Life beyond the planet of origin and implications for the search for life on Mars

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Outer space is vast, cold, devoid of matter, radiation filled with essentially no gravity. These factors present an environmental challenge for any form of life. Earthís biosphere has evolved for more than 3 billion years shielded from the hostile environment of outer space by the protective blanket of the atmosphere and magnetosphere. Space is a nutritional wasteland with no liquid water and readily available organic carbon. Moving beyond a lifeís planet of origin requires a means for transport, the ability to withstand transport, and the ability to colonize, thrive and ultimately evolve in the new environment. Can life survive beyond its home planet? The key to answering this question is to identify organisms that first have the ability to withstand space radiation, space vacuum desiccation and time in transit, and second the ability to grow in an alien environment. Within the last 60 years space technology allowed us to transport life beyond Earthís protective shield so we may study, in situ, their responses to selected conditions of space. To date a variety of microbes ranging from viruses, to Bacteria, to Archaea, to Eukarya have been tested in the space environment. Most died instantly, but not all. These studies revealed that UV radiation is the near term lethal agent, while hard radiation is the long-term lethal agent when the organism is shielded from UV radiation. In fact, bacterial spores, halophilic cyanobacteria and Archaea as well as some lichens survive very well if protected from UV radiation [1]. Some microbes, then, may be able to survive the trip in outer space to Mars on a spacecraft or in a meteorite.

Once on Mars can a terrestrial microbe survive? Although the conditions on Mars are not as harsh as those in space, they are not hospitable for a terrestrial microbe. Studies, however, have shown that certain microbes that can survive in space for several years may also be able to survive on Mars if protected from UV radiation [1]. Laboratory simulation experiments using a mock-up of the Phoenix lander have shown that microbes transported to the surface of Mars on a spacecraft come off the spacecraft and mix into the Martian regolith [2]. Additionally, studies simulating Martian dust storms demonstrate that microbes can survive in the Martian wind blown dust and be scattered across the Martian surface away from the spacecraft. Would these microbes that may survive on Mars metabolize and propagate? Growth requires liquid water, a carbon source and an energy source. Survival on Mars also requires protection from UV radiation. In the cold, dry environment of Mars the probability of microbial metabolism and growth at or just beneath the surface is extremely low.

[1] Horneck, G., Klaus, D., & Mancinelli, R. L. 2010. Microbiol. Molec. Biol. Rev. 74:121-156.
[2]Marshall, J. & Mancinelli, R. L. 2011. Int. J. Astrobiol. 10(4):335-340

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