The oldest animal fossils

Author:
Robert W. Gess[1]

Affiliation:
[1]Bernard Price Institute for Palaeontological Research, School for Geosciences, University of the Witwatersrand, Johannesburg, South Africa

Correspondence to:
Robert Gess

Email:
robg@imaginet.co.za

Postal address:
PO Box 40, Bathurst 6166, South Africa

How to cite this article:
Gess RW. The oldest animal fossils. S Afr J Sci. 2012;108(1/2), Art. #1064, 2 pages. http://dx.doi.org/10.4102/sajs.v108i1/2.1064

The description by Brain et al.[1] in this issue, of sponge-like organisms from Namibian rocks ranging in age between 760 Ma and 550 Ma, is extremely significant as these organisms represent the earliest record of metazoan life. This discovery places the origin of animals 100 million years to 150 million years earlier than has previously been accepted. That these organisms arose prior to the 'snowball earth'[2] and survived its extremes, presents a challenge to contemporary scientific thought.

The history of life is one of the most intriguing scientific subjects, the evidence for which is extrapolated from the comparative anatomy of living organisms, molecular studies and embryology. As early as the 6th century BC, Anaximander of Miletus proposed (presumably on the basis of comparative anatomy) that terrestrial vertebrates, including people, derived from fish.[3] Because of a lack of direct evidence, this brilliant scientific deduction did not gain ground against more romantic explanations.

Direct evidence for past life, the timing of its development and its environmental setting are provided by the fossil record. The scientific value of fossils, however, remained largely untapped until relative dating of geological strata placed them in an informative sequence. Lyell, during the early 19th century, established the basic sequence of strata in western Europe and realised that dissimilar strata of similar age could be correlated on the basis of their changing fossil content. Although he postulated environmental change as a mechanism for the loss of species, he could not account for the gradual introduction of new species.[4]

Darwin introduced the theory of natural selection based largely on his observations of anatomy and functional adaptation. Although he acknowledged that the fossil record should provide support for his theories he was concerned that it rather presented a number of challenges. Foremost amongst these challenges was the apparent sudden appearance of diverse animal forms at the beginning of the Cambrian Period (542 Ma), whilst no fossils were known from older rocks. This 'Cambrian Explosion' was at odds with his theory of the gradual diversification of life.[5]

Lack of recognised Precambrian fossils persisted until 1957 when a frond-like fossil, *Charnia masoni*, was described from Precambrian rocks of undoubted origin in Britain. This discovery led to the acceptance that various previously discovered metazoan fossils were also Precambrian. These fossils included five species collected in Namibia early in the 20th century and similar fossils described during the 1940s from the Ediacaran Hills in Australia. Ediacaran (or Naman) faunas, aged between 635 Ma and 542 Ma have subsequently been recorded from many parts of the world.[6] These post-date a series of ice ages that are believed to have enveloped the entire planet, creating a 'snowball earth'[2] and possibly triggering the emergence of animals. Peculiarly, Ediacaran faunas (mostly sessile soft-tissued filter feeders), appear to belong to a separate radiation of multicellular life from that seen in Cambrian and subsequent rocks.[7] The latest Precambrian of Namibia has also produced hard-tissued fossils in the form of calcareous tubes (*Cloudina*) and small goblet-shaped structures (*Namacalathus*), which may have housed early coelenterates. *Cloudina* have also been reported from other parts of the world.[8] In addition possible sponge embryos of Ediacaran age have been reported from China.[9]

Evidence for microbial life includes apparent bacterial fossils from approximately 3500-million-year-old rocks of the Warrawoona Group of Western Australia[10] and the Onverwacht Group (Barberton Supergroup) of South Africa. The overlying Fig Tree Group (Barberton Supergroup) contains stromatolites – finely layered domes and columns produced by mats of photosynthetic cyanobacteria. Stromatolites dating back 3500 million years are also found in Zimbabwe and Australia and continue to be produced. The almost 3000 million years between these earliest records of microbial life and the multicellular life of Ediacaran times, have unfortunately left a very sparse record of the emergence of multicellular life.

Recently described 2100-million-year-old pyritic structures from Gabon,[11] superficially resembling small bacterial monocultures, have been presented as the earliest evidence of multicellular life, although they may not represent a significant departure from the level of stromatolites. Somewhat more convincing are the similarly aged *Grypania spiralis*, bifurcating straps or tubes of up to 10 cm long from the banded iron formation strata of Michigan, which may represent cooperative bacterial colonies or perhaps early algae.[12] Peculiar strings of small rounded masses from Australia and China (*Horodyskia*), dating back 1400 million years may also represent some form of colonial organism.[13]

By contrast, the fossils newly reported by Brain et al.[1] demonstrate a complex rigid structure consistent with requirements for the feeding mechanism of sponges, suggesting the presence of animals of a high level of organisation. The rocks of southern Africa have yet again yielded up key evidence regarding the history of life.

References

1. Brain CK, Prave AR, Hoffmann KH, et al. The first animals: ca. 760-million-year-old sponge-like fossils from Namibia. S Afr J Sci. 2012;108(1/2), Art. #658, 8 pages. http://dx.doi.org/10.4102/sajs.v108i1/2.658
2. Hoffman PF, Kaufman AJ, Halverson GP, Shrag DP. A Neoproterozoic snowball earth. Science. 1998;281;1342–1346.
3. Russel B. History of Western philosophy. 2nd ed. London: George Allen and Unwin; 1961.
4. Lyell C. Principles of geology. 4th ed. London: John Murray; 1835.
5. Darwin C. On the origin of species. London: John Murray; 1859.
6. Narbonne GM. The Ediacara biota: Neoproterozoic origin of animals and their ecosystems. Ann Rev Planet Sci. 2005;33:421–442. http://dx.doi.org/10.1146/annurev.earth.33.092203.122519
7. Seilacher A. Vendozoa: Organismic construction in the Proterozoic biosphere. Lethaia. 1989;22:229–239. http://dx.doi.org/10.1111/j.1502-3931.1989.tb01332.x
8. Amthor JE, Grotzinger JP, Shroeder S, et al. Extinction of *Cloudina* and *Namacalathus* at the Precambrian-Cambrian boundary in Oman. Geology. 2003;31(5):431–434. http://dx.doi.org/10.1130/0091-7613(2003)031<0431:EOCANA>2.0.CO;2
9. Hagodorn JW, Xiao S, Donoghue PCI, et al. Cellular and subcellular structure of Neoproterozoic embryos. Science. 2006;314(5797):291–294. http://dx.doi.org/10.1126/science.1133129, PMid:17038620
10. Schopf JW, Packer BM. Early Archean (3.3 to 3.5 billion-year-old) microfossils from the Warrawoona Group, Australia. Science. 1987;237:70–73. http://dx.doi.org/10.1126/science.11539686, PMid:11539686
11. Albani AE, Bengtson S, Canfield ED, et al. Large colonial organisms with coordinated growth in oxygenated environments 2.1 Gyr ago. Nature. 2010;466:100–104. http://dx.doi.org/10.1038/nature09166, PMid:20596019
12. Han TM, Runnegar B. Megascopic eukaryotic algae from the 2.1-billion-year-old negaunee iron-formation, Michigan. Science. 1992;257(5067):232–235. http://dx.doi.org/10.1126/science.1631544, PMid:1631544
13. Dong L, Xiao S, Shen B, Zhou C. Silicified *Horodyskia* and *Palaeopascichnus* from upper Ediacaran cherts in South China: Tentative phylogenetic interpretation and implications for evolutionary stasis. J Geol Soc. 2008;165:367–378. http://dx.doi.org/10.1144/0016-76492007-074