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“What the Hell is Astrobiology?!”

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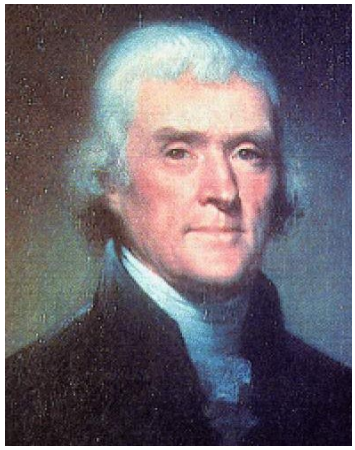
George has asked me write a few articles on the subject of astrobiology, and this will be the first in that series.

The complaint leveled against astrobiology has remained the same for forty years now: astrobiology is an area of study without a known subject. George Gaylord Simpson, one of the most highly regarded evolutionary biologists of the Twentieth Century, famously wrote in an issue of the prestigious journal *Science* in 1964: "this 'science' has yet to demonstrate that its subject matter exists!"



Thoughts of life on other planets, and what that life might be like, are “too idle to be worth a single hour of any man’s life.” This has been a common criticism among even the most revered of scientists, not for religious or philosophical reasons, but because the subject matter has been intrinsically out of reach and unprovable, one way or the other. Two of the most famous of these people have been Thomas Jefferson and the evolutionary biologist George Gaylord Simpson (Harvard and Arizona).

Yet even though the discovery of a second, independent genesis of life elsewhere in the universe may remain decades away, astrobiology will still nonetheless profoundly change of our views of the evolution of life on Earth. Geology was the science that informed and transformed biological thought during Darwin's time. Comparative planetology, although a new field of inquiry, will do the same during ours.

Speculating on the evolution of life in the universe has always been a risky business, and one not always highly regarded. Two hundred and fifty years ago, when the first thoughts that the formation of the planets must have occurred by natural means in the two competing cosmogenies of Buffon and Laplace, rather than as part of a supernatural command, the ideas were met with at best only tepid enthusiasm.

Indeed Thomas Jefferson, our most intellectual and erudite president, wrote fifty years later, in 1804, "Dreams about the modes of creation, ... [are] too idle to be worth a single hour of any man’s life."

Almost certainly Simpson and Jefferson would now change their minds when confronted with the possibilities of the discoveries that await us. Life, up until recently, has always been a property unique to the planet Earth. It really hasn't been considered in any other context. But we are now beginning an extraordinary new voyage of discovery: we are beginning to take a galactic survery of planets, at least in our very small region of the Milky Way. Because of this, we are beginning to get a sense of the diversity of planetary systems possible.

So far the results have been less than promising. The planetary systems we're finding would seem incapable of supporting life in general, and certainly not the kind of life we see here on the Earth. But those results have been greatly biased by the detection technologies we've devised so far.

The notion that the universe is populated by inhabited worlds is certainly not new. Giordano Bruno wrote in 1584, "There are countless suns and countless earths all rotating around their suns in exactly the same way as the seven planets of our system. We see only the suns because they are the largest bodies and are luminous, but their planets remain invisible to us because they are smaller and non-luminous. The countless worlds in the universe are no worse and no less inhabited than our Earth."

We are now embarking on a new series of Voyages of Discovery, reminiscent of Magellan, Cook and Darwin, but at a speed unparalleled in prior history. We are now discovering new planets at a rate of three to six a month. But we've just begun. It's been estimated that contained within the 10 parsec (32.6 ly) radius sphere surrounding Earth that there should be 30,000 planets. Some of these planets will almost certainly harbor life, and their discovery will transform evolutionary biology — if for no other reason than we are certain to be surprised.

Prior to 1995, we had no evidence of any planets outside of our own solar system. Because we were limited to just this one instance, we attempted to extract every bit of information we could from its existence. The resulting story we told ourselves was both intricate and convincing: the planets that formed near the central star were terrestrial in nature (Mercury, Venus, Earth and Mars), stony iron planets that had had their gaseous volatiles scrubbed clean by a constant solar wind. Only when the planets formed further out would they be allowed to become either the gas giants (Jupiter and Saturn) or the icy planets (Uranus and Neptune).

But the first extrasolar planets discovered were far from Earth-like. They were "hot Jupiters," orbiting just off the surface of their suns in 4-day years, something we did not even believe was possible. Indeed, we still don't believe that these planets could have

formed where they are. Current thought has these planets migrating inward in billion year trips.

The method by which these planets were discovered heavily biased the initial discoveries to finding these close-in Jupiters. We watched the light emanating from the central star being shifted from blue to red and back again in a periodic motion as these unseen massive planets jerked their suns around with each orbit, but this "radial velocity" method is far too insensitive to detect Earth-sized planets, especially at orbital distances similar to the Earth's. The planets we've discovered to date by this method are by necessity large.

To correct that deficiency, we are now in the process of building a number of spacecraft designed to be able to detect Earth-like planets. One of these missions is the Terrestrial Planet Finder. Another is the Kepler satellite. But these are just a few of the tools we've been able to devise so far, and the "science without a subject" has already proven itself to be one of the intellectually exciting and revolutionary adventures we've ever undertaken.

David Grinspoon of the Denver Museum of Nature and Science explains a bit of that excitement in this short exerpt from his 2003 book, *Lonely Planets: a natural history of alien life*:

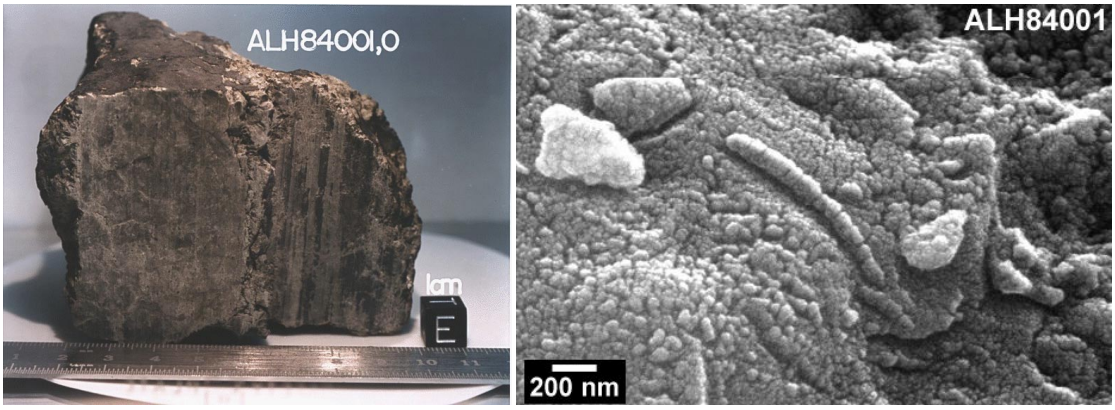
"True story: During the First Astrobiology Science Conference at NASA's Ames Research Center in April 2000, President Clinton was, by coincidence, landing at the adjacent Moffett Field Air Base, where Air Force One parks when the president comes to the San Francisco area. In a scene right out of *The X-Files*, one of his Secret Service men, who had stopped a suspicious-looking scientist, was heard to shout anxiously into his walkie-talkie, *'What the HELL is astrobiology!?'*

"Increasingly, astrobiology has become the public face of NASA, in press releases, schools, TV documentaries, and museum exhibits — astrobiology is the new hook. Across a wide spectrum of activities, aliens are in at NASA, like never before.

"What happened was that Dan Goldin, NASA's administrator at the time, took heed of the lavish press coverage [of ALH84001] and the enthusiastic public reaction to these discoveries. Halfway through his nine-year tenure at NASA (1992 to 2001), Goldin seemed convinced that exobiology, rechristened as astrobiology, should largely define NASA's mission and public image. We were given a green light to write press releases and funding proposals highlighting the question of alien life.

"It helped that, by the nineties, the second generation of planetologists was becoming well established in the field. Astrobiology may at times have been falsely hyped as a scientific revolution or a brand-new discipline, but it is a refreshing and encouraging development. A revolution really is going on — not a scientific revolution, but a revolution in the culture of science, one that is healthy for science in a number of ways.

"First, the biocentric tilt of NASA allows us to come clean about our true reasons for wanting to explore and understand the cosmos. Questions about life in the universe have



Allan Hills 84001 (ALH84001) is the meteorite from Mars that changed the course of NASA. What initiated this profound change was the discovery of the structures in the righthand image. Were these created by living processes? They look bacterial, but they are very much smaller than Earth bacteria, and the controversy concerning their origins remains one of the most intense in planetary astronomy.

always been behind our exploration of space. We just haven't always been free or willing to admit it. Of equal significance, astrobiology is bringing our space research more into line with the public's desires for NASA. You could look at this as merely improved marketing, but NASA administrators are encouraging us to pay more attention to what people respond to. As well we should. It is your tax dollars that pay for our science and exploration. We need to avoid [pandering] or [issuing] near reruns of press releases to boost our ratings, but by focusing on the question of life we are giving people what they want.

“Astrobiology's certain radical potential is in the way it bucks two deep trends in modern science. One is the tendency, in recent decades, for science (like everything else) to become much more market-driven. Profit is hot. Pure knowledge is not. An increasing portion of research is corporate-funded, which often blurs the scientific ethics. Particularly in the biosciences, corporate support has led to troubling conflicts of interest between scientists' pursuit of knowledge for the sake of humanity and the pursuit of private gain.

“Swimming against this stream is astrobiology. It is not for profit and can't pretend otherwise. We explore space for reasons that are romantic and idealistic. The universe beckons. We want to go because we want to know. With astrobiology there is no fronting the rationale is practical or the benefits material — we do it out of curiosity and longing, to satisfy the human need to know the cosmos that spawned us. Fancy that: a scientific movement that is justified on fundamentally spiritual grounds.

“There may be no turning back. NASA has thrown itself into astrobiology, and our administrators have let the planetary science community know that we are to be astrobiologists. We need the biologists now. By making ourselves dependent on astrobiology we placing a lot of trust in that relationship. This is no longer a flirtation — we're committed to an ongoing dance with biology. A divorce at this time would be messy, embarassing and costly.

“One cool thing about planetology has always been the chance to learn a lot of different kinds of science. Now this includes biology, too. For this reason I love going to astrobiology conferences. You never know what you're going to hear. The official support for astrobiology is making scientists braver in attempting to bridge disciplines. I say 'attempting' because we're out of practice at being interdisciplinary, and so there is an aggravating side to it, too. The enticingly eclectic mixture of disciplines can also be a recipe for frustration because we don't all speak the same language. All scientific conferences provide a mixture of fun and exasperation. Astrobiology conferences have more of both.”

Next Month: Astronomy’s Impact on Biology