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The Cambrian Fossils of Chengjiang, China: The Flowering of Early Animal Life, by Hou Xian-Guang, Richard J. Aldridge, Jan Bergström, David J. Siveter, Derek J. Siveter & Feng Xiang-Hong, 2003. Blackwell Science Ltd., 108 Cowley Road, Oxford, OX4 1JF, United Kingdom. 233 pp., hardback; £ 60.00. ISBN 1-4051-0673-5.

Chinese fossils are changing dramatically our understanding of the course of evolution. Two recently discovered sources of exquisitely preserved fossils contributed the most to this revolution in paleontology: the Early Cretaceous Jehol fauna, known from exposures of the Yixian Formation in northern China, and the Early Cambrian Chengjiang fauna, represented by several fossil assemblages from the Heilinpu Formation of Yunnan, southern China. The fossil feathered birds and furry mammals from the Chinese Cretaceous are widely known to the public, being easy to comprehend and appreciate. This is not so simple by the bizarre Cambrian organisms. The reviewed book, written by a group of British, Swedish, and Chinese experts on the subject is thus to be particularly welcomed, so more that it is addressed to a wide audience ranging from people with only a general knowledge of geology and biology to professional paleontologists.

The book contains a concise, but in depth, introduction to the geological context of the fossils, history of the discovery of sites, and an outline of the evolutionary importance of the Chengjiang fauna. Its main body is composed of a nicely illustrated review of the Chengjiang organisms, with color high quality photographs and line drawings of their restored life appearance. The fossil organisms are ordered according to their systematic position, with introductory chapters explaining the main evolutionary problems and importance of the new discoveries in solving them. Most of the species of general interest are included; others are listed at the end. Despite so many authors involved, the book is surprisingly well organized and the treatment of various groups of fossils is well balanced and uniform. It is not clear who of the authors is responsible for such well-done editorial job, but he has to be congratulated on the result.

The expression “Cambrian explosion” can be safely applied also to the current production of literature on the subject. The history of research on the Chengjiang fossils fits this opinion especially well. The first published report on the fauna appeared in print (in Chinese, with English summaries) in 1987. A long series of publications in international journals was initiated after a couple of years, and continues steadily until now. The moment seems good to summarize the achievements of the first decade of research and the book presents it very well. The authors have applied a conservative attitude to the theoretical aspect of the fauna, generally avoiding too radical interpretations of the fossils. I appreciate this very much so more that even editors of high profile scientific journals rarely hesitate to forward highly speculative and logically inconsistent interpretations of the Cambrian organisms, just to attract the audience. Admittedly, the authors of this book have tempered much of such conceptual noise. Obviously, we are still far from being able to describe in detail and understand the early evolution of the animals represented in the Chengjiang fauna. The expression commonly used in the book, that “cladistic analysis resolved” a phylogenetic relationship, is rather a kind of incantation than a description of real achievements. One can easily check in the literature how disparate are results of application of highly sophisticated numerical taxonomy programs to matrices of subjectively chosen and *ad hoc* defined characters of extinct and extant organisms mixed together without respect to their geological age. No wonder thus that the phylogenetic tree of the Cambrian organisms, expected to

be consistent with both their anatomical diversity and stratigraphic succession of findings, emerges so slowly. We still do not know, even in the most general terms, how the early transformations of the animal anatomy leading to the main phyla proceeded. Good news is that it offers an unprecedented opportunity to paleontologists: there is a lot of evidence awaiting proper evolutionary interpretation.

In two groups of the Chengjiang fossils this impression of chaos in currently available theories on their early evolution is especially painful. These are the arthropods (the phylum richest in species), and the chordates, extremely poorly represented in the Cambrian but of the top interest to us, the late members of the phylum. The Chengjiang arthropods are even more diverse than those of the celebrated Burgess shale fauna, with many lineages being represented in both sites. The great variety of the anomalocaridids and lobopodians (ancestors of present-day tropical velvet worms and microscopic tardigrades) found in Yunnan offered important support to the idea of their close relationship and ancestral position in respect to other arthropods. Among them, the most spectacular was the discovery of complete specimens of *Microdictyon*, a lobopodian earlier widely known from isolated phosphatic sclerites, once provoking the most fantastic speculations about their affinities, no one directed correctly. Yet, despite the great richness of the material we are far from achieving an orderly presentation of the evolution within the phylum. Although there is an agreement that in the evolution of the arthropods a stepwise subdivision of the originally uniform segments into functionally different sets (tagmosis) occurred, and appendages of at least the head tagma segments diversified and specialized functionally, neither of the processes is clearly visible in the fauna. Even the elsewhere apparent distinction between those arthropods that use their first pair of appendages as a sensory organ and those that grasp prey with them, is not always clear in the Chengjiang fossils. Perhaps the most striking aspect of these arthropods is the unstable number of thoracic and abdominal segments, unlike their successors from the Burgess shale. Apparently, the developmental control was that time still not strict enough to enable precise counts.

The Chengjiang fossils contributed the most to the understanding of the early phylogeny of lophophorates and chordates. In some cases, like discoveries of the lingulid brachiopods with peduncles preserved, this was just a confirmation that the anatomy of the Cambrian member of the group is exactly as expected from zoological evidence. In others, for instance the discoidal eldonioids, an unexpectedly bizarre anatomy is shown by the fossils. The controversy regarding pelagic *versus* benthic mode of these large Cambrian organisms continues.

The anatomical and phylogenetic interpretations of the Chengjiang fossils believed to be related to chordates are the most hotly disputed. *Yunnanozoon* from Maotian with seven pairs of branchial arches and series of gonads on both sides of the body, a fusiform closed structure interpreted as the notochord above, and segmented units proposed to be muscular blocks was first selected to be a candidate for the chordate ancestry. In even better preserved material from Haikou details of blood vessels supporting the gills were subsequently identified. Hou *et al.* are skeptical about chordate affinities of this organisms but accept as the earliest known chordate poorly preserved specimens suggested by other authors to be closely similar to, if not identical with, *Yunnanozoon*. Interestingly, the two poor specimens which were once proposed on the basis of cladistic analysis to represent genera of two separate subphyla (cephalochordates and vertebrates) have later appeared to belong to the same species! To add more to the confusion, the vertebrates (a subphylum within the phylum Chordata) are no longer defined by the presence of vertebrae or cranium but “are fundamentally characterized by the evolution of neural crest cells and epidermal placodes that give rise developmentally to a number of features of the skeleton and sensory organs”. This may sound highly scientific but of what use such a definition can be to the interpretation of Early Cambrian fossils, so more that it is generally agreed that the lack of elaborate sensory organs in recent cephalochordates is a result of secondary simplification?

The problem of the ancestry of chordates has been joined with the question of identity of perhaps the most bizarre fossils well represented in the Chengjiang fauna: the Vetulicolia. There

is a gradation in the anatomy of these enigmatic Cambrian animals from those being of a rather indifferent shape, weak segmentation and radial mouth apparatus (compared with that of Carboniferous lampreys and on this basis proposed to be a chordate), through similar forms with an oval unit of the body bearing a similar radial structure and a separate tail (proposed to be ancestral echinoderms), to the most complex form (proposed to be a tunicate) with laterally compressed anterior unit of the body and vertically moving segmented tail with a terminal fin. Noteworthy, the segmentation is apparently arthropod-like and strongly suggests that we are dealing with a molting animal, thus points out the ecdysozoan affinities, totally incompatible with those listed above. The alternative to the chordate-echinoderm (deuterostomian) affinities of the vetulicolians is thus a gradation towards extreme modification of the original arthropod body plan to a worm-like appearance (in fact, not coming as far as in the recent crustacean *Sacculina*). Rhomboidal structures with lamellar organization arranged in series along the body of some vetulicolians were once compared with phosphatized intestinal glands of some Burgess Shale arthropods. This controversy nicely shows how distant we are from agreement even in the crudest identification of the most interesting Chengjiang fossils. Hou *et al*. take a well-balanced attitude to the problem underlining the probable unity of the group but leaving its general systematic position open to debate.

Although the importance of the Chengjiang fauna in understanding the Cambrian world is unquestionable, not all fossils from there are superior to those from other fossil sites. As pointed out by the authors of the book, the original minerals of the fossils were removed by weathering from the mudstone. Skeletons were earlier crushed and are poorly preserved. This is why the material of Early Cambrian sponges known from probably coeval strata of the Sinsk Formation in Siberia, with original silica preserved, is more informative than that from Yunnan. Similarly, the hyoliths from Chengjiang are actually undeterminable taxonomically. Their much better preserved fossils, with sediment-filled intestine or phosphatized typically molluscan larval conchs and opercula, are known from other localities of the Cambrian.

In the book a reader may find a concise but well done review of opinions on the taphonomic origin of the Chengjiang fossils which helps substantially with understanding how so exquisite preservation of details of their anatomy, including rarely fossilizing soft parts, was possible (anoxia preventing sediment bioturbation and decay of tissues was apparently involved, as typical for fossil assemblages of this kind). This, and the early geological age, is the main value of the Chengjiang fossils. They enable incorporation of a great amount of information to the phylogenetic tree. A chance to base the theories on the earliest evolution of animals on hard fossil evidence, not only on speculations derived from knowledge of present-day organisms, is offered. After the relationships of the Cambrian animals, so well represented in Chengjiang, to their relatives from later epochs is established, all the evidence on skeletal and soft anatomy, as well as on its function (including information provided by trace fossils) can be put together to visualize them with flesh and behavior. Only then can we really trust interpretations of the Cambrian environment derived from fossils. The book by Hou *et al*. helps very much in achieving this goal. Being clearly written with a simple language and extensively illustrated, it is of interest also to those geologists, who are not fond of systematic paleontology. I recommend it wholeheartedly.

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