Varying Behavioral Manifestations of Animals

These books—S. A. Barnett's **A Study in Behaviour: Principles of Ethology and Behavioural Physiology, Displayed Mainly in the Rat** (Methuen, London, 1963. 304 pp. 45s.) and W. H. Thorpe's **Learning and Instinct in Animals** (Methuen, London, ed. 2, 1963. 568 pp. 63s.)—are written with a common purpose: to describe, from the point of view of ethology, the varying behavioral manifestations of animals. Each author succeeds in closing further the gap that exists between European and American studies of animal behavior. Barnett and Thorpe are ethologists in the British sense: they study and interpret animal behavior in laboratory as well as in natural settings. They are experimental zoologists whose approach is often closely comparable to that of comparative psychologists in the United States and Canada. Both books carefully and selectively review a journal literature that is roughly 60 percent European and the remainder chiefly American. They use chapter headings that are common to classifications used by American psychologists, but within chapters they omit many of the theoretical distinctions that one finds in American psychological literature. Some of the excitement of behavior theory is lost in this highly objective approach. Conversely, the emphasis on descriptive analysis and the care over species differences is gratifying to the reader who looks at a given animal as a unique expression of its evolution and present adaptations. Both works are impressive in the degree to which they take into account the complex background of factors which must be brought into focus in any attempt to explain behavior.

Barnett's "study" is deliberately rigorous in the attempted use of clearly defined technical terms. Unfortunately, the self-contained glossary is too small to meet the demands of the text, and the nonspecialist will need a more extensive dictionary of psychological terms, if he wishes to reap the full fruits of the rigor. Unlike many authors who describe rat behavior, Barnett knows thoroughly the wild rat as well as the strains ordinarily used in laboratory experimentation. He writes with full assurance of his facts, and he can be rigorous with no sacrifice of interest. The behavioral facts are sufficiently complex to fascinate without requiring any recourse to mysterious powers or abilities. There is mystery enough in the neurophysiology of elaborate behavior patterns, whether fixed by heredity or developed through learning. The rather different sensitivities of animals to environmental stimulation challenge comparative and physiological psychologists to conduct investigations that require tight laboratory procedures. Ethology has moved far toward the acceptance of these and other legitimate problems and methods. Only a few continental naturalists would still hold out for an exclusive field study methodology. Fortunately, more experimentalists are now looking carefully to data obtained within nature's environment.

Although Barnett attempts no systematic inclusion of studies conducted with animals other than the rat, there are frequent references to primates, birds, and other forms. These are mainly in connection with behavior that has clear counterparts and often similar ecological significance in diverse animals. The documentation is careful and convincing. And this is the point at which Thorpe's revision of his valuable comparative textbook carries the communication to its logical extension. Thorpe, in writing about the behavior of all animals, finds it necessary to expend many pages upon animal learning. This field has an extensive current literature. In this edition, Thorpe's chapter on mechanisms of learning is 50 percent longer than the one in the first edition (1956). He has revised and expanded several other sections, especially those on cephalopods and bird orientation. His own studies of insect and bird behavior contribute significant portions to the description of the learning abilities of the various animal groups.

The two authors agree (i) that all learning is not to be understood in terms of conditioned reflexes, and (ii) that, unless innate releasive mechanisms and innate action patterns are carefully worked out for a given organism, any effort to understand its developing repertoire of learned behavior will remain quite superficial. Barnett sounds more critical of the "myth" of the conditioned reflex than Thorpe, but he does not deny that the conditioning literature is still useful. The first step in salvaging its utility requires a recognition that, even in very simple organisms, conditioned and unconditioned responses are not identical.

Barnett and Thorpe marshal many facts in support of the phylogenetic trend, as emphasized earlier by Hebb and by Harlow, toward the increasing significance of "learning to learn" in the vertebrates, and especially the mammals, in contrast to animals with simpler nervous systems. Barnett calls the later learning, which is dependent upon previous learning, *deutero learning*, if the first experiences must be obtained in the early life history of the organism. Thus, there are distinctions between "learning set," "latent learning," and *deutero learning*, all of which have the common characteristic of a sequential dependence. Only deutero learning implies a sequence that is also tied to the age of the individual organism.

Hoarding (that is, gathering and depositing food), a class of behavior with partly innate determinants, is seen in many animals. Experimental studies have been largely confined to the rat, as Thorpe acknowledges. Barnett is justifiably reluctant to claim that this behavior is adequately understood, even in the rat. He shows that various components of the action sequence in hoarding may be individually affected by a given rat's experience, and he presents the evidence as an example of "how involved the interaction between nature and nurture must be in the development of such an activity" (p. 43).

Social behavior is more conspicuous in wild rats than laboratory workers might suspect. Indeed, Barnett's book contains a systematic discussion of the topic, whereas Thorpe gives only scat-

tered references to studies of social behavior and these relate to bees, fish, and birds. Neither author claims to provide a compendium for the animal behavior field. Rather each ranges selectively across a broad and diverse literature. Teachers should find good use for these as textbooks or as supplementary reading, depending upon the background of the student. They are intermediate in difficulty, each one presupposing as a minimum some introductory work in zoology, physiology, and psychology.

The seriously interested student will find himself impelled to go to original sources. Space did not permit these writers to present full details of many, or even of the majority, of the studies that supply the basis for their principles of animal behavior.

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Regulatory Biology

Control Theory and Biological Systems. Fred S. Grodins. Columbia University Press, New York, 1963. xii + 205 pp. Illus. $8.50.

Regulatory and adaptive processes have long been central subjects in biology. The principle of homeostasis, detailed knowledge about several control mechanisms, and, to a limited extent, an understanding of the interactions and integration through which orderly and stable function is achieved in the whole organism are in hand. Although there are many significant questions that remain unanswered, the time is ripe for a synthesis—for the establishment of generalizations which may ultimately become biological laws—and for a formal treatment that facilitates understanding and suggests predictions which could be tested experimentally. It was, however, less the present state of physiological knowledge and more the recent, well-developed analytical treatment of control systems by engineers that led Grodins to write this book. Since the last war, "feedback control," "servoregulator," "transfer function," and other bits of engineering jargon have come to be used by the biologist almost as commonly as by the engineer, but more often than not the biologist is still unaware of the rigorous foundation, or the complex ramifications of modern control theory. Clearly it is important that he catch up with more than the words, for despite the fact that engineers treat the nonliving world, there are close analogies between their models and many systems in the living animal. And in abstraction, all the differences should disappear. Although the biologist may eventually have to go beyond the point where the engineer stops, it is important that he start at the beginning and assimilate the concepts and the formalisms of modern physical control theory.

In the first six chapters of this book, Grodins summarizes the salient features of systems behavior, drawing exclusively on physical examples. Some of the important mathematical techniques, including the Laplace transform, are introduced very simply, and the usefulness of analog computers is repeatedly emphasized. Concepts, both intuitive and rigorous, of transient and steady state response are clearly set forth, and the problem of stability is introduced. Such a compressed digest will leave many readers dangling, for the treatment is not complete in either scope or depth. Almost certainly it was not meant to be. This is an introduction for biologists—far from exhaustive, but not too gentle either. It is not a condescending survey. Selected references are provided for the reader who seeks more. With or without the extra reading, it is a safe prediction that any biologist who grasps these six chapters will have acquired new and deeper insights into general aspects of control, whether in living, or nonliving things.

The next two chapters examine two well-studied physiological control systems, the respiratory and the cardiovascular, from the standpoint of the principles and methodology set forth earlier. At this point most physiologists are likely to feel somewhat let down. These chapters are inconclusive, but perhaps for good reason. Not only do the problems immediately take form as nonlinear differential equations which lie outside the scope of the introductory principles, but also some of the elementary experimental data are still too incompletely understood. Nonetheless, the reader has been led to expect more than he gets when the theory of control is focused on these physiological problems. The final chapter is devoted to a summing up and a discussion of prospects for the future.

For the biologist in general, and the physiologist in particular, Grodins' book can be recommended as a clearly written introduction to control system theory. In contrast to other books on the subject, this one is written by a physiologist for the use of physiologists. It signals an important step in the development of regulatory biology.

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Permian System

Standard Wolfcampian Series (Permian), Glass Mountains, Texas. Charles A. Ross. Geological Society of America, New York, 1963. viii + 205 pp. Illus. $7.50.

Although the type section of the Permian System is in Russia, North American geologists generally look to the Permian sequence of the Trans-Pecos region in Texas as a continental standard of reference. In this book, Charles Ross describes the stratigraphy and paleontology of the standard American section for the Wolfcampian, the oldest Permian series.

Perhaps the principal contribution here is the definition of stratigraphic ranges, for different species of fusulinid Foraminifera, within a complex sequence of strata that cross the boundary between the Pennsylvanian and Permian systems. More than half the book is devoted to systematic descriptions of the fusulinids, 50 species of which are represented. The ample and quantitative descriptions are illustrated by 248 enlarged photographs that show the diagnostic internal structures of the shells. The stratigraphic horizons of the fusulinids were determined by reference to 43 detailed sections. These, in turn, form the basis for a restored section of the Upper Pennsylvanian and Lower Permian rocks along the southern front of the Glass Mountains.

The Wolfcampian emerges from Ross's reconstruction as a time-stratigraphic unit, physically represented by two mutually unconformable formations, each of which rests locally upon Pennsylvanian or older rocks, and the younger of which is overlain unconformabily by the Leonard Formation. Thus defined, the Wolfcampian has been taken to correspond essentially with the ranges of *Pseudoschwagerina* and *Paraschwagerina*. This has called