed the important part played by Lithothamnion in the constitution of the Leithakalk of the Vienna Basin, while seven years later Rosanoff contributed further to our knowledge of tertiary forms. In 1871 Gümbel published his monograph on the "so-called Nullipores found in limestone rocks," with special reference to the Lithothamnion deposits of the Danian or Maestricht beds. Since then Lithothamnion has also been reported from Jurassic rocks, and even from beds of Triassic age, though in the latter case, at all events, the reference to this genus appears to require confirmation. In this country the recognition of fossil calcareous algæ dates from a considerably later period. It will be best first to review the chief genera which appear to be referable to the calcareous algæ, and afterwards to show the part they play as rock-builders in the different geological formations.

Two important genera are usually recognised at the present day as occurring in the British Palæozoic and Mesozoic rocks—namely, Solenopora and Girvanella—and to these I propose to add Wethered's genus, Mitcheldeania, together with certain new forms from the Carboniferous rocks of the North of England, which appear also to be referable to this group.

Solenopora.

This genus was first created by Dybowski in 1877 for the reception of an obscure organism, from the Ordovician rocks of Esthonia, which he described under the name *Solenopora spongioides*, and regarded as referable to the Monticuliporoids.

Nicholson and Etheridge in 1885 (*Geol. Mag.*, p. 529) showed that the form described by Billings in 1861 as *Stromatopora compacta*, from the Black River limestones of North America, was in reality Dybowski's genus Solenopora, and in all probability was specifically identical with the form from Esthonia. Moreover, they considered that the organism they themselves had described under the name of *Tetradium Peachii* in 1877, from the Ordovician rocks of Girvan, was also referable to Billing's species, though perhaps a varietal form. Thus *Solenopora compacta* was shown to have a very wide distribution in Ordovician times.

Nicholson in 1888 defined the genus as including "Calcareous organisms which present themselves in masses of varying form and irregular shape, composed wholly of radiating capillary tubes arranged in concentric strata. The tubes are in direct contact, and no coenenchyma or interstitial tissue is present. The tubes are thin-walled, irregular in form, often with undulated or wrinkled walls, without mural pores, and furnished with more or fewer transverse partitions or tabulæ." [3]

At that time Nicholson still considered Solenopora as representing a curious extinct hydrozoon, though already, in 1885, Nicholson and Etheridge had discussed its possible relationship to the calcareous algæ. They did not, however, consider that there was sufficient evidence for concluding that the true structure of Solenopora was cellular, but added: "If evidence can be obtained proving decisively the existence of a cellular structure in Solenopora, then the reference of the genus to calcareous algæ would follow as a matter of course." [4]

In 1894 Dr. A. Brown investigated more fully the material which had been placed in his hands by Prof. Nicholson, and gave an account of all the forms referable to Solenopora known at that date.

To those already recorded, he added descriptions of four new species from the Ordovician rocks—namely, *S. lithothamnioides, S. fusiformis, S. nigra,* and *S. dendriformis,* the two latter being from the Ordovician rocks of Esthonia.

In the same paper also he published for the first time a description of a new species of Solenopora from the Jurassic rocks of Britain, to which Nicholson, in manuscript, had already assigned the name of *S. jurassica,* though, as will be pointed out later, it is probable that two distinct forms were included by Brown under this name.

This record of Solenopora from the lower Oolites of Britain extended the known range of this genus, for the first time, well into the Jurassic period. In this paper Brown first brought forward good evidence for removing Solenopora from the animal kingdom, and placing it among the coralline algæ, and Prof. Seward, in Vol. i. of his work on fossil plants, considers that there are good reasons for accepting this conclusion.

At the time of the publication of Dr. Brown's paper, and for some years afterwards, the only formations in which Solenopora was known to occur were the upper Ordovician and the lower Oolites. The diversity of forms, however, met with in the Ordovician rocks, and their widespread distribution, pointed to the probability of the existence of an ancestral form in the older rocks, while it also appeared incredible that no specimens of intervening forms should have been preserved in the rocks representing the great time-gap between the Ordovician and Jurassic formations.

In this connection Prof. Seward remarks [5]: "It is reasonable to prophesy that further researches into the structure of ancient limestones will considerably extend our knowledge of the geological and botanical history of the Corallinaceæ." This prophecy has been amply fulfilled, especially as regards this particular genus, and recent discoveries go far towards filling the previously existing gaps in our knowledge of the vertical distribution of this interesting genus.

Thus the recent detection in the lowest Cambrian rocks of the Antarctic continent of a form which appears to be referable to this genus enables us to trace the ancestry of Solenopora back almost to the earliest rocks in which fossils have yet been discovered, while the gap in the succession which previously existed between the Ordovician and Jurassic forms was decreased by the description in 1908 by Prof. Rothpletz of a new species *Solenopora Gothlandica,* from the Silurian rocks of the Faröe Islands in Gotland.[6] A large number of deposits, however, still remained, between the Gotlandian and lower Jurassic beds, from which no example of Solenopora had so far been recorded.

The identification, therefore, a few years ago, by Dr. G. J. Hinde, of examples of this genus from among the nodules I had collected from the Shap dolomites, is of considerable interest, as the presence of Solenopora in the lower Carboniferous rocks of this

[3] "Geol. Mag., 1888, Dec. 3, vol. v, p. 19.

[4] "Geol. Mag., 1885, Dec. 3, 2, p. 534.

[5] *Op. cit.*, p 190.

[6] "Kungl. Svenska, Vets. akad. Handl." Bd. 42, No. 5, 1908, p. 14, pl. iv., pp. 1–5.

country materially decreases the gap in our knowledge of the succession of forms belonging to this genus, which had previously existed.

Girvanella.

This organism, which is now known to be widely distributed in the Palæozoic and Mesozoic rocks of this country, was originally described in 1878 by Nicholson and Etheridge, jun., from the Ordovician rocks of the Girvan district. The genus was established to include certain small nodular structures composed of a felted mass of interlacing tubes, having a width of 10 and 18 μ, the cells being typically simple, imperforate tubes without visible internal partitions. The geno-type, *G. problematica,* was, however, at that time referred to the Rhizopods and regarded as related to the arenaceous foraminifera ("Silurian fossils in the Girvan district," 1878, p. 23). In 1888 Nicholson, in redescribing this genus in the *Geological Magazine,* compares Girvanella with the recent form *Syringammira fragillissima* of Brady.

More recently Mr. Wethered has shown that an intimate association frequently exists between Girvanella tubes and oolitic structure, and he has described several new species of Girvanella, from the Palæozoic rocks and also from certain Jurassic limestones.

The reference of Girvanella to the calcareous algæ, though not yet supported by incontestable evidence, has been advocated by several writers in recent years. Even as long ago as 1887, Bornemann, in describing examples of Siphonema (Girvanella Nich.), which he had discovered in the Cambrian rocks of the Island of Sardinia, suggested that this organism might belong to the calcareous algæ.

In 1891 Rothpletz noticed that some of the specimens of Girvanella which he had examined were characterised by dichotomous branching of the tubes; on this account he removed the genus from the Rhizopods to the calcareous algæ, placing it provisionally among the Codiaceæ. Three years later Dr. A. Brown, in summing up the evidence in favour of the inclusion of Solenopora among the nullipores, expressed the opinion that Girvanella might ultimately come to be regarded as referable to the Siphoneæ Verticillatæ.

In 1898, however, this genus was still only doubtfully placed with the calcareous algæ, for Seward, in his work on fossil plants,[7] remarks: "The nature of Girvanella, and still more its exact position in the organic world, is quite uncertain. . . . We must be content for the present to leave its precise nature still *sub judice,* and, while regarding it as probably an alga, we may venture to consider it more fittingly discussed among the Schizophyta than elsewhere."

In 1908, however, Rothpletz, in discussing the relationship of Spherocodium and Girvanella, reaffirms his opinion that the latter must be referred to the Codiaceæ.[8]

Mitcheldeania.

This genus was first described by Mr. Edward Wethered from the lower Carboniferous beds of the Forest of Dean[9] under the name of *Mitcheldeania Nicholsoni*; it was referred by him to the Hydractinidæ, and considered to be allied to the Stromatoporoids. The figure accompanying this paper unfortunately fails to show any of the characters of the organism, but a better figure of the same species was subsequently published in the Proceedings of the Cotteswold Naturalists' Field Club.[10]

7 Vol. i, p. 125.
8 Rothpletz. "Ueber Algen und Hydrozoen," *op. cit.*
9 "Geol. Mag.," Dec. 3, 3, ccccxxxv, 1886.
10 Vol. ix, p. 77, pl. v., 1886.

In 1888 Prof. H. A. Nicholson published in the *Geological Magazine* figures and descriptions of a new species of this genus (*M. gregaria*), and redefined the genus as having "the form of small, rounded, or oval calcareous masses made up of capillary tubes of an oval or circular shape, which radiate from a central point or points, and are intermixed with an interstitial tissue of very much more minute branching tubuli." He compares the larger tubes to zooidal tubes, and states that they "communicate with one another by means of large, irregularly-placed foramina resembling "the mural pores" of the Favisitidæ, and they occasionally exhibit a few irregular transverse partitions or tubulæ."

With regard to the systematic position of this genus, Nicholson remarks: "In spite of the extreme minuteness of its tissues, the genus Mitcheldeania may, I think, be referred with tolerable certainty to the Cœlenterata . . . its closest affinities seem to be with the hydrocorallines . . . on the other hand, all the known hydrocorallines possess zooidal tubes which are enormously larger than those of Mitcheldeania; and there are other morphological features in the latter genus which would preclude its being actually placed, with our present knowledge, in the group of the Hydrocorallinæ."

Since this description by Prof. Nicholson, no further account of this organism, so far as I am aware, has been published, and its reference to the Hydrozoa rests on Prof. Nicholson's description.

During the past few years I have collected a large amount of material from both of the type localities from which Mr. Wethered and Prof. Nicholson obtained their specimens, and an examination of this material has impressed me strongly with the resemblance of Mitcheldeania to forms such as Solenopora and Girvanella, now usually classed among the calcareous algæ. In the rocks in which it occurs Mitcheldeania appears as rounded and lobulate nodules, breaking with porcellanous fracture and showing concentric structure on weathered surfaces, very similar to nodules of Solenopora; while under the microscope the branching character of the tubules and their comparatively minute size appear to separate them from the Monticuliporoids. Prof. Nicholson appears to rely on the presence of pores, which he thought he observed in the walls of both the larger and finer tubes, for the inclusion of this genus with the hydrocorallines, though he appeared to be doubtful about their occurrence in the interstitial tubuli. An examination of a large number of slides has failed to convince me of the presence of pores, even in the larger "zooidal tubes." The large "oval or circular" apertures noticed by Nicholson appear to be either elbows in the undulating tubes cut across where these bend away from the plane of the section, or places where a branch is given off from a tube at an angle to the plane of the section. If this view be accepted, there appears to be no sufficient reason why Mitcheldeania should not be ranged with Solenopora and other similar forms, and included among the calcareous algæ—a position which its mode of occurrence and general structure has led me, for some time, to assign to this organism.

In addition to the three chief forms described above from British rocks, a study of numerous thin sections from the Lower Carboniferous rocks of the north-west of England has revealed the presence of several distinct organisms, which will, I think, eventually be found to be referable to the calcareous algæ.

This meagre list appears to exhaust the genera known at the present time from the Lower Carboniferous rocks of Britain, while the only additional genus so far recorded from the Mesozoic and Tertiary

rocks of this country (if we except Rothpletz's subgenus Solenoporella) is Chara from the Wealden beds of Sussex, the uppermost Jurassic of the Isle of Wight and Swanage, and the Oligocene of the Isle of Wight.

Outside of this country the literature on fossil calcareous algæ is much more extensive. The interest originally aroused on the Continent by the writings of Phillipi, of Unger of Vienna, Cohn, Rosanoff, Gümbel, Saporta, and Munier-Chalmas has been further maintained in our own time by Bornemann, Steinmann, Früh, Solms-Laubach, Rothpletz, Walther, Kiaer, and others; while the more favourable conditions which obtained for the growth of these organisms, especially during Silurian, Triassic, and Tertiary times, has afforded a much wider field for their observation.

Thus, in addition to the forms recorded from this country, an important part has been played by members of the family of the Dasycladaceæ, together with such genera as Spherocodium, Lithothamnion, and Lithophyllum.

It is now time to turn to the consideration of the part played by these organisms in the formation of the sedimentary rocks through the successive geological periods.

Archæan.

In the Archæan rocks no undoubted remains of Algæ have, so far as I am aware, yet been recorded, but Sederholm considers that certain small nodules in the Archæan schists of Finland may represent vegetable remains. I may also perhaps here refer to some curious oolitic structures which I met with in Spitsbergen in 1896 when examining the rocks of Hornsund Bay. These oolites occur on the south side of the bay, and are closely connected with massive siliceous rocks which may represent old quartzites. The whole series is much altered, and detailed structure cannot now be made out. The rocks occur apparently stratigraphically below the massif of the Hornsund Tind, and may belong either to the Archæan or the base of the Heckla Hook series. As, however, similar rocks have not been recorded from the type district of Heckla Hook, they may be referred provisionally to the Algonkian, and may represent the quartzites and earthy limestone of the Jotnian series of Scandinavia. They are mentioned here in connection with Mr. Wethered's view that oolites are essentially associated with the growth of Girvanella.

Cambrian.

Passing on to the Palæozoic rocks, we find in the Cambrian deposits very few indications that calcareous algæ played any considerable part in their formation.

This is no doubt due, in part, to the conditions under which these deposits accumulated in the classical localities where true calcareous deposits are typically absent. In the Durness limestone, however, where considerable masses of dolomites occur, the conditions would appear at first sight to have been more suitable for the growth of these organisms; but even here the slow rate of accumulation and the large amount of contemporaneous solution may have militated against their preservation. At the same time, it is possible that a systematic search in the calcareous facies of the Cambrian rocks in the north of Europe and America might result in the discovery of the remains of some members of this group. That there is ground for this suggestion is shown by the recent work in the Antarctic continent.

Prof. Edgworth David and Mr. Priestly have discovered among the rocks in the north-west side of the Beardmore Glacier dark grey and pinkish-grey limestone containing the remains of Archæocyathinæ, Trilobites, and sponge spicules, together with abundant remains of a small calcareous alga referred provisionally to Solenopora; from the photographs exhibited by Prof. David on the occasion of his address to the Geological Society I have little doubt that this reference is correct.

A further occurrence is also reported from fragments of a limestone breccia collected by the Southern party from the western lateral moraine of the same glacier. Speaking of the fauna discovered in this limestone, Prof. David remarks: "The whole assemblage is so closely analogous with that found in the Lower Cambrian of South Australia as to leave no doubt as to the geological age of the limestones from which these fragments are derived."[11] This discovery, therefore, extends the vertical range of this widely spread genus down to the oldest Palæozoic rocks. It is interesting to note that the rocks in which the Solenopora occurs contain a development of pisolite and oolite, and that this is also the case in the Australian equivalents. In 1887 and again in 1891 Bornemann described and figured species of Siphonema and Confervites[12] from the Archæocyathus limestones of Sardina. As regards the former genus, it was shown by Dr. Hinde[13] to be congeneric with Girvanella (Nich and Eth). It is of interest, however, to note that Bornemann describes this form as a calcareous alga, and compares it with existing sub-aerial algæ growing on the surface of limestone rocks in Switzerland. The latter is stated by Seward to be possibly "a Cambrian algæ, but the figures and descriptions do not afford by any means convincing evidence."

More recently, in 1904, Dr. T. Lorenz has described remains of Siphoneæ from the Cambrian rocks of Tschang-duang in Northern China, for which he erects two new genera, Ascosoma and Mitscherlichia, placing them in a new family, the Ascosomaceæ. These algæ build important beds of limestone, the individuals often attaining a length of 4 cm. and a thickness of 1½ cm. In 1907 Bailey reported Girvanella associated with oolites in the lowest Cambrian Man-t'o beds in China. It is probable, therefore, that as our knowledge of these rocks is extended calcareous algæ will be found to play an important part in the Cambrian limestones of the Asiatic continent and Australia.

Ordovician.

In the Ordovician rocks, the remains of calcareous algæ become much more abundant. They are very widely distributed, and for the first time they become important rock-builders. In Britain, the chief genera met with are Girvanella and Solenopora. These two organisms occur abundantly in the Scottish Ordovician rocks of the Girvan area, where they appear to have contributed largely to the limestones of the Barr series in Llandeilo-Caradoc times.

As already mentioned, the genotype of Girvanella—*G. problematica*—was originally described by the late Prof. Nicholson and Mr. Etheridge, jun., from the Craighead limestone, where it occurs in great numbers in the Craighead limestone at Tramitchell. The officers of the Geological Survey also report it from the Stinchar limestone of Benan Hill.

It occurs in the form of small rounded or irregular nodules, varying in diameter from less than a millimetre to more than a centimetre—many of the nodules showing marked concentric structure. During a recent visit to Girvan I was much struck by the important part played by this organism in the formation of these upper compact limestones. In Benan Burn, where these beds are admirably exposed, the

[11] Eleventh Inter. Congress Report, 1910, p. 775.
[12] "Nova. Acta. Coes. Leop. Car.," 1887 and 1891.
[13] Hinde, "Geol. Mag.," 1887, p. 226.

Girvanella nodules occur conspicuously on the weathered surfaces, being so abundant as to constitute thick layers of limestone.

Solenopora compacta, var. *Peachii*, which, likewise, forms important masses of limestone, occurs, like *Girvanella problematica*, in the Girvan area, but at a somewhat lower horizon, namely, in the nodular limestone and shales forming the lower sub-division of the Stinchar limestone. It was originally described from pebbles in the Old Red Conglomerate of Habbie's Howe by Nicholson and Etheridge, jun., under the name *Tetradium Peachii*, and was subsequently discovered to occur plentifully in the Ordovician limestone at Tramitchell and Craighead, and to be synonymous with *Solenopora compacta* (Bill). In the shales associated with the nodular limestone of Craighead it occurs as spheroidal and botryoidal nodules up to 1½ in. in diameter; while in the limestone itself the nodules may have a diameter of 3 in. On freshly fractured surfaces it appears as buff-coloured on brownish spots, having a compact porcellanous texture, while weathered surfaces often show a concentric structure. Under the microscope the tubes of this species vary in diameter from 50–80 μ.

In the Geological Survey Memoir it is also recorded, under the original name of *Tetradium Peachii*, from the Stinchar limestone of Benan Burn, Millenderdale, and Bougang, where it is accompanied by two other species, *S. filiformis* and *S. fusiformis*,[14] which contributes conspicuously to the deposit, often forming large masses of limestone. The horizon of the Stinchar limestone is correlated by Prof. Lapworth with the Craighead limestone, and considered to represent the summit of the Llandeilo or the base of the Caradoc of the Shropshire district. It is of interest to note that Solenopora is here accompanied at times by well-marked oolitic structure, and that the same is true of the pebbles with which it is associated in the conglomerate at Habbie's Howe.

Although the marked development of Solenopora found in the Stinchar limestone ceases with the advent of the Benan conglomerate, the genus appears to have survived in the district into Upper Caradoc times, for Dr. Brown describes a new species (*S. lithothamnioides*) from Nicholson's collection from the Ordovician (? Silurian) at Shalloch Mill, where it occurs in conical masses the size of a walnut. The only beds in which we might expect algæ to occur in this locality are the nodular limestones or Dionide beds of the Whitehouse group of Prof. Lapworth's classification, but there is no mention of Tetradium or Solenopora from this locality in the fossil lists cited from Mrs. Gray's collection in the survey memoir.

As this point is of some interest, I have consulted Mrs. Gray, who very kindly sent me some small nodules which she had collected from the Whitehouse beds of Shalloch Mill. On slicing one of these I find that it is undoubtedly a Solenopora, and probably the species figured by Dr. Brown as *S. lithothamnioides*. A tangential section cut from this specimen shows clearly why the original specimen of Solenopora from Craighead was mistaken for Tetradium by Nicholson and Etheridge, jun.

South of the Scottish border there is, so far as I am aware, only one locality from which calcareous algæ have been recorded in rocks of Ordovician age, namely, Hoar Edge in Shropshire. Here large examples of *Solenopora compacta* were obtained in 1888 by Prof. Lapworth from the calcareous layers near the base of the Hoar Edge sandstone. The specimens were handed to Prof. Nicholson, who records the circumstance in his description of *S. compacta* in the *Geological Magazine* for 1888. The form occurs here at the base of the Caradoc beds, and therefore at a horizon which corresponds closely to that of the Craighead limestone of Girvan.

Prof. Lapworth also informs me that he has obtained specimens of Solenopora from a limestone in south-west Radnorshire. As the upper portion of the limestone in which it is found contains a Silurian fauna, it is possible that it is here present at a higher horizon, though the constancy with which it occurs elsewhere, in beds of Llandilo-Caradoc age, would seem to point to the possible presence of beds of Upper Ordovician age in this area. In any case, its occurrence here is of considerable interest.

Foreign Ordovician.

Outside of Britain, one of the most interesting developments of calcareous algæ in rocks of Ordovician age occurs in the Baltic provinces.

As already stated, Solenopora was first recorded from Herrküll in Esthonia, by Dybowski under the name of *Solenopora spongioides*. It occurs here in the Upper Caradoc or Borckholm beds of Schmidt's classification—where it makes up thick beds of limestone—and it is noteworthy that this horizon is practically identical with that at which *S. lithothamnioides* (Brown) occurs at Shalloch Mill.

Other specimens of *Solenopora* were collected by Prof. Nicholson in Saak, south of Reval, from the underlying Jewe beds, an horizon which corresponds very closely to that of the Craighead limestone of Girvan. Speaking of these beds, Nicholson and Etheridge remark: "At this locality *S. compacta* not only occurs as detached specimens of all sizes, but it also makes up almost entire beds of limestone; indeed, some of the bands of limestone at Saak look like amygdaloidal lavas, while others have a cellular appearance from the dissolution out of them of the little pea-like skeletons of this fossil."

In Prof. Nicholson's collection from these beds Dr. Brown afterwards distinguished two new species, namely, *S. nigra* and *S. dendriformis*. Thus in the Ordovician rocks of Esthonia, Solenopora plays quite as important a part (as a rock-forming organism) as it does in the Girvan district in Ayrshire.

In Norway again, in the Mjösen district to the north of Christiania, Solenopora occurs plentifully in Stage 5 of Kiaer's Ordovician series. Here it is very abundant and often builds entire beds, while, further east, at Furnberg, Kiaer again records the occurrence of abundant nodules of *Solenopora compacta*, var. *Peachii*.

In addition to Solenopora, however, examples of another important group of calcareous algæ, the Siphonæ, occur in great abundance in the Ordovician rocks of the Baltic region, where they play a part in the formation of calcareous rocks, scarcely less important than that played by Gyroporella and Diplopora in the rocks of the Alpine Trias.

The chief forms belong to the family of the Dasycladaceæ, represented by the recent genus Neomeris, and include the genera Palæoporella, Dasyporella, Rhabdoporella, Verimporella, Cyclocrinus, and Apidium. These algal limestones represent the beds from the Jewe to the Borckholm beds inclusive. They were originally investigated by Dr. E. Stolley, who described their occurrence in the numerous boulders which are strewn over the North German plain in Schleswig-Holstein, Pommerania, Mecklenburg, and Mark-Brandenberg. Many of these boulders can be identified by their lithological character and fossil contents as belonging to the Jewe beds of the Baltic Ordovician formations. Others have been derived from the overlying Wesenberg limestones, while yet others occur which resemble the

[14] Brown, *op. cit.*, pp. 195–197.

succeeding Lyckholm beds of the Baltic succession. This assemblage proves that the boulders did not originate on the Swedish continent, but from the more easterly-lying districts, probably from a part of the Baltic between Oeland and Estland, now covered by the sea. Similar boulders are also known at Lund in Schœnen, on Bornholm, and near Wisby in the north of Gotland.

These facts appear to show that during the deposition of the Jewe and the overlying Wesenberg and Lyckholm limestones an algal facies obtained which extended from Oeland to Estland and as far north as the Gulf of Bothnia.

But even this area does not represent the full extent of the algal limestone facies in Upper Ordovician times. In Norway, Kiaer has shown by his detailed work in the Upper Ordovician rocks, Stage 5 of the Christiania district, the important part played by the Dasycladacea in this area. Here the Gastropod limestone in places forms a "phytozoan limestone," made up of Rhabdoporella, Vermiporella, and Apidium associated with a considerable development of oolite.

Again at Kuven and Valle, in the Bergen district, Reusch and Kolderup have described knolls of crystalline limestone containing abundant remains of Rhabdoporella (formerly described as Syringophyllum) associated with a gastropod and coral fauna. This horizon they have unhesitatingly referred to zone 5*a* of Kiaer's sequence, and state that it may be found stretching from Geitero in the S.S.W. by Kuven, Valle, and Trengereid to Skarfen on Ostero, while Reusch has traced it further south to Stordo, near Dyviken and Vikenes.

We have, therefore, in Upper Ordovician times, in the north of Europe, one of the most remarkable developments of algal limestones met with throughout the geological succession. In North America also algæ are represented in Ordovician times by *Solenopora compacta*, which occurs in the Trenton and Black River limestones groups, whence it was originally obtained by Billings. It therefore occurs here at about the same horizon as in Saak and Britain.

We may also note the occurrence of Girvanella in the underlying Chazy limestone originally described by the late Prof. H. M. Seeley under the name *Strephochetus ocellatus*, but now generally admitted to be a form of Girvanella.

Other forms referred to this genus have also been reported by Schuchert from rocks of undoubted Ordovician age on the east coast of the Behring Straits.[15]

SILURIAN.

The rocks of Silurian age in Britain, in which calcareous algæ play an important part, appear to be limited to the Wenlock limestone, from which Mr. Wethered has described the constant occurrence of Girvanella tubes, especially in the beds of this age at May Hill, at Purley, near Malvern, and Ledbury.[16] Of these beds Mr. Wethered remarks: "The most interesting result of the microscopic study of these rocks was the discovery of new and interesting forms of Girvanella and the fact that this organism has taken so important a part in building up the limestone." It may here be mentioned that it was whilst studying these forms in the Wenlock limestone that Mr. Wethered first began to favour the suggestion of Rothpletz, published two years previously, in favour of Girvanella belonging to the calcareous algæ, for he remarks: "I certainly think that the forms which I have discovered in the Wenlock limestone seem more favourable to the vegetable theory of the origin of this fossil than those described in my former paper, and possibly it may be allied to the calcareous algæ."

So far as I can ascertain, this is all that has been published up to the present time with regard to the occurrence of calcareous algæ in British Silurian rocks; but I have every confidence that a more thorough microscopic examination of these rocks will reveal the presence of many other examples of this group.

Foreign Silurian.

Outside Britain at this period we find the most marked development of an algal facies, once more in the Baltic area, where, especially in the island of Gotland, algal growths contribute enormously to several of the limestones and marls. It is an interesting fact that very shortly after the disappearance of the various members of the Dasycladaceæ which were so much in evidence in Ordovician times, we have the marked development of another group of the Siphoneæ, which quickly reached a maximum, building up in their turn abundant calcareous deposits. Nodules from these limestones have long been known from Gotland under the name of "Girvanella Rock," and have been recorded by Stolley in boulders scattered over the North German plain. In 1908, however, Prof. Rothpletz showed, in his interesting work on these Gotland deposits,[17] that the forms hitherto alluded to under the term "Girvanella" were in reality referable to two different genera. One of these he showed to be a new species of Solenopora, to which he gave the name *S. gothlandica* (distinguished from *S. compacta* by the comparatively small dimension of the tubes, which are only about one quarter of the diameter of *S. compacta*, the genotype); the other he referred to his genus Spherocodium, which he had created in 1890 for certain forms from the Alpine Trias. The survival here of Solenopora into beds of undoubted Silurian age is an interesting fact and would lead us to expect that it may also some day be found in rocks of corresponding age in this country.

Of the different forms of algæ which occur in these Gotlandian deposits, perhaps the most interesting is Spherocodium. This organism occurs at several horizons in the succession. It first makes its appearance in the marl immediately overlying the Dayi flags—approximately of Lower Ludlow age—where Spherocodium occurs in considerable masses. Through the kindness of Dr. Munthe, who has made a special study of these beds in south Gotland, I have been able to examine specimens of this interesting form. In external appearance they resemble very closely nodules of Ortonella from the Lower Carboniferous of the north-west of England; some of the nodules appear to have reached a diameter of 1½ in. The bed is overlain by sandstone and oolite, which are succeeded by an argillaceous limestone rich in nodules of *Spherocodium gotlandicum* and well exposed at Grötlingbo, where it is closely associated with oolite. Among the fossils of this limestone Spherocodium itself plays a most important *rôle*.

In the overlying Iliona limestone, Spherocodium is decidedly rare, and its place is taken by nodules of Spongiostroma. It is, however, found not infrequently forming a thin crust on some of the nodules of Spongiostroma, which have also been described by Prof. Rothpletz (*op. cit.*). In appearance, Spongiostroma resembles very closely the nodules of Spherocodium, showing the same concentric arrangement round coral fragments and total absence of the radial structure which is so characteristic of Solenopora.

The actual systematic position of this organism, if organism it be, is still undecided. In his original

[15] See Hang. 2, 1, 643.

[16] Q.I.G.S., xlix, p. 236, 1893.

[17] "Ueber Algen und Hydrozoen in Silur von Gotland und Oesel" Kungl. Sven. Vet. Handl. Band 43, No. 5, 1908.

description of this genus from the Carboniferous rocks of Belgium, Gürich refers it provisionally to the Protozoa, while Rothpletz in his description of the two species *S. balticum* and *S. Holmi* from the Gotlandian of Gotland, although admitting the difficulties of assigning it to any group of the animal kingdom, decides in favour of its hydrozoan affinities.

As will be pointed out later, there appears to be no good reason why Spongiostroma may not be indirectly the result of algal growths; but whatever may be the final position assigned to it, there can be no doubt as to its importance as a rock-building form in the Iliona limestone of Gotland. The wide extent of this algæ horizon in the Upper Silurian of the Baltic area is shown by the abundance of boulders of these rocks scattered over Schleswig-Holstein, and it is probable that a careful examination will show the presence of this facies in the Silurian to the east of the Baltic provinces.

We may conclude, therefore, that the development of the Spherocodium beds of Gotland probably occupy as wide an extension in the Baltic area as that of the Rhabdoporella limestones in the Ordovician period.

With regard to other occurrences in Silurian rocks, it will be sufficient to note that of Girvanella in the Silurian limestones of Queensland, Australia, recorded by Mr. G. W. Card in 1900, and more recently by Mr. Chapman from Victoria.[18]

Quite recently Mr. R. Etheridge, jun., of Sydney,[19] has described "an organism allied to Mitcheldeania from the Upper Silurian rocks of New South Wales"; the figures given, however, and the description are not convincing that his identification can be accepted. The size of the tubes, which are from five to six times that of the largest tubes of *M. gregaria*, alone would appear to separate this organism from Mr. Wethered's genus, and almost certainly from the calcareous algæ.

DEVONIAN.

So far as I am aware, there is only one recorded occurrence of calcareous algæ in the Devonian rocks of Britain—namely, in the Hope's Nose limestone, from which Mr. Wethered has described aggregations of tubules resembling Girvanella, but in a very poor state of preservation. It is hoped that this meagre list will be increased in the near future.

Foreign Devonian.

On the Continent the records are, so far, equally poor. At the same time, the cursory examination which I was able to make of the thin sections of the Devonian limestones exhibited in the Brussels Museum leads me to expect that a careful investigation of the Belgian Devonian limestones will yield other examples besides Spongiostroma.

CARBONIFEROUS.

We now reach the period in Paleozoic times when calcareous algæ attained their maximum development in England, a development rivalling that which obtained in the Ordovician rocks of Scotland and the Gotlandian of Scandinavia. The genera here represented include Girvanella, Solenopora, and Mitcheldeania. In addition to these, there occur several lime-secreting organisms which, though still undescribed, will, I think, ultimately come to be included among the calcareous algæ. The most interesting of these organisms I have recently figured from the Lower Carboniferous rocks of Westmorland, where it forms a definite zonal horizon or "band."[20] For this form, on account of its stratigraphical importance and for facility of reference, I propose the generic name of Ortonella.[21]

Again, at the same horizon in the North-west Province I have frequently noticed concretionary deposits of limestone which occur as finely laminated masses often lying parallel to the general direction of the bedding planes, which, on microscopic examination, show no definite or regular structure, but have every appearance of being of organic origin. Many of these puzzling forms resemble very closely the somewhat obscure structures found in the Visean limestones of the Namur basin in Belgium, of which beautiful thin sections are displayed in the Natural History Museum at Brussels,[22], and which Gürich has described and figured under various names—namely, Spongiostroma, Malacostroma, &c., and included under a new family the Spongiostromidæ,[23] and a new order, the Spongiostromaceæ. He gives the following definition of the family: "Organismes marins, incrustants, coloniaux, à structure stratifiée. La structure de la colonie est indiquée, à l'état fossile, par la disposition de petits grains opaques (granulations), entre lesquels il y a des interstices, tantôt plus étroits, tantôt plus larges —canaux du tissu et canaux coloniaux—donnant naissance à un tissu spongieux. Dans plusieurs formes, on a observé des Stercomes," and suggests that they may possibly have been encrusting foraminifera.

I must confess that neither in the original sections nor in the beautiful illustrations which accompany his work can I see any grounds for referring these structures to the protozoa.

As regards the British specimens, I have long regarded them as due, directly or indirectly, to the work of calcareous algæ, on account of their intimate association with well-developed examples of these organisms, and, secondly, on account of the entire absence of foraminifera and other detrital organisms wherever this structure occurs. As, however, I have little doubt that they are closely connected in their mode of origin with the Belgian specimens, we may conveniently speak of them under the general term Spongiostroma.

Some of the best examples known to me occur associated with Ortonella in the "*Productus globosus* band" near the summit of the "*Athyris glabristria* zone" in the Shap district. They occur here in considerable masses, often many inches in thickness, and form undulating layers parallel to the bedding, and somewhat resembling huge ripple-marks. Thin sections show little definite structure, but consist of what appears to be an irregular flocculent precipitate of carbonate of lime, the interstices being filled with secondary calcite. Some of the layers resemble almost exactly, both in hand specimens and microscopic structure, the figures of *Malacostroma concentricum* given by Gürich in plates xvii. and xx. (23). Others approach closely to the same author's figures of Spongiostroma, Aphrostroma, &c. In all cases they appear to be due to the precipitation of carbonate of lime in the neighbourhood of algal growths. I have also met with similar deposits, not only at other horizons in the Lower Carboniferous of the north of England, but also in the Forest of Dean and in the rocks of the Avon Gorge; while quite recently Mr. C. H. Cunnington has sent me examples from several horizons in the Carboniferous limestones of South Wales.

Girvanella.

This organism appears to play a considerable part in the formation of calcareous deposits in the Lower Carboniferous rocks of Britain. Its presence in these

[18] Rep. Austr. Assn. Adv. Sci., 1907-8.
[19] Rec. Geol. Surv. N. S. Wales, vol. viii, pt. iv., 1909, p. 308, pl. 47.
[20] Q.J.G.S., 1912, vol. lxviii. pl. 67, fig. 2.
[21] From Orton, a village between Shap and Ravenstonedale, where this organism occurs in great abundance.
[22] One of these is also exhibited at the Jermyn Street Museum.
[23] "Mem. du Musée Roy. d'Hist. Nat. de Belgique," iii, 1906.

rocks was first suggested by the late Prof. Nicholson,[24] in his paper where he remarks: "I have found some of the Carboniferous limestone of the north of England to contain largely an ill-preserved organism which will, I think, prove to be referable to Girvanella." This prophecy has turned out to be fully justified not only as regards the north of England, but also in the case of other Lower Carboniferous districts. In 1890 Mr. E. Wethered described[25] two new forms from the Lower Carboniferous of the Avon Gorge and Tortworth, viz., *G. incrustans*, with tubes having a diameter of 0·1 mm., and *G. Ducii* with a diameter of 0·02 mm. Mr. Wethered appears to rely chiefly on the size of the tubes for the differentiation of these species, but as this distinction was made at the time when Girvanella was still considered to belong to the Rhizopods, and as the size of the tubes frequently varies in the same specimen, it is doubtful whether these species can be maintained. Mr. Wethered's specimens were obtained from the limestone near where the Bridge Valley road joins the river bank, apparently at the base of Dr. Vaughan's Upper Dibunophyllum zone. The position of this limestone is of interest, as it appears to correspond very closely with the horizon of the Girvanella nodular bed, which forms a well-marked band at the base of the Upper Dibunophyllum zone throughout the whole of the north and north-west of England. Indeed, I have traced this band at intervals from the neighbourhood of Ford, near the Scottish border, southwards through Northumberland and the Pennine area to Penygent, and from the west coast at Humphrey Head through Arnside and Shap to the east coast, near Dunstanburgh. These organisms must, therefore, have flourished over an area of at least 3000 square miles.

The Girvanella tubes found associated with these nodules usually occur in two distinct sizes having diameters of 0·03 and 0·01 mm. respectively. The two forms are closely associated, but the finer tubes occur in greater abundance, and are much more closely interlaced. They resemble Mr. Wethered's description of the two species from Gloucestershire, and the figures he gives in illustration of these might serve very well to represent our northern forms.

The best exposure showing the important development of these Girvanella nodules is to be found on the dip slopes forming the eastern shore of Humphrey Head in Morecambe Bay, where the base of the Upper Dibunophyllum zone is exposed over a considerable area.

Solenopora.

The discovery of a specimen of this genus in the Lower Carboniferous rocks of Westmorland is of considerable interest, as its occurrence here gives us some insight into the history of its wanderings between the time when we last recorded it in the Gothlandian rocks of the Baltic area, and its reappearance in the Lower Oolite of Gloucestershire. Whether it lived in the Baltic area during the Devonian and Carboniferous periods is, however, still unknown. The fact of its occurrence in the Caradoc, Carboniferous, and Jurassic rocks of the British Isles would appear to point to its existence not far off during the intervening periods, and I have hopes that before long it may be found in the Silurian, and possibly also in the Devonian rocks of this country.

In Westmorland and Lancashire Solenopora occurs in considerable abundance near the local base of the Lower Carboniferous rocks, and contributes largely to the formation of limestone deposits. It is present wherever the lowest beds of the succession are exposed, as at Shap, Ravenstonedale, and Meathop, and must formerly have flourished over a considerable area.

Though bearing a general resemblance, both in hand specimens and microscopic structure to the Ordovician and Jurassic forms, it has recently been shown by Dr. G. J. Hinde to be specifically distinct.[26] It occurs as small, spheroidal nodules up to an inch in diameter, having a markedly lobulate outline embedded in compact and usually dolomitic limestones, and it is occasionally associated with oolitic structure. When fractured, it exhibits the compact porcellanous texture and pale brownish tint characteristic of specimens of the genus found at other horizons; while weathered surfaces frequently show a concentric and occasionally a radially fibrous structure. It is noteworthy that the thallus of this organism shows no trace of dolomitisation, even when embedded in limestone containing over 30 per cent. of $MgCO_3$. The profusion of this form in Westmorland would lead one to expect its occurrence in other districts where the lowest Carboniferous zones are developed; but so far as I am aware, no such occurrence has yet been recorded. It may be of interest, therefore, to mention here that a few years ago my friend, Mr. P. de G. Benson, brought me a specimen of rock from near the base of the succession in the Avon Gorge, which on cutting I found to contain several examples of Solenopora identical with the Westmorland form. It is probable, therefore, that a careful microscopic examination of the lower horizons of the Carboniferous rocks of the south-west province will lead to the discovery of other examples of this interesting genus.

Mitcheldeania.

The specimens of *Mitcheldeania Nicholsoni* originally described by Mr. Wethered were obtained from Wadley's Quarry, near Drybrook, Mitcheldean, from the lower limestone shales at the base of the succession. Prof. Sibly, who has recently made a careful study of the Lower Carboniferous succession in the Forest of Dean,[27] has traced this algal layer over a considerable area, and considers it to represent a horizon near the top of K.I. of the Bristol sequence. He has also noted examples of Mitcheldeania at a higher level, namely, in the Whitehead limestone, an horizon corresponding probably to the base of C2. During a recent visit to the Mitcheldean district I collected specimens from both the lower shales, and also from the Whitehead limestone, and, thanks to Prof. Sibly's kind directions, I was able to see numerous sections in which he has found this algal development. There can be no doubt that Mitcheldeania is here an important rock-forming organism at least at two horizons in this district, and that it occurs over a considerable area. In the case of the upper horizon it frequently contributes largely to the rock, forming in places almost entire layers in the Whitehead limestone. As regards the forms met with at these two horizons, the upper form found in the Whitehead limestone agrees exactly in general characters and mode of occurrence, and also in detailed microscopic structure, with Nicholson's species, *M. gregaria*, from Kershope Foot. The character of the two sets of tubes, their size and mode of arrangement is identical, and it is impossible to distinguish between sections of well-preserved specimens from the two localities. Unfortunately, the specimens from the lower shales at Mitcheldean are very badly preserved, but if Nicholson's distinction between the two species holds, we shall have to speak of the form

[24] *Op. cit.* p. 24.
[25] *Q. J. G. S.*, vol. 47, p. 280, pl. 11, figs. 1 and 2. 1890.
[26] *Geol. Mag.*, Dec. 5, x, 289. 1913.
[27] *Geol. Mag.*, Dec. 5, 417.

from the lower horizon at Mitcheldean as *M. Nicholsoni*, and that from the Whitehead limestones as *M. gregaria*. Frequently associated with the latter is a curious *festoon-like* growth, while a Spongiostroma-like structure is often found in the matrix of the rock between the larger tubes of *M. Nicholsoni*. Some years ago Mr. Wethered also recorded a similar form of Mitcheldeania from the base of the middle limestones of the Avon Gorge, while I have myself collected nodules containing specimens apparently referable to *M. Nicholsoni* from the Modiola Shales near the base of the succession. Interesting as the development of Mitcheldeania in the Forest of Dean undoubtedly is, its real home in Britain is in north Cumberland and the Scottish border, where it flourished to a remarkable extent in the shallow water lagoons which spread over so large an area in the north of England during early Carboniferous times. Over the greater part of north Cumberland and the east of Roxburgh we find a remarkable development of algal limestones in the formation of which Mitcheldeania plays a very important part. They are met with especially at two horizons, an upper one, lying immediately below the Fell Sandstone, and a lower one in the middle of the underlying series of limestone and shales. The lower horizon is especially interesting on account of the thick masses of limestone composed almost entirely of algal remains. Though Mitcheldeania forms the basis of this reef-like development, it is accompanied by other algal forms, especially bundes of minute tubules of Girvanella and coarser tubes reminding one of the Spherocodium of Gotland. In places again the marked concentric coatings resemble certain forms of Spongiostroma. The substance of the reef has frequently formed round the remains of Orthoceratites; indeed, the chief layer is usually associated with remains of these Cephalopoda. With other layers occur tubes of Serpulæ, and others again with ostracod remains. In addition to the limestone of this massive reef, abundant nodules lie scattered through the calcareous shales above and below.

The upper layer, which includes examples from Nicholson's type locality, forms a compact limestone several inches thick. It is made up of small spheroidal nodules about half an inch in diameter, and occurs a short distance below the Fell Sandstone. It can be traced over the whole of north Cumberland and north-west Northumberland from near Rothbury on the east to the Scottish border at Kershope Foot, and from the head waters of the Rede in the north, to the Shopford district in the south. This layer must therefore have been originally deposited over an area of at least 1000 square miles. The horizon of the upper band is almost certainly that of the C. zone of the Bristol sequence.[28] It is quite possible, therefore, that it is contemporaneous with the Whitehead limestone of Mitcheldean. This supposition receives support from two other pieces of evidence. In the beds underlying the *Mitcheldeania gregaria* band in north Cumberland occur calcareous nodules largely made up of tubes of Serpulæ—an organism which is completely absent from the Westmorland succession, but which is reported by Prof. Sibly from the lower limestone shales containing Mitcheldeania in the Forest of Dean district. Again, this upper algal layer in Northumberland and Cumberland is almost immediately overlain by the Fell Sandstone series, while the Whitehead limestone at Mitcheldean passes immediately upwards into a sandstone, the Drybrook Sandstone of Prof. Sibly, which was originally correlated with the Millstone Grit, but was shown by Dr. Vaughan in 1905 to belong to the Lower Carboniferous series. It would be interesting if further researches should prove the existence of a former gulf at the end of Tournaisian times, running to the east of the North Wales Island, from the Forest of Dean through north Cumberland to the southern slopes of the Cheviot Isle, with a branch given off towards eastward into Westmorland.

In any case, it is a remarkable fact that we have a great development of algal deposits at this period in Gloucestershire, Westmorland, Lancashire, north Cumberland, and Northumberland.

Ortonella.

This form, as already mentioned, occurs in great abundance in the algal band in the "*Athyris glabristria* zone" of the north-west province It is found in spherical nodules up to the size of a small orange. In microscopic sections it resembles Mitcheldeania in so far as it consists of a series of tubes growing out radially from a centre. It differs, however, from this genus in many important respects. All the tubes are approximately of the same size, and there is no evidence of alternating coarse and fine turfs arranged concentrically, as in the case of Mitcheldeania. Further, the tubes are not undulating as in that genus, and therefore in thin slices lie for a long distance in the plane of the section. They are much more widely spaced and show marked dichotomous branching, bifurcation making a nearly constant angle of about 40°, and there is a strong tendency for the branching to take place in several tubes at about the same distance from the centre of growth, producing a general concentric effect in the nodule.

The diameter of the tubes is decidedly less than those in Mitcheldeania, being usually little more than half the size of the tubes of *M. gregaria*. The nodules of this genus occur in great profusion, contributing largely to the formation of the shaley dolomite at the base of the "*P. globosus* band" throughout the Shap, Ravenstondale, and Arnside districts and Westmorland and Lancashire.

In addition to these genera there occur also two other encrusting calcareous growths which require mention. The first of these appears in thin sections in the form of a *festoon-like growth*, surrounding fragments of calcareous algæ, especially Mitcheldeania and Ortonella. I have met with it abundantly in the "Algal band" in the north-west of England, but it also occurs not infrequently associated with Mitcheldeania in the Whitehead limestone in the Forest of Dean, while a similar structure occurs associated with *Mitcheldeania gregaria* in north Cumberland.

Although the exact nature of this growth is still undecided, I mention it here on account of its invariable association with undoubted calcareous algæ.

The other deposit is the form already alluded to under the term Spherocodium which I have found forming considerable masses of rock in many districts where the Lower Carboniferous beds are exposed; not only in Westmorland and north Cumberland, but also in the Bristol district, the Forest of Dean, and South Wales.

Foreign Carboniferous.

From its general similarity to the British deposits we might expect to find examples of an algal development in some portion of the Belgian Lower Carboniferous succession. As already mentioned, large masses of encrusting calcareous deposits have been described by Gürich[29] from the Visean limestones of the Namur basin as Spongiostroma, &c., which, though referred by him to the Rhizopoda, may very

[28] "Geology in the Field," pt. 4, p. 683, and *Q. G. S.*, vol. 73, 1912, p 547.

[29] "Les Spongiostromides du Visén de la Province de Namur. Mem. du Musée Roy. d'Hist. Nat. de Belgique," t. iii 1906.

well be calcareous precipitates deposited by algal influence. Many of these deposits are similar to those mentioned above from British rocks.

No undoubted remains of calcareous algæ have, however, yet been recorded from these Belgian rocks. It may be of interest, therefore, to mention the recent discovery by Prof. Kaisin, of Louvain, of undoubted algal remains in the beds overlying the Psammites-de-Condroz at Feluy, on the Samme. The form found here resembles Ortonella of the Westmorland rocks, but the tubes are much finer, and it may turn out to represent a species of Michelde ania. During a recent visit to Belgium I had the pleasure of visiting the Comblain au Pont beds, in the Feluy section, with Prof. Kaisin, and, although these beds have been previously classed as Devonian, I agree with him that they probably belong to the base of the Carboniferous, and correspond approximately to K of the Bristol sequence. In the company of Prof. Dorlodot and Dr. Salée, I also visited the chief sections of the Visean, and we succeeded in discovering at least three horizons at which nodular concretionary structures, probably referable to algal growths, occurred. It is pretty certain, therefore, that careful microscopic investigation of the Belgian rocks will show the presence of calcareous algæ at more than one horizon.

One other occurrence of Girvanella may be mentioned from foreign Carboniferous rocks: that is a form described by Mr. H. Yabe from the (?) Carboniferous rocks of San-yu-tung and other localities in China under the name of *G. sinensis*.[30]

Permian and Trias.

In Britain I have met with no reference to the occurrence of calcareous algæ in rocks of this period, but quite recently Mr. Cunnington, of H.M. Geological Survey, sent me a few nodules from the base of the Permian which resemble very closely fragments of Spongiostroma from the Carboniferous limestone, and may be derived from that formation.

Abroad, masses of limestone, composed almost entirely of remains of Diplopora and Gyroporella, have long been known from the Muschelkalk and lower Keuper beds of the eastern Alps, notably the Mendola Dolomite, the Wetten limestone of Bavaria, and the Tyrolian Alps—from the Zugspitz to Berchtesgaden. In the Hauptdolomit and from the Fassa Dolomite of the north limestone Alps and the stratified Schlern dolomite of the southern Tyrol. In the Lombard Alps the same facies reappears, and *Diplopora annulata* occurs abundantly in the well-known Esino limestone above Varenna.

In 1891 Rothpletz[31] showed that certain spherical bodies in the Triassic beds of St. Cassian, formerly regarded as oolitic structures, were in reality algal growths, and referred them to a new genus, Sphœrocodium, on account of their apparent resemblance to the living form Codium. He describes them as encrusting organisms forming nodules up to several centimetres in diameter. They contribute substantially to the rocks in which they occur, and are found especially in the Raiblkalk, the Kossenerkalk, and the Plattenkalk.

Jurassic.

The Mesozoic rocks of Britain contain but few examples of marine algal limestones, and important occurrence are confined to the Jurassic Rocks. The forms met with are limited to two genera, Girvanella and Solenopora.

Tubes of Girvanella occur fairly abundantly in the British Oolites, especially in the well-known Leckhampton Pisolites, and Mr. Wethered, who has made a special study of oolitic structures, appears inclined to refer all oolitic structures to organic agency of this nature.

The examples of Solenopora met with in the Great Oolite and Coral Rag are of special interest. In both cases they attain very much larger dimensions than any species yet discovered in the Palæozoic rocks.

At Chedworth, near Cirencester, I have collected masses of *Solenopora jurassica*, measuring up to a foot across, in which the original pink tint is still so conspicuous on freshly fractured surfaces as to give rise to the local appellation of "Beetroot Stone," and the colour also reminds one of the red algæ growing in great profusion at the present day in the Gulf of Naples.

It is also recorded from the same horizon by Dr. Brown from Malton in Yorkshire, and also, on the authority of the late Mr. Fox Strangways, by Prof. Rothpletz. (*Op. cit.*)

In Yorkshire, however, a form undoubtedly occurs at a higher horizon, namely, in the Coral Rag of the Scarborough district, where it is well known to local collectors. Specimens which I have collected from this horizon at Yedmandale and Seamer also attain a considerable size—up to six inches in their longest dimension.

The name *S. jurassica* was given by Prof. Nicholson in manuscript to the specimens from Chedworth, and was adopted by Dr. Brown in his description of specimens from both Chedworth and Malton.

Prof. Rothpletz points out that specimens examined by him from Yorkshire differ from the genotype in the fact that the cells are typically rounded in cross section and by the absence of perforations in the cell-walls, and he therefore proposes to separate it as a new genus Solenoporella. It seems probable that some confusion has arisen between the specimens to which Nicholson originally gave the name of *S. jurassica* from the Great Oolite of Chedworth and other specimens from a higher horizon—the Coral Rag—examined by Dr. Brown and Prof. Rothpletz.

The former indeed figures a longitudinal section from Chedworth (Glos.) and a tangential section from Malton (Yorkshire).

I have collected specimens from both horizons and consider that whilst the Chedworth specimen, to which the name *Solenopora jurassica* was originally given, represents a species of true Solenopora, showing closely packed cells with polygonal outline in tangential section, the form from the Coral Rag of Yorkshire, with distinct circular outline to the tubes in tangential section is specifically, if not generically, distinct, and is that described by Rothpletz as Solenoporella.

If this view be correct we should continue to speak of the specimens from the Great Oolite at Chedworth as *Solenopora jurassica*, while those from the Coral Rag of Yorkshire must be known as Solenoporella *sp.* Rothpletz.

Foreign Jurassic.

It is surprising that records of the occurrence of calcareous algæ in foreign Jurassic rocks are at present very scarce.

Quite recently, however, Mr. H. Yabe[32] has described a new species of Solenopora, under the title *Metasolenopora Rothpletzi*, from the Torinosu limestone Japan. This discovery is of interest, as it carries the known occurrence of Solenopora up to the base of the Cretaceous, in which formation Lithothamnion appears and thenceforward becomes the

[30] H. Yabe, "Science Reports of the Tôhoku Imp. Univ.," Japan, 1912.
[31] "Zeitsch. d. deut. Geol. Ges.," 1891.
[32] *Op. cit.*, p. 2

chief representative of the rock-building coralline algæ.

CRETACEOUS.

We here reach the period when Lithothamnion and its allies begin to make their appearance. They have not yet been recognised in British rocks, but are widely distributed in Continental deposits. They occur in the Cenomanian of France, in the Sarthe and the Var, but especially in the Danian of Petersburg, near Maestricht.

Other forms which may be mentioned are Diplopora and Triploporella. The former is met with abundantly in the lower Schrattenkalk in certain districts, especially Wildkirchli, where it plays a considerable part in the formation of the deposit.[33]

TERTIARY.

In Britain no important deposits of marine calcareous algæ have yet been reported, but considerable deposits of limestone, rich in remains of Chara, have for long been known from the Oligocene of the Isle of Wight.

Foreign Tertiary.

On the Continent, however, large deposits rich in Lithothamnion and Lithophyllum have been known for many years, among which I may mention the well-known Leithakalk of the Vienna Basin and Moravia. It will be remembered that it was these deposits which formed the subject of Unger's important monograph in 1858.

CONCLUSIONS.

The facts given above regarding the geological distribution and mode of occurrence of these organisms lead us to several interesting conclusions. In addition to the evidence of the important part they play as rock-builders, it is evident that certain forms flourished over wide areas at the same geological periods, and might well be made use of in many cases with considerable reliability as proofs of the general contemporaneity of two deposits. Thus, as general examples, we may cite the wide distribution of *Solenopora compacta* in the Baltic provinces, Scotland, England, Wales, and Canada during Llandilo-Caradoc times.

The wonderfully persistent development of the *Rhabdoporella* facies over the whole of the Baltic area at the close of Ordovician times was of so marked a character that by means of boulders scattered over the north German plain it can even be made use of for tracing the direction of flow of the ice-sheet during glacial times.

Again, to take examples nearer home. The Ortonella band found throughout Westmorland and north Lancashire near the summit of the Tournaisian occurs so constantly at the same horizon as to constitute one of the most valuable zonal indices in the succession of the north-west province, and can be used with the greatest confidence not only for correlating widely separated exposures, but also affords valuable evidence in the case of tectonic movements. Other examples are supplied by the "Girvanella nodular band" at the base of the Upper Dibunophyllum zone, and the *Mitcheldeania gregaria* beds in the north of England and the Forest of Dean.

Again, the presence of these organisms at a particular horizon furnish us with interesting evidence as to the conditions which obtained during the accumulation of these deposits.

At the present day calcareous algæ flourish best in clear but shallow water in bays and sheltered lagoons. As a good example we may take the algal banks in the Bay of Naples, described by Prof. Walther,[34] where Lithothamnion and Lithophyllum flourish to a depth of from 50–70 metres. There is seldom any muddy sediment on these banks, though detrital limestone fragments are widely distributed. Another interesting point is the constant association of fossil calcareous algæ with oolitic structure and also with dolomite.

Thus oolites occur in connection with Solenopora in the lower Cambrian of the Antarctic, in the Craighead limestone at Tramitchell in the Ordovician rocks of Christiania and the Silurian of Gotland and in the Lower Carboniferous limestone of Shap; while in the Jurassic rocks of Gloucestershire and Yorkshire it occurs in the heart of the most typical oolitic development to be met with in the whole geological succession. Though Mr. Wethered has made out a good case for the constant association of Girvanella tubes with oolitic grains, there are many cases in which their association cannot be traced. M. Cayeux,[35] in writing of a mass of Girvanella from the ferruginous oolites of the Silurian rocks of La Ferrière-aux-Etangs, expresses his opinion that Girvanella encrusts the oolite grains but does not form them, and that it is really a perforating alga of a parasitic nature.

The presence of dolomites in connection with algal deposits at different geological horizons appears to have taken place under definite physiographical conditions similar to those which obtain to-day in the neighbourhood of coral reef. Such lagoon conditions would come into existence *either* during a period of subsidence *or* elevation, and this is just what we find when we examine the periods at which these reefs are most persistent.

Thus the Girvan Ordovician reef occurred during an elevation which culminated with the deposition of the Benan Conglomerate; the Lower Carboniferous Algal band in Westmorland was laid down during the subsidence which followed the Old Red Sandstone Continental period of the Upper Girvanella; modular band occurred when the Marine period of the Lower Carboniferous was drawing to a close and a general elevation was taking place. Similar conclusions could be drawn from other periods recorded above did time permit.

In concluding this address, I wish to express the hope that however imperfect the account I have given of the succession of forms may be, that it will help to stimulate an interest in these rock-building algæ and encourage geological workers in this country to turn their attention to a hitherto neglected group of forms of great stratigraphical importance.

[33] Lorenz, 1908.

[34] "Zeitsch. d. deut. Geol. Ges." 1885, p. 230, and "Abh. d. Königl. Preuss. Akad. der Wiss," 1910.

[35] *Comptes Rendus Acad. de Sci.*, 1910, p. 359.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

LEEDS.—Dr. Charles Crowther, formerly lecturer in agricultural chemistry, has been appointed professor in that subject, and will have charge of the experiments in animal nutrition, which are being supported by a grant from the Development Commissioners.

The Council of the University has granted six months' leave of absence to Prof. Smithells, who is leaving England on September 26 to proceed to Lahore, where he is to give a course of lectures and to assist the Punjab University in other ways in the promotion of scientific education and research.

The position of research chemist to the Joint Committee on Ventilation Research of the Institution of Gas Engineers and of the University of Leeds has

been filled by the appointment of Mr. W. Harrison, of the Manchester Municipal School of Technology.

The medical school of the University of Leeds will hold its opening function on October 1, when Prof. C. S. Sherrington, F.R.S., will distribute the prizes and deliver an address.

LONDON.—Prof. E. W. MacBride, F.R.S., has been appointed successor to the late Prof. Adam Sedgwick in the chair of zoology at the Imperial College of Science, South Kensington.

THE presidency of Denison University has been accepted by Prof. C. W. Chamberlain, who, in consequence, has resigned the chair of physics at Vassar College.

THE new session of the Charing Cross Hospital Medical College will be opened on October 1 by an address from the dean, Dr. W. Hunter, on University medical education.

THE first Hunterian Society's lecture will be delivered at St. Bartholomew's Hospital on October 8 by Dr. F. J. Wethered, who will take as his subject "Fever in Pulmonary Tuberculosis: its Significance and Therapeutical Indications."

A CHAIR of hydrology and hygiene has been established at the Superior School of Pharmacy in Paris, which will take the place of one of mineralogy and hydrology. Prof. Délépine, the holder of the last-named chair, will occupy the new one.

DR. J. E. WODSEDALEK, of the zoological department of the University of Wisconsin, has been appointed professor of zoology and head of the department of zoology and entomology at the University of Idaho, Moscow, Idaho, in succession to Dr. J. M. Aldrich.

AN apprenticeship course in animal husbandry has been established at the Ohio State University. The course covers four years—two in the university and two in practical work on a stock farm. Many stock men in the United States are interested in the movement, and are cooperating with the University in carrying it out.

WE learn from *Science* that a bionomic laboratory has been established in connection with the University of Chicago, and that Prof. W. L. Tower, who has been appointed its curator, has left for South America to obtain material for it. The laboratory is to be equipped for the study of genetics and the problems of experimental evolution.

A SCHEME has been completed for the amalgamation of Bolton Grammar School and the High School for Girls in the town, and Sir William Lever has now endowed them as from January next with 50,000*l*. Lever Brothers 20 per cent. cumulative preferred ordinary shares, producing an income of 10,000*l*. per annum. The funds are placed at the discretion of the trustees, and it is proposed to use the first five years' income to build a new school with an administrative block.

A SCIENTIFIC and technical school of kinematography is to be inaugurated at the Polytechnic, Regent Street, W., on Wednesday, October 1. The opening meeting (which will be free) is to be followed by a course of twenty-four weekly lectures by Mr. R. Bruce Foster, who will deal with the subject under the following heads:—Historical development; modern film machines and intermittence mechanisms; films, their production and treatment; exhibiting; colour kinematography; the kinematograph combined with musical accompaniment; the Kinematograph Act and Regulations.

THE following lectures, among others, have been arranged for delivery at University College, London:—"Early Cylinders and Scarabs," Prof. Flinders Petrie, F.R.S.; "Primitive Religion in Egypt," Miss Margaret A. Murray; "The Scope of General Physiology," Prof. Bayliss, F.R.S.; "The Range of Consciousness in Organic Nature," Mr. Carveth Read; "Mental Energy," Prof. Spearman; "The Palæobotanist, his Past and Future," Dr. Marie Stopes. Particulars, syllabuses, &c., may be obtained from the Provost or the Secretary of the College.

AT University College, University of London, a course of lectures on the physical applications of the principle of relativity will be delivered on Fridays, at 5 p.m., by Dr. L. Silberstein, lecturer in natural philosophy at the University of Rome, beginning October 10. The syllabus includes consideration of the fundamental concepts and postulates of the theory of relativity, dynamics of radiation, fundamental electromagnetic equations, optical problems, the problem of gravitation, and Einstein's recent generalisation of the theory of relativity. Another course of lectures on the principle of relativity is to be given at Battersea Polytechnic by Mr. E. Cunningham, fellow of Trinity College, Cambridge, on Thursdays, at 6 p.m., beginning on October 23. The lectures will deal with the development of the principle and some consequences of the universal admission of the principle. Admission to this course is free and no ticket is required.

THE next session of Birkbeck College, which is the ninety-first, commences on September 29. The opening address will be given at 7 p.m. by Sir Francis Darwin, F.R.S., and visitors are invited to be present. The college is conducted in relation with the University of London, and classes are held both in the day and evening. We notice that thirty-two members of the staff are recognised teachers of the University of London. The courses of study provide for degrees in the faculties of arts, science, laws, and economics. It is again pointed out in the calendar, which contains full particulars of the numerous courses of study, that the usefulness of the college is curtailed by its limited accommodation. Its most pressing need is for increased space. More spacious college buildings, with additional class-rooms and larger laboratories better adapted to modern requirements, would give a great stimulus to the work of the college and add to its public utility.

THE report of the United States Commissioner of Education for the year ending June 30, 1912, has reached us from Washington. It consists of two large volumes, one dealing with educational topics in a broad way and the other devoted almost entirely to statistics. The section of the report concerned with the work of universities and colleges in the United States shows that the total amount of gifts to these institutions for higher education for the year 1911–12 was 4,956,600*l*., excluding grants by Federal, State, and local political bodies. This amount represents an increase of 363,989*l*. over the benefactions for 1910–11. Of these gifts 1,274,960*l*. was for the increase of plant in the institutions, 745,980*l*. for current expenses, and 2,935,660*l*. for endowment. These amounts do not include subscriptions or promises received in campaigns for endowment, though they do include some property not producing an income at the present time. Fifty-four institutions reported gifts during the year of more than 20,000*l*. Five universities received more than 200,000*l*., namely, Yale, Chicago, Harvard, Columbia, and Cornell. Columbia University seems to have been most fortunate with its 378,256*l*.

SOCIETIES AND ACADEMIES.

PARIS.

Academy of Sciences, September 1.—Général Bassot in the chair.—H. **Deslandres** and L. **d'Azambuja**: Variations of the upper layer of the solar atmosphere with the approach of a sunspot minimum. An account of work done at the Observatory of Meudon from 1911 to 1913; a general account of the relations observed between spots and filaments; no general conclusions are drawn.—G. **Bigourdan**: The variable nebulæ and, in particular, the nebula G.C. 4473=N.G.C. 6760. The observations of Borrelly on the change of luminosity of this nebula require confirmation.—A. **Laveran** and G. **Franchini**: Experimental infection of mice by *Herpetomonas ctenocephali*. The mice were infected with parasites obtained from fleas, and details are given of the changes undergone by the organism after transmission to the mouse.—Pierre **Duhem**: On the velocity of sound. A discussion of the formulæ given by Ariès and J. Moutier.—Charles **Saint-John**: Exploration of the solar atmosphere by measurements of the radial velocities in the spots. Evershed, in 1909, announced the displacement of the Fraunhofer lines in the penumbra of spots removed from the centre. The author commenced the more complete study of this phenomenon at Mount Wilson in 1910, and in the present communication summarises his results. The phenomenon is a Doppler-Fizeau effect, since the displacements are proportional to the wave-lengths. The relative levels of emission of the different lines can be determined by this method.—M. **de Séguier**: Quadratic and Hermitian groups in a Galois field.—Georges **Claude**: Influence of the diameter on the potential difference in luminescent neon tubes. The relation between the fall of potential in volts per metre of tube and the diameter of the tube was found to be hyperbolic.—Paul **Godin**: Influence of the weight of the arms on the respiratory modifications in the course of growth.—F. **Heckenroth** and M. **Blanchard**: A fixation reaction, in presence of a syphilitic antigen, in syphilis, yaws, trypanosomiasis, and phagedenic ulcer in the French Congo.

September 8.—M. **de Forcrand**: Experiments on the cupric hydrates and the heat of formation of copper nitrate. Comparison with uranyl nitrate. Calorimetric determinations on $Cu(OH)_2$, CuO, and intermediate hydrates.—J. **Guillaume**: Observations of the Metcalf comet (1913*b*) made at the Observatory of Lyons. Positions given for September 3, 5, and 6. On the 3rd the comet was of the tenth magnitude.—A. **Schaumasse**: Observations of the Metcalf comet (1913*b*) made with the Coude equatorial at the Observatory of Nice. Positions given for September 3, 4, 5, and 6. On the 3rd the comet appeared as a round nebulosity of about the tenth magnitude, about 2′ in diameter, with a badly defined nucleus.—M. **Moulin**: The terminal curves of balance springs. Influence of terms of the second order.—E. **Briner** and A. **Kuhne**: The mechanism of the formation of sulphuric acid in leaden chambers. The authors have been able to prove that pure dry nitrogen peroxide and sulphur dioxide react at 60° C., sulphur trioxide being formed. From the results of this experiment they discuss the possibility of the direct oxidation of sulphur dioxide to sulphuric acid in the leaden chamber.—J. A. **Urbain**: Morphological modifications and floral anomalies resulting from the suppression of the albumen in some plants. A study of the modifications in growth produced by removing the albumen from the seeds of various plants. Edm. **Bocquier** and Marcel **Baudouin**: The discovery and exploration of a prehistoric submarine station at the mouth of the Vie, in Vendée.—Paul **Jodot** and Paul **Lemoine**: The existence of a fault on the right bank of the Loire near Cosne.

September 15.—Général Bassot in the chair.—E. L. **Bouvier**: New observations on the larval development of the spiny lobster (*Palinurus vulgaris*). (See NATURE, August 21, p. 633.)—Jules **Andrade**: The regulation of a marine chronometer with four spirals.—Georges **Claude**: The drying of air to be liquefied by cooling. The difficulty of removing water by cooling in the ordinary heat exchanger is discussed. This can be surmounted by making the expanded gas circulate through the tubes of the exchanger instead of round them, whilst the compressed air circulates round the tubes, the path of the compressed air being composed of horizontal elements. The liquid water can be removed from the bottom without difficulty, and it is only at the end of fifteen to twenty-four hours that stoppages are produced by the hoar frost; a second exchanger is then substituted. The cost is very small compared with chemical methods of drying, and the apparatus has already been used in apparatus for the production of pure nitrogen on the large scale.—MM. **Taffanel** and **Le Floch**: The combination of gaseous mixtures and temperatures of inflammation. The combustible mixture is introduced suddenly into a vessel, the walls of which are at a known temperature, the combustion being recorded by a self-recording manometer. Results are given for mixtures of air with methane, hydrogen, carbon monoxide, acetylene, ethylene, pentane, and finely divided oil.—Maurice **Durandard**: The amylase of *Rhizopus nigricans*.

CAPE TOWN.

Royal Society of South Africa, August 20.—Dr. J. K. E. Halm in the chair.—E. J. **Goddard**: The significance of the position of the genital apertures in Hirudinea. The number of somites entering into the constitution of the Leech body is, according to one school, thirty-three, according to another thirty-four. This constitution holds good except in the doubtful exceptions of *Acanthobdella peledina* (Grube) and Semilageneta (Goddard). The ancestral stock from which the Hirudinea arose must have been Oligochætan and aquatic in nature, and having a body of 33 or 34 somites. This ancestor must have been provided with setæ, as indicated by Acanthobdella, similar to those found in aquatic Oligochæta such as Lumbriculidæ, Phreodrilidæ, &c. Further investigation may reveal a close association between the distribution of certain archaic Oligochætan families and the origin of the Hirudinea.—E. J. **Goddard**: A Phreodrilid from Sneeuw Kop, Wellington, South Africa. A new form has been discovered on the Wellington mountains. The ventral setæ are typically Phreodrilid in nature, but both are simple. Hence in Africa, which is apparently rich in Phreodrilids, all the varieties of setæ noted in the family are to be found in the African representatives.—G. C. **Scully** and A. R. E. **Walker**: Note on Spodumene from Namaqualand. The lithia-bearing mineral described in this paper was collected by the authors near Jackals Water, Steinkopf. An examination of its optical and other physical characters enables them, with confidence, to refer it to the species Spodumene. Quantitative chemical analyses of the mineral will be made, the results of which the authors hope to publish in a later paper along with a detailed account of the associated minerals.

BOOKS RECEIVED.

Botanische Jahrbücher fur Systematik, Pflanzengeschichte und Pflanzengeographie. Edited by A. Engler. Band 50. Heft 2 and 3. (Leipzig and Berlin: W. Engelmann). 14 marks.

Zeitschrift fur Wissenschaftliche Zoologie. Edited by Prof. E. Ehlers. Band 106. Heft 3. (Leipzig and Berlin: W. Engelmann.) 11 marks.

Problem Papers. Supplementary to Algebra for Secondary Schools. By Dr. C. Davison. Pp. 32. (Cambridge: University Press.) 8*d*.

Canada. Department of Mines. Mines Branch. The Nickel Industry, with Special Reference to the Sunbury Region, Ontario. By Dr. A. P. Coleman. Pp. viii+206+plates. (Ottawa: Government Printing Bureau.)

Biology. By Dr. W. D. Henderson. Pp. 92. (The People's Books series.) (London and Edinburgh: T. C. and E. C. Jack.) 6*d*. net.

Sir Williams Huggins and Spectroscopic Astronomy. By E. W. Maunder. Pp. 94. (The People's Books series.) (London and Edinburgh: T. C. and E. C. Jack.) 6*d*. net.

Spiritualism and Psychical Research. By J. A. Hill. Pp. 94. (The People's Books series.) (London and Edinburgh: T. C. and E. C. Jack.) 6*d*. net.

Entstehung der Welt und der Erde nach Sage und Wissenschaft. By Prof. D. M. B. Weinstein. Zweite Auflage. Pp. vi+116. (Leipzig and Berlin: B. G. Teubner.) 1.25 marks.

Die Dampfmaschine. By Prof. R. Vater. II., Ihre Gestaltung und Verwendung. Pp. vi+99. (Leipzig and Berlin: B. G. Teubner.) 1.25 marks.

Memoirs of the Geological Survey. England and Wales. Explanation of Sheet 339. The Geology of the Country around Newton Abbot. By W. A. E. Ussher. Pp. vi+148+iii plates. (London: H. M. Stationery Office; E. Stanford, Ltd.) 3*s*.

Viśvakarmā: Examples of Indian Architecture, Sculpture, Painting, Handicraft. Chosen by Dr. A. K. Coomaraswamy. Part v. 12 plates. (London: Luzac and Co., Ltd.) 2*s*. 6*d*.

Die Kultur der Gegenwart ihre Entwicklung und ihre ziele. Edited by Prof. P. Hinneberg. Teil iii. and Teil iv. Pp. 84. (Leipzig and Berlin: B. G. Teubner.)

Drapers' Company Research Memoirs. Biometric Series ix. A Monograph on Albinism in Man. By Karl Pearson, E. Nettleship, and C. H. Usher. Part iv. Text. Appendices. Pp. iv+136+xxiii. Part iv. Atlas. Pp. iv+lix plates. (London: Dulau and Co., Ltd.) Text and Atlas, 21*s*. net.

Department of Marine and Fisheries. Report of the Meteorological Service of Canada, Central Office, Toronto, for the year ended December 31, 1909. Pp. xxi+565+4 plates. (Ottawa.)

Handworterbuch der Naturwissenschaften. Edited by E. Korschelt and others. Lief. 54 and Lief. 55. (Jena: G. Fischer.) 2.50 marks each part.

Probleme der Entwicklung des Geistes. Die Geistesformen. By S. Meyer. Pp. v+429. (Leipzig: J. A. Barth.) 13 marks.

Quantitative Analysis in Practice. By Dr. J. Waddell. Pp. vii+162. (London: J. and A. Churchill.) 4*s*. 6*d*. net.

Practical Chemistry. By the late Prof. J. C. Brown. Sixth edition edited by Dr. G. D. Bengough. Pp. 78. (London: J. and A. Churchill.) 2*s*. 6*d*. net.

Report of the Commissioner of Education for the Year ended June 30, 1912. Vol. i. Pp. xxvi+647. Vol. ii. Pp. xviii+669. (Washington: Government Printing Office.)

Fire Tests with Glass. Three Window Openings filled in with "Luxfer" Electro-glazing by the British Luxfer Prism Syndicate, Ltd., London. The Committee's Report. Pp. 16. ("Red Books" of the British Fire Prevention Committee, No. 182.) (London: British Fire Prevention Committee.) 2*s*. 6*d*.

Practical Mathematics. By N. W. M'Lachlan. Pp. viii+184. (London: Longmans, Green and Co.) 2*s*. 6*d*. net.

A Medley of Weather Lore. Collected by M. E. S. Wright. Pp. 144. (Bournemouth: H. G. Commin.) 2*s*. 6*d*. net.

The Modern Geometry of the Triangle. By W. Gallatly. Second edition. Pp. vii+126. (London: F. Hodgson.) 2*s*. 6*d*. net.

Medizinische Physik. By Prof. Dr. O. Fischer. Pp. xx+1120. (Leipzig: S. Hirzel.) 36 marks.

The Upper Thames Country and the Severn-Avon Plain. By N. E. MacNunn. Pp. 124. (The Oxford Geographies.) (Oxford: Clarendon Press.) 1*s*. 8*d*.

DIARY OF SOCIETIES.

WEDNESDAY, OCTOBER 1.

ENTOMOLOGICAL SOCIETY, at 8.—The Urticating Properties of *Porthesia similis*, Fuess.: H. Eltringham.

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