factory, partly because the chapters that comprise it have not been well integrated. Those who wish to use this book as a text for a course in behavioral pharmacology will be tempted to supplement it with, say, G. S. Reynolds' *A Primer of Operant Conditioning* (Scott Foresman, New York, 1968, 135 pp.), which sets down the principles of the experimental analysis of behavior in greater detail and more clearly than Thompson and Schuster's account.

Finally the authors devote a little less than a hundred pages to behavioral pharmacology itself. The best parts of the book appear here. Rather than trying for broad coverage they give extensive accounts of how specific problems are attacked by research workers. Here they talk to the reader in an almost conversational fashion about the problems they are tackling. Especially in the long sections that contain reports of their own work with drugs administered by the subjects themselves and Schuster's work (in collaboration with Zimmerman) on the development of behavioral tolerance to amphetamine, they succeed in giving the reader the feeling that he is watching intelligent men search for answers to difficult questions that, since posed in behavioral terms, will almost surely be answered.

The authors point out that whereas workers in more mature areas in pharmacology can look to physiology for background information, the behavioral pharmacologist usually cannot look to the psychologist for comparable information concerning behavior. This lack of knowledge of whether even slight changes in the parameters of the behavioral situation will lead to changes in the action of a drug forces the behavioral pharmacologist to spend much time studying the behavior itself.

One product of this study has been the growing realization that parametric variation is as essential on the behavioral side as is dose variation on the pharmacological side. I would predict that one day it will be thought as foolish to study a single example of the behavior as it now appears foolish to study a single dose of a particular drug.

The goals of behavioral pharmacology, according to Thompson and Schuster, are first, "to devise the most parsimonious techniques of behavioral control in the investigation of drugs," and second, "to use these behavioral control techniques to investigate the mechanisms of drug action." The "mechanisms of drug action" they refer to are behavioral rather than physiological or biochemical; the questions asked concern which aspects of behavior and its controlling variables are affected by particular drugs. The examples they give all reflect this emphasis upon behavioral mechanisms of action. However, perhaps because of space limitations, the authors nowhere attempt a more theoretical account of these mechanisms. Fortunately such an account does exist, and the interested reader could supplement this text by referring to R. T. Kelleher and W. H. Morse's recent article "Determinants of the specificity of behavioral effects of drugs" (*Ergebnisse der Physiologie*, vol. 60, pp. 1–56, 1968).

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Vertebrate Structures

The Membranes. ALBERT J. DALTON and FRANÇOISE HAGUENAU, Eds. Academic Press, New York, 1968. xiv + 224 pp., illus. $12.50. Ultrastructure in Biological Systems, vol. 4.

This volume contains four review articles which are clearly written and well illustrated. There are no cross-references and only the membranes of vertebrate cells are considered. No explanation for this is given. In a book on the ultrastructure of membranes in biological systems protozoa, bacteria, and higher plants deserve some attention. In his foreword, J. F. Danielli points out some other recent work that is pertinent but not covered here and summarizes new results from his laboratory. He also reemphasizes the limitations of his model, which are sometimes forgotten by its more ardent proponents.

Audrey M. Glauert and J. A. Lucy in their contribution mainly recount experiments on the electron microscopy of negatively stained mixtures of different lipids in water. The results are of interest; however, their relevance to the elucidation of ultrastructure in biological membranes remains to be demonstrated. The bibliography covers literature up to 1964 very well; there is one reference to an abstract from a meeting dated 1965 and one quotation of a 1967 paper "in press."

The paper on isolated liver cell membranes by E. L. Benedetti and P. Emmelot gives by far the most comprehensive and unbiased review available of present knowledge and views of membrane ultrastructure. Some minor inaccuracies can be found in the historical introduction; for instance, the orientation of the lipid molecules in the bimolecular leaflet was already specified by Gorter and Grendel in 1925 and should not be attributed to Danielli and Davson. Most of the space is devoted to a very detailed morphological analysis based on many technically excellent electron micrographs. The otherwise lucidly written paper becomes somewhat confused and hazy in the attempt to apply to membranes the subunit concept developed by Caspar and Klug for virus structure. Biochemical studies on the membrane fractions are presented concisely with a short but comprehensive coverage of related studies in other laboratories including papers up to 1967. The conclusions, that so far there is no chemical evidence for a subunit structure and that an integrated picture of membrane ultrastructure from chemical and morphological data cannot at present be constructed, may fall short of what readers might expect and what other workers are willing to conclude from similar or poorer data. In my opinion, it reflects a realistic evaluation of the experimental results.

The title of G. de-Thé's paper, "Ultrastructural cytochemistry of the cellular membranes," is misleading. The paper is essentially a catalog of the different phosphatase activities that can be demonstrated in cellular membranes by cytochemical techniques.

"Ultrastructure and function of cellular membranes" by F. S. Sjöstrand is based mainly on the morphological work done in the author's laboratory during the last 20 years. Sectioned material is used almost exclusively. The electron micrographs show a resolution far superior to that achieved by most other workers in the field; detail down to a size of 10 Å is clearly shown. The style is rather polemic and sometimes flamboyant; for instance, the inner membrane particles of mitochondria are consistently referred to as "lollipops" and judged to be "artifacts introduced by a primitive preparation procedure" yielding pictures that "would lend themselves beautifully as a source of inspiration for the creation of abstract art or for fortune tellers" (pp. 185–86). These particles have, however, been isolated by Racker and his group and shown to be a protein with adenosine triphosphatase activity and part of the oxidative phosphorylation mechanism. From the results obtained

with sectioned tissues, Sjöstrand accepts the Danielli model as a plausible structure for the cell membrane but maintains that many intracytoplasmic membranes, especially those of mitochondria and the endoplasmic reticulum, consist of globular lipoprotein particles. Reasonable arguments for and against this thesis can be advanced, but the problem most likely will not be solved by electron microscopy alone.

The otherwise well-produced book suffers from many typographic errors and a lack of language correction for the contributions by foreign authors.

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Creatures That Abound

Life on a Little-Known Planet. HOWARD ENSIGN EVANS. Illustrations by Arnold Clapman. Dutton, New York, 1968. 320 pp. $7.95.

There is something about the study of hunting wasps and social insects that brings out the philosopher in a person. Most entomologists know what it is—the complex behavior and special perceptions of such insects almost defy human comprehension and inspire a profound sense of awe. Author-scientists like J. H. Fabre, W. M. Wheeler, and G. W. and E. G. Peckham, to name a few, became hooked on such mind-expanding studies and fortunately shared their awareness of nature in popular works. The latest of this line of writers is wasp-specialist Howard E. Evans, of the Harvard University Museum of Comparative Zoology, author of *Life on a Little-Known Planet.*

Biologists, especially the lonely biosystematists, confronted wtih the vast, little-explored taxonomic "territories" on earth quickly grasp the implications of this unusual title. Writing in a pleasant, conversational style, Evans soon makes it clear that he is more than a little wistful and concerned about the attention and support given to space biology, moon shots, and other far-flung ventures while man is faced with the grim, if not hopeless, prospect of biologically adjusting himself to his one and only and little-known planet.

A series of chapters reveal the intricate habits of familiar insects. Much of this constitutes a review and the first popularization of recent technical research. The chapters not only are highly informative and entertaining to laymen and even scientists, but also suggest that there is glittering promise in studies yet to be undertaken.

One of the most thought-provoking chapters deals with the crowded "Cities of the soil: the world of springtails." While discussing the fascinating habits of these seldom-noticed, microscopic soil creatures, Evans calls attention to their tremendous populations, in one case calculated to be 50 individuals per cubic inch of pasture soil, or 248,375,000 per acre! Yet, in spite of all, only "a scattered handful of underpaid and underequipped researchers struggle to decrease vast areas of ignorance about creatures that abound in our lawns, gardens, and woodlands."

After this broad, multitudinous base of minute soil creatures, the world of cockroaches is explored. These are animals well worth knowing, for their ways of coping with earth environments are age-old and time-tested. In succession, dragonflies, crickets, fireflies, butterflies, flies, bedbugs and conenoses, grasshoppers, and wasps are treated in highly informative chapters.

The book is climaxed by the author's most important statements concerning man's relation to his environment. Of interest are his comments on the use of insecticides. Evans reminds us that the greatest losses and modifications are due to expanding and shifting populations with increasing material expectations, all of which increase the urban sprawl over useful farmlands and esthetic open spaces while fouling the land, waters, and air with pollutants. Not the least of the causes of "silent springs" where we most need bird songs (around our homes), and one which is perhaps overlooked in all the attention paid to insecticides, is the increasing number of cats.

Those who think that scientists—especially those "cloistered" in natural history museums, are out of touch with realities and the most pressing issues facing mankind, should read and reread the final chapter, entitled "Is nature necessary?" If we cannot have a man with Evans' insight as the nation's Secretary of the Interior, let us hope that at least we will have one who has read and understood the message of *Life on a Little-Known Planet.*

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Radiation and Its Effects

Radiation Biology. ALISON P. CASARETT. Prepared under the auspices of the American Institute of Biological Sciences for the U.S. Atomic Energy Commission. Prentice-Hall, Englewood Cliffs, N.J., 1968. xiv + 368 pp., illus. $9.25.

Apart from Bacq and Alexander's *Fundamentals of Radiobiology* and the popular paperback by Alexander, *Atomic Radiation and Life*, previous efforts to present a comprehensive treatment of the biological effects of ionizing radiations have been the joint enterprise of a number of specialists (for example, *Radiation Biology*, edited by Hollaender). All other volumes published in this field have been at least somewhat limited in scope. The reasons for this are not hard to find: courses in radiation biology are not often taught to undergraduate students; over a period of a few years, significant advances take place in a limited number of areas within the field; and the subject is so broad that few workers would venture to write authoritatively about all of it.

Casarett undertook the difficult assignment of writing a general text apparently because she felt that there was need for a volume from which to teach an elementary undergraduate course in radiation biology. In this task she has succeeded admirably. The treatment is indeed comprehensive; the book includes four chapters on the radiation physics and chemistry necessary for a presentation of radiation biology. The writing is clear and the book reads well. There are few errors, typographical or otherwise (though four of the figures are missing in the copy I read, and the scales on some of the graphs are incorrect). The topics are equitably treated; emphasis of those areas in which there has been rapid, fundamental recent progress has been avoided, as may be proper in an introductory text (although the scant treatment of cellular radiation biology, from study of which fundamental understanding of the biological effects of ionizing radiations is likely to come, might have been a mistake). The presentation is elementary, and no knowledge of physics, chemistry, or biology on the reader's part is assumed.

But this last characteristic, rather than adding to the book's usefulness, probably limits it. The very elementary level of presentation will restrict readership to the scientifically naive. For the nonscientist in this category, Alexan-