

## Book Review

**Perspectives in Animal Phylogeny and Evolution.**—Alessandro Minelli. Oxford: Oxford University Press, 2009. 336 pp. ISBN 978-0-19-856620-5. \$150 (hardback). ISBN 978-0-19-856621-2. \$70 (paperback).

Animals (=metazoans) have attracted scientists since the early days of biological research, and they have played a major role in our understanding of all biological disciplines from evolution to development. But our understanding of the relationships among animals has changed dramatically in the past 2 decades, and with this our understanding of the evolution and the development of animal organ systems has been slowly shifting in directions never before predicted. With these shifts, almost all the major concepts that zoologists have learnt about animal body plans and their evolution—origins of body cavities, symmetry, segmentation, or even multicellularity—needed to be extensively revised in the light of new phylogenetic and developmental information to the point that most classical textbooks have become obsolete.

I have been teaching Metazoan Systematics as well as the Biology and Evolution of Invertebrate Animals for a number of years, which are 2 of my major research areas, and I find this book an excellent choice for both courses. It is about time that a textbook came out revisiting these very issues, which have been discussed in the recent primary literature but that have not yet made it into the mainstream books.

Alessandro Minelli has produced a superb volume in *Perspectives in Animal Phylogeny and Evolution*—a must-read for anybody interested in any aspects of animal evolution, systematics, development, or paleontology. Profusely illustrated with detailed examples, the book is only possible through the precision seen in a meticulous taxonomist, the broader evolutionary perspective of a systematist, and the integrative views of a paleontologist and a developmental biologist. Few modern scientists wear those four hats as smoothly as Minelli does. The book is divided in 9 chapters, although there is a little imbalance in the depth of the topics treated in each chapter.

The first 3 chapters consist of succinct introductions to several aspects of reading the history of life (Chapter 1) and phylogenetic theory and molecular evolution (Chapter 2) to finally “enter the stage” of metazoan evolution in Chapter 3. This chapter introduces key concepts such as multicellularity and the molecules involved in such a key development. Choanoflagellates are then discussed as the closest relatives of metazoans. The chapter follows with a quick review of key Late Precambrian and Early Cambrian fossils and with a discussion of the Cambrian “explosion”.

These chapters are generally good introductions, but they do contain a few inconsistencies. For example, Table 3.2 lists the number of animal genera (and species) described from 2 Cambrian sites, even though earlier the comparison of ranks above the species level in ecological studies has been criticized explicitly, in Chapter 2. Other aspects of the Cambrian explosion section could be revisited according to the more recent analyses of Dunn et al. (2008), cited by the author in the Preface and in some other chapters. Finally, the author states that “we would not be able to recognize, on their morphology, soft-bodied protomolluscs ...” even though *Odontogriphus anomalus*, a Cambrian fossil from the Burgess Shale, has been interpreted precisely as a soft-bodied stem-mollusc ... (Caron et al. 2006). Inconsistencies aside, these 3 chapters read as an excellent introductory section before discussing animal evolution in detail.

Chapter 4 (Deep branches of the metazoan tree) is an exquisite example of an integrative discussion of early metazoan evolution that combines phylogenetic, anatomical, and developmental information to a degree rarely seen in the literature. Key issues such as body layers (numbers and types) and symmetry are discussed thoroughly and in a nontraditional manner. It reminds me very much of the way I teach these issues to my invertebrate students, questioning the traditional views of almost every textbook out there. The table listing higher taxon names (4.1) is also extremely useful, although some key names such as Platyzoa, sensu Cavalier-Smith (1998), defining the non-trochozoan, non-ecdysozoan protostomes, are sorely missing.

Chapter 5 attempts to give a quick view of what Minelli calls “The entangled phylogeny of the Bilateria”, and I find this chapter a bit entangled. Together with a nice general discussion of Bilateria and the Urbilateria concept—the ancestor to all bilaterians—the book describes a selected list of bilaterian clades, many of which are mutually exclusive, whereas others are subclades of the previous ones but use different names for their component taxa (e.g., 5.3.3 Platyzoa lists as component clades Acanthocephala and Rotifera, among others, whereas 5.3.4 Gnathifera lists Syndermata, a term introduced earlier for Rotifera including Acanthocephala). Spiralia has several meanings, and it is used by Minelli as a synonym of Trochozoa (5.3.5) (e.g., sensu Nielsen), whereas the recent literature using Spiralia often differentiates its 2 subclades, Trochozoa and Platyzoa (Giribet et al. 2000; Dunn et al. 2008). Instead, those who prefer to use Lophotrochozoa (5.3.7) use it in the exact same sense as the latter Spiralia. Nevertheless, the discussions of all these clades are interesting and summarize a great deal of the recent literature on this topic.

A long Chapter 6 provides background and a phylogenetic discussion to all bilaterian phyla (a gallery of the major bilaterian clades) that compose the higher clades introduced in Chapter 5. The section focuses on several aspects of each phylum's position in the bilaterian tree as well as their internal relationships, at least for the largest and best-studied lineages. The discussions about annelid, mollusc, and arthropod relationships are especially useful reviews, reflecting their diversity and body plan disparity and integrating well the fossil record with the most current phylogenetic analyses and views. However, other phyla, perhaps less dear to the author's heart, do not receive a whole lot of attention (e.g., echinoderms and vertebrates). The chapter has also some omissions, such as those referring to molecular phylogenies of loriciferans (Park et al. 2006; Sørensen et al. 2008), but in general it is very complete, which actually shows that the position of these phyla in the tree is not as straightforward as the author thought.

Overall, Chapters 4–6 constitute an excellent initiation for newcomers to the field of animal phylogenetics and could well constitute the basic reading for a broader discussion of the topic.

An impressive Chapter 7 devotes 74 pages to discussions of "The life cycle and its evolution", considering an enormous array of different topics, from sexuality and other forms of reproduction to tissue organization, gametes, embryogenesis, life stages, and gene expression or presence of certain developmental genes. This chapter amasses an enormous number of illustrative examples for all the topics discussed and clearly shows the scholarly mastering of the developmental literature by the author. I must admit, though, that it could have benefited from a more structured form in shorter chapters treating the main topics, such as cells and tissues, developmental processes and mechanisms, and reproduction, to mention a few.

Chapter 8 (The evolution of animal body architecture) is divided into 2 main sections. The first one provides a detailed discussion of basic concepts such as body axes and symmetry, body appendages (with emphasis on Minelli's [2003] hypothesis of paramorphism), and segmentation. The second section focuses on organogenesis and organ systems in metazoans, providing a brief but clear discussion of key concepts such as body cavities in addition to the different organs and organ systems of animals.

Chapter 9 (The overall picture) reminds us that there is something else beyond elucidating the phylogenetic patterns of animals: the processes that led to the patterns and the many interesting evolutionary stories that such patterns can explain. This chapter explores concepts such as evolvability, evolutionary trends, ecological trends, and whether there are hierarchies in nature, among others.

Whereas traditional textbooks on animals (often restricted to invertebrates) have focused on all aspects

of each animal phylum, Minelli's *Perspectives in Animal Phylogeny and Evolution* complements a series of radically different approaches to understanding animal evolution. Hence, I see this book as the fourth in a series of books with a new concept of animal evolution, following the radically different approach initiated by Claus Nielsen's *Animal Evolution* (Nielsen 1995, 2001), continued by James Valentine's *On the Origin of Phyla* (Valentine 2004) and complemented by Andreas Schmidt-Rhaesa's superb *The Evolution of Organ Systems* (Schmidt-Rhaesa 2007). Now that I finally have the complete series of books, I would recommend them to any student or researcher wanting to master the complex field of animal evolution from a modern perspective.

*Perspectives in Animal Phylogeny and Evolution* constitutes a milestone in what can be called the field of "phyloevodevo" or the integration of phylogenetic, morpho/anatomical, evolutionary, and developmental information. Only a writer with the broad knowledge and synthetic capacity of Alessandro Minelli could put together all those aspects of animal biology in such an exquisite manner.

Gonzalo Giribet, *Museum of Comparative Zoology, Harvard University, 26 Oxford Street, Cambridge, MA 02138, USA; E-mail: ggiribet@oeb.harvard.edu.*

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