

one of the few styles that are related to the Olmec while possibly existing as early if not earlier in time. Finally, she notes evidence highly suggestive of antiquarianism in later Classic times, when Olmec and other early monuments were apparently reused at certain ceremonial centers. Peter T. Furst, in the third and last of these interpretative essays ("The Olmec were-jaguar motif in the light of ethnographic reality") develops the interesting notion that the were-jaguar theme so pervasive in Olmec art may reflect the concept of shaman-jaguar transformation and equivalence widespread in the Tropical Forest and Circum-Caribbean cultures to the south. The appeal of this idea is that it suggests a possibly older source for at least one element of Olmec culture which, so far, has seemed remarkably lacking in antecedents, whole or partial.

The attractive book by Michael D. Coe in the Smithsonian Library series covers some of the material presented in the Dumbarton Oaks volume. Here, however, the findings are fitted into a narrative, at times suspenseful, of the history of research on the Olmec. The style is agreeable, the illustrations pleasing, and the factual content high. Appealing features include a number of hitherto unpublished sketches by the Mexican artist and art historian Miguel Covarrubias. The volume's intended audience is evidently the ubiquitous "intelligent layman." In view of this, one readily forgives the enthusiasm which the author displays toward his own views on controversial matters, since this not only makes for good reading but also avoids the sort of obscure controversy which even the most intelligent of laymen often fail to appreciate.

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## The Ice Age in Britain

**Pleistocene Geology and Biology.** With Especial Reference to the British Isles. R. G. WEST. Wiley, New York, 1968. xiv + 377 pp., illus. \$9.50.

This is a little book about a big subject—not only the geology and biology but also some of the glaciology, geochemistry, geophysics, and archeology of the Pleistocene, which, in West's usage, includes the entire Quaternary period of geologic time. Broad coverage

is inevitable when one attempts a textbook dealing with the processes and history of the Quaternary, even if the coverage is restricted geographically. Such a book might be an exhaustive compendium (like Charlesworth's two-volume *The Quaternary Era*), as difficult to handle as an encyclopedia, or it can turn out to be superficial or perfunctory. This book is a kind of compromise. The number of pages (excluding illustrations) devoted to ice and glaciers cannot properly treat modern glaciology, and an equal number of pages concerned with the design and operation of coring devices seems out of balance. On the other hand, the two chapters on the British Isles, comprising a third of the book, constitute a systematic summary of geologic and paleontologic studies of that area.

Other chapters consider glacial geology, nonglacial sediments and stratigraphy, the periglacial zone, stratigraphical and biological investigations, land/sea-level change, chronology and dating, climatic change, and Pleistocene successions and their subdivision. In addition, appendices are devoted to methods of isolating and counting fossils and the lacquer method of treating sections. Bibliographic coverage is selective but up-to-date. Comments on methods are inserted in order to provide students with a practical guide to research.

Richard West has had a long association with the Sub-Department of Quaternary Research at the University of Cambridge and is now its director. This diversified and productive research center has been involved in many facets of Quaternary study, especially vegetational history. As a consequence West has been able to discuss with acumen and authority the central results and problems of the British Pleistocene in the context of events on the mainland.

The text is supported by more than 130 line drawings, about 50 tables, and many photographs. Most of the line drawings have a pleasing uniformity in cartographic style. Many of the figures and tables had to be placed sideways on the page, but some could have been redesigned so as to reduce the annoying necessity of turning the book around so many times.

*Pleistocene Geology and Biology* provides Americans with a larger choice of English-language textbooks and basic reference works on the Quaternary. It gives American readers a modern review of the Pleistocene of northwestern Europe with especial emphasis on the

biologic history, and as such it will be more useful to students than the encyclopedic Charlesworth, more accessible than the German-language Woldstedt, and more integrated (and less detailed) than the country-by-country summaries edited by Rankama in the series entitled *The Quaternary*. Wiley, the publisher, seems to have its hand firmly in the Pleistocene, what with Flint's textbook, the Rankama volumes, and now West's. It is a sign of growing interest in this diversified field of study.

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## Some Arthropods

**Aspects of the Physiology of Crustacea.** A. P. M. LOCKWOOD. Freeman, San Francisco, 1968. x + 328 pp., illus. \$9. University Reviews in Biology.

Since the two volumes of *Physiology of Crustacea* edited by T. H. Waterman appeared in 1960 and 1961, the number of research papers dealing with this important group of animals has steadily increased. Lockwood's book is not an attempt to update the earlier volumes. Its most important stated objective is to provide an outline of certain aspects of crustacean physiology for advanced students to read "at a few sittings." Although Crustacea are obviously one of the most fascinating groups of organisms for study because of their extreme diversity in ecological and physiological requirements, I think the general student in zoology will not derive a basic appreciation of biological problems by reading this book. He will gain an appreciation of specific physiological topics relative to crustaceans, but a unifying biological theme is lacking. In general, Lockwood writes clearly and with authority, as he has done in his previous publications.

There does not seem to be any general principle governing the choice of "aspects" to be included in or excluded from this book. For example, there is no chapter devoted specifically to reproductive physiology, although this topic has recently been the subject of renewed investigation. Some of the chapters reflect the updating (about 40 percent of the 567 publications cited have appeared since 1960) or judicious paring down of previous work but suffer from the lack of new physiological themes.

Understandably, the first physiological subject discussed is that of osmotic and

ionic regulation, on which Lockwood is a recognized authority. Respiration and metabolism are dealt with in chapter 6, while related subjects of energy input into an organism, feeding and digestion, are not discussed until chapter 9. Chapters on the neuromuscular system and the sense organs intervene. This arrangement is not too distracting, however, since each chapter is independent. By and large the illustrations are adequate though not exciting. I would buy this book for my own library, but I question its basic value to the student.

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## Cosmological Theory

**Relativity and Cosmology.** H. P. ROBERTSON and THOMAS W. NOONAN. Saunders, Philadelphia, 1968. xxxiv + 460 pp., illus. \$16.50.

In an excellent tribute to the late H. P. Robertson, his lecture notes have been edited and augmented by one of his students as "co-author." Many physicists and former friends of the Caltech mathematical physicist will find this book a useful summary of his important contributions and an outstanding textbook for advanced courses. The introductory pages, including a foreword by William A. Fowler, give some impression of the "senior author," but neglect his work for the armed forces in England and France during and after World War II, and the now famous Robertson Panel on Unidentified Flying Objects. Except for a 10-line excerpt from his lecture notes on the rotating-disk paradox, the humorous side of Robertson's character does not show in the text (as it did on the wall decorations of his kitchen, or in his salty remarks on poker games after a hard day's work on Air Force photographs).

However, I suspect that Robertson, a meticulous mathematician, would have preferred to keep his theoretical work serious, brief, and to the point, in the manner in which Noonan presents it in this book. The rigorous treatment, in vector and matrix notation, starts with Euclidean space and classical electromagnetism, and proceeds with special relativity and Riemannian geometry to general relativity and a detailed treatment of its consequences. These include the three classic tests (advance of planetary orbit peri-

helion, gravitational deflection, and gravitational redshift of light), the Poynting-Robertson effect on small particles (updated to include the effect of the solar wind), gravitational waves, the effects of changing stellar mass, and several experiments possible with artificial satellites (orbital precession, clock rate differences, and others). All of these are expressed in specific equations derived rigorously, often with numerical values compared with actual or possible observational results, and clear indication of approximations made or unknown parameters in the most general formulation.

Although the history of the development of special relativity is outlined in more detail than is known to most modern physicists (experiments by Fizeau, Hoek, Hammer, Sagnac; Thomas precession; the Michelson-Morley, Kennedy-Thorndike, and Ives-Stillwell experiments; the Minkowski universe; and Birkhoff's gravitational theory), nothing is said about Milne's kinematical relativity or the recent Brans-Dicke scalar theory. However, the upper limit of velocity of material particles ( $c$ ) set by the principle of causality is noted—the recently popular "Tachyon theory" of E. Sudarshan and others thus being eliminated.

The text generally emphasizes mathematical rigor, occasionally to the detriment of physical insight. For instance, the Lorentz transformation can be derived without complex mathematics from the relativity principle and the postulate that light has velocity  $c$  relative to any inertial frame, but the authors omit this conceptually simple derivation (and the diagram showing observers O and P, each considering himself at the center of a spherical wave front resulting from a light pulse released as they passed each other with relative velocity  $v$ ). In the conceptual vein, Robertson and Noonan dispose of the twin paradox by using a simple Minkowski diagram showing the 18-year gap in the journeying twin's time scale as that twin reverses velocity ( $0.6c$ ) 15 light-years away. Similar, notable demonstrations are given of the gravitational redshift, the inconsistency of gravitation and special relativity, the equivalence of gravitation and acceleration, the generalized Doppler effect and Planck's constant, cosmological constant and curvature, and cosmological distances.

In the last five chapters, all dealing with cosmology, Noonan augments Robertson's notes very effectively and

follows his mentor's efforts to find observational tests of the various relativistic models. He uses observational data as of 1965 (and notes 1967 additions in an appendix), including the Hubble constant 100 km/sec-Mpc, quasars with redshift of 2, and the background 3°K radiation, but does not note all their implications (for instance, the "disproof" of steady-state theory by the 3°K background).

The metrics and geometries of eight cosmological models are derived and summarized in a table. Astronomically observable quantities (redshift, bolometric distance, angular size, and counts to various limiting magnitudes) are related to cosmological parameters and discussed briefly, and the inescapable conclusion is drawn that observations to date cannot confirm any one cosmological model.

Most of the calculations are illustrated with schematic diagrams that add greatly to the clarity. One of the more detailed diagrams that I found particularly interesting illustrates the trajectories of test particles and photons near the Schwarzschild singularity. There are a useful list of symbol definitions, a good bibliography, and an excellent ten-page abstract of the text, chapter by chapter, in an appendix designed to help the reader find particular topics and to follow the line of reasoning. I am sure that Robertson would be proud of this product of the many years he devoted to relativity and cosmology.

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## Some Aquatic Animals

**Australian Inland Waters and Their Fauna.** Eleven Studies. A. H. WEATHERLEY, Ed. Australian National University Press, Canberra, 1967. xvi + 287 pp., illus. \$A10.50.

**Australian Freshwater Life.** The Invertebrates of Australian Inland Waters. W. D. WILLIAMS. Sun Books, Melbourne, 1968. x + 262 pp., illus. Paper, \$A2.50.

Australia remains, as the editor of *Australian Inland Waters and Their Fauna* has noted, terra incognita as far as biology is concerned. This book, which includes contributions from ten Australian specialists, is valuable in reducing our ignorance of the