k16 Stromatolite heyday < bacteria >

> He who would explain to us when men like Plato spoke in earnest, when in jest or half jest, what they wrote from conviction and what merely for the sake of the argument, would certainly render us an extraordinary service and contribute greatly to our education.
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> —Johannn Wolfgang von Goethe (1749-1832).[1]

A fossil is any evidence of prehistoric life. Some of these are mound-like finely layered structures called *stromatolites*. By the physical features of their non-flat laminations, associated sedimentary textures and structures, stromatolites were long suspected to be shallow water, calcareous, organic (bacteria) built, reefs. Stromatolites, are also distinctive by being free of animal skeletal features (as say the spicules of stony sponges or the pillars of stromatoporoids).

Living free-standing stromatolites were discovered in 1956 in Hamelin Pond (Hamlin Pool) in the southern part of Shark Bay, Western Australia,[2] and in 1986 in Exuma Sound of the Bahamas.[3] They are constructed by the sediment binding or precipitating activities of microbial mats or biofilms (composed mainly of cyanobacteria).

Thereafter, a biological explanation for similar structures in limestones (and dolostones) became generally accepted.[4] However, the biogenicity of fossil stromatolites is for the most part a working assumption as they only rarely contain fossil microbes and compared to living examples they have a finer grain (which could be diagenetic or could indicate a different method of growth). Some forms could have originated by abiotic chemical precipitation (*see* Topic *L8*).

The same photosynthetic bacteria that build the living free-standing stromatolites are found in abundance as major contributors along with crustose coralline algae to the bulk of present animal skeletal-reefs. In these, the reef-building animals inhibit grazers and allow cyanobacteria and algae to flourish, but only in nooks and crannies between them. In keeping with this observation, free-standing stromatolites form today only in extreme marine environments of high salinity, as in Hamelin Pond, or where fast currents, as in Bahamian examples, exclude grazing animals.

Peter Garrett in 1970 noted that grazing and boring invertebrates began their expansion mid-Ordovician. And, Phanerozoic fossil stromatolites are rare *except* in Early Ordovician and Cambrian epeirogenic-sea sediments in which isolated stromatolite reefs are common. Interpretation is that the evolution of efficient grazers during the early Phanerozoic changed the ecological rules as to where thereafter the cyanobacteria could flourish.[5]

In Late Proterozoic shallow water marine sediments, stromatolites are everywhere common and are readily visible as the only macrofossils, some being giant reefs, even though the microscopic and rarely fossilized cyanobacteria that built them are not. Stromatolite diversity was greatest in the Late Precambrian (***Figure k16.1***) when shallow-water carbonate deposition first became abundant.

The reef-building cyanobacteria have left a clear record of their existence from the earliest times. This is because they left something hard that was preserved as a visible part of the sedimentary rock record. Old stromatolites are described from Early Proterozoic 2.1 Gy Mary Ellen Jasper, Minnesota, and 2.2 Gy Kona Dolomite, Michigan,[6] and from Late Archean 2.724 Gy Tumbiana fm, Australia.[7] ❑

Figure **k16.1** [8] Ranges of some distinctively shaped stromatolites in the Precambrian of Russia which have been used there to distinguish subdivisions of the Riphean. To classify stromatolites, the methodology is to describe their morphology and surface characteristics (reconstruct from serial sections) and then to petrographically analyze the microstructure (the geometry and orientation of primary components of the laminations). Classification is into groups or “genera” distinguished by shape, branching, morphology of the marginal zone, and the geometry of the laminations. In a genera, different forms or “species” are distinguished by details of fine structure and (cont.)