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BOOK REVIEW

Huys, R., and G. A. Boxshall. 1991. Copepod evolution.—The Ray Society, London, England. Pp. 1–468.

Despite its title, the primary focus of this book is not copepod evolution as a whole; there is little inquiry into speciation or phylogenetic analyses below the ordinal level. Instead, the focus of "Copepod Evolution" is primarily on copepod morphology, particularly appendage morphology. Huys and Boxshall present data from morphological studies of over 200 copepods which were selected because they exhibit the greatest morphological diversity among species known by the authors from different orders of copepods. Appendages of many of these species are illustrated and an excellent introduction to the morphological diversity of copepods is available from the illustrations. More significantly, the authors attempt to establish an identity for each segment of every appendage, and to infer homologous relationships for these segments among all copepod appendages.

After a brief introduction to copepod habitats, the subclass Copepoda is defined. Appendage nomenclature then is introduced, based on the authors' concept of character states of a presumed ancestral copepod. Each copepod order is defined, its ancestral condition established, and its appendage diversity described. In a later chapter, the character state of each appendage on the ancestral copepod is described more fully and the presumed evolutionary transformations of these character states are discussed. A phylogenetic analysis of the ten orders of copepods is followed by an interesting description of the ecological radiation for each order. A useful glossary precedes an index which is restricted to names of taxa. A subject index of important terms like "homology," "oligimerization," "character reversals," "post-displacement," and "relict characters" would have strengthened the conceptual organization of the book.

Illustrations and photographs comprise a large part of "Copepod Evolution." The line drawings are visually pleasing. However, many are not always informative as aids in determining or verifying structures because the origin of setae on appendage segments is occasionally obscure, for example, Figure 2.2, 18A, p. 71. Antennules, antennal and mandibular endopods, maxillules, and the tips of maxillae and maxillipeds on many copepods are densely armed with setae and could be presented more effectively in a stylized format. SEM photos are in some cases not very helpful in understanding or interpreting delicate morphological structures.

Efforts by the authors to infer identities for each segment of an appendage and homologues of each segment among all appendages are hampered by two problems. First, information about appendage development was not included; this information would have suggested different segment identities in some cases. For example, the development of calanoid mouthparts provides useful insights into the identities of the terminal segments of the calanoid maxilla and maxilliped which add setae during development like an exopod or an endopod, respectively. Similar developmental information also could have helped the authors identify the enigmatic sixth lobe on the maxilla of *Pleuromamma xiphias*.

Second, the authors' process of inference for homologous segments is not consistent. Homologies can be inferred by the position of an appendage segment, by its morphology, its armament, or its formation during development. Usually Huys and Boxshall apply homology by armament, but they do not present a consistent explanation of the relationship between an appendage segment and its armament. For the exopod of the antenna and mandible, they assume a strict one-segment-one-seta relationship for subterminal segments, but provide no information about how this one-segment-one-seta relationship is derived. The authors simply count the number of setae and then equate this number with the number of ramal segments on the antennal and mandibular exopods. However, this number often does not correspond to the actual number of segments shown in the illustrations and leaves the reader confused. In all other cases except antennal and mandibular exopods, Huys and Boxshall use a concept called oligomerization to infer homology. The largest number of setae, segments, or lobes which can be found on all or parts of each appendage among all species of a group is presumed to be the ancestral condition. Fewer numbers always represent derived character states, and these states always are derived in a stepwise manner. There are many problems with this concept of evolution; unfortunately none of them are discussed in this book.

The discussion of a basic problem in copepod tagmosis, the identity of prosomal and urosomal somites, is hindered by an inconsistent application of definitions. Huys and Boxshall begin their discussion of the copepod prosome and urosome by defining these two groups of somites on the basis of their functions. The authors then propose using the position of an articulation between the fifth and sixth thoracic somites (podoplean) or the sixth and seventh thoracic somites (gymnoplean) to group copepod orders. However, the case of *Thespesiopsyllus paradoxus,* with its articulation between the fourth and fifth thoracic somites, is not included in this discussion. Instead, this case is introduced in the section on tagmosis, page 316. Here the authors discard their original functional definition of prosome and urosome, and substitute an anatomical definition. Epimera on tergites now define a prosomal somite, but these structures are not recognizable in any of the illustrations. The authors' justification for placing *T. paradoxus* in the Cyclopoida seems debatable, because of this selective definition of prosomal somites. The differentiation of prosomal and urosomal somites by the presence or absence of epimera on tergites is an interesting idea, but its application in phylogenetic analysis should await a uniform assessment of its character states throughout the Copepoda.

Despite these questions about interpretation, the abundance of morphological detail presented by Huys and Boxshall makes "Copepod Evolution" a useful addition to both libraries and laboratories. For copepodologists studying species of Cyclopidae in fresh-water habitats this book provides an introduction to free-living and parasitic represenatives of the Cyclopoida. For marine planktonologists, here are clear examples of the divergence in mouthparts of calanoids and *Oncaea,* which should continue to encourage reassessments of the trophic positions of Oncaeidae, Corycaeidae, and Sapphirinidae. For deep-sea ecologists, here is a look at the Poecilostomatoida, which is an order of copepods as important to benthic habitats as the Harpacticoida. The information which can be derived from the morphological diversity of copepods is marvelously complex, as Huys and Boxshall show in "Copepod Evolution."—Frank D. Ferrari, Department of Invertebrate Zoology, National Museum of Natural History, Smithsonian Institution, Washington, D.C. 20560, U.S.A.