BOOK REVIEWS

BULLETIN OF MARINE SCIENCE, 62(1): 297–298, 1998

MICROSCOPIC ANATOMY OF INVERTEBRATES

VOLUME 13: LOPHOPHORATES, ENTOPROCTA, AND CYCLIOPHORA *by Frederick W. Harrison and Robert M. Woollacott, eds. 1997. 500 p. ISBN 0471561207. Wiley, New York. US$185.00, cloth.*

VOLUME 15: HEMICHORDATA, CHAETOGNATHA, AND THE INVERTEBRATE CHORDATES *by Frederick W. Harrison and Edward E. Ruppert, eds. 1997. 537 p. ISBN 0471561223. Wiley, New York. US$210.00, cloth.*

This 15-volume series, edited by Frederick Harrison, has already established itself as the premier treatise on microscopic comparative and functional anatomy; volumes 13 and 15 rise to this challenge of quality. Volume 13 treats five phyla (Entoprocta, Bryozoa, Phoronida, Brachiopoda, Cycliophora), and Vol. 15 treats three (Hemichordata, Chaetognatha, Chordata). The volumes are authored by international teams of specialists, and each contains an outstanding array of line drawings and photomicrographs that compliment the text. Volume 13 has an Introduction by R. Woollacott and R. Harrison that reviews the problematic and growing controversy of lophophorate relationships. Vol. 15 has an introduction by E. Ruppert, who reviews the current state of knowledge regarding chordate evolution and the probable role of heterochrony in the evolution of chordates and vertebrates. It seems fitting to review these 2 volumes together, because each treats a suite of taxa whose phylogenetic history has long been debated—the lophophorates and the protochordates.

These volumes are more than mere compilations. For each phylum treated, cutting edge data (much of it never before published) and modern interpretations on tissue and cellular-level ultrastructural comparative and functional anatomy are covered with more completeness than in any preexisting published literature. I found the chapters on Bryozoa (H. Mukai, K. Terakado and C. Reed; a whopping 162 pages), Brachiopoda (A. Williams and M. James), and Hemichordata (J. Benito and F. Pardos) especially notable in this regard. Every chapter follows an editorial structure that carries the reader through external anatomy, over the integument, into the glands and connective tissues, and finally to the depths of organ system fine structure. This consistency of treatment for each chapter is one of the great strengths of these volumes, and the series itself, and Rick Harrison is to be commended for his ability to maintain this logical and parallel structure throughout the 15 volumes. Less successful has been the series' goal of emphasizing *functional* morphology, as comparative ultrastructure and internal anatomy clearly remain the themes in these two volumes.

The phylogenetic relationships of the lophophorates (Ectoprocta [=Bryozoa], Phoronida, Brachiopoda) have long been argued. Recently, their relationships have become even more problematic as molecular phylogenetic work, based on 18s rRNA sequence data, has suggested that lophophorates have protostome affinities. Majority opinion had long placed the lophophorates as a monophyletic lineage of deuterostome coelomates, united by their common possession of deuterostome embryogeny and a unique feeding structure—the lophophore. However, the Phoronida have always been a maverick in the triad, in possessing two features

normally encountered only in protostomes: their mouth arises from the blastopore and their larvae possess protonephridia. Further, Claus Nielsen has argued that Ectoprocta are protostomes—most closely related to the Entoprocta—and that lophophorates are not a monophyletic group at all. The 1995 discovery of the latest animal phylum to be described, the Cycliophora, further stirred the pot. Nielsen has argued that these enigmatic symbionts, which live only on the mouth appendages of decapod crustaceans, are also closely related to the Ectoprocta and Entoprocta. And, as revealed in Vol. 13, bryozoans may lack a key feature diagnostic of the deuterostomes—the trimerous arrangement of the body coelom. These recent studies suggest the possibility that the "lophophore" of ectoprocts might not be homologous to the "lophophore" of phoronids and brachiopods.

On the other hand, in Vol. 15 Woollacott and Harrison point out the possibility that the water vascular system of echinoderms could arise (embryonically) from coelomic extensions of a middle body cavity that likely originally served a function in feeding (i.e., a possible deep homology with the lophophore!). Of course, the tentacled, upstream-feeding structure of pterobranch hemichordates also arises from a middle body compartment, and its hollow tentacles contain coelomic extensions (i.e., another possible deep homology with the lophophore). If these homologies are real, they suggest a close relationship between the lophophorate phyla and the echinoderms and pterobranchs, reaffirming the placement of these taxa solidly within the deuterostomes. Thus, if these interpretations are correct, the degree of convergence necessary to support the preliminary molecular data on lophophorate-protostome affinities would be high—the embryogenesis of the "lophophore" would have to be convergent among pterobranchs, echinoderms, phoronids, brachiopods and bryozoans!

Whereas the lophophorates present problems for zoologists in the form of similar-appearing structures and body plans, the deuterostomes force themselves upon us with a diversity of bauplans unmatched elsewhere in life's panorama. Beyond the hand-full of embryological synapomorphies that unite the deuterostomes, we are confronted with a bewildering array of body forms. Two phyla, the echinoderms and the chaetognaths, have consistently defied attempts by biologists to place them confidently in the metazoan tree. The chaetognaths seem to share no unique features with any other phylum (i.e., they lack a recognizable sister-group altogether). However, the review of Chaetognatha in Vol. 15 argues forcefully against Nielsen's suggestion that they are protostomes, and it places them squarely in the deuterostome line. Similarly, data in the hemichordate chapter argue against Nielsen's splitting of the Hemichordata into two separate phyla, Pterobranchia and Enteropneusta. Readers interested in phylogeny will find Ruppert's cladogram of the protochordates (based on notochordal microscopical anatomy) especially interesting.

These two volumes, like the others in the series, belong in every serious zoologist's library. Rick Harrison's series is probably the closest thing we will ever have to an English-language revision of Libbie Hymen's great treatise on invertebrates, albeit with a microanatomical emphasis. It is only regrettable that the volumes are so expensive to purchase. At about $225/volume, it would cost over $3,000 to acquire the entire set. When I bought my set of Hymen's original 5 volumes they were $15 each; as a student in the 1960s, that probably represented the largest single investment I made in building my undergraduate library. Students today, even under the best of circumstances, could not afford to acquire the *Microscopic Anatomy of Invertebrates* series at the Wiley-Liss pricing. However, any college library that fails to purchase the series would be remiss.—*Richard C. Brusca, Columbia University, Biosphere 2 Center, P.O. Box 68, Oracle, Arizona 85623.*