plicitly once and attempting a preliminary link in several places. The linkage is strongest in his discussion of disproportionate predator searching on aggregated prey; it is less strong in his discussion of how variation in the amount of time allocated to feeding causes a sigmoidal functional response. Improvement here should also result in improvement in the functions used in the population models, some of which seem to have been chosen for descriptive prowess rather than mechanistical derivation.

Finally, the difference-equation models Hassell uses throughout have some nasty mathematical properties in the "unstable" region. Limit cycles having long periods and even "chaotic" population dynamics (random numbers within an interval) are possible with single-species models, once certain parameter bounds are exceeded. Such properties become more frequent and more varied in several-species models, such as those for predator and prey (Guckenheimer *et al., J. Math. Biol.* **4**, 101 [1977]). For a particular single-species model, Hassell shows that most real populations have parameters that imply stable dynamics. This optimistic result is tempered by the fact that another model results in substantially more unstable cases; moreover, this kind of analysis is not made for predator-prey models at all. An important current issue in ecology is the extent to which chaotic or infrequently repeating limit-cycle dynamics, which characterize difference-equation models, equivalently characterize nature. Certain models that assume less pulselike processes than do pure difference equations (E. Poulsen, cited in F. Christiansen and T. Fenchel, *Theories of Population in Biological Communities*, Springer-Verlag, 1977) and certain difference-equation models that restrict density dependence to particular portions of the life cycle (R. Deriso, Ph.D. thesis in biomathematics, University of Washington, 1978) are less unstable than the sort of model Hassell uses; the issue even in theory is still very much open. A major task will be to investigate the probable biological importance of the unstable region for those models that produce one.

In my opinion, none of these shortcomings, except possibly to a limited extent the first, could easily have been avoided in a book written now. Among other issues raised but not settled in Hassell's excellent book, they provide a wealth of departure points for future research in this galloping area of ecology.

THOMAS W. SCHOENER
Department of Zoology,
University of Washington, Seattle 98195

Marsupial Model

Opossum Neurobiology. (Neurobiologia do Gambá.) The Opossum as an Experimental Model for the Study of the Mammalian Nervous System. Proceedings of a symposium, Rio de Janeiro, May 1978. C. E. ROCHA-MIRANDA and ROBERTO LENT, Eds. Academia Brasileira de Ciências, Rio de Janeiro, 1978. vi, 292 pp., illus. Paper, $10.

Opossum Neurobiology is a collection of 15 research reports from experiments utilizing the opossum as an experimental animal. The volume is an outgrowth of a symposium held at the Brazilian Academy of Sciences that was organized to advertise the opossum as an experimental model for studies of the mammalian nervous system. In the foreword the editors describe the advantages offered by the opossum, which include its phylogenetic significance as well as its usefulness for developmental studies. The latter is particularly emphasized because of recent interest in mammalian neurogenesis. The opossum is born after a gestation period of only $13^1/_2$ days and immediately climbs into an external pouch (marsupium), where it remains attached to a teat for two months or more. In this immature but externalized state, the opossum young are available for direct observation and experimental manipulation.

Except for a paper by Ford Ebner from the United States, the volume is limited to contributions from Brazilian investigators and heavily weighted toward the work of the group from the Universidade Federal do Rio de Janeiro. The Brazilian workers present several good papers on specifics of the opossum's eye, retina, optic nerve, visual cortex, and superior colliculus, as well as one that deals with the development of certain areas related to vision. The paper by Lent and Rocha-Miranda on aberrant projections after eye removal and tectal lesions is particularly interesting because it shows by example how the opossum's embryology can be used to advantage in an experimental situation. Although most of the papers deal with the opossum's visual system and cortex, there is one that reports the results of body mapping experiments within the dorsal column nuclei and another that describes the pattern of monoaminergic innervation of the opossum brainstem.

The quality of the papers is somewhat variable, but the data presented appear to be reliable. Much of the information contained in the volume will be interesting to investigators who might consider using the opossum as an experimental animal or who want to compare its visual system with that of more commonly used laboratory animals. In my view, the major contribution of the book is its attempt to emphasize the potential importance of marsupials for developmental studies.

GEORGE F. MARTIN, JR.
Department of Anatomy,
Ohio State University
College of Medicine, Columbus 43210

A Cephalopod

Octopus. Physiology and Behaviour of an Advanced Invertebrate. M. J. WELLS. Chapman and Hall, London, and Halsted (Wiley), New York, 1978. xiv, 418 pp., illus. + plates. $42.50.

Wells has long been known for his work on cephalopod behavior and physiology. The present book, which follows a previous one (*Brain and Behaviour in Cephalopods*, Stanford University Press, 1962) by Wells, is testimony to his steadfast interest in cephalopods. The goal of the new book is "to produce a comprehensive physiology of a single invertebrate species. Here it should be possible, for once, to get a feel for the workings of an animal as a whole, rather than as a series of isolated organ systems." This rather ambitious goal is tempered, however, by another statement: "A monograph is, inevitably, a rather personal thing and the account is bound to be skewed by too much print squandered on things that interest the author, and too little on the things that may interest others."

The author has collected in every chapter a wealth of information, through which he leads the reader with a sure hand. The literature is adequately reviewed, and the observations of the author do not overshadow other people's data.

The book begins with an anatomical overview of the octopus and continues with accounts of respiration, circulation, feeding, digestion, reproduction, and endocrinology. Each of these subjects is treated comprehensively and well, notwithstanding the author's claims that on matters not close to his interest he is reluctant to do the necessary homework. The last portion of the book, constituting more than half of it, deals with the nervous system and brings together work done mostly by J. Z. Young and by the author. As is customary, a major portion of the account is devoted to visual system physiology and behavior. Mechanoreception is also extensively treated,

leaving the chemosensory system a good third. The emphasis of the treatment reflects that of the research that has been done.

While the octopus is mostly known scientifically through the work of J. Z. Young and for the hope that its brain may provide us with a key to the "engram," this book presents the animal in a broad perspective. This will make the book useful for the neurobiologist who needs to know what kind of body the nervous system lives in and has to adapt to.

The book is well written and pleasant to read. There are many illustrations, all of good quality, and a lot of information that is difficult to find elsewhere. This book should be on the bookshelves of all zoologists, for themselves and for their students.

P. P. C. GRAZIADEI
Department of Biological Science, Florida State University, Tallahassee 32306

Medieval Sciences

Science in the Middle Ages. DAVID C. LINDBERG, Ed. University of Chicago Press, Chicago, 1979. xvi, 550 pp., illus. $40. The Chicago History of Science and Medicine.

Stimulated by the earlier work of men such as Pierre Duhem and Lynn Thorndike, the study of medieval science has in the last few decades blossomed forth into a well-defined and illuminating field of study, flourishing particularly in North America. At present there are a number of distinguished workers in the field, and a good number of them are represented in the present volume, which shows the collectively high level of the subject. Until recently there have been no adequate general introductions to the subject for nonspecialists. Now, within a few years of one another, we have two splendid additions to the literature: Edward Grant's *A Source Book in Medieval Science* (Harvard University Press, 1974) and the book under review, which together provide as good an orientation as any beginner is entitled to expect.

The volume edited by Lindberg consists of 15 chapters, each devoted to a different aspect of medieval science. Except for the excellent concise chapter (by Lindberg) on the transmission of Greek and Arabic learning to the West, the focus is squarely upon Western European science, and little note is taken of Islamic or Jewish science. Though the editorial preface characterizes the Middle Ages as the period 400 to 1500, some contributors say little about the period after 1350 and others continue their narrative into the 16th and even 17th centuries. The lack of a definable "Renaissance" in science has made the boundaries between "medieval" and "modern" very flexible. The level of exposition is also somewhat variable, many contributors achieving important brief syntheses of their subjects, as valuable for the specialist as for the beginner, and others doing no more than provide adequate introductions. As might be expected, given the state of research, the balance is very much in favor of physical science. The topics covered include mathematics, the science of weights, the science of motion, cosmology, astronomy, optics, the science of matter, medicine, and natural history. In addition there are sections on early medieval science, the transmission of Greek and Arabic science, the philosophical and institutional settings, "the nature, scope, and classification of the sciences," and the relation of science to magic. There is also a useful bibliography.

Several of the contributions are particularly noteworthy. These are "Mathematics" by M. S. Mahoney, "Natural history" by J. Stannard, and "The science of motion" by J. E. Murdoch and E. D. Sylla. Each brings a vast primary and secondary literature under control. Never do I recall seeing the general trends of medieval mathematics discussed so clearly as Mahoney has done; the techniques of computation by the abacus, for example, are well explained; and the notes provide a most useful bibliographical orientation for the more advanced student. Stannard's piece is also a bibliographical tour de force, supporting a clear exposition of the strengths and weaknesses of medieval natural history, based on the latest (mostly German) research in the field. Murdoch and Sylla have presented their difficult subject with their accustomed thoroughness, pointing to the failure as well as the accomplishments of medieval ideas on motion.

There is but one paper in the volume that I find seriously deficient, B. Hansen's "Science and magic." The focus of the paper is on the 16th and 17th centuries, and there is little detailed discussion of the medieval aspects of the subject or of the Islamic background to medieval magic. Moreover, medieval and Renaissance magic are interpreted as part of the same whole, though the generation of Ficino and Pico gave the subject an intellectual respectability that it generally lacked in the Middle Ages and paved the way for the concern of Agrippa, Reuchlin, Cardano, Postel, Dee, and Bruno, and others with it in the next century. In this regard the illuminating studies of Garin, Vasoli, and Zambelli have not been utilized. Hansen also uncritically follows certain authorities in adopting the term "Hermeticism" to portray a particular type of magic (why is nothing said of the role of the *Picatrix* and of Orphic and Zoroastrian texts in the development of magic?). One characterization of "Hermeticism" that he cites could equally well be applied to Platonism, Neopythagoreanism, or numerous other more clearly defined and more widespread bodies of ideas, and he does not take into account recent critical comments on the validity of "Hermeticism" as a historical term.

CHARLES B. SCHMITT
Warburg Institute, London WC1H 0AB, England

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