Did the 1976 Mars Viking LR Biology Experiments Detect Life From Earth?

Belinda Davis*
Geological Research Foundation,
Mexico City, Mexico

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(Invited Commentary: "Is there life on Mars?")
Editors-in-Chief: K. Wołowski, G. Bianciardi, R. del Gaudio,

Abstract

The validity of the 1976 Mars Viking LR biology experiments have been disputed. Microorganisms, fungi, lichens, algae, form spores, resist sterilization, survive direct exposure to space and survive long term exposure to Mars simulated environments. NASA has never been able to completely sterilize equipment sent to Mars. If the LR experiments detected biological activity, we should ask: Did the Viking LR experiments detect life from Mars or bacterial hitchhikers; i.e. life from Earth? And what are the implications for NASA's Sample Return Program? Will NASA retrieve from Mars bacteria they sent from Earth?

Key Words: Viking LR Experiments; Spores; Life from Mars vs Life from Earth.

*BelindaPaulineDavis@gmail.com

1. Viking LR Experiments, Spores, and Biological Hitchhikers From Earth

In 1976 the Mars Viking life Labeled Release (LR) detection experiments, based on the sensitivity of ^{14}C respirometry, provided evidence of biological activity on Mars (reviewed in Levin 2010; Levin & Straat 2016). These results were immediately dismissed by NASA officials as "false positives." Since the addition of more nutrients into the soil temporarily decreased the level of biological activity NASA officials argued "the LR therefore had not detected life on Mars, but had detected a chemical or physical agent that had produced false positive results" (Levin 2010). Although not reviewed here several investigators proposed non-biological explanations for these "false positives;" objections Levin and Straat have tried to address (Levin & Straat 1977, 1979, 2016). To counter the "false positive" argument Bianciardi, Miller, Straat, and Levin (2012) performed a computerized analysis of the Viking LR data, and reported the LR positive results exhibited highly organized responses characteristic of biology and had a different pattern from control responses that were similar to random noise. Providing additional support in relation to past life, Bianciardi et al. (2014) utilized computerized image analysis and identified Martian microbialites that may have been constructed by cyanobacteria.

In further support of a biological explanation for the LR results, Joseph et al (2019, 2020a,b,c, 2021) have published pictorial evidence documenting what resembles lichens, mushrooms, algae and stromatolites on Mars. However, in some of these same articles, Joseph et al (2019, 2020a) have

documented NASA was not able to sterilize the Viking equipment and other space craft and up to 540 distinct colonies per square meter on the outer surfaces of the Mars Viking Landers consisting of millions of aerobic and mesophilic organisms remained viable (Puleo et al. 1977) including fungi and other microorganisms (see La Duc et al. 2014; Venkateswaran et al. 2012). Joseph et al. also reviewed evidence documenting fungi, algae, lichens, and various microorganisms survive ejection from this planet, long duration exposure to the frigid and radiation intense environment of space and descent and even crash landing onto the surface (Joseph et al. 2019, 2020a). Joseph and his team also provided NASA photos of the rovers Opportunity and Curiosity contaminated with what could be bacterial and fungal growth and raised the possibility these organisms were transported to Mars from Earth attached to the rovers. In support of this hypothesis the Joseph team cite De la Torre Noetzel et al. (2017) who exposed lichens to a Mars simulated environment for 18 months, the majority remaining viable and demonstrating normal metabolic activity. For 16 months Onofri et al. (2018) exposed Antarctic cryptoendolithic black fungus *Cryomyces antarcticus* to a simulated Mars-like environment and reported these organisms were "able to tolerate the combined stress of different extraterrestrial substrates, space, and simulated Mars-like conditions in terms of survival, DNA, and ultrastructural stability."

Although arguing in favor of interplanetary transfer of life and despite citing De la Torre Noetzel et al. (2017), Onofri et al. (2018) and other experiments documenting that aerobic and mesophilic organisms can survive direct exposure to space, Joseph et al (2019, 2020a) inexplicably failed to apply this reasoning to the Viking LR experiments the validity of which they endorsed. Why? If the pictorial evidence of what Joseph claims to be masses of fungi and bacteria growing on the rovers Curiosity and Opportunity originated on Earth and survived transit to Mars, then we must ask the question Joseph did not ask: did the Viking LR experiment detect life from Earth?

The LR experiments were based on the assumption Martian microbes are identical to terrestrial microbes; and thousands of field tests were performed proving the LR capable of detecting a very wide range of terrestrial microorganisms (Levin 2010; Levin & Straat 2016). The LR field tests also showed an absence of terrestrial biological activity immediately following heat sterilization of terrestrial soil.

Should terrestrial organisms be considered a biological analog for Martian organisms? It has been theorized that Martian life forms may utilize iron and radiation for their metabolic needs with iron promoting pigmentation and melanin production that protects against and absorbs radiation (Joseph 2021). Would Martian organisms feed on nutrients from Earth? Conversely was the LR's radioactive carbon a food source?

Houtkooper and Schulze-Makuch (2010) suggest that microbial Martian organisms may utilize a mixture of hydrogen peroxide, Mg and Na perchlorate salts, and water as an intracellular "anti-freeze" solvent as an adaptation to the harsh Martian surface environment and, theoretically, this solvent would enable organisms to remain biologically active even at temperatures as low -70°C. If Martian organisms rely upon alien means of metabolism, would they respond to nutrients provided in the Viking biological experiments as theorized by Houtkooper and Schulze-Makuch (2010)?

The Vikings landed on two locations over 4000 miles from each other and eight sols (Mars days) later the LR experiments were launched and a nutrient laced with radioactive carbon was added to a Martian soil sample. Radioactivity in the gasses released was construed as evidence of active metabolism. A control experiment heat-treated a second sample to kill microorganisms. When one sample was heated at 46°C, as well as when two samples of Martian soil were long-term stored in the dark at 10°C, there was a 90% and 100% reduction in activity, respectively (Levin & Straat 1977, 1979, 2016). Levin (2010) concluded the "amplitudes and kinetics of the Mars LR results were similar to those of terrestrial results, especially close to those of soils in, or from, frigid areas." And here is the flaw: Heat treated samples were not tested hours, days or weeks after "sterilization" when it is well documented NASA is not capable of killing all organisms following heat sterilization which instead form dormant spores (La Duc et al. 2014; Venkateswaran et al. 2012). The cold storage LR experiments suffer the same flaws. The heat and cold sterilization experiments, conducted on Earth and Mars, did not take into account that microorganisms instantly form heat and cold shock proteins and become spores and will remain dormant until environmental conditions become favorable for life.

Microorganisms become spores by shrinking in size and fashioning a highly mineralized core enclosed in heat or cold shock proteins that wrap around and protect them (Marquis and Shin 2006). Microbial DNA also becomes coated with acid soluble proteins making their genome resistant to harm (Setlow and Setlow 1995). As summarized by Nicholson et al. (2000): "In the dormant stage a spore has no metabolism and resists cycles of extreme heat and cold, extreme desiccation including vacuum, UV and ionizing radiation, oxidizing agents and corrosive chemicals."

2. Conclusions

Microorganisms, fungi, lichens, algae, form spores and resist sterilization. These organisms survive direct exposure to space and Mars simulated environments (de la Torre Noetzel, et al. 2020; De Vera 2014, 2019; Onofri et al. 2018). Theoretically, terrestrial organisms, via a bolide, wind, or space craft, may be continually transported to Mars (Beech et al. 2018; Joseph et al. 2019, 2020a; Schulze--

Makuch et al. 2005). This may account for why what have been identified as mushrooms, lichens and stromatolites on Mars are morphologically similar to those of Earth.

Possibly, the rovers Opportunity and Curiosity transported spores from Earth to Mars (Joseph et al. 2019) and the same may be true for the Viking equipment, possibly confounding and raising serious questions about the experimental results, the criteria of which was based on detecting the presence of "terrestrial" organisms. Therefore, if space craft are transferring viable organisms, and if the Viking LR experiments detected biological activity we should ask: Did the LR experiments detect life from Mars or bacterial hitchhikers attached to the Viking landers and equipment; i.e. life from Earth?

And what are the implications for NASA's Sample Return Program? Will NASA retrieve from Mars bacteria they sent from Earth?

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