Comparative Evolution of Life on Planets in the Solar System

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We have isotopic evidence for life on Earth at 3.8 b.y. in rocks from Greenland (1) and the first microfossils are found in 3.5 b.y.-old cherts from South Africa and Australia (2-5). The earliest fossils appear to be simple prokaryotes. Although some of the early fossils were interpreted as possible cyanophytes (5), the earliest evidence for oxygenic photosynthesising bacteria comes from biochemical markers in the 2.7 b.y.-old, Australian Hammersley Basin shales (6). The latter sediments also contain chemical derivatives of molecules commonly attributed to eucaryotes, thus intimating perhaps earlier evolution of the eucaryotes than commonly believed (7). Be that as it may, widespread divergence and evolution appears to have occurred only after a dramatic rise in atmospheric O2 levels at about 2.2-2.3. b.y. (8).

Two other planets in our solar system are candidates for possible extinct life, Mars and Venus. After the consolidation of the planets, both had liquid water on the surface (9,10). Although the surficial environment of Mars deteriorated early in its history (about 3.5 b.y (9)), with the loss of continuous liquid water at the surface and also loss of much of its atmosphere, there was plenty of time for life to have developed. However, owing to the deteriorating conditions, there was probably not enough time for it to have evolved beyond the procaryote stage. Terrestrial procaryotes are remarkably resilient and are capable of living in the most extreme environments. It is feasible that Martian life could have taken refuge in underground aquifers (now frozen) and may still resurface as reactivated spores during impact related melting of the frozen aquifers. Similarly to Mars, early climatic deterioration on Venus due to a run- away greenhouse effect would have precluded evolution beyond the procaryotic stage. However, given the elevated surface and subsurface temperatures, life could not have survived.