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EARLY ARCHEAN (~3.4 Ga) PROKARYOTIC FILAMENTS FROM CHERTS OF THE APEX BASALT, WESTERN AUSTRALIA: THE OLDEST CELLULARLY PRESERVED MICROFOSSILS NOW KNOWN

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In comparison with that known from later geologic time, the Archean fossil record is miniscule: although literally hundreds of Proterozoic formations, containing more than 2800 occurrences of bona fide microfossils, are now known, fewer than 30 units, containing some 43 categories of putative microfossils (the vast majority of which are of questionable authenticity), have been reported from the Archean. Among the oldest fossils now known are Early Archean filaments reported from cherts of the Towers Formation (Awramik et al., 1983) and the Apex Basalt (Schopf and Packer, 1987) of the 3.3-3.6 Ga-old Warrawoona Group of Western Australia. The paleobiologic significance of the Towers Formation microstructures is open to question: thin aggregated filaments described by Awramik et al. are properly regarded as "dubiomicrofossils" -- perhaps biogenic, but perhaps not -- and they therefore cannot be regarded as firm evidence of Archean life. And although authentic, filamentous microfossils were reported by Awramik et al. from a second Towers Formation locality, because the "precise layer" containing the fossiliferous cherts "has not been relocated" (Awramik et al., 1983, 1988), this discovery can neither be reconfirmed by the original collector nor confirmed independently by other investigators.

Discovery of microfossils in bedded cherts of the Apex Basalt (Schopf and Packer, 1987), the stratigraphic unit immediately overlying the Towers Formation, obviates the difficulties noted above. The cellularly preserved filaments of the Apex Basalt meet all of the criteria required of bona fide Archean microfossils: (i) they occur in rocks of unquestionably Archean age; (ii) they are demonstrably indigenous to these Archean sediments; (iii) they occur in lithic clasts that are assuredly syngenetic with deposition of this sedimentary unit (with the fossils themselves pre-dating deposition of the bedded cherts in which the clasts occur); (iv) they are certainly biogenic; and (v) as demonstrated by replicate sampling of the fossiliferous outcrop, the provenance of these microfossils is known with certainty. Recent studies indicate that the Apex assemblage includes at least six morphotypes of uniseriate filaments, composed of barrel-shaped, discoidal, or quadrate cells and exhibiting rounded or conical terminal cells and medial bifurcated and paired half-cells that reflect the occurrence of prokaryotic binary cell division. Interestingly, the majority of these morphotypes are morphologically more similar to extant cyanobacteria than to modern filamentous bacteria. Prokaryotes seem clearly to have been "hypobradytelic," exhibiting exceptionally slow rates of morphological evolutionary change, and the evidence suggests (but does not prove) that physiologically advanced oxygen-producing photosynthesizers may have been represented in the Early Archean biota.