What is Life

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At the Astrobiology Science Conference last March, Astrobiology Magazine organized a debate about alien life. Using Peter Ward's book, "Life As We Do Not Know It" as a launching pad, the participants debated everything from how to define "life" to what kind of strange aliens we can expect to find in our explorations. In part three of this seven-part series, Pam Conrad touches on the practical aspects of searching for life, while Carol Cleland takes a more philosophical approach.

Lynn Rothschild: Our next speaker is Pam Conrad, who is very interested in habitability in our solar system and beyond. She is actually putting the wheel to the ground, involved in instrumentation out of the Jet Propulsion Lab to go look for it.

Pam Conrad: I'm a geologist, and so as far as I'm concerned, all of life is the residua. I think that we are basically the stuff of the Earth, at least on this planet, and that after we finish making all the good stuff, all the rest of the chemical elements that are still available, we make those biological organisms.

So that was what I was going to posit in this debate. But now I have to think about whether or not my minerals are more soluble in water or in something else. And aside from the fact that I'm middle-aged and haven't had any dinner, I'm totally confused.

But what I wanted to bring to the discussion tonight was a vision for how to look for life. I can't believe that we haven't made Star Trek real.

That's what turned me into a scientist. I really wanted to be a musician, but I couldn't resist the draw of science. And really what I couldn't resist was the draw to understand what else is there. What else is there that we do know about that we haven't uncovered yet, and what else is there that we haven't predicted, that we can't even imagine how to know about.

And looking for life is a little bit like dealing with that problem, because we think we have an idea how to look for life here. But there is no general agreement about what are the best methods to look for life that we do know about. So we're very far from consensus about how to look for life that we don't know about.

So I've defined life very loosely. It's a collection of chemical elements, and it's distinct from the collection of chemical elements that surround it, and it's arranged in three dimensions in some way that make you able to pick it out from the surrounding environment.

Now, that's a little disingenuous, because if I look at the chemical elements that make up a mineral, surely I can tell the difference between the mineral and the human. But if we get to looking at the chemical elements that make up a virus, and the properties of the mineral, the virus, and the human, then you run into a little bit of trouble, because you've got a continuum going between something that's clearly definable on one end, and something that's intuitively definable on the other. And then something that we still argue about in the middle. And I'm hoping that will be a little bit of the essence of the debate. Whether or not viruses are alive, I don't have a clue. Whether or not prions are alive, similarly, I have no clue. But whether or not they play a role and a link between what we clearly know to be the non-living and the living, I think therein lies some discussion room.

Lynn Rothschild: Next on our panel is a person who's perhaps a little unusual on a panel like this. We're very fortunate to have Carol Cleland,

a philosopher at the University of Colorado. Probably right now she wishes she was at an Aristotle convention instead of with all of us wild Indians. But she is also part of the NAI team from the University of Colorado, and has been very interested in the question of "What is life?"

Carol Cleland: The question, "What is life" is at the heart of what we're talking about on this panel today, and the strategy that's most commonly used to answer that question is to provide a definition of 'life'.

I am going to talk about problems with this approach. These problems are grounded in philosophical considerations from logic and language.

Definitions are concerned only with language and concepts. What a definition does is provide an analysis of the meaning of a word in a language. So, for example, the word "bachelor" is analyzed as "unmarried human male."

What definitions can't do is go beyond concepts and language and get at things that are independent of mind and language. And yet when we ask the question, "What is life?" this is really what we want. We don't want to know what our current concept of life is, we want to know what it really is, wherever and whenever it may be found, independently of what concepts we may happen to currently hold about life.

What this reveals is that there's a serious problem with trying to answer the question, "What is life?", and designing a search for life based upon definitions. Yet this is something that's been commonly done. The Viking mission, for example, went with a chemical metabolic definition. NASA currently has an official working definition, which is the chemical Darwinian definition. The problem with this strategy is that a definition of "life" can only reveal our current beliefs about life.

So if you go and search for life as we don't know it with a definition,

what you will tend to do is entrench our current preconceptions about of life. And this may make it more, not less difficult to recognize examples of life as we don't know it.

Let me give you an example from the history of science which I think nicely illustrates this problem. Let's imagine that we're scientists back in the seventeenth century. This is before the discovery of molecular theory - the foundations for molecular theory were laid by Lavoisier at the end of the eighteenth century.

In the seventeenth century, nobody knows about molecules or the atoms hydrogen and oxygen. So a scientist in the seventeenth century trying to answer the question, "What is water" by defining 'water' doesn't have access to molecular theory. All he has access to are the sensible properties of water. Things like being liquid, transparent, thirst-quenching, and a good solvent. And indeed the alchemists, who were early chemists, chose solvency as the pertinent feature of water. Because of this, they identified nitric acid as aqua fortis. And they also identified hydrochloric acid as aqua regia. The use of the expression "aqua" was not an accident.

The important point for us is that we know the alchemists were wrong. We know that water is H_2O. But no amount of analysis of the seventeenth century concept of water could have revealed that water is H_2O.

We run the same kind of danger when we pursue an answer to the question, "What is life?" by trying to come up with a definition based on our current concepts, and then proceeding to look for life as we don't know it using that definition.

This problem is exacerbated by the fact that we have very good reasons for believing that life as we know it on Earth today is basically a single

sample. Everything from a bacterium to the most sophisticated mammal is descended from the same last universal common ancestor. We also have reasons for believing that life as we know it may not be a representative sample of life. We know that there are ways in which life could have been modestly different. The proteins that compose the structural material of life might have used a different suite of amino acids, the nucleic acids that constitute the heredity material might have used different nucleotide bases.

So we're actually at an even greater disadvantage than the seventeenth-century scientists were with water, because we know that life as we know it may not be representative of all of life, wherever it may be found in the universe.