Invertebrate Eyes

Comparative Physiology and Evolution of Vision in Invertebrates. Part B, Invertebrate Visual Centers and Behavior. I. H. AUTRUM, Ed. Springer-Verlag, New York, 1981. x, 632 pp., illus. $159. Handbook of Sensory Physiology, vol. VII/6B.

Eyes are sensory organs that direct onto thin layers of neural tissue—retinas—whatever of the external world can be conveyed by emitted, refracted, scattered, or reflected quanta of light. For there to be vision, quanta must reach the retina; to be seen, quanta must be absorbed; for the absorbed quanta to be of use, neural images must result. Some of the ways invertebrate eyes have evolved to gather, absorb, and utilize light for vision are the subjects of the four chapters of this volume (the second in a series of three on invertebrate vision) of *Handbook of Sensory Physiology*.

Invertebrate eyes have always fascinated, as much for their exuberant, even bizarre, anatomical forms as for the common visual strategies that they share with their vertebrate counterparts. To the cognoscenti of the former, the chapter on optics and vision (Land) will be a delight. There are described, in addition to more widely known invertebrate ocular forms, such optical devices as serial lenses (copepods), spheroidal or ellipsoidal reflectors (scallops, ostracods), light guides (amphipods), and compound eyes with internal reflecting surfaces instead of simple lenses (decapods) or with cylinder lenses (*Limulus*). Additionally, the important point is reiterated that, however deficient an invertebrate's eyes may or may not appear compared, for example, to those of humans, they are generally just as well suited for the visual needs of the particular animal.

Portions of other chapters likewise bring out general visual principles that for historical and anatomical reasons have received greater attention in invertebrates (polarized light detection; Waterman) or that are similar in animals with well-developed visual systems, despite gross anatomical differences (columnar organization of higher visual centers; Strausfeld and Nässel). On the other hand, it is now known only from invertebrate preparations that estimates of quantum efficiencies may be in error if the statistics of receptor noise (from openings and closings of ion channels, for example) are not also evaluated (Laughlin). The chapter by Laughlin presents an energetic harmonization of strategies of peripheral visual neural processing in arthropods and in vertebrates.

The value of this volume is enhanced for the specialist by the considerable number of unpublished or original results and figures that are included. Up-to-date (through 1980) references are provided at the end of each chapter and in a final author index. Most users are unlikely to read the book straight through from cover to cover, but those seeking a way to approach it might well read the chapters in reverse order, proceeding from optics to the neuroarchitecture of brain regions instead of the other way around. The book will find an essential place on the visual physiologist's bookshelf, alongside other volumes of the *Handbook*.

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The Space Science Program

Beyond the Atmosphere. Early Years of Space Science. HOMER E. NEWELL. National Aeronautics and Space Administration, Washington, D.C., 1980 (available from the Superintendent of Documents, Washington, D.C.). xviii, 502 pp., illus. Paper, $11. NASA History Series. NASA SP-4211.

Through the continuing publication of its History Series, the National Aeronautics and Space Administration has led the scientific and technical agencies of the U.S. government in providing the public with professional historical review and analysis of their major programs. Most of NASA's histories published so far have concentrated on the development of rockets and spacecraft, in projects like Vanguard, Mercury, Gemini, and Apollo, or on general administrative history. Scientific research and its management have been treated as subsidiary subjects. Homer Newell's *Beyond the Atmosphere* helps redress the balance.

Newell was a participant in the story he tells. He started in space science at the Naval Research Laboratory in the years following World War II and in 1958 transferred to NASA, where he helped oversee the space science program for many years before serving, from 1967 to 1973, as deputy administrator. Yet although the book reflects Newell's career, especially in its focus on NASA, it is far more than his reminiscences. Autobiographical reflections are rare. Instead, Newell reviews broadly a subject in which his own work was but a small part.

The book is organized into accounts of how space research was managed and, interspersed among them, descriptions of major scientific advances that flowed from the research. The administrative sections cover the structure of space science in the pre-NASA period, the origin of NASA, the oversight of space science under the new agency, and NASA's international relations. The technical sections review some of what was learned about the magnetosphere, the shape and structure of the earth, the sun, the planets, and the stars. Concluding chapters examine selected topics, including the emergence of the space shuttle as the main NASA project, and review major themes. Appendixes reproduce several significant historical documents.

Readers will find that Newell provides a thoughtful, wide-ranging overview of the development of American space science under NASA's leadership. He elucidates complex scientific and tangled administrative topics without retreat to either technical or managerial jargon. He articulates clearly the many considerations involved in formulating a scientific program that was acceptable not only to the government, including the president, Congress, NASA, the Department of Defense, and other agencies, but also to university researchers throughout the nation. In describing the struggles between NASA and America's scientific elite over the direction and control of the space science program he portrays a fascinating episode in the politics of science. Finally, he gives valuable perspective and insight into such perennial issues as evaluating manned against unmanned space missions and handling the conflicts between scientists and engineers.

Only when Newell reaches beyond his particular story and attempts to relate it to the evolution of science in general is the book disappointing. For guidance, he turns to Thomas Kuhn's thesis that the history of science may be explained through division into periods marked by the status of prevailing theoretical constructs or "paradigms" within the professional community. This view, Newell argues, provides "a way to trace and assess the development of space science through the first decade of NASA's existence." The assessment is extremely limited. Newell's use of Kuhn is restricted to ambivalent judgments on whether or not results from research in space "revolutionized," or upset the prevailing paradigm in, selected fields of science. The paradigm analysis does not include such topics as the impact of Sputnik, policy formulation in NASA, and the challenge of President Kennedy