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Book Review

Animal Evolution: Interrelationships of the Living Phyla. 3rd ed. Claus Nielsen.

Oxford, UK: Oxford University Press, 2012. 402 pp. ISBN 978-0-19-960602-3 (hardcover), $135.00, and 978-0-19-960602-0 (paperback), $69.99.

The third edition of Claus Nielsen's *Animal Evolution* is perhaps the first textbook that truly integrates the vast traditional anatomical knowledge on animals to understand their position in the Tree of Life with all the recent evidence from the fields of phylogenetics, 'evodevo', and genomics. The book is a must-have for anyone interested in animal morphology, systematics, evolution, and even for the curious naturalist who wants to know more about animals in general—although it may be a bit too technical for the latter. It also complements a fantastic series of books from Oxford University Press, including Schmidt-Rhaesa's *The Evolution of Organ Systems* (2007), Minelli's *Perspectives in Animal Phylogeny & Evolution* (2009), and Telford and Littlewood's *Animal Evolution: Genomes, Fossils, and Trees* (2009). No other "collection" of books on broad animal evolution can be compared with this one. But let us return to Nielsen's newest book.

Animal Evolution has always been a favorite in my collection of invertebrate textbooks—well, technically there is a chapter on vertebrates (Chapter 65), but it is brief. It is one of the few textbooks that is written in such a manner that reading a chapter on, let us say, molluscs, is not a tedious exercise. In fact, Chapter 27 (Phylum Mollusca) takes up 16 pages, including references. It contains a lot of important information about molluscs and highlights those aspects of their development, anatomy, or systematics that are of key importance to understand the group. It does not have long sections discussing their lower level taxonomy or goes group-by-group explaining all their morphological idiosyncrasies, but it gives a broad sense of the phylum. Like most other chapters focusing on phyla, it ends with a section on interesting subjects requiring further research, which can stimulate students (and other scientists) to choose future lines of inquiry. Obviously, to fully understand these chapters requires certain previous knowledge of the groups. As I tell my own students, they need to have a general background about molluscs before really getting Nielsen's chapter. But they can easily spend the time reading it through in one sitting without the feeling that they are studying to learn lots of facts for an exam. I myself like to go back and forth and re-read these chapters. Speaking of the mollusk chapter, Nielsen has avoided recent controversies on molluscan phylogenetics and has taken a rather conservative approach, dividing them into Aplacophora and Testaria, the latter contrasting with most current phylogenetic evidence, either suggesting Serialia (Giribet et al. 2006; Wilson et al. 2010) or Aculifera (Kocot et al. 2011; Smith et al. 2011; Sutton et al. 2012; Vinther et al. 2012).

The third edition of *Animal Evolution* has changed drastically from previous versions. The second edition had 57 chapters; the third edition has 66, "Problematica" being the last one (it was Chapter 55 in the second edition). The taxa treated in this chapter have changed between editions, as some taxa that were considered of uncertain affinity in the previous edition are now better understood phylogenetically. Cycliophora or *Buddenbrockia*, for example, are now in other chapters. Other problematic taxa, such as Diurodrilida, after the seminal work of Worsaae and Rouse (2008) showing that they are not annelids, have entered this "rank," before being placed phylogenetically with less ambiguity.

The third edition has spared the last two chapters of the second edition, one following up on Nielsen's own cladistics analyses of animal morphology (Nielsen et al. 1996; Nielsen 2001), and a final chapter, a bit disconnected from the rest of the book, on molecular data analyses. The third edition has adopted a more consensual view on animal evolution, primarily based on two decades of phylogenetic advances based largely on molecular data. These phylogenetic results are finally very well integrated with other sources of evidence throughout the book, making the last two chapters of the second edition unnecessary. This allowed Nielsen to adopt unquestioned animal clades, such as Ecdysozoa, which gives the book a much more modern aspect. So the structure of the new book follows, for the most part, the newest ideas on animal phylogeny,

making decisions on the most controversial issues as needed, and cleverly adopting morphological views in those areas where molecules do not provide resolution. Sponges now take five chapters, three for the phyla Silicea, Calcarea, and Homoscleromorpha, and two for the unranked clades Euradiculata and Proepitheliozoa (although the five chapters take up only 13 pages). This may not be to the liking of the proponents of sponge monophyly, but the issue continues to be unresolved and contingent to taxon and gene selection (Nosenko et al. 2013). The book rejects, however, the ample phylogenetic evidence placing ctenophores more basally than cnidarians and placozoans, or even sponges (see a discussion in Edgecombe et al. 2011), to preserve the synapomorphy of the three embryonic body layers. The traditional concept that animals go from diploblast to triploblast may, however, become obsolete under certain scenarios that show expression of mesodermal genes in cnidarians (Martindale et al. 2004).

It is refreshing to see the accepted membership of protostomes and deuterostomes (phoronids and brachiopods are now in Protostomia, while they were still in Deuterostomia in the second edition), or the clades Spiralia and Ecdysozoa, as accepted in virtually all published molecular phylogenetic analyses to date. The new arrangement of the deuterostomes is also more in accord with current phylogenetic results. Nielsen, however, insists in treating Enteropneusta and Pterobranchia as separate phyla, although this time forming a clade (Hemichordata) and not a grade, unlike in the previous editions, thus getting rid of the poorly received Neorenalia and Cyrtotreta. Still, there is now ample evidence nesting Pterobranchia within a paraphyletic Enteropneusta, rejecting the two-phylum arrangement (Cannon et al. 2009; Osborn et al. 2012; Worsaae et al. 2012). Although Nielsen recognizes this potential pitfall, he follows morphological analyses and treats them as separate phyla "for practical reasons." In the hemichordates chapters, I missed a mention of the newly discovered deep-sea torquaratorid enteropneusts, a whole new family discovered quite recently (Holland et al. 2005, 2009; Osborn et al. 2012). Opposite to the case of hemichordates, Nielsen accepts acanthocephalans as an ingroup Rotifera, as supported also by all molecular data analyses (Garey et al. 1996; García-Varela and Nadler 2006; Sørensen and Giribet 2006). I liked finally seeing Micrognaphozoa recognized as a phylum of its own (Chapter 33), as happened with Gnathostomulida in the second edition (now Chapter 32). Together with Rotifera (Chapter 34), these three phyla are now discussed as Gnathifera (Chapter 31).

Some of our phylogenetic discrepancies are discussed here because of the strictly phylogenetic structure of the book, but in reality the text goes way beyond these phylogenetic arguments and it is refreshing to read about the characters that define these clades and about all the taxa that are so well described here. The book is exquisitely written and illustrated and the reader can learn a lot from it.

Some final minutia: Nielsen continues to use a phylum name that is not broadly used, and I would have preferred to see the standardized name used by experts of the group. This applies to the ribbon worms, called Nemertea by virtually all experts, but Nemertini by Nielsen. The book has an inset with eight color pages, as many publishers now use this cheap solution for including some color illustrations, but I find these more annoying than helpful. It would have been beautiful to have the color images where they should be, as some of the gray-tone figures are difficult to interpret—for example, in Fig. 57.1 it is almost impossible to follow the different coelomic compartments unless checking the color inset.

Reiterating my earlier statements, *Animal Evolution* has always been a preferred textbook to me for its quality and information based on primary literature, but I was rather conflicted with the phylogenetic scheme maintained by Nielsen in his second edition, which I thought did not keep up with the newest phylogenetic schemes for animals. This has been largely resolved in the third edition, and now I am happy to say that this is not just a preferred textbook for me, but *the* preferred one.

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