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Anaerobic Microbial Interactions with Fullerenes: Implications for the Use of Extra-terrestrial Organics by Life on Early Earth

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The appearance of the first microbial life on Earth coincided with the Late Heavy Bombardment, during which time a large amount of meteoritic material was accreted. A significant fraction of this material contained organic carbon of extra-terrestrial origin which likely survived atmospheric entry. It is therefore highly plausible these extra-terrestrial carbon compounds interacted with primitive microorganisms in some respect. Of the known extra-terrestrial carbon compounds found in meteorites, little is known about the effect of fullerenes and their derivatives on microbial communities. An anaerobic community is used in our studies as a model to infer how these compounds may have influenced the metabolic development of primitive microbes with respect to the environmental conditions on the early Earth.

Pristine high molecular weight fullerenes C_{60} and C_{70} appear to have no effect on the growth of anaerobic microorganisms when an additional carbon source is present. Community growth is significantly reduced when C_{60} is present as the sole carbon source and no intermediate breakdown products are detected with mass spectrometry. Some features observed with transmission electron microscopy indicate ingestion of small amounts of C_{60} may be occurring, however C_{60} and C_{70} remain to appear relatively inaccessible to anaerobic microbes.

The naturally occurring water-soluble C_{60} derivative, C_{60} fullerol, is inhibitory to the growth of this anaerobic community, particularly when exposed to ambient or short-wave UV light. The presence of these fullerene derivatives on the early Earth therefore may have had an inhibitory effect on the development of primitive microbes and added to the selection pressures driving metabolic evolution.

Current and future work focuses on simulating early Earth environmental conditions to produce naturally occurring fullerene breakdown products as potential sources of accessible carbon for primitive microorganisms.