

# Studies dispel claims of 'shadow biosphere' on Earth

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A few scientists have argued that descendants of an alternative origin of life may still lurk in a "shadow biosphere" somewhere here on Earth. It's an intriguing idea, but the search for the shadow inhabitants is becoming the Bigfoot hunt of microbiology.

Not that Bigfoot isn't potentially exciting. But there isn't much convincing evidence that one exists and it's hard to know where a viable population could live without being squeezed out of existence by modern humans. Likewise, the real biosphere leaves little room for a shadow one. All [life](#) ever observed shows the DNA signature of common [ancestry](#).

Last week, two teams of researchers published refutations of one of the most striking claims allegedly supporting the shadow biosphere. The original claim came out in December 2010 when scientists suggested at a [NASA](#) news conference that [microbes](#) from California's [arsenic](#)-rich Mono Lake either came from a shadow biosphere or at least helped bolster the notion that it might exist.

The lead researcher, Felisa Wolfe-Simon, compared the importance of her work to the original discovery of the [structure of DNA](#) by Watson and Crick. It seemed like quite a grand comparison to make if they didn't actually have a shadow biospherian. In some statements, the Wolfe-Simon team implied they knew their bacteria weren't part of a shadow biosphere, but they considered it weird enough to lend credibility to the idea.

Except that it wasn't that weird. They claimed that the [organisms](#) substituted arsenic for phosphorus in their DNA, and in their news conference implied their microbe needed no phosphorus and ate arsenic like it was ice cream.

It's textbook knowledge that all living things require six elements: carbon, nitrogen, [hydrogen](#), oxygen, sulfur and phosphorus. While the researchers were vague about whether the organism lived without any phosphorus, a news release from NASA definitely said it did. NASA even used the title: "Get out your biology textbook ... and an eraser."

Some biologists consider the episode a failure on NASA's part as well as on the part of the journal Science for publishing the original findings.

Felisa Wolfe-Simon has maintained that she's right, but she's not particularly clear which part she's still right about. What became clear last week was that the new papers, just published in Science, refute any part of the original claim that would have made it remotely exciting. Biologists weren't surprised by the refutation, since most who read the paper said the team never produced data to support their shadow biosphere-related claims in the first place.

It's unfortunate that other more interesting and established findings haven't attracted the public's attention, said Cornell University biologist John Helmann. He has just published a review paper describing the variety of "austerity measures" that life has evolved to adapt to shortages of essential chemical elements - the building blocks of matter found in the periodic table. "It's fascinating the extent to which organisms have evolved mechanisms to optimize growth despite the limited availability of essential elements," he said.

One organism described in his review adapted to a high-cadmium environment by substituting that toxic metal for zinc. And the Lyme

disease bacteria has adapted to life without iron, he said. "But that's not being used to invoke the shadow biosphere." Of course, invoking the shadow biosphere is what produced the fawning press attention to the Mono Lake findings.

A shadow biosphere would be a godsend for NASA, helping them narrow down their definition of life, and thereby figure out what to look for on other planets. NASA defines life as any self-replicating system that can undergo Darwinian evolution, but it would be helpful to know just how different alien life might look from our own.

University of British Columbia biologist Rosie Redfield, who authored one of the papers refuting the arsenic-based life claim, said the Mono Lake organisms were growing on small amounts of phosphorus that contaminated the medium in which they were kept in the lab. She and another team got samples of the same bacteria used by the Wolfe-Simon team and with more precise measurement techniques showed that there was no arsenic in the organisms' DNA. They also showed that the bugs didn't grow without [phosphorus](#).

But even if Wolfe-Simon's controversial findings had been confirmed, its DNA proves it's not part of a shadow biosphere but a product of adaptation. That's exactly the kind of adaptability that would make it hard for a shadow biosphere to compete with life as we know it. It's possible that different forms of life once coexisted, but today, just one kind of life with one origin seems to occupy all possible habitats. Anywhere there is a source of energy and the right elements, people are finding DNA-based life - a mile underground, buried in permanently frozen lakes, and even in nuclear reactors.

"What people forget is that the known biosphere is so flexible and versatile that it can adapt to almost anything, which rules out the niche that a shadow one could use," said Brandeis University biologist Gregory

Petsko.

If there was another biosphere, I'm betting it got crowded out by the one we see now, he said, the same way Neanderthals and various other human cousins were displaced by modern humans.

Unless, that is, you believe in Bigfoot.

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