Aliens and Arsenic: A Love Story

Description

NOTE: THIS POST IS TAKEN FROM MY NEWEST LABSPACES POST WHICH CAN BE FOUND HERE

Are there aliens among us?

Short answer â€“ No, at least not yet.

Despite the journalistic frenzy that was the NASA press conference held a few days ago, the paper published in the journal *Science* about a rather unique organism that was hailed as â€œextraterrestrialâ€• by the news media fell short of its promise.

Sadly, the organism they discuss is clearly terrestrial, albeit an odd one.

In the paper, the authorâ€™s discuss a bacterium that was able to use the element arsenic instead of phosphorus, but Iâ€™m getting ahead of myself. First, a little information is needed regarding DNA.

DNA possesses a backbone of a phosphate bound to a sugar molecule. The phosphate is a phosphorous atom bound to four oxygen atoms. Now remember this, it is important.

Arsenic, which is directly below phosphorus on the periodic table, shares many of the same properties with phosphorous. In fact, arsenic can bind with four oxygen atoms to create arsenate, which behaves in a very similar way to phosphate.

Now, what the researchers did in the science paper was go to Mono Lake in California and find an â€œextremophileâ€• bacteria, which is a bacteria that can survive in extremely harsh conditions (such as very high salt, temperature, high concentrations of acid, etcâ€¦). The scientists then isolated a strain of the bacteria in the lab and began to examine it.

In the lab, the researchers fed the bacteria essential nutrients, including phosphate, with little arsenic. Then, they gradually removed phosphate and replaced it with increasing concentrations of arsenic. Over time, there was no phosphate left in the nutrients and only arsenic. By probing the DNA and proteins of the bacteria, they found that the organisms were using arsenate instead of phosphate.

Basically, they had **created** arsenic-based life. They did not find arsenic-based life, but had experimentally created it.

This is where the news media got it wrong.

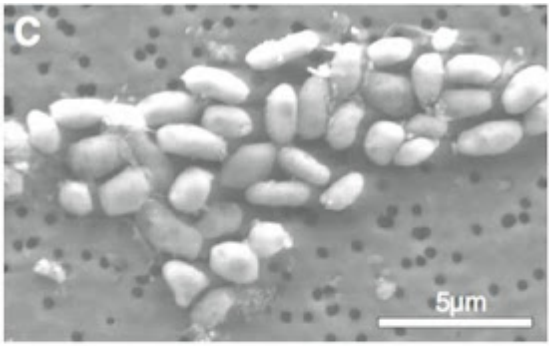
Itâ€™s just like my mom when she got me to eat spinach. She would place a few leaves of spinach into a salad, saying it was a different type of lettuce, and I would eat it all together and not be able to tell the difference. Gradually, the salads became more and more spinach and less lettuce, until there was no lettuce left.

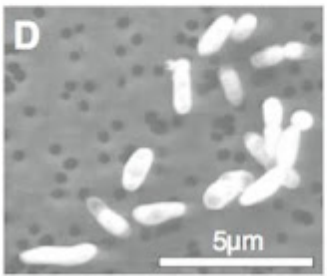
When asked if I liked the â€˜saladâ€™ and I replied with a big yes, did my mother admit that there was no lettuce in the salad â€“ just spinach. From then on, I began to eat spinach.

See, the bacteria uses phosphate just like us. They prefer it!

But, they are adapted to live in Mono Lake, which has high concentrations of arsenic (the ability to survive there is amazing in and of itself), and can incorporate it into their biological mechanisms when absolutely necessary.

Also, by taking a look at a diagram from the paper below, you can see that all was not well with the arsenate bacteria. In fact, the arsenic bacteria (D) took longer to grow than their phosphate counterparts (C), despite their increased size.





As well, the arsenic-reared bacteria had huge vacuoles (fluid filled sacs) within them. What those sacs mean is up to interpretation, as arsenic-based compounds are not very durable in water. Perhaps it was to segregate water from the fragile compounds?

Suffice to say, the discovery was cool, but it is not extraterrestrial life. It was alien, but not unlike a genetically altered *E. coli* or *Drosophila*.

Other questions also rise up regarding a phosphate-free existence:
â€“ What about ATP/ADP/AMP?
â€“ Were there traces amounts of phosphorous used in such low amounts that they were undetectable?
â€“ What about all other DNA replication, translation and transcription?

This research is interesting, and has some great potential, but is lightyears away from proof of extraterrestrial life.

Here is the paper from Science:
Wolfe-Simon, F., Blum, J., Kulp, T., Gordon, G., Hoeft, S., Pett-Ridge, J., Stolz, J., Webb, S., Weber, P., Davies, P., Anbar, A., & Oremland, R. (2010). A Bacterium That Can Grow by Using Arsenic Instead of Phosphorus *Science* DOI: 10.1126/science.1197258

Also, here is a great article written by Carl Zimmer about the discovery, where he actually interviewed the lead author and researcher in the paper:
http://blogs.discovermagazine.com/loom/

Category

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Author
mrmanly2hotmail-com