Thomas Lewton

It's life, but much as we already know it

Mono Lake, home to the arsenic-tolerant bacteria. The strange rock formations are made of tufa, a form of limestone.

The controversial paper was published by the prestigious American journal *Science* in its rapid online version, *ScienceXpress*.

"It's life, but not as we know it" beckoned the Sun newspaper's headline last December following NASA's supposed discovery of a 'second form of life'. The scientific paper, published by the eminent journal Science, even created widespread speculation about the existence of extra-terrestrial life.

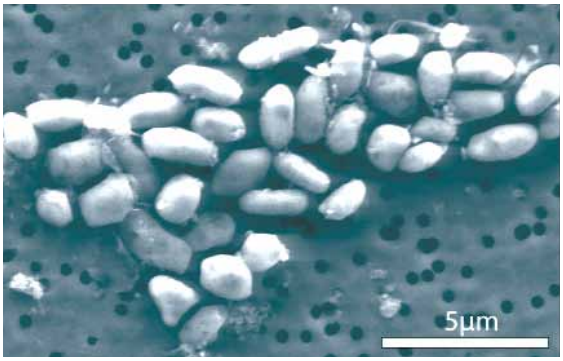
The findings turned out be rather less dramatic. If anything, scientists had discovered a new step in the order of life, rather than an entire new form of life. And that was before serious questions were raised about the scientists' methods.

Alien bacteria?

Researchers studied bacteria from Mono Lake in California, well known for its high concentrations of the poisonous chemical arsenic. Despite being highly toxic to most life, it was found that arsenic could be incorporated into the proteins and even the DNA of the bacteria. Arsenic was thought to be replacing the chemical phosphorus normally found in these molecules.

Life is mostly made up of six simple elements: carbon, hydrogen, oxygen, nitrogen, sulphur and phosphorus. Phosphorus forms the backbone of DNA molecules, the genetic blueprint of life, and is a vital component of the molecule ATP used for energy production in cells.

Arsenic has a similar atomic structure to phosphorus. Both elements lie in Group 5 of the periodic table, meaning they have the same number of electrons in their outer electron shells. This enables arsenic to be substituted for phosphorus in many chemical reactions. But the outer electrons in arsenic are more weakly attached, making molecules containing arsenic less stable than those that contain phosphorus.



A micrograph of bacteria from Mono Lake

Normally this instability stops molecules like DNA and ATP working when arsenic is substituted for phosphorus. This partly explains why arsenic is so poisonous. However, the bacteria in Lake Mono seem to have adapted to produce stable life molecules using arsenic.

The finding raised speculation about whether the unusual bacteria could be classified as a new form of life. Some people believe there could be whole communities of microbes that work using radically different molecular processes from traditional life. These are known as 'shadow biospheres' and could go unnoticed because we only go searching for life that works like our own.

Though the Mono Lake bacteria may use molecules surprisingly different from our own, they still prefer to use phosphorus when given the chance. It is only in the very extreme phosphorus-free, arsenic-rich laboratory settings that the bacteria are forced to use arsenic in their molecules. Rather than a new form of life existing in a shadow biosphere, the bacteria are just a cleverly adapted form of life from the same evolutionary tree as us.

Bad science?

While not exactly being ET, the Mono Lake bacteria were still a profound discovery. They questioned what it was possible for life to be and even extended the possibilities of what extra-terrestrial life could look like.

However, shortly after the publication of the scientific paper a number of prominent scientists spoke out against the findings. Critically, it is known that DNA with a backbone made of arsenic will split when put in water-it is not stable. The DNA of the Mono Lake bacteria was found to be stable in water, suggesting its backbone was actually made of phosphorus. It seems more research needs to be done to justify the claim that the bacteria can replace arsenic for phosphorus in their molecules.

The principal researcher on the project, Felisa Wolfe-Simon, tests sediment samples at Lake Mono.

Peer review – is it reliable?

The flaws in the science were all the more surprising because the paper was published in the well respected journal *Science*. Virtually all scientific research is published in a scientific journal. Before papers can be published they are put through a process known as peer review.

Peer review is a system used by scientists to decide which research should be published. Only research whose claims are supported by the data is meant to get published, but in the case of the Mono Lake bacteria it seems this wasn't wholly the case.

Evidently, peer review isn't a flawless process. It could be that reviewers at *Science,* over-excited about the potentially radical findings of the paper, didn't scrutinise the research enough in their haste to publish.

Felisa Wolfe-Simon (left) and her colleagues announced their findings at a NASA press conference, rather than at a scientific conference.

This isn't the only problem with peer review. Peer review doesn't check the actual scientific data on which the conclusions are based. Scientists are trusted to tell the truth about their measurements, and so peer review is unlikely to detect fraud.

Further, the reviewers of papers are often leading experts from that particular scientific field. It is suggested this could suppress ideas which disagree with mainstream scientific thinking. There is also evidence to show that reviewers are more critical of research that contradicts their own views compared to research that is in agreement.

Despite these problems, peer review does stop a lot of bad research getting through the net. The important point to recognise is that peer review is an imperfect process. Published science can be flawed, much like any other subject, and a critical eye should always be maintained.

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