

dielectric properties of insulating materials. A more balanced programme of work has been possible in the Division of Physics, where about half the time of the scientific staff is now available for research. Three new major projects have been commenced: the setting up of equipment for research at very low temperatures; laboratory investigations on the artificial production of rain; and the absolute measurement of ultra-violet spectral energy distributions with the view of determining solar energy distributions. Advice has been given on special devices for temperature measurement and control, and work is also reported on the physical phenomena involved in the formation of ice crystals, on the physics of solids, photometric standards and evaporation plant.

In the Division of Aeronautics greater concentration on the fundamental and long-term projects was also possible, and, while the Australian Council for Aeronautics was disbanded during the year and will be replaced by a research committee, the relations of the Division with the Universities of Sydney and of Melbourne have already been strengthened. Reference is made in the report to work on such varying topics as the stability of plates and shells, the life of aircraft and effect of temperature on their strength, fatigue of metals, properties of alloys, powder metallurgy, high-speed subsonic and transonic flow, the use of suction to increase efficiency at moderate speeds, piston-ring lubrication and the elimination of wear due to dust. In the Division of Industrial Chemistry progress is reported in the inauguration of ceramic research, but the work of the Biochemistry and Organic Sections has been handicapped by absence of proper accommodation. Construction of a new building was expected, and in the meantime the work of the Division has continued much on the lines described in the last report. Collaboration with the Division of Physics in studies of the structure of the wool fibre continued, and theoretical and experimental investigations have been conducted on luminescent materials used in the lamp and radio-valve industries.

Work in the Division of Radiophysics has led to fuller knowledge of the radiations emitted at radio frequencies from the sun and in the universe. This Division has opened up a promising new avenue of research which should provide basic information on the physics of cloud formation and may lead to the practical possibility of stimulating rainfall by artificial means and to the completion and successful demonstration of new radar aids to civil aviation. The Section of Tribophysics has confined its work on lubrication mainly to a study of the frictional properties of molecular layers of lubricating substances. Wear is being studied by mechanical and metallurgical methods as well as with a radioactive tracer technique. The group dealing with the mechanical properties of metals is endeavouring to obtain a better knowledge of the properties of metallic crystals and the way the mechanical properties in particular are changed by heat. The work on explosives has already made substantial contributions to knowledge of the mechanism of explosion in liquids.

The work of both the Building Materials Research Laboratory and of the Flax Research Laboratory has been seriously handicapped by limited accommodation and, for the former, by the further difficulty in recruiting staff. Nevertheless, weathering studies have proceeded, as well as investigations on concrete, masonry, surfacing materials, building boards and

insulating materials, adhesives, etc. The Dairy Research Section, which has now incorporated the Dairy Section of the Division of Industrial Chemistry, has studied the advantage of eliminating the washing of buttermilk from the butter granules, weed taint in butter and the utilization of the solids of skim milk. Among miscellaneous investigations is included an account of the study of the growth and rubber content of the guayule plant under Australian conditions at the Waite Institute, Adelaide, which was commenced five years ago and which is now approaching a stage when interesting and important comparisons will be possible.

10/4

DESIGN OF RADIO AERIALS

THE number and diversity of the radio communication services now in operation in an overcrowded spectrum demands that the utmost efficiency must be obtained in the design and operation of both sending and receiving stations. At the transmitting end it is necessary that the minimum power be used and the radiation be concentrated in the desired direction; while at the receiving end aerials of high directivity are also required in order to ensure that the incoming field produces a satisfactory signal, to the exclusion of any unwanted noise or radiation coming from some other direction.

Thus, in point-to-point communication it is desirable to make the two aerial systems as directional as possible. At fixed frequencies high directivity can be obtained by using aerial-array, long-wire, or rhombic aerial systems, but if several frequencies are to be used with the same system, aerial arrays are unsuitable.

A report which will help the engineer in designing a radio communication service for maximum efficiency has recently been published*. It presents in a convenient form a generalized analytical method of calculating the polar diagram of any long-wire aerial system over a wide band of frequencies. The analysis is also applied to the determination of the polar diagrams of horizontal rhombic aerials.

The object of the paper is to describe the simple theory of long-wire aerials in such a manner that the physical principles involved may be readily understood and the results applied to special or new systems. Methods are developed whereby the probable polar diagrams of long-wire systems may be rapidly estimated for a wide range of operating frequencies or for changes in other parameters. These may be used to reduce the work involved in calculating an accurate polar diagram in which allowance is made for second-order effects; the technique is to sketch the approximate polar diagram given by the simplest theory applicable to the problem, and then to calculate the exact values for the important maxima and minima. The results of the analysis are presented in the form of design charts with such information as: families of contour curves of constant directivity against angle of azimuth and elevation for a constant frequency; or as curves giving the position and relative amplitude of the main lobes in the vertical plane through the aerial against angle of elevation and frequency. A similar treatment is

* Department of Scientific and Industrial Research. Radio Research Special Report No. 16. A Method of Determining the Polar Diagrams of Long-Wire and Horizontal Rhombic Aerials. By W. R. Piggott. Pp. iv + 39. (London: H.M. Stationery Office, 1948.) 9d. net.

followed for the case of the horizontal rhombic aerial. The methods described may easily be applied to other types of long-wire aerial, or to linear arrays of aeriels having constant input amplitude in each aerial, and constant relative phase shift between aeriels.

The approximate methods described are particularly useful when calculating coverage areas obtained by reflexion from the *E*- or *F*-regions in the ionosphere. It is unnecessary to know the polar diagram shapes exactly as the movements of the reflecting layers from day to day cause appreciable changes in the exact zone covered, and the approximate results are therefore of great practical value.

1946

MIDDLE DEVONIAN OSTEOLEPID FISHES OF SCOTLAND

FOR more than a century, since the days of the pioneer workers on the Old Red Sandstone, the osteolepid fishes have proved a source of difficulty to vertebrate palaeontologists, and even more so to stratigraphers. One has only to glance at the restorations of the whole fishes on p. 103 of Dr. E. Jarvik's recent monograph* and of the heads of the various forms dealt with to understand why. For so uniform in general are their characters that unless the bodies are well enough preserved to show the details and the disposition of the fins it is almost impossible to be certain even of the genus, and if the skull-roof is not clearly shown then the species is more often than not in doubt; and finely preserved bodies and clearly detailed heads are not so very common in these ancient strata, laid down 300 million years ago. The long historical accounts of each of the three genera and seven species described clearly indicate the confusion that has arisen in the past, and even Dr. Jarvik's exhaustive investigations leave some loose ends for future workers to tie up.

The group is a most important one, anatomically by reason of its close relationship to the fishes from which the land vertebrates sprang, and geologically as one of the dominant types present in these complicated stratal series. This fine volume is a worthy addition to the classical series of exhaustive and luxuriant memoirs on the early fossil Vertebrata that have issued in an endless stream from the Stockholm school under the guiding genius of Prof. Stensjö, and in it Dr. Jarvik gives a full account of the external anatomy of this difficult group and of its systematics, which will long remain a standard on the subject, even if one cannot accept all his conclusions. The long-fought controversy regarding the identity of the external bones of the skull, upon which their nomenclature, of course, depends, is again gone over, and Dr. Jarvik has decided definitely in favour of the 'Fusionist' or Swedish school of thought as against the 'Replacement' or Anglo-American school. Yet Dr. Jarvik himself makes some admissions and expresses some doubts, though of a minor nature, as to the completely universal application of his conclusions—much depends on analogies with similar structures in modern fishes; and the evidence of analogies is not always conclusive, especially as no living fishes are closely related to the archaic osteo-

lepid. We may perhaps be pardoned, therefore, for hesitating to believe that the final word on the subject has been written.

The stratigraphical results are important, but before full advantage can be taken much new collecting would be necessary—and that, unfortunately will not be possible in all cases. The early collectors of fossils, and not only of Old Red fishes, either did not appreciate the need for exact localization, or deliberately omitted details from labels in order to keep to themselves the whereabouts of 'rich strikes', and so the source of many of the specimens is uncertain.

Finally, Dr. Jarvik is not quite clear on the rules of systematic nomenclature. In naming a group of the genus *Osteolepis* which Pander had apparently wrongly referred to Agassiz's uncertain species *O. microlepidotus*, he calls it *O. panderi* (Pander). Pander may have properly defined this group for the first time, but a name cannot be attributed to a man who died decades before it was invented (and anyway, why in brackets? Pander at least put it in the right genus); and the species, if valid, must be known as *Osteolepis panderi* Jarvik. This is a minor point, and it is, perhaps, ungrateful to mention it in reviewing a work of this importance; but whatever one may think about the subject of systematic nomenclature, it has a proper function and should be used correctly, especially when the author makes some show of taking the matter seriously by quoting rules and opinions, and particularly in a volume that is likely to remain the standard work of reference on the subject for some time to come. ERROL WHITE

FORTHCOMING EVENTS ²⁷

(Meetings marked with an asterisk * are open to the public)

Monday, March 14

ROYAL GEOGRAPHICAL SOCIETY (at Kensington Gore, London, S.W.7), at 5 p.m.—Mr. G. S. Crawford: "Some Mediaeval Theories about the Nile".

UNIVERSITY OF LONDON (in the Assembly Hall, Institute of Education, Malet Street, London, W.C.1), at 5.30 p.m.—Mr. T. G. Ridling: "The Translation of Technical Education".*

CHEMICAL SOCIETY, EIRE SECTION (joint meeting with the UNIVERSITY COLLEGE OF DUBLIN CHEMICAL SOCIETY and the WERNER SOCIETY, in the Department of Chemistry, Trinity College, Dublin), at 7.45 p.m.—Prof. T. S. Wheeler: "The Development of the Periodic Table".*

Tuesday, March 15

CHEMICAL SOCIETY, LEEDS SECTION (joint meeting with the UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Lecture Theatre, The University, Leeds), at 5 p.m.—Display of Scientific Films; at 6.30 p.m.—Prof. E. L. Hirst, F.R.S.: "Structural Relationships amongst the Polysaccharides".

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 5.15 p.m.—Prof. H. J. Emeléus, F.R.S.: "Some Recent Advances in Radiochemistry" (Further Lectures on March 22 and March 29.)

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Geological Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. H. G. P. Tyrer: "Outline of the History and Development of the Beet Sugar Industry in Great Britain".

UNIVERSITY OF LONDON (at the Institute of Archaeology, Inner Circle, Regent's Park, London, N.W.1), at 5.30 p.m.—Prof. K. de B. Codrington: "Cultivated Cereals and Early Civilizations".* (Further Lecture on March 22.)

SOCIETY OF CHEMICAL INDUSTRY, PLASTICS GROUP (at the Royal Society of Tropical Medicine, Manson House, 26 Portland Place, London, W.1), at 6.30 p.m.—Mr. D. L. Clarkson and Mr. N. D. MacLeod: "Polyvinyl Chloride Pastes".

INSTITUTION OF THE RUBBER INDUSTRY, LONDON AND DISTRICT SECTION (at Caxton Hall, Caxton Street, London, S.W.1), at 7 p.m.—Mr. W. H. Reece: "Continuous Vulcanisation Processes".

INSTITUTION OF THE RUBBER INDUSTRY, SCOTISH SECTION (at the Institution of Engineers and Shipbuilders, 39 Elmbank Crescent Glasgow), at 7.30 p.m.—Annual General Meeting; Dr. W. J. S. Naunton and Mr. J. M. Buist: "Rubber to Metal Bonding".

Wednesday, March 16

ASSOCIATION OF APPLIED BIOLOGISTS (in the large Physics Theatre, Imperial College of Science and Technology, Imperial Institute Road (morning session), and the Metallurgy Lecture Theatre, Prince Consort Road (afternoon session), London, S.W.7), at 11.45 a.m. and 2.15 p.m.—Papers on "Growth-promoting Substances in Agriculture and Horticulture".

*On the Morphology and Taxonomy of the Middle Devonian Osteolepid Fishes of Scotland. By E. Jarvik. Kungl. Svenska Vetenskapsakademiens Handlingar, Serien 3. Band 25, No. 1. Pp. 301 + 37 plates (Stockholm: Almqvist und Wiksells Boktryckeri A.-B., 1948.)