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EDITORS LETTER

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We Are Still Alone!

The discovery of extraterrestrial life is considered to be one of the "holy grails" of science. There are occasional reports of "signs" of extraterrestrial life, but even after billions of dollars have been spent in space exploration and scientific research, no concrete evidence has been found. Many people believe that it might be only a matter of time before we discover life beyond our planet. The Drake equation, which estimates the number of detectable communicative extraterrestrial civilizations present in the Milky Way, predicts that a large number of such life-sustaining "planets" exist within our galaxy.[1] Reports varying from the discovery of new "Earth-like" planets, to the detection of methane gas on Mars, to "arsenic-bacteria" on Earth have fueled the imagination of both the scientific and popular presses. A recent report on the discovery of the "most-Earthlike" exoplanet, Gliese 581 g, led to the sale of four hectare plots on this planet on the popular Internet auction site, eBay. Yet, the planet in question may not truly exist.[2]

The discovery of methane on Mars by independent groups has also fueled the interest of alien life form enthusiasts.[3] Since most atmospheric methane on Earth is derived from living organisms and in particular methanogenic microorganisms, excitement stems from speculation that Mars may have some subsurface biological activity. An alternative and less sensationalized explanation is that the presence of geologic activity resulted in the release of methane from methane-ice clathrates, similar to those found in the deep ocean of our own planet.

On Earth, scientists have also focused on isolating microorganisms that use alternative energy sources and unusual metabolism to provide clues to what possible alien life forms might implement to survive seemingly inhospitable environments. Studies characterizing microorganisms isolated from ice cores of the subglacial Lake Vostok in Antarctica are an example of this line of research.

Interest in alternative metabolism under "harsh" conditions also drives research on unusual metabolism in hydrothermal vents. The energy-yielding metabolism involving the production of methane from hydrogen and carbon dioxide is sufficient to produce biomass. Microorganisms that utilize the energy derived from the oxidation of hydrogen sulfide or ammonia have also been widely studied. These microorganisms form the bottom of the food chain at these hydrothermal vents that supports higher life forms such as tubeworms, clams, shrimp, *etc*. These drastically different environments may provide analogous environments to those predicted to exist on the Mars or on the Jovian moon, Europa.

Recently, Wolfe-Simon *et al.* reported the isolation of an "arsenic-bacteria" from Mono Lake in California.[4] Living things primarily contain six elements: carbon, nitrogen, hydrogen, oxygen, sulfur, and phosphorus. Hence, the study claiming the presence of a microorganism that substitutes the key element phosphorus for arsenic heralded the possibility that yet unknown life forms were waiting to be discovered on this planet that might aid in a broader search for life elsewhere. Two simultaneous peer-reviewed manuscripts on the challenges that bacteria would face if it were to exchange out phosphorus for arsenic have now been published. In the current issue of *ACS Chemical Biology*, Fekry *et al.* (DOI: 10.1021/cb2000023) highlight the kinetic challenges encountered in exchanging arsenic in place of phosphorus in DNA. In another perspective in *Biochemistry*, Dan Tawfik (DOI: 10.1021/bi200002a) reviews the implications of replacing phosphorus with arsenic in phosphorus-containing enzymes.[5,6] We invite you to peruse through these manuscripts.

Ultimately, even if future studies prove that the "arsenic-bacteria" does in fact completely swap phosphorus for arsenic, it does not translate to isolating an alien life form. It simply means that we have to expand the paradigm when looking for extraterrestrial life.

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