

evolved forms of this type, usually, though not always, referable to a well-advanced period.

Other stone objects include numbers of discoidal ochre-stained grinders; these, when hollowed out by excessive wear, seem to have given rise to a series of heavy stone perforated rings, which may, the author thinks, have been club-heads. They recall similar rings in the otherwise dissimilar lithic products of the agricultural 'Para-Tumbian' Neolithic of the French Sudan and Nigerian Sahara on about the same latitude as Khartoum. Waisted or centrally grooved pebbles found in Early Khartoum also have distant connexions, for similar objects have been recorded from the Faiyum as well as from Taferjit in the Nigerian Sahara, where bone spear-heads referred to below are their surface associates. In Faiyum these stones were thought to be net-sinkers (see "The Desert Fayum", p. 66), a suggestion advanced also for the Khartoum examples.

In bone the multi-barbed spear and harpoon-heads are important for comparative purposes, though Mr. A. J. Arkell's typological sequence, based admittedly on insufficiently documented Egyptian material, may need revision. None the less, his comparisons with the barbed bone spear-heads from Taferjit and adjacent sites are arresting, though the dissimilarity of their apparently associated stone implements (recalling the Faiyum A group) raises complicated questions of interrelationship.

But, above all, it is the pottery which is most remarkable in Early Khartoum. It consists of round-based bowls of red-brown unburnished ware, scored, in its most characteristic form, by beautifully executed wavy-lines incised with fish-spines, and other subsidiary decorations also, presumably, based on basketry. Contemporary sherds of bright red pottery occasionally occur also. Clearly these wares are far from the infancy of pottery making; and they lead one to a careful scrutiny of the evidence which decided Mr. Arkell to venture the designation "Mesolithic", the chronological implications of which he fully accepts.

The evidence is both stratigraphic and climatic. The former is pieced together from other sites, where the upper dating limit is set by the long-known and misnamed 'A' group Sudanese rippled ware of Protodynastic date (*circa* 3000 B.C.). Separating this from the Khartoum Mesolithic is a Neolithic culture, still unpublished, referred to in this work as the "Gouge Culture". It contains a peculiar gouge-like tool, elsewhere known only in the Neolithic Faiyum, as well as some novel additions to prehistory.

The climatic evidence is unusually definite and of the greatest value to those struggling with climatic determinations in other desert areas. The Blue Nile ran at a flood-level 4 m. higher than now. The present mean annual rainfall at Khartoum is now only 164 mm.; the assemblage of mammals, molluscs and vegetation in Early Khartoum, though with one notable exception of modern species, proclaims a rainfall of at least 500 mm., comparable to that now supporting a similar wild life 200-300 miles farther south. The single exception is an extinct and archaic reed rat related to a fossil form from the Nigerian Sahara.

On the cumulative archaeological and climatic evidence, Mr. Arkell justifiably concludes that Early Khartoum discloses trans-southern Saharan connexions "before the oncoming desert initiated movements of man and animals from the Saharan steppe in the direction of more favourable areas such as the

Nile Valley"—a view favoured by the present reviewer, but open to a broadside from those who believe a diffusion of primitive civilization westwards from Egypt to be more probable.

The discoveries, so clearly described and suggestively presented, introduce a number of stimulating fresh possibilities into late African prehistory. The volume is sumptuously produced. The sumptuous price will prohibit its possession by the vast majority of students.

G. CATON-THOMPSON

116

## ELECTRONS IN IONIC CRYSTALS

### Electronic Processes in Ionic Crystals

By N. F. Mott and Dr. R. W. Gurney. (International Series of Monographs on Physics.) Second edition. Pp. xii+276. (Oxford: Clarendon Press; London: Oxford University Press, 1948.) 25s. net.

THE last decade has seen an increasing number of applications of modern theoretical physics to questions which are of appreciable technical importance. Often such applications arise from problems which at an earlier stage of development were of interest for the investigation of more fundamental properties of atoms and electrons. Mott and Gurney's book on electrons in ionic crystals, of which the second edition is now available, is an excellent and perhaps the first monograph on what might be called applied theoretical physics.

The first edition of this book, which appeared in 1940, is no doubt well known to all interested in the subject; a short survey of its contents should therefore be sufficient. An introductory chapter on perfect ionic crystals is followed by a chapter on lattice defects in crystals. It is shown that properties like diffusion or ionic conductivity are to be understood in terms of certain deviations from the perfect structure which in thermal equilibrium are bound to occur except at very low temperatures. The following three chapters, which deal with various electronic properties, again demonstrate the importance of defects, or of foreign additions, for many of the practically important properties. A short chapter on luminescence leads to the theory of the photographic latent image on which much progress has been made in recent years, largely due to the authors' contributions. The book ends with a chapter on properties which are believed to be due to processes involving the transport of both ions and electrons.

The second edition differs from the first one only by short additions on rectifying contacts, photographic emulsions, and the theory of oxidation. They describe briefly the results of more recent work. In dealing with such a variety of subjects—often for the first time in literature—it cannot be expected that on every occasion the proposed model, or theory, is final. It is, however, just the tentative suggestions which stimulate further research, as is shown by the frequent citation of the authors' book in original papers.

In the second edition the authors have chosen not to alter the text of the first edition, but rather to add remarks on later developments at the end of the relevant chapters, as they felt that the time for an extensive revision had not yet come. Until then, the book in its present form represents an excellent introduction to the subject. It will, no doubt, continue to be extensively used by research workers.

H. FRÖHLICH