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Primary producers and detritivores: Microbial fossils from the lowest Cambrian of South China

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Trophic relationships determine the routes of energy flow and chemical cycling in an ecosystem. In modern marine environments, the trophic level that ultimately supports all others in an ecosystem consists of autotrophs, the primary producers, above which are sequentially herbivores, carnivores and tertiary consumers. Detritivores or decomposers connect all trophic levels. Therefore, primary producers and decomposers play a central role in energy and material cycling, which flow through the trophic levels eventually to detritus and then cycle back to primary producers. Such complexity of marine ecosystems has been built since the Cambrian explosion with advents of diverse metazoans. In the past much attention has been paid to evolutionary and ecologic aspects of earliest metazoans that are herbivores and carnivores in Cambrian marine ecosystems. However, much less has been known about primary producers and decomposers in metazoan-dominated ecosystems initially established during the Cambrian explosion, largely because they are microorganisms that have less potential for preservation or discovery. Here we show fossilized microbial colonies (Fig. 1) from a phosphatic grain-stone bed, immediately below an ash layer dated as 536 Ma in age, in eastern Yunnan, South China. The early diagenetic phosphatization and siliceous cementation are responsible for the preservation of microbial structures. Interweaved microbial filaments in phosphatized mat fragments are primary producers colonized in benthic microbial mats (Fig. 1A, B), while filamentous and coccus colonies in cavities of shells and interstitial spaces are interpreted as remains of detritivores (Fig. 1C, D). The microbial filaments are heavily coated with phosphorous precipitates, and thus played a crucial role in phosphorus cycling within the ecosystem.

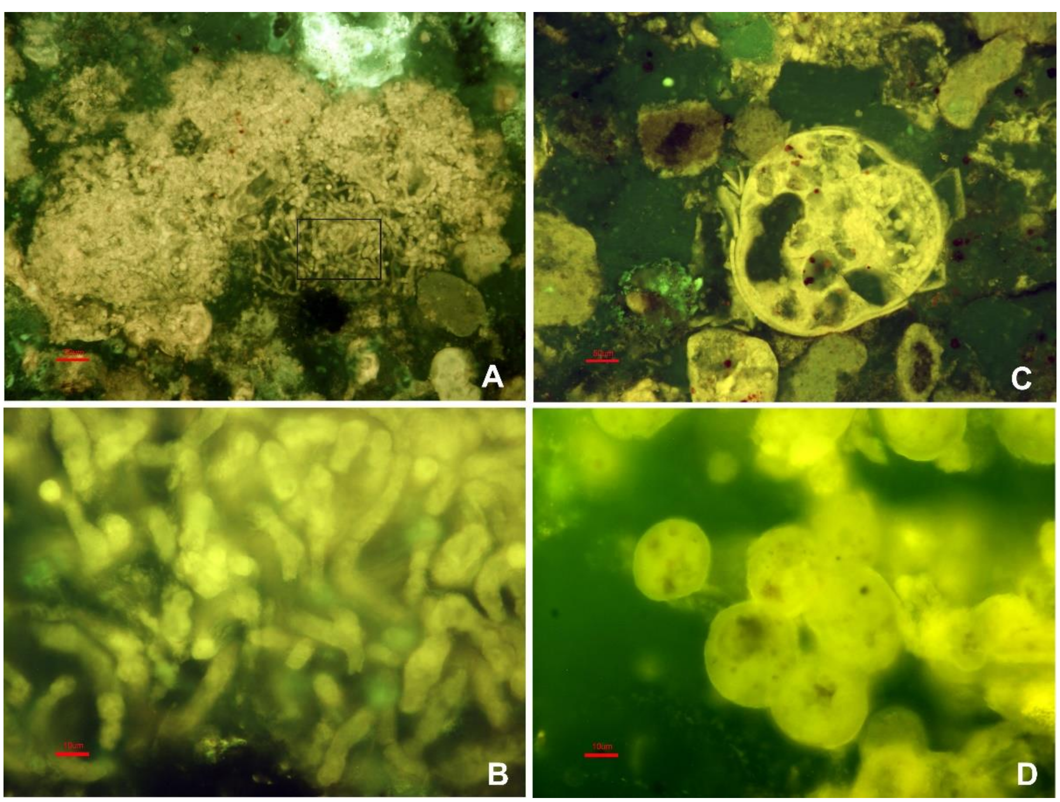

Figure 1: Epifluorescent images of microbial fossils from the lowest Cambrian phosphorites of South China. Microbial remains, bioclasts, and phosphatized peloids are strongly autofluorescent compared with the siliceous cements. A, mat fragment; B, enlargement of squared field in A, showing interweaved microbial filaments; C, shell of Anabarites trisulcatus with microbes living in the cavity; D, interstitially colonized cocci. Scale bars, 50 µm in A and C, 10 µm in B and D.