

tion occurs, and many statements cry out for further explanation. The statement about the Renaissance cited above is an illustration. Though some of the technical operations of the 16th century may have been known in China centuries before, or in the Middle Ages, their development and utilization were an outgrowth of the intellectual ferment of the Renaissance. For example, the improvement in English methods of building and handling ships increased that nation's potential as a sea power and helped to change the course of world history.

Wars have had an enormous impact upon technological development, especially during the past century and a half. In a chapter on Military Technology, Thomas A. Palmer, after enumerating developments during the Civil War, comments: "The Civil War proved to be the first occasion when the achievements of the Industrial and Scientific Revolutions were put to large scale military use—a war in which the artisan, the farmer, and the mechanic as well as the soldier played essential roles in determining the final outcome of the conflict." Presumably volume 2 will devote much of its space to describing the complete utilization of a nation's technological potential in time of war and the byproducts for peaceful use that have resulted.

Although specialists will find many statements throughout this volume with which they may not agree, few will fail to profit from reading it from beginning to end. For those who wish to pursue special subjects further, the authors have provided 28 pages of bibliographical references.

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The Sense of Location

Human Spatial Orientation. I. P. HOWARD and W. B. TEMPLETON. Wiley, New York, 1966. 541 pp., illus. \$13.50.

Pilots of high-speed aircraft and space vehicles become disoriented during flight maneuvers. They may misjudge the location of a visible target, misreach for an object, or report seeing motion where objectively there is none. These consequences of man's exposure to the unusual circumstances created by technological advance dramatically emphasize that orientation in space is dependent upon a large variety of environmental factors, some obvious,

others unexpected. Howard and Templeton have done a considerable service by bringing together, from very diverse sources, many of the experimental results that bear on the human capacity to orient with respect to objects and events. In addition, they have examined the manner in which the orientation of the body in space affects the perception of objects.

The text begins logically by considering the first step in any act of orientation, the reception of sensory stimulation which provides the basic information concerning the location and spatial properties of either objects or events. Accordingly, the early chapters of the book are devoted to a discussion of the stimulation available to, and processed by, the visual and auditory systems. Kinesthesia, the sense understood to be responsible for discrimination of movement and position of bodily parts, is considered in a separate chapter, as is the closely related vestibular system. Three chapters deal with oriented responses in which gravity can be assumed to play a role by defining a unique reference direction.

Having considered the sensory basis for orientation, the authors go on to discuss the available data on the conditions which influence the accuracy and precision of oriented responses. In addition to this material, references are made throughout the book to studies of alterations in orienting behavior produced by atypical experiences. These changes may be provoked by prolonged exposure to particular constellations of stimuli. Sensory inputs rearranged so as to produce altered feedback initially cause inaccuracies in localizing behavior, but as exposure continues these effects are cancelled by adaptation. The authors indicate that since the sensory feedback in a stable environment is patterned, this information may be used for adaptive modification as well as for maintenance of orienting behavior. Consequently, the technique of rearranging stimuli provides a tool for analyzing normal spatial behavior. Howard and Templeton's review of this topic is the most balanced account in the literature of a field which has become the subject of much controversy in recent years. Several chapters deal with the effects on perception of the locus and orientation of shapes relative to the observer. A final chapter discusses what is publicly known of orientation in the weightless state.

This book is largely a compendium

of relevant literature, and its 78 pages of bibliography attest to its thoroughness. The authors make their contribution in several ways. First of all, they have interspersed clear-cut analyses of particular issues among the reviews of various topics. Occasionally they present their own very reasonable interpretations of controversial issues. However, in their efforts to cover a diversity of topics, they have been unable to show very much overall coherence in the material. The reader might have hoped for an organization of contents based on a more general theoretical analysis. This lack of continuity probably reflects more about the state of the field than about the efforts of the authors. They are to be commended for their industry and the resultant benefit to a field which is attracting increasing interest.

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Cytogenetics

Sex Chromosomes. URSULA MITTWOCH. Academic Press, New York, 1967. 316 pp., illus. \$14.

A little over a decade ago, dramatically improved techniques began to give superlative results with the previously obstinate chromosomes of the higher vertebrates, including man. New discoveries have been appearing at a remarkable rate, but often from workers whose primary interest has been not in genetics or cytogenetics but in the clinical implications or in the organisms themselves. The reports are very widely scattered through biological and medical publications. Thus any attempt at summary and assessment against a background of general genetics, cytogenetics, and biology is welcome.

The most intriguing variations in genetic mechanisms among the vertebrates and by far the widest range of known chromosomal abnormalities in man involve the sex chromosomes. The longest chapters of the present volume are devoted to these chromosomes in man and other mammals, and to the related problems of "sex chromatin," a phenomenon evidently confined to mammals. There are shorter chapters on the sex chromosomes of the other classes of vertebrates, the sex chromosomes of *Drosophila*, sex determination in the Lepidoptera, and such mech-

anisms as multiple sex chromosomes and sex determination by haploidy, mainly in other insects. There is also a chapter on sex chromosomes in plants which adequately covers this limited field. Mittwoch has performed a very useful service in assembling this diverse material under one cover, with references up to 1966, and her style is highly readable.

Unfortunately, the same excellence is not to be found at the beginning and end of the book where the factual and conceptual framework is offered. There are some curious errors. On page 15 we find, "The nucleic acids are themselves composed of large numbers of nucleotides, each of which consists of four chemical entities: a pentose sugar, phosphoric acid, one purine, and one pyrimidine base." On page 29, "... if one chromosome carries an inversion and its partner the normal sequence, pairing fails to take place along the length of the inversion and a loop is formed." Actually the term "loop" has been used for over three decades to denote the twist required for pairing, not its failure, in a heterozygous inversion. On page 34, "Although there is no biological definition of the term 'sex,' the differentiation of male and female gametes must be regarded as a basic requisite." These familiar with isogamy in many algae and fungi will be surprised at this. On page 66, "The male and female parts of gynandromorphs in *Drosophila* are always self-determining as regards the expression of sex-linked genes." In fact, the sex-linked gene *vermillion* provides a classic example of nonautonomy. On page 223 there is a reference to the "nucleolar membrane," a nonexistent structure.

The conceptual material includes the subjects of sex determination, development, and heterochromatin, admittedly some of the most difficult areas of modern biology. The author's handling of this material is not always insightful or critical, and at times is contradictory. For example, on page 215, we find, "By assuming that the second X-chromosomes of females (and of abnormal males) consists of two parts, a major one which becomes inactivated and a minor one which does not, all genetic effects of the X-chromosome could be formally explained." The author assumes, however (p. 231), that the heterochromatin of the inactive X not only does have a metabolic type of function but that the sex chromosome mechanism of mammals provides

"the most striking example" of such effects. A formally acceptable explanation certainly does not provide a striking demonstration of its opposite.

This small volume is an excellent sourcebook but cannot be recommended for the novice. The high quality of the format, printing, and illustrations are what we have come to expect of this publisher. So unfortunately is the price.

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Mineralogical Method

Electron-Diffraction Analysis of Clay Mineral Structures. BORIS BORISOVICH ZVYAGIN. Translated from the revised Russian edition by Simon Lyse. Plenum Press, New York, 1967. 380 pp., illus. \$19.50.

This book is an important addition to the growing literature on clay mineralogy and is the first to deal specifically with the application of electron-diffraction analysis. The slow development of electron diffraction in this field is easily understood; "ring patterns" contain no more information than can be obtained more easily by x-ray powder diffraction, and single-crystal methods are handicapped by problems of crystal orientation. Between these extremes comes the "oblique texture method," which has been used quite extensively in the U.S.S.R. but relatively little elsewhere. The book provides a good introduction to this method of analysis and contains numerous examples of texture diagrams; though not reproduced as plates, these diagrams are reasonably good. Clay mineralogists are likely to read the book backwards, starting with the final section, which summarizes a great deal of structural data accumulated by Zvyagin and his colleagues. It is claimed that kaolinites exist in well-ordered triclinic and monoclinic forms and that various kinds of disorder produce intermediate situations called "triclinomonoclinic." Robinson and I in 1945 struggled with pseudo-monoclinic forms of kaolinite by x-ray powder methods, but the limitations of the method precluded much progress. Zvyagin *et al.* appear to have a better tool, but whether all their conclusions are correct will be appreciated better when

the method has been more widely applied and independent analyses made. Their conclusions regarding halloysites are revolutionary. Halloysites are not poorly organized kaolinites, but have a structure of their own approaching a two-layer monoclinic arrangement. Although there has for some time been evidence pointing in this direction, the concept of halloysites having a prismatic structure is difficult to accept as a general description. As regards chrysotiles, Zvyagin discusses in considerable detail diffraction by rolled and cylindrical structures; for other serpentine minerals, he considers that the "high information content of the texture patterns and the unusual intensity distributions open up a real possibility of determining not only individual structure types . . . but also their combinations." Table 64, pages 305-16, "A structural and mineralogical classification of clay minerals and related structures investigated by electron diffraction," contains a wealth of data on the materials studied by Zvyagin and goes far beyond what can be found in any other text.

Enough has been said to show that this book presents many new points of view to clay mineralogists and to electron diffractionists. The translation reads smoothly and seems to be very good. The book is pleasant to handle and read, but the subject is not an easy one; probably most readers will need considerable activation energy in order to study the finer details.

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Water Transport Phenomena

Movement of Water in Plants. G. E. BRIGGS. Davis, Philadelphia, 1967. 154 pp. \$6.50.

This book provides, in concise form and easy-to-follow style, a particularly good account of water-transport phenomena in plants. It begins with a chapter on the escaping tendency of water. The chapter includes an introductory section on chemical thermodynamics, which deals with phenomena such as equilibrium vapor pressure, partial molal free energy, chemical activity, chemical potential, and water potential. This is followed by a section