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Ediacaran macroalgae and the early evolution of animals

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The Ediacaran Period represents a critical transition in the history of the Earth and life. During this interval our planet experienced major carbon cycle perturbations, subtle but critical oxygenation of global oceans, and transformative biological innovations. One of these key innovations is the radiation of macroscopic and complex eukaryotic life. Traditionally, scientists have focused their research on Ediacaran animal evolution, its environmental context, and its geobiological consequences. However, microbial communities and algae were also important players in the late Neoproterozoic biosphere.

The oldest-known macroalgal fossils are preserved as carbonaceous compressions in the Paleoproterozoic [1, 2], but macroalgae did not begin to diversify morphologically and ecologically until the Ediacaran Period [3]. Because macroalgae are important primary producers in modern ecosystems, it is reasonable to infer that they played a pivotal role in the evolution of early animals by providing novel ecospace. It is important, therefore, to gain knowledge about the Proterozoic and Paleozoic evolution of macroalgal communities. To address questions about biospheric evolution before and shortly after emergence of animals, we carried out a comprehensive analysis of Proterozoic and Paleozoic macroalgal fossils.

Our study focused on morphological disparity and trends in morphospace evolution of macroalgal fossils spanning from the Paleoproterozoic to Silurian. We assembled a database of published occurrences and morphologies of fossil macroalgae. The database includes information about geographic and stratigraphic occurrences, morphological characters, and inferred functional form groups [4, 5].

Preliminary data reveal key trends in macroalgal morphospace evolution. First, empirical morphospace expanded continuously from the Paleoproterozoic through the Neoproterozoic. This confirms an earlier finding based on a smaller dataset [3]. Second, in terms of functional form groups, Paleoproterozoic to Mesoproterozoic macroalgal communities were dominated by forms adapted to low-disturbance environments, whereas those in the Neoproterozoic and early Paleozoic developed strategies to tolerate increasingly greater disturbances. These patterns may have been driven by increasing animal activities, particularly grazing, that had an impact on the evolution of macroalgal forms and functions.

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