BOOK REVIEW

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Watling, L., and M. Thiel (eds.). 2013. The Natural History of Crustacea. Vol. 1. Functional Morphology & Diversity. Oxford University Press, Oxford. 500 pages. Hardcover, ISBN: 978-0-19-539803-8. $175.

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"No group of plants or animals on the planet exhibit the range of morphological diversity seen among the extant Crustacea." Joel W. Martin and George E. Davis, 2001

This excellent book covers a wide range of fundamental topics in crustacean functional morphology/anatomy, with chapters authored by recognized experts in their fields. In many cases, the topical chapters are *tour de force* contemporary reviews that will stand as benchmarks for many years in the field of crustacean biology. This volume is the first in "The Natural History of Crustacea" series, envisioned as a multi-volume work treating all aspects of crustacean biology, physiology, behavior, and evolution. The series will update and synthesize a growing wealth of information on the biology of this remarkable group.

The 15 topical chapters are mostly excellent. In the introductory/opening chapter, Frederick Schram alludes to hexapods (insects and their kin) being derived from within the crustacean stem line, noting that Crustacea *sensu stricto* lack any defining synapomorphies. His Conclusions section states that Crustacea + Hexapoda (the Pancrustacea) "might in some way be monophyletic," but that that grouping also lacks any clear synapomorphies. In fact, a number of well-known synapomorphies of Pancrustacea exists, e.g., features of the central nervous system, development, and gene sequences. In this regard, it is surprising that virtually none of Nicholas Strausfeld's (Sinakevitch et al., 2003; Struasfeld, 2005, 2011; Strausfeld and Andrew, 2011; Strausfeld and Hirth, 2013) groundbreaking and elegant research on Crustacea/Hexapoda comparative anatomy (of both living and 535 million BP fossils) is cited (Ma et al., 2012). Schram's summary of crustacean biodiversity (Table 1-2) estimates 49 658 described species, but this does not align well with authority estimates that I am aware of, and it is out of sync with two previous careful calculations (Brusca and Brusca, 2003; Ahyong et al., 2011) that place the number at 67 000 and 66 914, respectively.

Joachim Haug and colleagues (Chapter 2) provide a comprehensive summary analysis of crustacean appendage diversity based on four great *Lagerstätten*: Canada's Burgess Shale, the Sirius Passet of Greenland, the Chengjiang fauna of China, and worldwide Orsten microfossil deposits. Terri Williams (Chapter 3) gives an overview of the genetic regulation of patterning in crustacean thoracic limb development – mostly a review of the limited research on this topic, as no general model of developmental patterning has yet emerged that explains adult limb diversity in this group. Williams notes that we confront two big challenges with Crustacea. First, because of larval stages we must discern not simply how one limb is patterned, but how a series of quite distinct limbs is patterned on each segment during the life history of an individual. According to Williams, in most species adult limb morphology develops from modifications of preexisting larval limbs, which may be modified one or more times before assuming the adult morphology. The second challenge is to confront the biramous limbs of many crustacean groups, and we still have no idea how the branches of such limbs are patterned. Nor, for that matter, do we understand the ontogeny of many different forms of endites and exites, or "setae" of Crustacea.

Chapter 4 (Jørgen Olesen) presents an excellent review of crustacean carapaces, while complementary Chapters 5 (Richard Dillman and colleagues) and 6 (Anders Garm and Les Watling) provide detailed reviews of the crustacean integument. Chapter 7 (Geoff Boxshall and Damiá Jaume) gives readers an outstanding review of form and function in crustacean antennules and antennae.

Chapters 9-12 (Jim Belanger, Zen Faulkes, Jeannette Yen and Michel Boudrias) provide fine overviews of living crustacean appendage diversity, swimming, walking, and burrowing, while Chapter 13 (Raymond Bauer) gives an overview of appendage use in grooming and reproduction.

Chapters 8 and 14-16 review internal functional anatomy, including crustacean feeding and digestion (Les Watling), the circulatory system (Christian Wirkner and Stefan Richter), reproductive system (López Greco) and nervous system (Jeremy Sullivan and Jens Herberholz). The last of these seems a bit superficial and gives short shrift to the important comparative anatomical work of Strausfeld and his colleagues on crustacean (and non-crustacean) brains. The most recent work from Strausfeld's group proposes higher-order brain homologies that span the Bilateria, e.g., arthropod central complex:vertebrate basal ganglia; arthropod mushroom bodies: vertebrate hippocampus, suggesting that the ancestral bilaterian might have already had complex neural structures mediating selection and maintenance of behavioral actions (see Strausfeld references below).

Like many edited volumes with chapters by specialists, this book is a bit uneven. There are mostly strong chapters, but also a few weaker ones, and content depth is variable. Chapters range from short and fairly superficial, e.g., a 14-page Chapter 9 on appendage diversity and locomotion, to in-depth research reviews more typical of a specialized journal, e.g., a 39-page Chapter 2 on appendage evolution.

As is typical of books published by Oxford University Press, the text suggests a lack of both peer review and rigorous content/copy-editing (aside from that of the volume ed-

itors). Fortunately, it is clear that the volume editors worked hard to see that every chapter has a consistent coverage and style. However, the font size is small, too small for such a specialized book that demands careful reading, in some cases the publisher did not do the best job preparing the b/w photographs for the press nor is the uncoated paper the best choice for a book with this many half-tone photographs, and the design is simplistic and not particularly engaging, with wasted space in an unused outer page margin over 1.5 inches wide. The predictably poor editing-design-printing of Oxford University Press, and their lack of insistence on peer review (the gold standard of scientific writing), have always baffled me, as does the $175 price tag for this book – which was printed in Asia. It seems an ignominious shame that Oxford has developed a habit of turning quality scientific writing in poorly produced books.

These minor criticisms aside, this important volume will quickly become the modern point of reference for our knowledge of crustacean functional morphology/anatomy. Editors Watling and Thiel should be congratulated on assembling a great team of researchers, pursuing consistency and thoroughness in topical coverage, and producing an outstanding reference text that belongs on the shelf of every invertebrate zoologist.

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