"Polygonal pattern of underlying ice-wedge casts exposed along U.S. Interstate 80 about 24 km east of Rawlins and 100 km northwest of Laramie, Wyoming." [From T. L. Péwé's paper in *Late-Quaternary Environments of the United States*; photo by Brainerd Mears, Jr.]

cicki and others. They discuss volcanism in relation to geothermal data and plate tectonics and provide detailed information on and maps of the major tephrochronological markers that are proving so useful in the northwestern United States. Moreover, I would single out Knox's outstanding contribution on fluvial response to climatic change. This difficult topic is treated with clarity as Knox sorts out the relative roles of vegetation cover and flood frequencies on sediment yield and water discharge across different climatic regions, all of this in the face of changing circulation patterns. A standard response to the question "aggradation or incision?" cannot easily be transferred from one climatic region to another.

Also worthy of special mention is Stoltman and Baerreis's chapter on the evolution of human ecosystems in the eastern United States. The ecosystem concept is introduced as a new perspective on human prehistory based on the simultaneous evaluation of five variables (subsystems): environment, subsistence, population, technology, and social organization. This approach preempts the oversimplified analysis of cause and effect within a two-component system of "culture" and "environment." It is apparent that this chapter was written prior to the appearance of K. W. Butzer's *Archaeology as Human Ecology* (Cambridge University Press, 1982), with which there are some strong parallels.

Finally, the pervasive theme of climatic factors and climatic change throughout these volumes makes it clear that one cannot "do" Quaternary science these days without a good understanding of climate and its intricacies. The final chapter of each volume addresses the climatic system directly. Volume 2 ends with a summary by Kutzbach of climatic modeling, especially utilizing earth-orbital parameters as deterministic external forcing. His own experiment involving the 9000 B.P. insolation maximum, enhanced monsoonal precipitation and high-level tropical lakes is aptly reviewed. Barry concludes volume 1 with an outstanding summary of late Cenozoic climatic history; he focuses stepwise on progressively finer detail in passing from late Tertiary to late Wisconsinan time, the latter being treated region by region across the country. This account should be read by anyone who is looking for an authoritative thumbnail sketch of what we understand and don't understand about ice-age climates.

Late-Quaternary Environments of the United States is indispensable for any practicing Quaternary scientist. All of us will find several chapters of immediate interest. It is likely to be the standard reference on the interpretation of Quaternary environments for the next decade.

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Behavioral Neurobiology

Neuroethology and Behavioral Physiology. Roots and Growing Points. FRANZ HUBER and HUBERT MARKL, Eds. Springer-Verlag, New York, 1983. xviii, 412 pp., illus. $33. From a symposium, Mainz, Germany, Sept. 1982.

Animal Behavior. Neurophysiological and Ethological Approaches. KIYOSHI AOKI, SUSUMU ISHII, and HIROMICHI MORITA, Eds. Japan Scientific Societies Press, Tokyo, and Springer-Verlag, New York, 1984. xx, 274 pp., illus. $39.50. From five symposia, 1979–1982.

The two volumes reviewed here are part of a small but growing literature in a relatively newly defined subdiscipline of neuroscience called neuroethology. Neuroethology refers to the neural analysis of behaviors that occur under natural conditions, evoking names like Tinbergen, Lorenz, and von Frisch. These pioneer field behaviorists explained the mechanisms of behavior by means of such concepts as key stimuli, releasers, search images, innate releasing mechanisms, and fixed action patterns. Most neuroethologists take their marching orders from the ideas of classical ethology and probe the nervous systems of their animals for neural correlates of fixed action patterns, releasers, and the rest. The bestiary of neuroethology would gladden the heart of any zookeeper—bats, frogs, electric fish, exotic songbirds, owls, walkingsticks, and crickets, to name a few. The study of mechanisms of behavior remains important, and neuroethology has inherited the mantle from classical ethology. This reflects a split in ethology. Nowadays, field behaviorists draw less from classical ethology and more from population genetics and evolution and are more comfortable being called behavioral ecologists or sociobiologists; the emphasis has shifted to a different level of analysis—the evolution of behavior.

The volume edited by Huber and Markl is dedicated to one of the founding fathers of neuroethology, K. D. Roeder, whose death at age 71 in 1979 prevented him from seeing the growth of a field in which his visionary and brilliant studies set the style and tone; he was doing neuroethology long before there was a word for it, and his work on the evasive mechanisms of moths in relation to predacious bats is still one of the best examples of neuroethological research. The contributors to the volume are drawn from friends, collaborators, and students of Roeder's. Since he was an experimental entomologist, the volume is heavy on insects and light on the vertebrates.

Nearly half of the book deals with two subjects, the neural bases of motor systems and sensory strategies of adaptation. Most of the chapters deal with insects, and they include perspectives by the elder statesmen of neuroethology—Bullock, Hoyle, Dethier, and Huber. Although Roeder did not do major work on neural development and learning, the book includes an interesting section on these subjects, which are major concerns of modern neurobiology. Murphey and Truman each show why insects are good organisms for neurodevelopmental studies. The neurobehavioral basis of feeding (slugs) is described by Gelperin, and that of foraging (bees) is described by Erber and by Menzel and Bitterman; the focus is on the role of learning in these behaviors. Predator-prey relationships occupy a major part of the book, and the section on them concentrates on the acoustic interaction between insects and their predators, bats that detect and hunt them down with biosonar signals. This emphasis is appropriate, since the subject was the highlight of Roeder's career. The contributors, who are active researchers on the subject, include Simmons, Schnitzler, Miller, and Neuweiler; Treat provides a delightful glimpse of the circumstances that led him to convince Roeder to study the ears of moths in the first place. The book concludes with a potpourri of subjects called "ecological aspects of social relations and orientation," which deals with interesting mechanisms of behavior the analysis of which does not center on the nervous system.

Many of the papers in the book are of a quality that would make it useful for an advanced seminar. One can certainly get the flavor of neuroethology by gleaning this book.

The volume edited by Aoki, Ishii, and Morita also deals with neuroethological topics, and it is dedicated to M. Kuwabara, a prominent Japanese neurobiologist. It is similar to Huber and Markl's book in its emphasis on invertebrates, especially insects, but there are important differences between the two. Aoki *et al.* have included four chapters on the neurogenetics of *Drosophila* and one on *Paramecium*; these topics are not the usual fare of neuroethology, but they are vitally important in research on comparative neurobiology and development. This book also includes treatments of central isues of neuroethology that are omitted by Huber and Markl, namely the analysis of hormonal control of behavior and circadian rhythms in vertebrates (birds, fish, and amphibians).

While Aoki *et al.* should be complimented on the broad selection of topics from behavioral neurobiology, there are several aspects of the volume that make it less valuable than Huber and Markl's. For one thing, many of the reviews are too brief (five to ten pages) to be really satisfying to the specialist; for another, the illustrations are not of the quality of Huber and Markl's—in particular, the reproduction of photographs is terrible. Some major contributors to this book—Huber, Wyman, Hotta, Heiligenberg, Ewert, and Yamaguchi—have reviewed their work elsewhere and at greater length. It is too bad that a book that covers so many interesting aspects of behavioral neurobiology is flawed by the brevity of its reviews, so that it is of limited value, even for the professional bookshelf.

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Skeletal Tissue

Cartilage. BRIAN K. HALL, Ed. Academic Press, New York, 1983. In three volumes. Vol. 1, Structure, Function, and Biochemistry. xvi, 385 pp., illus. $55. Vol. 2, Development, Differentiation, and Growth. xiv, 409 pp., illus. $55. Vol. 3, Biomedical Aspects. xiv, 353 pp., illus. $49.50.

This treatise aims to cover in depth all aspects of cartilage, an ambitious aim in which it partly succeeds.

Volume 1, "Structure, Function, and Biochemistry," containing 12 chapters, treats chondrogenic differentiation and normal and abnormal development from the standpoint of cell biology. There is an interesting comparison between vertebrate and invertebrate cartilages. A chapter on cell kinetics contains a critique of current methods of estimating mitotic indexes. The ultrastructure of cartilage is beautifully illustrated by both transmission and scanning electron micrographs that serve to remind those working with isolated chondrocyte cultures of the complexity of the matrix and the microenvironment of the chondrocyte.

An authoritative review of cartilage collagens, including minor collagens, includes a section on immunolocalization of collagen. Given the experience of the authors, a critical assessment by them of this technique, which is being increasingly used, would have been valuable. An account of the chemistry of proteoglycans and their constituent glycosaminoglycans is somewhat old-fashioned and overlooks some crucial facts, although it does cite several main reviews.

A review of the metabolism of cartilage attempts to encompass far too many aspects of the subject, including anabolic and catabolic factors, hormones, prostanoids, and mechanical stress. Some of these topics could be subjects of chapters themselves, and some are in any case covered elsewhere in the book. Calcification of cartilage has long been a subject about which there is contention. In an interesting and forcefully argued contribution on the role of matrix vesicles it is pointed out that deposition of apatite crystals is a different process from metaphyseal bone growth, which involves accretion and nucleation on existing crystals.

An admirable survey of biomechanics explains basic concepts and theoretical models without mathematical treatment, giving some idea of how mechanical properties of cartilage are explained in bioengineering terms and the meaning of the tests that are used.

Volume 2, "Development, Differentiation, and Growth," contains ten chapters, some very good and some mediocre and rather descriptive. The variations in quality are partly reflections of variations in the state of knowledge of the topics under review. The central topic of this volume is chondrogenesis in fetal development and in postfetal life. Many of the contributors discuss current concepts of limb morphogenesis. The chick embryo is the main model system used. The importance of cell-cell interaction, cell condensation, and tissue interaction is made clear. A hypothesis is put forth concerning how cells within the developing limb possess positional information. It seems that a crucial process of cell sorting takes place at the precartilage stage of chondrogenesis. Shape and form are presented as the outcome of the interplay between specific factors intrinsic to the cells and nonspecific factors due to the environment within the embryo. The question of how differential growth is programmed in different species is carefully considered. Certain achondroplasias in which the biochemical defect is known have thrown some light on this question.

A great deal of work has been done on the effects of hormones, vitamins, and growth factors. The book brings this work together, though no clear picture emerges, probably because, as is pointed out in the book, many growth factors are impure and different workers use tissues at different stages of development. There is some duplication between chapters. In particular, a diffuse and unselective first