Earth's life support systems discussed

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In the search for life on Mars or any planet, there is much more than the presence of carbon and oxygen to consider. Using Earth's biogeochemical cycles as a reference point, elements like nitrogen, iron and sulfur are just as important for supporting life. As explored in studies published in February's open-access Special Issue of *Frontiers in Ecology and the Environment*, the most basic elements work together to support an extraordinary diversity of life.

Cycles of carbon, nitrogen and phosphorous are intertwined and rely on organisms just as much as organisms rely on these elements, explains Edward Rastetter from the Marine Biological Laboratory in Woods Hole, Massachusetts, in one of the issue's articles. For instance, fallen leaves on a forest floor supply food for microbes which excrete nutrients back into the soil, benefitting nearby trees.

Microbes transform raw materials—such as chemicals, gases and sunlight—into biomass by a variety of metabolic processes. These energy-converting processes are as diverse as the microbes that conduct them, and are much more diverse than the metabolic capabilities of plants or animals, according to Amy Burgin from Wright State University in Dayton, Ohio, and colleagues in one of the issue's articles.

Burgin and her team study rock-eating microbes, officially called chemolithotrophic microbes, and their roles in the ecosystems they inhabit. A well-known example habitat is the extreme environment of deep-sea hydrothermal vents, wherein these microbes metabolize dissolved minerals into organic forms of carbon that support complex food webs of tube worms, mussels and clams. These microbes and food webs have adapted to life without photosynthesis.

"While hydrothermal vents are an especially extreme environment where chemolithotrophic organisms play a particularly important and conspicuous role, they are also found in most aquatic environments, often at boundaries along oxygen-depleted zones of sediments or groundwater," says Burgin. "Their metabolic processes provide insight into the life forms that existed before Earth had an oxidized atmosphere. There were biogeochemical cycles, but they were driven by microbes that lived in the absence of oxygen, and these most ancient life forms persist today. Their activity helps drive biogeochemical cycling in today's world too."

In Frontiers' Life Lines column, Adrian Burton ponders a biogeochemical riddle of Mars where nitrogen is a major missing element. However, Mars may have once had much more nitrogen before losing it to space. "The interconnectedness of biogeochemical cycles is essential for life as we know it on Earth and would be for any life on Mars," says Burton. "But did any ancient Martian life that may have arisen get the time it needed to adapt to the Red Planet's changing environmental conditions, including disappearing nitrogen? Wouldn't it be nice to know!"

More information: The Special Issue of Frontiers in Ecology and the Environment on Coupled Biogeochemical Cycles is open access and available at www.esajournals.org/toc/fron/9/1

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