Reconstructing the lipid composition of Ediacaran macroorganisms using molecular fossils

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The emergence of modern animal phyla in the Cambrian was preluded by the appearance of large architecturally complex organisms, the Ediacara biota (571 to 539 Ma). These fossils might hold clues to the history of the animal lineage and the evolution of complex multicellular life on Earth. However, most of them have evaded taxonomic classification, with interpretations ranging from marine animals or giant single-celled protists to bacterial colonies and terrestrial lichens.

A technique of analysing biomarkers from individual fossils opens a new dimension in the study of the Ediacara biota. Instead of looking at their morphology, it allows to analyse remains of organic molecules of these enigmatic organisms. Biomarkers represent skeletons of biomolecules produced by living organisms; as different groups of organisms possess different lipids, biomarkers can be used to unravel their biological origins. Thus, Ediacaran fossils *Beltanelliformis* have been shown to contain abundant hopanes and long-chain *n*-alkanes with odd-over-even predominance, indicating that these fossils represent colonies of cyanobacteria similar to modern *Nostoc*. Biomarkers from *Dickinsonia*, along with two other dickinsoniid genera, *Andiva* and *Yorgia*, indicate that they belong among the oldest animals in the rock record.

The biomarker technique has yet broader applications than uncovering the biological origins of ancient organisms. In addition to membrane lipids, animals may contain molecules of what they have eaten. Using biomarkers, we were able to detect the presence of a gut in some of Ediacaran macroorganisms and distinguish the lipid composition of their last meal. Gut content analysis is one of the most powerful tools for deciphering trophic structure of ancient ecosystems and ecology of their members. Biomarkers provide a new dimension to these studies, allowing to analyse the gut content of ancient macroorganisms even when it is not fossilized.