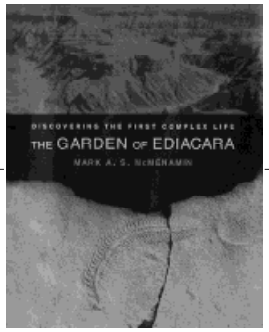
Reviews
book & software

A Neovitalist View of Evolution



THE GARDEN OF EDIACARA: DISCOVERING THE FIRST COMPLEX LIFE
By Mark A.S. McMenamin, Columbia University Press, New York 1998. pp. 293 $29.95 (hard)

No paleontological subject comes close to stimulating the public's interest like dinosaurs, but the origin of animals is probably a solid second. As is well known, representatives of nearly all of the animal phyla (e.g., arthropods, molluscs, echinoderms) appear at roughly the same moment in geologic time, the beginning of the Cambrian period, about 550 million years ago. Their sudden appearance has been dubbed the "Cambrian Explosion," and in recent years the apparent abruptness of the event has increased as improved dating has shrunk the duration of the Cambrian. To some, the Cambrian Explosion presents an evolutionary puzzle that is at odds with the neodarwinian paradigm, and to Mark McMenamin, the author of *The Garden of Ediacara,* the puzzle can only be solved by accepting a progressivist, neovitalist view of evolution. Although not the first to express dissatisfaction with the neodarwinian paradigm, McMenamin does present some unusual arguments and employ some unique strategies in making his point.

McMenamin's neovitalist ideas are based on his interpretation of a group of soft-bodied organisms, the Ediacarans, that appear in the fossil record of the Precambrian, just before the Cambrian Explosion, 550–750 million years ago. Although initially discovered in the 1940s at Ediacara, South Australia, the evolutionary importance of these organisms was not widely appreciated until the 1980s. Since then, they have stimulated a lively debate. At the center of this debate is the question of Ediacaran affinities: Do they represent the ancestors of Cambrian organisms or are they an evolutionary dead end, a "failed experiment" that left no descendants? Ediacaran fossils have now been found in Australia, Eurasia, Africa, and North America. They are often large, up to one meter long. And they lack any mineralized body parts, normally occurring as impressions in sandstones and siltstones. In the early 1960s, most Ediacarans were placed within modern animal phyla, such as sponges and corals, implying that the diversification of animals had started during the Precambrian and that some of the major animal body plans were already present prior to the Cambrian Explosion. But a less conventional interpretation, that Ediacarans represent an independent branch of "the tree of life," not directly related to modern animals, has been championed by Adolf Seilacher. In the 1980s, Seilacher suggested that the Ediacarans had an odd air mattress–like construction, and this, together with their unique mode of preservation, led him to conclude that they were a Precambrian experiment, one that ended with their extinction.

McMenamin, who favors the Seilacherian view over the approach that shoehorns Ediacarans into modern taxa, published a paper in 1986 that added another twist to the story. At that time, McMenamin reintroduced the concept of endosymbiosis, in which one organism lives inside another in a mutually beneficial association, to the Ediacarans, contending that these flat organisms harbored within them photosynthesizing algae or bacteria, and that they survived for over 100 million years exposed and unprotected because no predators were present in the peaceful "garden." This Ediacaran experiment ended with the origin of predators during the Cambrian Explosion. That interpretation is developed further in *The Garden of Ediacara*. Using a methodology that favors intuition with a twist of the "irrational," and not hindered by too strict an "adherence to the doctrine of falsifiability and testability," McMenamin intuits that the Ediacarans shared an unusual mode of cell division and

CCC 1076-2787/99/03039-02

growth that he refers to as "metacellularity" and that they were on the verge of developing a brain. Both of these claims are based solely on the shapes and symmetries exhibited by the Ediacaran fossils; for example, the latter claim is supported by the "cephalized bilateral symmetry" of forms such as *Spriggina* and *Marywadea*. Insights such as those lead McMenamin to conclude that he has solved the Ediacaran puzzle.

But let us return for the moment to the realm of the testable and reexamine several issues surrounding the Ediacarans. The idea that the Ediacarans represent an independent evolutionary experiment rather than a direct link to the Cambrian Explosion has lost some of its significance recently because evidence of other animals in the Precambrian has been rapidly accumulating. Fossilized animal trails, animal embryos, molecular clock estimates, and some of the Ediacarans interpreted as metazoans even by the "failed experiment" proponents all suggest that the Cambrian Explosion was preceded by a long interval, tens to hundreds of millions years long, of soft-bodied animal evolution. Regardless of the actual affinities of the Ediacarans, the Cambrian Explosion now seems to represent the sudden appearance not of animals per se but of animals with mineralized skeletons. Of course, plenty of important questions about the Cambrian Explosion remain; for example, what was the trigger that set off the Cambrian mineralization, event, and why was has the origin of major body plans essentially ceased since the Cambrian. As for McMenamin's idea of photosymbiotic Ediacarans living in a predation-free garden, the new interpretations indicate that some of these Ediacarans lived in deep water, where photosymbiosis would have been impossible, and that the Precambrian may not have been totally predation-free. Thus, although McMenamin goes to great lengths to dismiss these difficulties with the garden, the new findings make his scenario less tenable now than when he initially proposed it in the mid-1980s.

Finally, what about McMenamin's call for a neovitalism? In his scenario, the "cephalo Ediacarans" and metazoans represent two lineages that independently evolved awareness and a brain, an example of what is called "evolutionary convergence." To McMenamin, this is evidence that evolution is progressive, that it inevitably leads to intelligence, and since in his view neodarwinism cannot explain this, something new, neovitalism, must be invoked. These claims raise some problems. First, is evolution progressive in this way? I agree with McMenamin that this is an interesting question, but I did not find any of his claims for progress convincing and do not see that he has added anything new to the debate. His assertion that "life evokes mind" is based on speculative, untestable notions about Ediacaran brains, and even if those were true, the fact that brainless life (e.g., land plants) has done quite well suggests that his claim of inevitability is a bit premature. Second, if evolution were progressive, would neodarwinian explanations suffice? Stephen Jay Gould's [1] view is that neodarwinism predicts progress, which is why Gould, who sees evolution as nonprogressive, finds neodarwinism unsatisfactory. McMenamin also finds neodarwinism unsatisfactory, but for exactly the opposite reason: In his view, neodarwinism apparently does not accommodate progressive evolution. Third, what about McMenamin's alternative, vitalism? Although unlike many vitalisms his version invokes no mystical force to explain convergence and evolutionary progress, it fails to provide anything beyond the neodarwinian interplay among a "shared genome" and "environmental constraints," and the vague and untestable, "something about the structure of the material world." Ultimately, McMenamin's neovitalism is like "the emperor's new clothes," something that only he can see. To put it another way, it is a failed experiment.

Reviewed by Tomasz Baumiller, Museum of Paleontology, University of Michigan.

REFERENCES

1. Gould, S.J. The Paradox of the First Tier: An Agenda for Paleobiology. Paleobiology 11:2–12, 1985.

BOOKS RECEIVED

Biodiversity Dynamics: Turnover of Populations, Taxa, and Communities, Michael L. McKinney and James A. Drake (Eds.), Columbia University Press, New York, 1998, pp. 528, $60.00 (hard)

Biophysics of Computation: Information Processing in Single Neurons, Christof Koch, Oxford University Press, New York, 1998, pp. 562, $59.95 (hard)

Butterfly Economics, Paul Ormerod, Faber and Faber Ltd., London, 1998, pp. 217, U.K. 16.99 RRP

Graphical Models for Machine Learning and Digital Communication, Brendan J. Frey, The MIT Press, Cambridge, MA, 1998, pp. 195, $32.00 (hard)

My Brain Is Open: The Mathematical Journeys of Paul Erdos, Bruce Schechter, Simon & Schuster, New York, 1998, pp. 224, $25.00 (hard)

Once Upon a Number: The Hidden Mathematical Logic of Stories, John Allen Paulos, Basic Books, New York, 1998, pp. 214, $23.00 (hard)

Patterns in Java, Vol. I, Mark Grand, John Wiley & Sons Inc., New York, 1998, $49.99 (paper) U.S., $70.50 Canada