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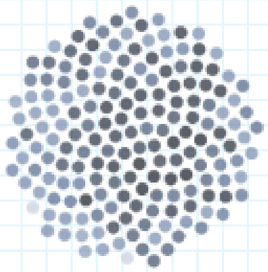

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Prior to two billion years ago, oxygen wasn't as necessary for life to exist as it is now.

by Britt Peterson • Posted March 29, 2006 12:17 AM

Oxygen was not always an integral part of terrestrial life. More than two billion years ago, Earth's atmosphere was composed mostly of carbon dioxide, sulfur dioxide and nitrogen—oxygen made up only 0.01% of the mixture. Early organic life forms primarily consumed amino acids and organic carbon, and actually found oxygen to be toxic.

But just over two billion years ago, oxygenic photosynthesis evolved in a type of algae known as cyanobacteria, which metabolized sunlight, carbon dioxide and water into carbohydrates, producing oxygen in the process. Since the organism's three food groups were plentiful, the cyanobacteria population thrived, resulting in higher atmospheric oxygen content.

"There is evidence that oxygen was [first] made available by photosynthetic organisms about 2.2 to 2.3 billion years ago," said Daniel Segrè, a Boston University biochemist and co-author of a study published in the March 24th issue of *Science*. "This caused new troubles, due to oxygen's destructive reactivity, but also new opportunities for organisms able to take advantage of O_2 for respiration as well as for biosynthesis of previously unavailable molecules."

Segrè and his co-author, Jason Raymond of Lawrence Livermore National Laboratory, used computer models linking all known metabolic reactions across all known species into a giant network. Using this map, they were able to trace the metabolic progression of different molecules from nutrient to energy. In the more complex metabolic networks, Segrè and Raymond found that the presence of oxygen was always required.

"We were interested in understanding whether the network itself can tell us something about its history, how it may have changed upon the appearance of specific key players, like molecular oxygen," Segrè said.

As oxygen proliferated in the atmosphere, gradually reaching its current level of 20%, Earth's organisms had to evolve or die off in response to the environmental change. The organisms that did adapt found ways to transform oxygen into energy, and their cells became more complicated as new metabolic tools and organelles, like mitochondria, developed. This transformation marked a decisive shift towards more complex forms of life, said Segrè.

Segrè and Raymond's discovery hints at the possibility that a similar turn of events could effect the development of life on a different planet, somewhere in outer space. Segrè himself remains neutral.

"Our analysis emphasizes the extent to which oxygen can enrich the set of building blocks that life can utilize," Segrè said. "If we can still be surprised by analyzing what we know about life on our planet, I would think that much bigger surprises may await us with respect to possible biochemistries on other planets."

Oxygen and the Growth of Complex Organisms, written by Britt Peterson, posted on March 29, 2006 12:17 AM, is in the category Environment & Ecology. Permalink.