

weigh and sift their separate conclusions.

Despite—or possibly even because of—these difficulties, the book is an excellent compendium of our current knowledge about the solar system. Among other insights, it shows how our increasing knowledge about the separate members of the solar family illuminates our understanding of the whole system. One cannot help but endorse the stated wish of many of the authors that spacecraft will continue to be sent out on their missions of exploration. The riches in this book give eloquent testimony to the power of such machines to gather wonderful information about our solar system.

TOBIAS OWEN

*Department of Earth and Space
Sciences, State University of
New York, Stony Brook 11794*

Ancient Mining

Prehistoric Mining and Allied Industries. R. SHEPHERD. Academic Press, New York, 1980. xii, 272 pp., illus. \$37. *Studies in Archaeological Science.*

During the last decade renewed interest in prehistoric technology has generated numerous studies of the processes by which both stone and metal artifacts were made. In lithic analysis, studies of the mechanical aspects of production and of microwear predominate, whereas archeometallurgical investigations comprise elemental and metallographic analyses of copper, bronze, and iron artifacts. End products—that is, finished artifacts—generally have been the focus of research, and little attention has been given to the initial process in their production, in which raw materials are extracted from the earth's crust.

Shepherd aims to fill the need for a survey of prehistoric mining directed especially to archeologists. He devotes approximately half his book (four chapters) to European flint mining, which started perhaps as early as the fourth millennium B.C. In these discussions the author's expertise as a mining engineer is best demonstrated. Through description of the two largest excavated flint-mining areas (Grimes Graves, Norfolk, England, and Spiennes, Belgium) and of other flint mines in Europe, one sees the extent and sophistication of this early mining. The mining of flint is perhaps better understood in archeological terms than the mining of metals, and levels of

preservation not only of the mines themselves but of artifacts found in them make it clear that reconstruction of not only the technological but also the social aspects of this activity warrants more attention from scholars. In chapter 6 the author does turn to brief overviews of the cultural background of the flint-mining sites to try to place them in proper context.

Shepherd's treatment of prehistoric ore mining and related issues in archeometallurgy, to which he devotes two chapters, is not as thorough as the evidence permits. For example, the Bronze and Iron Age mining center at Timna in the Wadi Arabah in the Negev desert, Israel, receives little attention although it is one of the most extensively investigated of all mining sites. Also, the site of Laurion in Attica, Greece, which is perhaps the most important source of lead and silver for the entire eastern Mediterranean world and undoubtedly was exploited in prehistory, is not discussed.

The attempt by the author to review basic concepts in archeometallurgy that concern the development of the technology runs into difficulty. Archeometallurgical research has become sharply focused in a number of areas of Europe and elsewhere in the Old World, and one can no longer easily describe a developmental sequence that is applicable to all areas. Though the archeology of mining is adequately surveyed, the bibliography on archeometallurgy is neither current nor sufficient. Glaring omissions such as the more recent articles of Theodore A. Wertime (*Science* **159**, 927 [1968] and **182**, 875 [1973]) and James D. Muhly's *Copper and Tin* (1973) reflect on the nature of the research. In addition, the book is marred by the acceptance of several hypotheses that have been vitiated by more recent research or that represent only one of several possible explanations. None of these dicta can be considered as accepted fact: that the collapse of the Hittite Empire around 1200 B.C. allowed the dissemination of iron-working technology (p. 203), that the increased use of iron that marks the Iron Age occurred as a result of the disruption in the tin trade (p. 203), and that in prehistory arsenical copper artifacts were produced by mixing arsenic with copper (p. 240). All are currently the subject of considerable speculation and debate.

A pervasive problem is caused by the uncritical presentation of the ideas of a wide variety of scholars, both past and present, which makes the text rather erratic and disjointed; this book could

have been the vehicle for the synthesis of current and relevant data into a useful, comprehensive body of information. In addition, editing should have ensured consistency in style, spelling, and content, and here the fault lies partly with the publisher.

This volume stands, nonetheless, as the only modern survey of prehistoric mining. Future users may find that flaws in the reporting of certain basic information as well as in format and style render it less valuable as a reference volume than one might have hoped.

VINCENT C. PIGOTT

*Museum Applied Science Center for
Archaeology, University Museum,
Philadelphia, Pennsylvania 19104*

Biological Records

Skeletal Growth of Aquatic Organisms. Biological Records of Environmental Change. DONALD C. RHOADS and RICHARD A. LUTZ, Eds. Plenum, New York, 1980. xiv, 750 pp., illus. \$47.50. *Topics in Geobiology*, vol. 1.

This book reviews current understanding of the sorts of information stored in animal skeletons, how it is stored, and how it can be recovered. Examples given in the book show that such information can be used not only to reconstruct aspects of the environments in which skeletons grew but also to determine population features such as growth rate, recruitment, and survivorship.

Analysis of past environments from the structure and morphology of skeletal materials was given a new twist by J. W. Wells in the early 1960's. Wells brought together the annual banding long recognized in the morphology of rugose corals and the tiny surface ridges that give this fossil group its name. He suggested that the ridges in these fossil corals (and in their modern relatives) represent daily growth increments. Since there are about 400 ridges to an annual band in Devonian fossils, the length of the Devonian day must have been about 22 hours. A geophysicist, S. K. Runcorn, saw the potential of this information. He stimulated further research and was rewarded with an estimate of 30.6 days for the length of the Devonian lunar month. This was obtained from repeated patterns of daily growth ridges within each annual band. These values were used with Kepler's second and third laws to calculate the loss of angular momentum from the earth to the moon. The transfer of energy occurs because tides raised by the moon

slow the earth's rotation and increase the moon's orbital rate, causing the moon to move further away from the earth. Thus, environmental effects reflected in coral skeletons provided a new understanding of the history and evolution of the earth-moon system.

The possibilities raised by this combination of astronomy, biology, and geology kindled new interest in skeletal growth patterns and were responsible for focusing of efforts to understand how growth rhythms are recorded in skeletal materials. Scattered earlier work was looked at from a new vantage point and there was an intensification of efforts to determine the chronometric reliability of banding patterns in modern organisms in order to justify measurements on their fossil relatives. Over the last two decades, understanding of environmental records in skeletal materials has considerably deepened and broadened. A variety of environmental information can now be recognized in skeletal materials, and the uses to which such information can be put are rapidly increasing. The introductory chapter to the book, written by the editors, reviews the uses of skeletal records dealt with in later chapters. This excellent essay will undoubtedly form the basis of many student reviews. I only wish that the editors had permitted themselves a few extra pages for speculation about further uses for skeletal records. The introduction states that the book has been prepared for the nonspecialist, but the student who goes to subsequent chapters for material to pad out his or her essay may well find it hard going. Some of the chapters are indeed nonspecialist reviews. Some include ex-

cellent but all too brief introductions and then plunge into discussion directed toward other specialists. Other chapters are highly specialized. The editors have overlooked the considerable reliance that many chapters place on the reader's familiarity with mollusc classification at the family level.

Three quarters of the volume is devoted to molluscs. This simply reflects the greater body of work that has been done with growth banding and growth patterns in molluscs, especially bivalves. Corals, probably the next most studied group, receive a chapter. Fish sagittae (otoliths), long favored in age-class analyses because of annual banding, are shown to display daily, subdaily, lunar, and perturbation-related banding. Recent work with growth banding in barnacles is described, and a chapter is devoted to growth bands in polychaete jaws. There are extensive appendixes detailing techniques for preparation of skeletal materials for analysis of growth patterns, the complexities of bivalve shell mineralogy and microstructure, and quantitative techniques for analyzing skeletal growth in relation to environmental effects.

Besides material on growth banding, the chapters on molluscs include discussions of environmental effects on the morphology of larval and adult shells and the chemical composition and mineralogy of shell. There can be little doubt, however, that it is the presence of daily, tidal, lunar, seasonal, and annual bands that has vastly increased the usefulness of skeletal materials for environmental and paleoenvironmental studies. Where previously skeletal materials offered largely circumstantial evidence about

past environments, they are now seen as virtual transcripts of what happened in their environment during their deposition. Of course, the transcripts are in code, and the deciphering of the codes has only just begun. In time, skeletal materials may well become handy tools for measuring almost anything that alters, or has altered, the physical, chemical, and biological nature of their environment. The lighthearted message could be, delay your environmental baseline studies because the instruments are already in position and recording—and some of them have been doing it since the Cambrian.

D. J. BARNES

*Australian Institute of Marine Science,
Townsville, Queensland 4810, Australia*

Books Received

Advances in Developmental Psychology. Vol. 1. Michael E. Lamb and Ann L. Brown, Eds. Erlbaum, Hillsdale, N.J., 1981. viii, 248 pp. \$19.95.

Annual Review of Biophysics and Bioengineering. Vol. 10. L. J. Mullins, William A. Hagins, Carol Newton, and Gregorio Weber, Eds. Annual Reviews, Palo Alto, Calif., 1981. x, 632 pp., illus. \$20.

Annual Review of Plant Physiology. Vol. 32. Winslow R. Briggs, Paul B. Green, and Russell L. Jones, Eds. Annual Reviews, Palo Alto, Calif., 1981. xii, 642 pp., illus. \$20.

The Application of Ion-Selective Microelectrodes. Thomas Zeuthen, Ed. Elsevier/North-Holland, New York, 1981. xiv, 284 pp., illus., \$99.50. Research Monographs in Cell and Tissue Physiology, vol. 4.

Approximation Theory and Applications. Proceedings of a workshop, Haifa, Israel, May 1980. Zvi Ziegler, Ed. Academic Press, New York, 1981. xii, 358 pp. \$26.

Aquatic Chemistry. An Introduction Emphasizing Chemical Equilibria in Natural Waters. Werner Stumm and James J. Morgan. Wiley-Interscience, New York, ed. 2, 1981. xvi, 780 pp., illus. \$45.

Are Pesticides Really Necessary? Keith C. Barrons. Regnery Gateway, Chicago, 1981. xvi, 246 pp. Paper, \$6.95.

Ascomycete Systematics. The Luttrellian Concept. Don R. Reynolds, Ed. Springer-Verlag, New York, 1981. x, 242 pp., illus. \$42.80. Springer Series in Microbiology.

Attention and Self-Regulation. A Control-Theory Approach to Human Behavior. Charles S. Carver and Michael F. Scheier. Springer-Verlag, New York, 1981. xviii, 404 pp. \$29.90. Springer Series in Social Psychology.

Auditory Regions of Primates and Eutherian Insectivores. Morphology, Ontogeny, and Character Analysis. R. D. E. MacPhee. Karger, Basel, 1981. xvi, 282 pp., illus. Paper, \$39.75. Contributions to Primatology, vol. 18.

Automatic Vehicle Locating Systems. Edward N. Skomal. Van Nostrand Reinhold, New York, 1981. x, 324 pp. \$28.50.

Babesiosis. Miodrag Ristic and Julius P. Kreier, Eds. Academic Press, New York, 1981. xvi, 590 pp., illus. \$45.

Basic Lubrication Theory. A. Cameron and C. M. McEttles. Horwood, Chichester, England, and Halsted (Wiley), New York, ed. 3, 1981. 256 pp., illus. \$34.95. Ellis Horwood Series in Engineering Science.

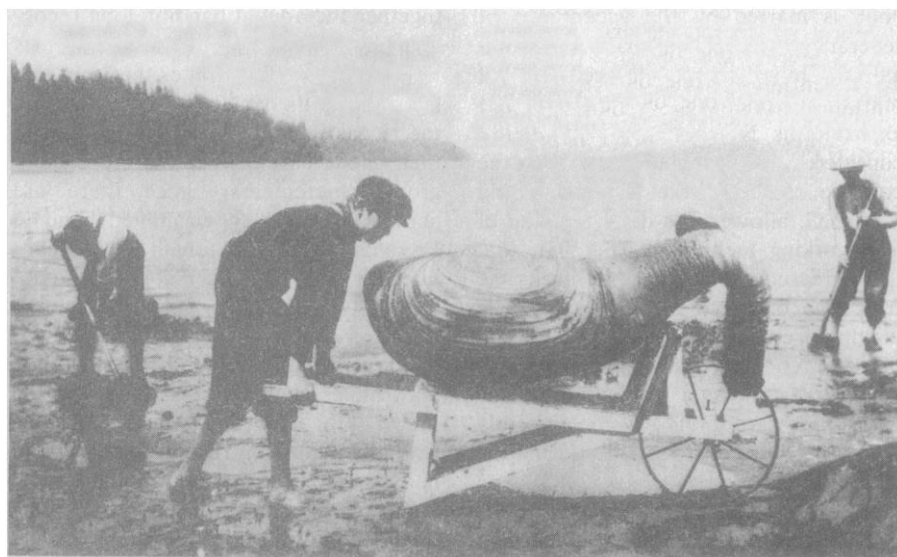
Basic Methods for Mental Health Practitioners. Marvin W. Kahn. Winthrop (Prentice-Hall), Cambridge, Mass., 1981. xiv, 246 pp. \$15.95.

Basic Population Genetics. Bruce Wallace. Columbia University Press, New York, 1981. xiv, 688 pp., illus. \$25.

The Billings Method. Controlling Fertility without Drugs or Devices. Evelyn Billings and Ann Westmore. Random, New York, 1981. 256 pp., illus., + plates. \$12.95.

Biochemical Regulation of Blood Pressure. Richard L. Soffer, Ed. Wiley-Interscience, New York, 1981. viii, 456 pp., illus. \$49.50.

Biochemistry of Normal and Abnormal Epidermal
(Continued on page 216)



"The geoduck, *Panope generosa* (Gould). Distinct growth patterns are visible on the external surface of the shell." [From Lutz and Rhoads's chapter in *Skeletal Growth of Aquatic Organisms*; source of photograph is unknown]