H. BORTMAN

Felisa Wolfe-Simon has been criticized for her work on bacteria recovered from an arsenic-rich lake.

MICROBIOLOGY

Will you take the 'arsenic-life' test?

Critiques prompt researchers to offer samples of poison-tolerant microbe to doubters.

BY ERIKA CHECK HAYDEN

At first, it sounded like the discovery of the century: a bacterium that can survive by using the toxic element arsenic instead of phosphorus in its DNA and in other biomolecules.

But scientists have lined up to criticize the claim since it appeared in *Science* six months ago[1]. Last week, the journal published a volley of eight technical comments[2–9] summarizing the key objections to the original paper, along with a response from the authors[10], who stand by their work.

The authors of the original paper are also offering to distribute samples of the bacterium, GFAJ-1, so that others can attempt to replicate their work. The big question is whether researchers will grab the opportunity to test such an eye-popping claim or, as some are already saying, they will reject as a waste of time the chance to repeat work they believe is fundamentally flawed. "I have not found anybody outside of that laboratory who supports the work," says Barry Rosen of Florida International University in Miami, who published an earlier critique of the paper[11].

Some are also frustrated that the authors did not release any new data in their response, despite having had ample time to conduct follow-up experiments of their own to bolster their case. "I'm tired of rehashing these preliminary data," says John Helmann of Cornell University in Ithaca, New York, who critiqued the work in January on the Faculty of 1000 website[12]. "I look forward to the time when they or others in the field start doing the sort of rigorous experiments that need to be done to test this hypothesis."

The original study[1], led by Felisa Wolfe-Simon, a NASA astrobiology research fellow at the US Geological Survey in Menlo Park, California, looked at bacteria taken from the arsenic-rich Mono Lake in southern California. The authors grew the bacteria in their lab using a medium that contained arsenic but no phosphorus. Even without this essential element of life, the bacteria reproduced and integrated arsenic into their DNA to replace the missing phosphorus, the paper reported.

"We maintain that our interpretation of As [arsenic] substitution, based on multiple congruent lines of evidence, is viable," Wolfe-Simon and her colleagues wrote in last week's response[10].

But critics have pointed out that the growth medium contained trace amounts of phosphorus[2,3] — enough to support a few rounds of bacterial growth[5]. They also note that the culturing process could have helped arsenic-tolerant bacteria to survive by killing off less well-equipped microbes[3].

Others say that there is simply not enough evidence that arsenic atoms were incorporated into the bacterium's DNA[4,6–9]. The chemical instability of arsenate relative to phosphate makes this an extraordinary claim that would "set aside nearly a century of chemical data concerning arsenate and phosphate molecules", writes Steven Benner[4] of the Foundation for Applied Molecular Evolution in Gainesville, Florida.

A leading critic of the work, Rosemary Redfield of the University of British Columbia in Vancouver, Canada, says that it would be "relatively straightforward" to grow the bacteria in arsenic-containing media and then analyse them using mass spectrometry to test whether arsenic is covalently bonded into their DNA backbone.

Redfield says that she will probably get samples of GFAJ-1 to run these follow-up tests, and hopes that a handful of other laboratories will collaborate to repeat the experiments independently and publish their results together.

But some principal investigators are reluctant to spend their resources, and their students' time, replicating the work. "If you extended the results to show there is no detectable arsenic, where could you publish that?" asks Simon Silver of the University of Illinois at Chicago. "How could the young person who was asked to do that work ever get a job?"

Helmann says that he is in the process of installing a highly sensitive mass spectrometer that can measure trace quantities of elements, which could help refute or corroborate the findings. But the equipment would be better employed on original research, he says. "I've got my own science to do." ■

NATURE.COM
For a longer version of this story see:
go.nature.com/oaetjq

1. Wolfe-Simon, F. *et al. Science* doi:10.1126/science.1197258 (2010).
2. Foster, P. L. *Science* doi:10.1126/science.1201551 (2011).
3. Redfield, R. J. *Science* doi:10.1126/science.1201482 (2011).
4. Benner, S. A. *Science* doi:10.1126/science.1201304 (2011).
5. Cotner, J. B. & Hall, E. K. *Science* doi:10.1126/science.1201943 (2011).
6. Schoepp-Cothenet, B. *et al. Science* doi:10.1126/science.1201438 (2011).
7. Csabai, I. & Szathmáry, E. *Science* doi:10.1126/science.1201399 (2011).
8. Oehler, S. *Science* doi:10.1126/science.1201381 (2011).
9. Borhani, D. W. *Science* doi:10.1126/science.1201255 (2011).
10. Wolfe-Simon, F. *et al. Science* doi:10.1126/science.1202098 (2011).
11. Rosen, B. P., Ajees, A. A. & McDermott, T. R. *BioEssays* **33,** 350–357 (2011).
12. Helmann, J. F1000.com/6854956 (2011).

© 2011 Macmillan Publishers Limited. All rights reserved