Book Reviews

A Special Invertebrate

The Anatomy of the Nervous System of Octopus vulgaris. J. Z. YOUNG. Oxford University Press, New York, 1972. xxxii, 690 pp., illus. $35.25.

Cephalopods are unique among invertebrates in having brains and sense organs comparable in size, complexity, and general design to those of vertebrates. The resemblances are entirely due to convergence, but they are no less striking for this reason, and it is possible to feel a sense of kinship with an octopus that one can never feel with an insect or a crab. An octopus has a personality. He behaves differently from other octopuses. His behavior is largely the product of individual experience. In the octopus, man can recognize a stranger and a brother, a sapient being from another world.

The brain of an octopus has between 1 and 2×10^8 nerve cells, compared with 1 to 2×10^{10} in the human brain. There are 30 distinct lobes, differing in numbers and types of cells, amounts of neuropil, fiber distribution pattern, and types of synaptic connections. There are higher and lower motor centers, receptor analyzers, memory stores, and centers concerned with motivation and the pursuit of goals.

Octopuses can accurately distinguish textural differences with their suckers, although they appear to be insensitive to differences in the shape and weight of objects handled. They cannot hear, but they have acute vision and color sensitivity. Suitably rewarded or punished, they learn to modify their behavior. Learning is rapid and memories are retained for lengthy periods. They can learn both by sight and by touch, using different parts of the brain.

These facts have been made widely known to the general zoological public through the writings of J. Z. Young, M. J. Wells, and others, particularly over the last decade. Now, in the present volume, Young provides what he calls "a progress report on the functional anatomical organization of the octopus brain mainly at the level of light microscopy." As a progress report it is remarkable in being 690 pages long and having taken oven ten years to produce. Far from being a mere summing of the main themes, it is a compendious and very largely original work of scholarship, beyond question the *opus major* in its field. It is also, as B. B. Boycott states in his interesting historical introduction, a monument to Young's creative industry as an anatomist.

All the main components of the nervous system are dealt with: the brain, the eyes and statocysts, the stellate ganglion, the nervous system of the arms, where much reflex activity is locally organized, the blood supply to the nervous system, the glia, and the neurosecretory tissues. There are appendices on surgical and histological procedures.

Contributions by P. Graziadei, J. B. Messenger, R. D. Lund, and P. R. Stephens are included, but in such a way that there is no break in continuity, and only minor stylistic differences can be found from one part to the next. Indeed, a striking thing about this book is the craftsmanship with which it has been put together. The print is unusually large. Line drawings and optical and electron micrographs are grouped together in logical and esthetically pleasing formations.

One glance at this volume and its page upon page of superb illustrations of Golgi and Cajal stained nerves leaves no doubt that we are dealing with an anatomical treatise, but the approach is strongly functional throughout. Without consulting Young's other writings one can get a clear picture from this account of the general way in which the brain works and how it has evolved. On this latter point, a comparison with the primitive *Nautilus* is included in chapter 1. All this will tend to increase the interest of the volume for the large group of people who are not specialists in the field but who try to keep up with the cephalopod work because of its general significance for evolutionary and comparative neurology.

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Living Machines

How Animals Work. KNUT SCHMIDT-NIELSEN. Cambridge University Press, New York, 1972. vi, 114 pp., illus. Cloth, $5.95; paper, $1.95.

This book is a little gem; it treats in an authoritative and charming manner a number of physiological and morphological adaptations which animals evolved in coping with certain environmental exigencies. The title is broad; after all, the verb "to work" occupies nearly one finely printed three-column page in the Oxford Universal Dictionary. Flying, swimming, and breathing are discussed, and they all involve work, but what really ties the chapters together is the attention to evolutionary finesse which often leads to energy saving in the performance of gross metabolic activities. Since the author's lifework has been done with vertebrates, mostly birds and mammals, and since more is known about their energetics, locomotion, excretion, and so on than of like aspects of invertebrates, it is not surprising that the latter, and even fish, get rather short shrift. That is not to say that fish are not mentioned where appropriate, as in the excellent chapter on countercurrent mechanisms where the difference between exchangers and multipliers is properly stressed and lucidly explained.

The book is short, and even though it treats a few general topics only, it covers a lot of ground. Through the selective marshaling of facts, it strives, successfully, and effortlessly at that, toward the exposition of principles. It so conveys Schmidt-Nielsen's excitement with his own research that I read it in one sitting, as did Torkel Weis-Fogh, the head of the department of zoology at the University of Cambridge, who wrote a short foreword. Specific chapters deal with respiration and evaporation, panting and heat loss—this one with a subsection headed "on cooling hot dogs"—with the special anatomy that makes for highly efficient gas exchange in the bird lung, with energy costs of activity, with countercurrent devices in various organs, and with body size and the problem of scaling.

The first chapter, for instance, ends with an account of the Stirling heat engine, which, to quote from the book, "utilizes the same principle as that which is the single most important factor in the water balance of small rodents in some of the hottest deserts of the world." Amusingly enough, when I read *How Animals Work* I happened

to note in the evening paper that the Ford Motor Company has apparently rediscovered the Stirling external combustion engine as worthy of research as a possible replacement for the internal combustion device. Could this lead to research support for further work on small rodents, I wonder?

The last chapter starts with remarks about Jonathan Swift's intuition—before energy metabolism was heard of—of having the Lilliputian emperor adequately guess Gulliver's lunch needs and then talks about how much LSD to give an elephant. Possible doses range from 0.4 to 8 milligrams with some caution against the also-mentioned 80 and just condemnation of the 297 actually used in an experiment. In a letter to the editor of *Science* (**139**, 684–85 [1963]), Paul D. Harwood rightly described that last dosage as an "elephantine fallacy." The elephant so treated died within minutes, and Schmidt-Nielsen very succinctly tells us why and what all we may need to consider if we must indeed experiment with LSD on elephants.

I picked this last item and the one about the Stirling heat engine to illustrate the range of urbane erudition in a book essentially intended as supporting reading for undergraduate students in physiology. I wish I had had it to read when I took physiology, and I recommend it to fellow biologists of all ages as one of the better buys of its kind, especially since it is also issued as a paperback.

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Tierleben in English

Grzimek's Animal Life Encyclopedia. English edition. BERNHARD GRZIMEK, Ed. Van Nostrand Reinhold, New York, 1972. Vol. 10, Mammals I. 628 pp., illus. Vol. 13, Mammals IV. 566 pp., illus. Each volume, $29.95; the set (13 volumes), $325.

Zoo keepers throughout the world know Bernhard Grzimek as the director of the Frankfurt Zoological Garden; long interested in the conservation of African wildlife, he serves as trustee of the Tanzanian National Parks and oversees the operations of the Michael Grzimek Laboratory (named for his son) of the Serengeti Research Institute at Seronera; and he holds an appointment as professor at the Liebig University of Giessen, Germany. With all these commitments, one wonders how he could undertake the imposing task of acting as editor-in-chief of this series. He has worked with over 200 specialists throughout the world serving as editors and contributors. The first edition, in German, appeared in 1968; a special staff of 11 has produced the present English edition.

As one might expect, the treatment accorded the various phyla of animals bears no relation to their numbers in the wild. The emphasis is placed on the larger, more exotic, spectacular, and familiar forms. This is quite natural, for these are the ones commonly seen in captivity and the ones about which we know the most. The series is to consist of 13 volumes. Of these, volume 1 will deal with the "lower animals," volume 2 with insects, and volume 3 with mollusks. The other ten volumes will all concern the vertebrates—three are to cover the fishes, amphibians, and reptiles, three the birds, and four the mammals.

The first two volumes to appear are volumes 10 and 13, the first and, oddly, the last of the sequence dealing with the mammals. Volume 10 is devoted to the monotremes, marsupials, insectivores, and most of the primates. The first chapter considers mammals in general—their anatomy, physiology, ways of life, evolution, and distribution. Thereafter they are discussed by natural groups (families, genera), with details of their behavior, ecology, and relationships. Maps indicate their geographical range, small sketches depict distinctive anatomical features, special symbols designate extinct or endangered species and subspecies. The volume is handsomely and generously illustrated in color, with accurate paintings or photographs of most species discussed, as well as phylogenetic charts and habitat scenes. An appendix includes a systematic classification of Recent mammals, a dictionary of common names (in English, French, German, and Russian), a selected list of references to the literature, and an index. The general format of volume 13 and the manner of treatment are the same as in the earlier volume. Covered are the ungulates or hoofed mammals of the orders Perissodactyla, in part (tapirs, rhinoceros), and Artiodactyla (pigs, hippopotamuses, camels, deer, giraffes, antelopes, cattle, sheep, and goats). Typographical and other errors in both volumes appear to be remarkably few.

A fascinating amount of material is here assembled, and it is authoritative and well presented. The encyclopedia will be an invaluable reference work not only to the personnel of zoological parks but to biologists and naturalists generally. My only complaint is its bulk —these volumes measure 10 by 7 by 3 inches and weigh 4½ pounds each. The use of a lighter stock, and the elimination of the wide inner margins and side headings, would have made them far more compact. As it is, they should well withstand the heavy use they are bound to receive.

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The Biochemistry of Disease

Free Radical Mechanisms in Tissue Injury. T. F. SLATER. Pion, London, 1972. xii, 284 pp., illus. £4.80. Pion Advanced Biochemistry Series, 1.

A central concern in understanding disease is the mechanisms involved in cell injury. The study of cell injury has been largely the province of the pathologists, who have provided an extensive catalog of terms to describe aberrant morphological features of the injured, dying, and dead cell. Investigation of the significance of these structural alterations and the functional changes associated with them is of much more recent vintage, representing an area of overlap for biologists, biochemists, and pathologists. The need for model systems to mimic naturally occurring disease became very apparent when more than a descriptive account of the illness was sought. A very reproducible multifaceted liver injury model, the carbon-tetrachloride-induced rodent liver necrosis, was developed by Cameron and coworkers at University College Hospital. With this system the first modern steps in biochemical analysis of cell injury were taken by Cameron's students Judah, Christie, Gallager, and Rees, and concomitantly the first attempt was made to explain the role of the inciting agent in chemical and physical terms.

Of all the model systems of hepatic change, probably carbon tetrachloride injury and its effects have been most extensively studied. The use of the symmetrical saturated haloalkane suggested a high order of probability that a detailed understanding of its noxious nature could be developed. This material is dehalogenated, be the process of dehalogenation active or passive, enzymic or nonenzymic. It is now evident that this process most likely oc-