
Amphibians have been a somewhat neglected and phylogenetically enigmatic group of vertebrates despite the fact that they made the fundamental step in the evolution of terrestrial vertebrates: the adaptation to a nonaquatic environment. Amphibians are a highly successful group with more than 6000 species and important ecological and evolutionary histories. Thus, a thorough understanding of their evolutionary history is essential to the resolution of vertebrate evolution and phylogeny. The early paleontological record of the amphibians is interrupted by wide gaps, often resulting in the sudden appearance of advanced characters. Recent, exciting new fossil findings have improved the picture of amphibian evolution and even parts of their developmental biology. Therefore, Robert Carroll's new book The Rise of Amphibians is a timely review, providing a modern reference for amphibian paleontology and evolution.

Although some readers might prefer to have an expansion of some sections, The Rise of Amphibians should be on the bookshelf of anyone involved in vertebrate evolution because this comprehensive review is packed with information, making it an excellent source of information before delving into the primary literature. The narrative is fluent and makes even the most detailed descriptions of key fossils pleasant to read. Robert Carroll, an international paleontological authority, has assembled during his career and described for this book a number of fossils important to the understanding of amphibian relationships and evolution.

The first three chapters of the book provide an introduction to the field and the origin of amphibians. It might not have been necessary to start the book with the big bang, the beginning of life, plate tectonics, and metazoan evolution because these topics are probably better covered in dedicated publications. The account of how modern developmental genetics can assist in the understanding of the evolution of amphibian limbs at first seems misplaced in a primarily paleontological book, but it is useful and provides relevant references pointing to more detailed literature. These introductory chapters serve as a useful prologue leading to the core of the book, the comparative description of amphibian fossils.

In the subsequent 84 pages of “The Radiation of Carboniferous Amphibians” (Chapter 4), numerous figures, photographs, and diagrams provide a detailed comparative account of the most important amphibian fossils and their characteristics. Although this chapter may be a demanding read for the nonspecialist, it provides a comprehensive survey of early fossils and the rise of amphibians. The chapter draws attention to the phylogenetic problems related to the extended “Romer’s Gap” (ca. 359–345 Ma) in the fossil record, when the key inventions for conquering land evolved during the Lower Carboniferous. In case no more fossils are discovered, this gap and other questions can, in principle, be closed and answered only by phylogenetic analyses of the existing data.

Unfortunately, Chapter 5, “Adaptation, Radiation, and Relationships,” demonstrates that the current collection and selection of characters may not enable a coherent picture of amphibian evolution. This is, however, not due to the limitations of phylogenetic methods, and therefore, the critique in this and other chapters of modern phylogenetic analysis is somewhat misdirected. In the paragraph “Limits of the Applicability of PAUP” pun intended or not, Carroll states “... that phylogenetic analysis using PAUP has failed to provide consistent ... answers ...” [my italics]. Needles to say, this is not a problem of PAUP (Phylogenetic Analysis Using Parsimony), which is merely a widely used computer program, nor is it a problem of the limits of parsimony itself. As Carroll acknowledges, it is due simply to the limitations of the data that paleontologists have so far unearthed and to their apparently uncritical use by some authors. Carroll’s suggestion to go back to the virtues of Hennigian analysis and personally select (whatever this implies), weight, and polarize characters can be performed in most phylogenetic programs using parsimony. Given the lack of data, even this approach may not lead to new insights.

Problematic, however, are the suggestions in later chapters to use primitive character states (p. 194, 232) to reconstruct evolution. These statements somewhat overshadow the book’s otherwise modern review of amphibian paleontology and evolution. It is unfortunate that hardly any molecular results have been included for comparison and illustration of the rise of amphibians. Even if paleontologists may regard molecular phylogeny as preliminary until genome data from more species are available, the virtues of modern approaches are not limited solely to developmental genetics. In general, Carroll’s presentation of amphibian evolution would have benefited from a discussion of conflicting results. Unfortunately, a recommendable paper on amphibian molecular evolution by Zhang and Wake (2009) was published only after the appearance of Carroll’s book.
The remainder of the chapter is a summary of the key characters that define early major amphibian lineages and previously suggested connections. Here, an overview of the phylogenetic bearing of these characters would have been beneficial, and also for other chapters, as it would have allowed side-by-side comparisons between different lineages. An approach of this kind would have been extremely useful to the nonspecialist reader. For students and nonspecialists lecturers of vertebrate evolution, it would have also allowed an easier access to the detailed descriptive chapters.

“The Zenith of Amphibian Diversity” (Chapter 6) describes the wealth of amphibian fossils and the diversity of this group during the Late Carboniferous and Early Permian. Carroll’s narrative style and references to their ecology and behavior bring these “fossils” to life. The rich fossil record even enables fascinating conclusions about the development (sequence of ossification) of Permian amphibians some 300 Ma. Yet again, clear descriptions of their relationships, or at least possible connections between the lineages, are missing. The tree in Figure 6.8 and its reference are not particularly helpful but require purchasing yet another book on amphibian biology.

Chapter 7, “The Origin of Amniotes,” attempts to connect the amphibians to their competing sister group, the amniotes, which led to the dinosaurs and mammals. Unfortunately, except for a laundry list of tetrapod (actually amniote) characters, the chapter focuses only on reproduction (evolution of the amnion), functional anatomy, and environment. Chapter 8, “Stereospondyls,” describes the Permian extinction from which amphibians suffered heavily and the rise, diversification, and extinction of the later temnospondyls.

“The Enigma of Modern Amphibian Origins,” Chapter 9, and the subsequent chapters on the “Ancestry and Origin” of frogs (Chapter 10), salamanders (Chapter 11), and caecilians (Chapter 12) portray the paleontology and evolution of recent amphibians. Carroll helps the reader to experience the frustration related to limitations in the paleontological and morphological evidence that connects these groups. Despite the rich fossil record, each major lineage appears suddenly in the fossil record with limited, if any, synapomorphies shared with other groups. Many lines of current evidence, including developmental biology, are used to make sense of their origin, but references to molecular phylogenetics are strikingly few. The chapter on the rather cryptic and little known caecilians might have been easily overlooked, but it is noteworthy. It gives a nice overview of caecilian characters and fossils, but most importantly it provides a comprehensive and clear summary of the origin and possible relationships of not only caecilians but also frogs and salamanders.

In the “Success of Modern Amphibians” (Chapter 13), the distribution and history of recent amphibian families are reviewed, followed by descriptions of selected modern features in reproduction and feeding and a paragraph on genome size evolution. The latter one curiously measures and compares genome size in millionth of a gram [sic] per cell (should read trillionth-picogram).

The final chapter on the “Future of Amphibians” (Chapter 14) is written by David Green (McGill University) and presents the threat of the loss of diversity of this group. Even though amphibians survived the major extinctions of the Permian and Cretaceous, their numbers have been undeniably declining in the last few decades. The short but comprehensive and densely referenced chapter includes many examples and provides a critical discussion of the numerous possible reasons for the decline.

Even though they do not reduce the scientific value of the book, there are a few technical things that are somewhat disturbing. The resolution of the figures could be better as they are rather pixilated and not really crisp. The color figures are limited to 16 plates. Also, the drawing of most graphs appears rough. Furthermore, epochs, ages, and stages usually are given only by their names, their dates being rarely provided. Presumably, only a few readers will be familiar with the time spans referred to by Pennsylvanian, Westphalian D, or Tournaisian, for example, and would find it helpful if the dates were provided in the text. As outlined above, however, the book is packed with information, and it may be for that reason that some information, such as phylogenetic relationships, is often difficult to locate in the text. It would have also been beneficial if the narrative had sometimes been interrupted to yield space for a clear summary of what a whatcheerid, a stereospondyl, or even an amphibian actually is, what their diagnostic characters are, and when and where they lived.

Nevertheless, The Rise of the Amphibians brings amphibian paleontology to life and presents the reader with a massive amount of up-to-date information as well as problems and open questions about their paleontology and the reconstruction of their evolution. It is a first-choice reference book that stimulates further studies and research, which are desperately needed to elucidate the history of this fascinating but underrated vertebrate group.

REFERENCE


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