Journal of Sedimentary Research
An International Journal of SEPM
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Review accepted 25 January 2005

Vertebrate Palaeontology (3rd ed.), by Michael J. Benton, 2005. Blackwell Publishing, 350 Main Street, Malden, MA 02148-5020, USA; 455 pp., paperback; price £ 29.95, $ 79.95. ISBN 0-632-05637-1.

The importance of fossil vertebrates has already been recognized in old textbooks of paleontology and historical geology. Appropriate chapters were illustrated there with woodcuts of selected bones of diluvial mammals or dinosaurs. I wondered while reading such books, what chance there was for geology students to find the same parts of fossilized skeletons while working in the field. Probably few of them had such luck. A lot has changed in teaching natural sciences since those days. There is no longer a need for students not specializing in vertebrate paleontology to memorize Latin names of bones and train themselves in the identification of particular units of the human wrist. Instead, a general knowledge of the organismal evolution seems more important in developing a reasonably complete understanding of the ancient Earth. Students are expected to know how the present-day diversity of animals originated and how it looked in the epochs of the past. The book by Michael Benton fits these needs for a concise review of paleontological facts and theories on the course of evolution, not going too deeply into technical details. Its simple language and general attitude make it accessible even for readers not familiar with paleontology at all.

Obviously, the task of writing a university textbook in a plain language cannot be achieved to complete satisfaction of all readers. One may notice that some parts of the text are probably too simplified (for instance the chapters on taphonomy and paleontological techniques), while still a lot of the technical anatomical terminology remains in the main body of the text. Anyway, taking the book as a whole, the author has succeeded in making it as comprehensive as possible in respect to such complex factual material. In few other books is the biological diversity of vertebrates presented in such an elegant and precise manner. Issues more difficult, controversial, or irrelevant to the presentation of the main evolutionary issues are separated from the main text. Among them are presentations of quite fresh paleontological discoveries of importance not only to the professional naturalist but also to journalists writing on natural sciences. An expression of the most recent and completely unexpected turn in the development of paleontology is its connection with evolutionary developmental biology. These parts of the book impressively show the unusual extent of the author's knowledge.

Michael Benton is an expert on the early evolution of dinosaurs but his expertise in a range of problems of vertebrate paleontology is astonishing. As a result, the contents of his book is very well balanced. Equal care is given to the evolution of fishes and mammals, with no preferences to the author's pet ideas. Even the Permian–Triassic faunal change, which the auhtor developed and popularized in several articles and books as allegedly the greatest catastrophe in the history of life, as well as the Carnian–Norian extinction, have not received greater attnetion than other aspects of the evolution of vertebrates.

The only potential bias to be noted by a skeptical reader is perhaps that the description of the changes at the above-mentioned boundaries are somewhat exaggerated. The counts of taxa allegedly disappearing exactly at the boundary are unconvincing. One may point out that in the best documented Eastern European succession, archosaurs (the celebrated ancestors of dinosaurs), present in the Late Permian appear to increase in abundance and diversity in the early Triassic,

apparently unaware of the "great extinction." Also, dicynodonts continued from the Permian to mid-Triassic, as did procolophons. If there were truly dramatic faunal changes, these influenced not so much the fully terrestrial tetrapods but rather the amphibians. In showing the discontinuous distribution of such ecologically sensitive animals, the Permian–Triassic transition does not seem fundamentally different from other segments of their evolutionary history. Similarly, the diagram in the book showing the allegedly sudden faunal replacement at the Carnian–Norian boundary probably deviates too much from the raw evidence.

It is also somewhat annoying to find in several places in the book a presentation of the popular belief that any mass occurrence of fossils is an expression of mass mortality. Organisms do die steadily and the problem is not with the supply of carcasses to the sediment but rather with saving them from disintegration at various stages from deposition to lithification within the rock.

These critical comments are actually not addressed to the book itself. It has to be admitted that the book's contents quite reliably represent the state of the art as it stands. Whether the science of paleontology is always properly done is another problem.

What then is the main lesson from reading Benton's book? Probably the most general observation coming to the mind of the reader is quite close to the expectations: the reliability of the fossil evidence is inversely proportional to its geological age. Whereas there is fairly general agreement regarding the course of evolution of Cenozoic mammals and Mesozoic reptiles, the early Paleozoic origin of fishes is a rather foggy issue. The origin of vertebrates and relationships between chordates remain still a mystery. No wonder that even listing of the raw data on Cambrian fossils of possible chordates is far from being logically consistent, although the efforts of the author to do it reliably and up-to-date are to be appreciated.

First of all there is no clear concept of what constitutes a vertebrate or chordate that could be applied to paleontology. In result, the collection of the alleged Cambrian chordates consists of animals which cannot be related to each other, and their interpretation as chordates or vertebrates is mutually contradictory. Among them there is the mid-Cambrian *Pikaia* with a pair of tentacles and serial head appendages making it different from any other chordate. No wonder that originally it was described as an annelid, the interpretation recently supported by a restudy of its possible Early Cambrian ancestor, the Australian *Myoscolex*. To vertebrate relationship were also nominated the Early Cambrian vetulicolians, with their segmented, obviously external skeleton pointing rather to arthropod (or at least ecdysozoan) affinities. The bizarre concept of "calcichordates," that is the origin of various chordate lineages from carpoid echinoderms, seems to be now only a curiosity not deserving discussion in a textbook. Even regarding these Cambrian fossils, chordate affinities of which are supported by unquestionable remains of gill arches, gonads, and even blood vessels, there is a deep split in opinions on their relationship to geologically younger fossil chordates. No wonder that this situation may be truly puzzling for a paleontologist who has based his knowledge of evolution on easily interpretable bones and skeletons.

The oldest fossils are the most difficult to be used in answering evolutionary questions, but these are among the greatest problems of paleontology yet to be resolved. The energy with which some researchers fight with theories proposed by others should not be taken too seriously. In fact, there is tremendous progress in understanding the early evolution of vertebrates in recent years. This becomes obvious when one compares this book with its two earlier editions. It will be interesting to see the change in future presentations of the issue. No doubt that an internally consistent interpretation of the basal part of the vertebrate's evolutionary tree will emerge soon; probably in a similar way to that exemplified by the history of studies on the origin of mammals.

Particular evolutionary lineages of early mammals, reviewed in the book, are already rather well recognized owing to findings of isolated teeth. Less common fossil skulls give insight into the fundamental transformation of the anatomy of jaws and middle ear. The general picture of mammalian evolution in its time and spacial dimensions, based on these two sources of evidence, requires only a last touch to be relatively complete. The distinction between the fossil

record of isolated teeth and skeletons, so nicely illustrated by the history of research on conodonts (the most ancient of the well known chordates), shows how taphonomy interferes with evolutionary studies.

Actually, the taphonomic factor introduces much noise to the general relationship between geological age and completeness of the fossils record. A good example, discussed in the book, is offered by early birds, until recently known from few fossils, with the celebrated *Archaeopteryx* at the bottom of their evolutionary tree. The recent progress in assembling the fossil record of these vertebrates is truly astonishing, but these are mostly ancient water games. Forest birds, to which perhaps also ancestors of *Archaeopteryx* belonged, are rather unlikely to be fossilized in their environment because of acidity of the soil. Few of them had the luck to die near a lake or sea shore to be covered by a limy mud. Consequently, the issue of the origin of birds remains entangled into contradictions equal to that of the origin of vertebrates. Some of the concepts reviewed in the book, for instance the "cursorial theory" of the origin of birds' flight, should perhaps be dropped, as they violate plain laws of physics. It is understandable that birds use front limbs to fly, but why should wings develop there in the ancestor? Unlike birds, all the early archosaurs had most of their muscle mass at hind limbs. Therefore, it begs to be explained how it was possible for those putative ancestral birds running on the ground to fly having the center of body weight well behind the center of their wings' surface. No way to escape from the idea of arboreal birds' ancestry and the stage of "Tetrapteryx" (convincingly supported by the recent finding of the Early Cretaceous bird with four wings, *Microraptor*). Obviously, to resolve such problems to their end, we have to wait for findings of pre-Tithonian Jurassic or Triassic ancestors of *Archaeopteryx*.

Another observation emerging during reading Michael Benton's book (and especially his explanations of cladograms) is that much of the difficulty in seeing an order in conflicting hypotheses on either the origin of birds or any other evolutionary issue is not with facts but rather with nomenclature. I remember a similar experience with one of the best 19-century textbooks on paleontology, *Éléments de Paléontologie,* published in 1895 by Félix Bernard. It was astonishing for me to notice how little his evolutionary tree of the relationships of fossil mammals differed from that accepted today. But old and modern classifications of mammals are far from similar to each other. It is the taxonomic nomenclature which makes knowledge of the course of evolution and paleontological record so difficult to comprehend. This was the case already in my student days, when the evolutionary pattern of transformation of the Linnaean taxonomy had not been questioned. With the recent expansion of cladistics, taxonomy entered into a disastrous stage of instability and nomenclatorial inconsistency. Fortunately, Michael Benton is a good cladist but not a zealot of the new taxonomy. It has also to be appreciated that the text is illustrated with classical evolutionary trees exposing the importance of the stratigraphic succession of particular anatomies (although too easily extending hypothetical lineages back in geological time). Cladograms, ignoring chronological evidence and complicating rather than explaining issues, are put into framed 'boxes' separated from the main body of the book.

No doubt that Michael Benton's professional review of the evolution of the most complex of animals has to be placed high on the evolutionary tree of university textbooks. There is probable no better, more comprehensive, and up-to-date source of this kind of knowledge.

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