Nervous Systems and How They Work

"The work is primarily for reference but is not an encyclopedia or compendium. Rather, it attempts a synthetic, personal evaluation of the state of our knowledge. . . ." So write the authors, Theodore H. Bullock and G. Adrian Horridge, in the preface to **Structure and Function in the Nervous Systems of Invertebrates** (Freeman, San Francisco, 1965. 1747 pp., $75). The key words here are "synthetic, personal evaluation," for this monumental, two-volume treatise is no ordinary review. It is a comprehensive, coherent account of what is known, believed, and understood about nervous systems and how they work. It is a reasoned, evaluated survey of the literature in this field, spanning nearly a century of time. It is information distilled and judged. Evidence abounds on every page that the material selected for inclusion has been tempered by a keen and attentive human mind.

The scope and extent of coverage is prodigious. It encompasses the entire animal kingdom exclusive of the vertebrates, embracing as well the minute details of ultrastructure as the topography of entire "systems," and considering every facet of function from excitability to integration. In 21 chapters the pertinent, relevant data on invertebrate nervous systems are judiciously considered. But that is not all.

Volume 1 begins with six chapters that give a concise but comprehensive overview of what is known in fact about the way nervous systems are put together, and of what is understood in principle about the way they work. These introductory chapters are background to the remaining 21; they are also, by themselves, a coherent, masterful summary and evaluation of the present state of knowledge in each of the topics treated: patterns of nervous system organization; microanatomy of neural elements; excitability and conduction; transmission; integration; and neurosecretion. Because the selection of material has been governed by the criterion of relevance for *all* animals, vertebrate as well as invertebrate, these six chapters could serve, and doubtless they will, as a modern textbook for students of the nervous system. Here, as throughout the entire work, the comparative point of view is paramount. Unifying, basic principles are stressed, but the bewildering variety and diversity in which so many invertebrates indulge is also examined. Nor are conflicting evidence and unexplained phenomena overlooked; they are placed in perspective with the whole body of knowledge. For those who are beginning their career and for research workers whose experience has been limited to the vertebrate animals, these six chapters are a boon—and a necessity.

A somewhat closer look at one of these chapters is warranted. Chapter 2, on microanatomy, is a good model for describing the format. It is divided into two parts. The first, "General and comparative considerations," includes in ten succinct pages a description of the cytology and histology of varied forms of nerve cells and their processes, the distribution of different kinds of neurons among the phyla, and a review of common features among different nervous systems. The second, longer section treats the special relations and components of nervous tissue. This ranges all the way from minute organization of nervous elements—for example, plexuses, ganglia, nerves, connectives, and commissures—to the microscopic and ultramicroscopic fine structure of synapses, nerve cell inclusions, neuroglia, and sheaths, and the phenomena of degeneration and regeneration. To all these topics, brief but thoughtful consideration is given, and the references cited provide a guide to the key literature. The chapter begins with a summary that is "informative rather than indicative," and it is, as the authors point out, "meant to be read first." The bibliography for this chapter alone lists about 600 papers which cover the world literature from 1878 to 1963.

Many special features are unobtrusive and valuable aids to the reader. They are not unique to this chapter but characterize the entire two volumes. They deserve special mention.

First is the summary. It precedes each chapter and tells the reader what to expect. Brief explanations of terms and concepts are given. Boldface type highlights important words and topics. With great economy, the summary provides both orientation and background to the substance of each chapter. Paragraph and section heads and boldface type assist the reader throughout the body of the text. The liberal use of top-quality illustrations is a delight to the eye. Although they abound, their number is not superfluous for each serves to clarify, amplify, or extend the text. Every technique and mode of illustration is included, some because they have been taken or adapted from another source, and others because the authors consciously chose the best means of illustration, whether that be micrograph or drawing, diagram, chart, record, or halftone. Puzzled by why the figures should be so pleasing, I have concluded that the reason lies only partly in their technical excellence; it is also a function of their diversity. There is here none of the dull sameness in technique, none of the sheer monotony of uniformity, that many authors and publishers doubtless work hard to achieve.

And then there are the bibliographies —separate ones for each chapter. The world's literature is surveyed; roughly a century of time is covered. The papers, all of which have clearly been consulted by the authors, total an astonishing 9900. In the chapters on arthropods alone there are references to 2740 papers. These are the author's figures. More important than numbers, the comment, or the context of reference to the bibliographies, serves as a guide to the literature, and titles to all papers are given. For this last, readers will forever bless the authors. And finally, another device, whose usefulness will probably be great, is the list of authors classified by subject, which accompanies many of the chapters.

From the elegant frontispiece, which is itself a pictorial summary of the neuroanatomy and neurophysiology of *Aplysia californica*, to the glossary of terms in wide use and having a special meaning, this work fully justifies the

authors' expectation of producing a "synthetic, personal evaluation of the state of our knowledge."

There is little to temper enthusiasm for the sheer competence that has gone into the preparation of this work. Of course there are a few places where one could wish for a bit more information or explanation. In some respects it is not an "easy reading" book. Sometimes a sentence requires repeated reading before its meaning is clear—for example (from the summary, p. 1434), "The brain is large, but the optic lobes together and sometimes each one of them are even larger; species differences have been correlated with habit of life." Occasionally subordinate clauses get in the way of understanding as in the following example (p. 338), "Mutual exclusion is, of course, a necessary facet of behavior which includes push-button responses, like giant fiber startle reflexes—a necessary facet, that is, if frequent jams and stalls from coincidence of stimuli are to be avoided." But these examples are trivia, and on the whole the quality of writing is high.

The contributions of the publisher should not go unnoted, for no work of this comprehensive nature could be produced without a remarkable degree of understanding between author and publisher. The Freeman Company must share credit for a job well done. To the contributing authors, Howard A. Bern and Irvine A. Hagadorn for their fine treatment of neurosecretion and J. E. Smith for his handling of the Echinodermata, commendation is also due. Their chapters fit nicely into the spirit and philosophy of the entire work, with no jarring divergence in style or approach.

Bullock and Horridge are research scientists of great competence. That they should take time from their own interests and particular areas of investigation to produce these volumes is a special kind of service to science. The cost must have been high. So too, the purchase price may seem extravagant. But no student of nervous systems could, by the expenditure of many times $75, duplicate what is here presented in coherent fashion. For as long as men investigate nervous systems and try to understand their perplexing ways, so long will Bullock and Horridge be remembered with gratitude.

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International Series of Monographs on Analytical Chemistry

Nuclear Techniques in Analytical Chemistry. Alfred J. Moses. Pergamon, New York, 1965. viii + 142 pp. Illus. $6.50.

This book will give the analytical chemist a bird's-eye view of the applications of radiochemical methods to a wide variety of problems. It is not really a book that stresses techniques. For detailed discussions of such classical topics as self-absorption, Feather analysis, absolute beta counting, and back-scattered radiation, the reader is referred to other sources. There is no discussion of the chemical niceties of exchange reactions, and the statistical problems encountered as the counting rate approaches background are deemed outside the scope of this monograph. There is, however, an adequate introduction to such topics as instrumentation, the measurement of natural radioactivity, activation analysis by neutrons, positive ions and gamma rays, the application of radiochemistry or tracer methods to the study of surface-exchange reactions, gas adsorption, geo- and cosmochronology, and the detection of tracer impurities in semiconductors.

A section devoted to the analysis of biological materials presents detailed procedures for the determination of phosphorus, cobalt, molybdenum, gold, arsenic, and manganese in beetle wings, tissue, plant material, biological materials, and marine organisms. No consideration is given to the problems that would arise if the chemist were faced with other combinations of these elements and sources. It is this recipe-like quality, admittedly unavoidable in a book this size, that will strike the discerning chemist as a limitation to the book's usefulness.

In the appendix, the General Electric KAPL Chart of the Nuclides is reproduced at less than half the original size, thereby rendering it essentially illegible. Except for this defect, the typography and composition of the book are excellent. I noted only a few trivial errors, and the bibliographies at the end of each chapter provide ample sources to help the reader to extend his knowledge. I feel that perusal of the book by the uninitiated will provoke as many questions as it will answer. But that is all that a bird's-eye view should be asked to do.

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"Loadstones, Onyons and Garlick," and Magnetic Theory

The Theory of Magnetism. An introduction to the study of cooperative phenomena. Daniel C. Mattis. Harper and Row, New York, 1965. xvi + 302 pp. Illus. $11.50.

This thoroughly delightful book is a highly personalized essay, neither pretending completeness nor claiming representation of any but its author's unique and individual interest. Mattis is concerned strictly with fundamental issues, and in discussing the central core of magnetic theory his insight is incisive and his style is lively and lucid.

The first chapter of the book is a charming account of the history of magnetism, written jointly by the author and his wife. This history ranges from Pliny's account of the discovery of the magnet stone by the shepherd Magnes, "the nails of whose shoes and the tip of whose staff stuck fast in the magnetick field while he pastured his flock," through the 16th century account by Porta of his disproof of the popular superstition that "if a loadstone be annointed with garlic, it does not attract iron. . . . but when I tried all these things, I found them to be false: for . . . breathing and belching upon the Loadstone after eating of Garlick, did not stop its virtues. . . . And again, When I enquired of the Mariners, Whether it was so they were forbid to eat onyons and Garlick for that reason; they said, They were old Wives fables and seemed ridiculous; and that Seamen would sooner lose their lives, than abstain from Onyons and Garlick." No professor who teaches a course in magnetism should henceforth venture into class unarmed with this ready supply of anecdotes and vignettes.

The author's choice of topics through the remainder of the book is dictated by his formal leanings. Given a physical problem, and a qualitative physical explanation, Mattis much prefers a rigorous solution of a clean model (even though it may be only vaguely related to the physical system) to an