

ciple of electroneutrality would be violated.

When we turn from the articles that are merely descriptive to those that deal with molecular mechanisms and the driving forces in energy coupling, simplicity and clarity fade away. It becomes painfully obvious that the fundamental principles of energy coupling and the molecular mechanisms underlying electron transfer and oxidative phosphorylation are as far out of reach today as they were when oxidative phosphorylation was first discovered some 30 years ago, despite the tremendous increase in our knowledge of the structure of the mitochondrial transducing system. What can account for this lack of progress? The first and obvious explanation is that the theoretical cart has been put in front of the experimental horse. To understand the mechanism of electron transfer, we must at least know the internal structure of the complexes that carry out electron transfer. To understand the mechanism of coupled ATP synthesis, we must at least know the internal structure of the complex and the relationship among the parts that carry out the synthesis. That knowledge is still lacking. The second explanation is that the test of theory is not proficiency in debate but the solution of outstanding problems. If the chemosmotic model or the conformational model of energy coupling is valid, one of them should lead to the experimental resolution of all outstanding problems. Model builders are content to rest their case on argument and persuasion, and models become dogmas and not stepping-stones to wider experimentation.

It was a magnificent achievement to bring 100 or more participants from all parts of the world to have a three-day scientific dialogue in Selva di Fasano, and the concentration of talent in bioenergetics was at an all-time high at this conference. Yet there is a danger in this type of conference—the danger of perpetuating and reinforcing dogma. The powerful grip of dogma has all but strangled mitochondrial biology, and these continuing annual conferences supported by huge outlays of money have played a not inconsiderable part in bringing about this distressing situation.

As a summary of knowledge of the mitochondrial transducing system, this book can be recommended to all workers in bioenergetics. It will undoubtedly be one of the most referred to volumes in mitochondrial biology.

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16 JULY 1976

Vertebrate Vision

Vision in Fishes. New Approaches in Research. Papers from a NATO Advanced Study Institute, Lennoxville, Quebec, Aug. 1974. M. A. ALI, Ed. Plenum, New York, 1975. xiv, 836 pp., illus. \$62. NATO Advanced Study Institutes Series A, vol. 1.

The bony fishes and their allies constitute one of the three major vertebrate radiations, and in terms of number of species and ecological diversity they must also be considered the most biologically successful one. In most fishes vision is a prominent sensory modality utilized in complex behaviors such as predator-prey interactions, territoriality, dominance, pair bonding, and parental care. Long separated from the land vertebrates in evolution, the fishes offer biologists the opportunity to examine a vertebrate group that has solved a number of biological problems independently and often uniquely. An understanding of fish vision will add new information regarding a unique group of vertebrates and should also add greatly to our understanding of vertebrate vision in general. Any volume dealing extensively with vision in fishes should therefore be welcome.

This book includes 61 papers by researchers from seven countries. It is heavily slanted toward the organization of the eye proper, and the fish retina is used as a convenient model for the vertebrate retina in general. Only nine of the papers deal specifically with central nervous system aspects of vision. Unfortunately, it is impossible to gain from the 20 papers that touch on the subject any picture of the exact brain regions that receive primary retinal efferents. It is not even clear whether neurophysiological studies have characterized these primary retinal targets in a single fish, much less their possible variation.

Like most symposium volumes, this work falls short of its aims. One of its main purposes, according to the editor, was to focus attention on the significance of electrophysiological and visual pigment studies for revealing the life histories and habits of fishes. There are ten papers in the electrophysiology section, but only two (Schwassmann; Ali and Muntz) deal at all with variation in the visual systems of fishes or attempt to correlate that variation with habitat. Schwassmann clearly summarizes the available data concerning the spatial orderliness of the retinal projection onto the optic tectum of teleosts. This review reveals a puzzling phenomenon: in most freshwater fishes, even those with excellent vision, there is a linear projection of the

retina onto the tectum, whereas most marine teleosts exhibit nonlinearity in the retinotectal map. These results suggest that most freshwater fishes do not have an "area centralis," whereas most marine fishes do.

The section on behavioral aspects also fails to make comparisons or to relate information about visually mediated behavior to the life history and ecology of fishes. The papers in this section deal, for the most part, with specific psychological techniques or results, with the exception of a broad outline compiled by Northmore and Yager of psychophysical methods utilized in work on fishes. The lack of any reference to the ethological literature (the most extensive literature on fish behavior) and to the importance of vision in much of the species-typical behavior of fishes is particularly glaring in a volume that purports to emphasize a broad variety of approaches.

The sections on optical and mechanical aspects, comparative and developmental aspects, and environmental aspects are the heart of this volume and contain a number of insightful and stimulating contributions. Papers by Schwassmann and by Sivak on accommodation and papers by Ali and by Easter on retinomotor responses are clearly written and provide excellent summaries of their subjects.

Sadoglu provides a particularly interesting paper, based primarily on her own work, on the genetic control of eye development in cave fishes. Her research may also prove to add considerable insight into the genetic control of eye development in vertebrates in general. Gruber provides a chapter summarizing what is known regarding peripheral vision in a nonteleost group, the elasmobranchs. One could wish that more such summaries had been provided.

Dartnall's analysis of visual pigments and their relationships to photic environments is a particularly effective review. His discussion of the sensitivity hypothesis of visual pigments—that these pigments have been selected to absorb the greatest number of quanta in a given photic environment—clearly reveals that we still do not know what visual surfaces fishes are scanning in most environmental circumstances. Muntz's contribution continues in a similar vein. He discusses variation in the visual pigments of fishes that most likely cannot be explained by the sensitivity hypothesis and emphasizes the need for more detailed information on the actual visual tasks that fishes perform.

Easter presents a concise and stimulat-

ing paper on retinal specializations in fishes and speculates on the relationships of these specializations to aquatic vision. The possible adaptations are outlined clearly and in such a way as to suggest hypotheses and appropriate methodology for testing them.

Overall, the book is uneven in coverage and depth. It will be of interest to a few specialists, but it cannot be recommended to the biologist interested in an overall view of vision in fishes.

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Regulating Nervous Activity

Cholinergic Mechanisms. Papers from a symposium, Boldern, Switzerland, Mar. 1974. P. G. WASER, Ed. Raven, New York, 1975. xviii, 556 pp., illus. \$29.50.

This symposium proceedings opens with a historical survey by Bo Holmstedt of some of the less well known traditions in research on cholinergic functions. The paper reminds us of the surprising fact that, although the synthesis of acetylcholine in vitro was achieved by Adolf von Baeyer in 1867, the control of that process in vivo has yet to be fully elucidated. The study of acetylcholine metabolism in vivo had to be postponed until the recent development of the sophisticated methods reviewed in this volume by Donald J. Jenden. The availability of these methods has invigorated acetylcholine research, although our understanding of central cholinergic neurons still lags behind our knowledge of brain monoamines.

The topics covered in the book include the morphology of cholinergic synapses; methods for determining the acetylcholine and choline contents of tissues; the formation, transport, and uptake of choline; the synthesis, turnover, structure-activity relations, enzymology, and receptor interactions of acetylcholine; the therapy of anticholinesterase poisoning; and various pharmacological and behavioral phenomena associated with cholinergic neurons. The papers vary in degree of specialization and complexity. There are only a few reviews, such as F. Fonnum's "Review of recent progress in the synthesis, storage, and release of acetylcholine" and A. G. Karczmar's "Cholinergic influences on behaviour." Most of the 52 papers describe specific research projects, and the results of many of these have appeared in journals. Nevertheless, a collection of key results

of the acetylcholine research of the past four years is a useful addition to the library of any neuroscientist.

Furthermore, the book includes studies on widely different systems, ranging from the electric organ of *Torpedo marmorata*, to the neuromuscular junction, to the mammalian brain. Most interesting to this reader are freeze-etch electron micrographic studies of synaptic junctions; the possibility of isolating cholinergic receptors and of localizing choline acetyltransferase and acetylcholine histochemically; the study of acetylcholine biochemistry in the mammalian brain; and, finally, the evidence that central cholinergic neurons are involved in controlling various behavioral states.

In the two years since the symposium took place, many new findings have been published that amplify our knowledge of the topics discussed in this book. One example is the identification of precursor availability as a factor in controlling the rate of acetylcholine synthesis in vivo; another topic that is receiving new attention is the involvement of cholinergic mechanisms in various neurological diseases.

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