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USING BIOMARKERS TO INVESTIGATE ANCIENT SYMBIOSIS

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Biomarkers are organic molecules that can be unambiguously assigned to groups of organisms, on the basis of their unique chemical structures and/or stable isotopic signature. Many prokaryotic biomarkers can be recognised in the fossil record, and some have been recovered from macrofossils or coprolites. In such materials, they can be used to reconstruct the microbial assemblages symbiotically associated with ancient animals.

Examples of modern macrofauna with endosymbiotic microbes include cold seep bivalves with chemosynthetic bacteria, ruminant mammals with cellulose-digesting bacteria and methanogenic archaea and corals with photosynthesising dinoflagellates.

Previous work has confirmed the presence of biomarkers (including bacterial fatty acids, methyl sterols and bacteriohopane polyols) from endosymbiotic bacteria in a modern cold seep mussel (Jahnke *et al.*, 1995). The presence of methanogenic archaea in faeces has been confirmed for a variety of different animals using non-biomarker techniques (e.g. Sorlini et al., 1988) and one study has recovered bacterial biomarkers from a Cretaceous dinosaur coprolite (Hollocher *et al.*, 2001). To our knowledge, the biomarker content of dinoflagellates living symbiotically with corals has not yet been investigated, but dinoflagellates in other settings have been shown to contain a characteristic suite of biomarkers, most importantly dinosterol (e.g. Shimizu et al., 1975).

We aim to investigate the potential of extending the biomarker approach to track biochemical processes such as chemosymbiosis, photosymbiosis and methanogenesis in the fossil record, on the scale of individual organisms. Our geochemical analyses of body fossils and coprolites will be interpreted with reference to a suite of equivalent modern samples. Although symbiotic associations between microbes and macrofauna in the geological record are often inferred on the basis of uniformitarianism, ecology and preservational features, the biomarker approach will provide a critical complementary means of demonstrating the presence of symbiotic microbes. This has the potential to provide insights into larger questions such as the evolution of nutritional and digestive strategies through time.

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