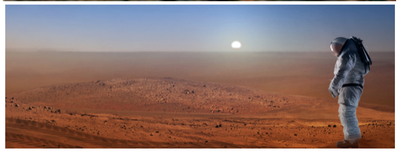

"Be Careful What You Wish For": The Scientific, Practical, and Cultural Implications of Discovering Life in Our Solar System

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- *A projection that looks back at those discoveries from the vantage point of 2050*

The 'Search for Life' is, for some in the planetary science and astronomy communities, as much a marketing strategy as it is a serious scientific pursuit. Astrobiologists are in it for the critters, but many others are happy to have the "life" brand speak for them when it comes time to attract public and private funding, but have not seriously contemplated the implications of a successful search for extinct AND extant life The hypothesis that the presence of life on Earth indicates that there should be evidence of life elsewhere in this solar system (and beyond) may not be directly relevant to the characterization of gamma-ray bursts or the measurement of the topography of Venus—but that is no condemnation. Sure, a case can be made that such results are of interest to the overall potential for life elsewhere in the universe, but it is clear that neither microbial or macro-life will have much to say about them. As such, it should be no surprise that many (if not most) space scientists—and a surprising proportion of astrobiologists—have not fully considered the implications of discovering life in our own planetary neighborhood.

Success Has a Thousand Fathers . . . and Many More Brothers and Sisters (Mars)

Upon the return of humans to the Moon in the mid-2020s, in situ sampling of former Apollo landing sites demonstrated new techniques for the use of highly sensitive instruments in a laboratory setting to search for biologically derived organic compounds (and dead organisms) to assess the contamination of the Moon by previous lunar spacecraft [1, 2]. Such studies, and the technology and technique-development that went with them, later provided a strong basis on which to build a similar crew-tended laboratory on the surface of Mars in the mid-2040s. This turned out to be an important contribution to the discovery of life on Mars, as the work in that laboratory proved the existence of extant (and, of course, extinct) life there. Life on Mars has a rough time of it between obliquity changes that favor warmer, wetter conditions, so a large percentage of Mars life goes extinct on a regular (if extended) basis—but not everywhere on Mars, all at once.

The really shocking news to the scientific community, and (eventually) to the uninvolved public, was that the work of the Mars surface laboratory proved that life on Mars was not first discovered in the mid-2040s, but had been been "discovered" in the late 2020s, when the first robotically returned samples from Mars were brought to Earth for scientific analysis. That was the first time that Mars life (seemingly, the spore of a small lichen) was seen. Unfortunately, it was judged by the sample analysis/biohazard team to be one of the numerous contaminating organisms from Earth that had made the round-trip journey with the sample. The true significance of this organism, which shares DNA, RNA, and proteins with modern Earth organisms, was not understood at that time.

It was the experience gained with degraded organics and organisms in the lunar-surface laboratory, transported to Mars with the first human landings, that allowed scientists on Mars to conclusively prove that the "lichen spore" first discovered in the robotically returned Mars sample was actually a martian organism no longer under containment on Earth. Those Mars samples had been released from rigorous containment in the late 2030s after "false" positive indications of life were all that were detected in containment.

The Regulatory Burden (Fool Me Once, Shame on You)

Naturally, when "life from Mars" was discovered, the US National Institutes of Health, the Centers for Disease Control, and the Environmental Protection Agency had linked their public obligations to a major increase in funding, and even before the first human-crewed scientific expedition to Mars had returned, they had recovered all of the robotically returned samples from investigator laboratories and had asserted the right to do their duty by conducting their own quarantine of the Mars samples collected by the first human mission, as well as the human crew themselves. By 2050, NASA and its international partners were trying to rearrange the scientific study of the robotically collected samples, and to understand how future astrobiological studies of a Mars lichen could be done under the conditions present in containment facilities provided by the Earth's public health authorities.

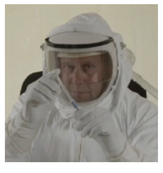
Elsewhere, the discovery of two forms of life in our own solar system had, by 2050, greatly expanded public interest in efforts to completely characterize the signs of life that could be read in the atmospheres of planets orbiting other stars. Funding had grown, accordingly. While sending humans to Mars seemed to becoming more risky, should the Mars lichen have nasty relatives. Clean rover technology with artificial intelligence and autonomy were considered to be safer and nearly as competent (with virtual reality video). The characterization of life on extrasolar planets seemed both safe and possibly leading to a future real estate boom, which for most people seemed as likely to happen as their own move to Rakitu Island (a small, self-sufficient island off New Zealand's North Island)—highly entertaining to consider as an exotic change in locale, but not a practical necessity for most taxpayers.

Solar System Values

From a cultural perspective, and despite the fervent hopes of ethicists and political scientists, there were almost no major surprises regarding public attitudes after the discovery of life in our solar system. Government (e.g., NASA) had managed to "hide" the discovery of life on Mars for almost 20 years. That the pertinent mistakes were made almost 10 years earlier than the final sample-return mission didn't alter a skeptical view of the government and its candor and competence. But the attitude that there could (and should!) be aliens living in our solar system had been accepted by the vast majority of people with the first Star Wars film. The fact that the new aliens were likely to be microbes had turned out to be a large disincentive for most of the public to care about them. Of course some were interested in the potential for pharmaceuticals developed from this new life, and those interested in such things were also interested in investing in such things, but by-and-large the public's view of the universe would need to change only if a particularly clever alien were to come into the room and either entertain or threaten, or sell real estate that someone could actually visit. Until that time, the Earth's cultural norms would not be threatened nor modified.

And we would have a little while to wait for the follow-on extrasolar-planet real estate boom.

Such is the nature of scientific progress!



- Would you buy a used planetary protection policy from this man?

What's a Universe Good For (Europa)?

The space agencies involved in the first human mission to Mars, as well as those that participated in the first robotic sample return mission, could be forgiven for their acceptance of a negative result for two basic reasons. In the first place, the Mars lichen really did look a lot like Earth contamination, both genetically and structurally, as might befit an organism whose ancestors could have come from either planet. The second reason was that NASA was distracted elsewhere. The space agency had become focused on Moon and Mars distances and cruise times in the late 2010s and early 2020s as it (and most of its international partners) had signed agreements with commercial companies to conduct scientific exploration and (eventually) tourism as partners. These agreements were forward-looking with respect to the overall movement of humanity into space, but they focused attention, time, and money on short missions that were intended to build up capabilities on nearby planetary surfaces. Accordingly, new missions to the outer planets and their satellites were in short supply. Imagine the dismay of strategic planners at NASA when their one-and-only (well-sterilized) Europa lander mission, launched in the early 2020s, discovered a second source of extraterrestrial life just beneath Europa's icy surface. The solar system, rather than being cold, dry, and dead, was starting to feel a little crowded. Eventually, when the Mars-life realization was added, it would seem that the universe exists for the express purpose of generating life.

Commercial Development of Astrobiology Science Discoveries

Before the Mars discovery was understood, however, much time and effort in the early 2030s had been exerted to follow-up on the detection of this second genesis of life from Europa. Despite a demonstration of the motility of cells recovered from melted Europan ice, the lander had conducted tests for DNA, RNA, and their degradation products, as well as for proteins and lipids. There were equivocal results regarding proteins and lipids, but DNA and RNA had not been detected.

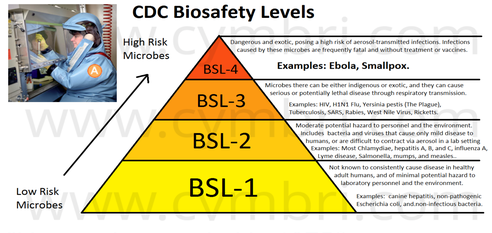
None of the material detected by the Europa lander had yet been returned to Earth, but what consumed the attention of NASA astrobiologists was the renegotiation of commercial agreements originally focused on missions to the Moon and Mars, but now being rescheduled and modified to include licensing agreements regarding the possible commercial benefits of the life discovered on Europa. The pharmaceutical industry had joined the tourism and space resources companies in their enthusiasm for future spaceflight opportunities.

Good News, Bad News

Some of those same agreements would have to be negotiated again in the late 2040s once it was discovered that the Mars lichen was actually from Mars. Mars agreements would reflect the need for the US and its international partners to consider the ethical and practical implications of continuing human exploration (and eventually tourism) on Mars. Agencies shared a reticence to expose a human crew to a demonstrably uncharacterized biosphere with possible implications to crew health and the safety of the Earth. Likewise, the Mars exploration partners had been challenged by other treaty signatories under the surviving Article IX of the 1967 UN Outer Space Treaty [3], which prohibits harmful contamination of other worlds and seeks to protect against "adverse changes in the environment of the Earth resulting from the introduction of extraterrestrial matter." That same treaty had been altered to encourage space resource development only 20 years previously.

References

[1] Glavin D. P. et al. (2010) *Int. J. Astrobio.* 3, 265–271. [2] Glavin D. P. et al. (2004) *Earth Moon Planets,* 107, 87-93. [3] "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial Bodies," Article IX, U.N. Doc. A/RES/2222(XXI) January 227, 1967; TIAS No. 6347, IN: U.S. Treaties and Other International Agreements. 18, 2410-2498, 1967. [4] Rummel, J. D., J. H. Allton, and D. Morrison (2011) A microbe on the Moon? Surveyor III and lessons learned for future sample return missions, LPSC Abstract 5023.



- How much different are current concepts from what the *Viking* landers carried in 1975?
  - Can cryptobionts such as these lichens from Spain store atmospheric water vapor at night (RH of 1.0), and use it during the warm (>-18C) martian day?
    - Would Mars explorers notice these miniature life forms?
      - If we find life, can we work on it in the required containment laboratories?