Book Reviews

A Bird's-Eye View

Vision, Brain, and Behavior in Birds. H. PHILIP ZEIGLER and HANS-JOACHIM BISCHOF, Eds. MIT Press, Cambridge, MA, 1993. xxiv, 415 pp., illus. $75 or £67.50.

The more than 8500 species of birds on this planet exploit an amazing diversity of habitats and exhibit an incredibly rich repertoire of behavior. Little wonder, then, that visual, neural, and behavioral scientists have selected certain species of birds as a model system with which to gain fundamental insight into the underlying principles of visual organization. Take, for example, the exquisitely precise dive of kingfishers and gannets, or the strike of herons and ospreys: All these species beautifully compensate for refraction of light at the air-water interface and visual distortion caused by ripples to deftly capture their fish prey. Likewise, the visual systems of ground-feeding birds such as the much studied pigeon and domestic chicken allow them to skillfully search for grain and food items and to adjust the gape of their beaks so as to pluck them from the ground, rapidly and accurately.

Many other aspects of birds' behavior are also predicated on an appropriately tuned eye and visual system. These include visuomotor behaviors such as avoiding branches when flying through thickets, landing on branches, striking prey with talons, and flying in formation in flocks. Visual recognition of predators and prey, conspecifics and nonconspecifics, mates and rivals, nest material and nest sites, home territory and neighbors' territories, familiar landmarks for navigation, and sites to hide food (in hoarding species) all require a visual processor with sophisticated perceptual and cognitive functions. It is not surprising, then, that we find many of the classical problems of sensory physiology, neuroanatomy, ethology, and psychology addressed in this book, often with respect to a particular avian species, but also, where appropriate data exist, as a context for comparison between different species. The book consists of five parts, each of which addresses a major topic in avian vision. The parts cover, respectively, the eye and basic visual capacities, the functional anatomy of the visual system, the development of the visual system, visuomotor mechanisms, and perceptual and cognitive processes.

Major differences in lifestyle, such as are found between daytime predators like hawks and falcons and grain-eating birds like pigeons and doves, are associated not only with differences in the structure of the eyes but also with the differential elaboration of specific areas of the visual system (such as the *Wulst*, which is remarkably similar to the visual cortex in mammals), and corresponding differences in perceptual phenomena. In general, this opportunity for comparison is handled well throughout the book, not only between different avian species but also between more phylogenetically remote species. It is especially refreshing to see comparison and contrast of mammalian and avian visual systems in relation to parallel processing of visual information, developmental visual neuroanatomy, head and eye movements, cerebral lateralization, stereopsis, and color vision. All too often those working on the mammalian visual system pass up the opportunity to explore how similar and different solutions to common visual problems have evolved across a broad spectrum of species.

Although the scope of this book is broad, it is not an exhaustive review of the field. Rather, it conveys the current state of knowledge in those areas where there has been sufficient progress over the past decade or two for fruitful model systems to emerge, at the same time reminding us of major questions that remain unanswered. Although much of the book deals with information derived from laboratory studies, considerable effort is made to relate these findings to the natural ecology of the species in question. Students of behavioral ecology, visual and comparative neuroscience, cognitive science, and experimental psychology will find much of interest in this volume. It will be especially welcomed by all those with a serious interest in avian vision and behavior.

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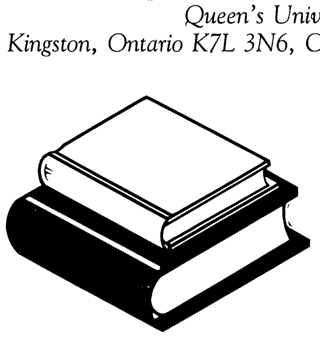

Neural Mechanisms

Synaptic Plasticity. Molecular, Cellular, and Functional Aspects. MICHEL BAUDRY, RICHARD F. THOMPSON, and JOEL L. DAVIS, Eds. MIT Press, Cambridge, MA, 1993. xiv, 263 pp., illus. $50 or £44.95.

Neuroplasticity encompasses a broad set of phenomena that have become central to our view of nervous system function. Synaptic plasticity—that is, alterations in synaptic structure and function—has received special attention as a key to our understanding of complex issues such as information processing, neural correlates of behavior, and nervous system responses to injury and trauma. The 11 contributions to this volume cover a wide range of topics, from extracellular-matrix molecules (Hockfield) to mathematical models of visual cortex function (Intrator *et al.*) to models of degenerative disease (Finch and McNeill), the thread linking them together being, apparently, the personal interests of the editors. The result is an informative but rather idiosyncratic collection.

For the naïve but curious, the book is not easily accessible, in part because it is not always clear how a given chapter relates to the theme of synaptic plasticity. Some of the best contributions fall into this category—for example, Steward's chapter on "molecular sorting," which is lucid and conceptually important with respect to the development of the basic mechanism of cell structure–function relationships. Similarly, the contribution by Berger *et al.* on "modeling the hippocampus" provides an appealing discussion (even if one doesn't have a mathematical background) of how modeling techniques can be used to investigate CNS function but does not make it clear how such a model can be used to illuminate (and predict) the mechanisms and consequences of synaptic plasticity. This is not to say that these chapters are irrelevant to the main subject of the book, but only that further clarification is needed to establish their place in this volume.

For those who have followed the field closely, the contributions on long-term potentiation (Teyler and Grover; Baudry and Lynch) and long-term depression (Ito; Artola and Singer) are both useful and a little disappointing. Although they provide good reviews of recent studies and identify key issues in a very active field, as a group they are poorly integrated, each apparently having been written completely independently of the others, even though the material overlaps considerably. Thus the authors do not deal substantively with controversies in the field: For example, are LTP and LTD generally similar (as suggested by Artola and Singer), or is LTD—at least in cerebellum—unique (as implied by Ito)?

An especially attractive feature of this volume is the inclusion of chapters in which cellular and molecular mechanisms of "synaptic plasticity" are discussed within the context of interesting animal models of behavior. Rose, in detailing his studies on the biochemical changes found in the chick brain, presents an intimidating array of possible changes (from phosphorylation to immediate early gene induction) that could be related to the chick's learning behavior. The data from these studies do not define cause–effect relationships but do give the reader a sense of the direction in which much of this work is moving. Fittingly, the final chapter (by Thompson *et al.*) provides an excellent overview of electrophysiological and morphological data that bear on the learning and memory "circuits" underlying some complex behaviors—especially behaviors that may rely on LTP- or LTD-like mechanisms—and helps pull together many of the issues described earlier in the volume in terms of their relevance to complex behaviors.

Clearly, it is this tie between the cellular-molecular and the behavioral, this search for the "engram," that has attracted many of us to the field of synaptic plasticity. Given this interest, the current volume is a partial success and a useful complement to other recent works dealing with various aspects of neuroplasticity.

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Early Crustal Evolution

The Geology of Multi-Ring Impact Basins. The Moon and Other Planets. PAUL D. SPUDIS. Cambridge University Press, New York, 1993. xiv, 263 pp., illus. $59.95 or £37.50. Cambridge Planetary Science Series, 8.

The term "multi-ring impact basin" evokes an interesting but exotic phenomenon, important perhaps to planetologists, and approachable only by spacecraft or large telescopes. The phenomenon is indeed interesting. But multi-ring impact basins are broadly significant, and surprisingly accessible. They have had an enormous influence on the geology of many planets and satellites, possibly including the Earth, and the best-studied ones on the moon can be seen in great detail even with 7-power binoculars.

Impact craters are the most common landform in the solar system. Those over 300 kilometers wide are often termed basins. These are not simply oversize versions of Copernicus; with increasing diameter, their structure becomes more complex, culminating in the enormous rings of the Orientale basin. Recognized on the moon by Ralph Baldwin several decades ago, multi-ring impact basins have now been found on Mercury, Venus, Mars, several satellites, and perhaps the Earth, although this is controversial. To a surprising degree, the study of planetary geology is the study of multi-ring basins.

The rings of these basins resemble the concentric ripples generated by a pebble dropped into a pond; in fact this homey analogy has been invoked to explain how basins hundreds of kilometers wide formed. The analogy is probably too good to be true, and competing theories have been proposed. In *The Geology of Multi-Ring Impact Basins* Paul Spudis, one of the protagonists in the controversy, presents results of some two decades of research on the topic.

Spudis breaks the problem of basin formation into two parts: excavation of the initial basin and formation of the rings. Excavation processes have been interpreted either as scaled-up versions of small impacts (proportional growth) or as a fundamentally different phenomenon (nonproportional growth). Formation of the rings has been ascribed to three different mechanisms, which are not necessarily mutually exclusive. The "pebble-in-a-pond" analogy interprets the rings as essentially frozen waves formed by impact fluidization of the crust of the target body. Another interpretation is that the rings are concentric blocks of crust that slumped inward, in the same process that produced the internal terraces of Copernicus and similar craters. A third interpretation is that layering in the crust of the target body caused formation of giant nested craters.

Spudis presents examples of multi-ring basins from several planets and satellites, but his basic approach is lunar, with individual chapters describing the near-side basins of the moon: Orientale, Nectaris, Crisium, Serenitatis, and Imbrium. Surprisingly, the Orientale basin is not considered representative of lunar basins; although as the youngest lunar basin it is well preserved and exposed, it was formed after the lunar crust had been consolidated, and internal processes were minimal compared to those occurring, for example, in the Imbrium basin.

East half of the 930-kilometer-wide Orientale basin on the moon's western limb; earthward face to the right, north at top. [Lunar Orbiter 4 photograph 187M, National Aeronautics and Space Administration]

Spudis's approach shows clearly the value of focused research, that is, studies aimed at a particular problem. He relates evidence from photogeology, orbital remote sensing, Apollo and Luna landing site geology, returned sample petrology, and Earth-based reflectance spectroscopy. Collectively, these discussions amount to an excellent and concise treatise on lunar geology, with the only thing missing being a detailed treatment of the mare basalts. The descriptions of the four Apollo and three Luna landing sites will be invaluable to those who, like this reviewer, have been unable to keep up with two decades of post-Apollo lunar research. (The astronauts should find it interesting to see how their magnificent work has been applied.)

How were the multi-ring basins formed? Using the Imbrium basin as an example, Spudis presents an eclectic "synthesis," illustrated by detailed line drawings. If Spudis is correct, the formation of this basin—triggered by the 20-kilometer-