Learning to Care for Those in Harm's Way

Uniformed Services University
of the Health Sciences
4301 Jones Bridge Road
Bethesda, MD 20814-4799

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Contact: Sarah Marshall, Office of External Affairs
Email: sarah.marshall@usuhs.edu

New study improves the chances of finding life on Mars

Bethesda, Md. – If in fact there is or has been life on Mars, it would likely still be there today, billions of years later, according to a new study published Oct. 25 in Astrobiology led by the Uniformed Services University of the Health Sciences (USU).

The first-of-its-kind study, "Effects of Desiccation and Freezing on Microbial Ionizing Radiation Survivability: Considerations for Mars Sample Return," was led by USU's Dr. Michael J. Daly, professor of Pathology, in collaboration with Northwestern University. Without knowing whether there is life on Mars, ongoing and projected missions to Mars and its moons will soon return samples to answer this timeless question.

In the meantime, these researchers sought to answer the question: if life has ever in fact existed on Mars, would it still be there today, given that the preconditions for life on Mars occurred around the same time as they did on Earth (4.6 billion years ago, when both planets started out with water)? They found that ancient bacteria could survive simulated Mars conditions much longer than previously assumed; when the bacteria are desiccated, frozen and shielded from galactic cosmic radiation and solar protons. These findings strengthen the possibility that if life ever evolved on Mars, its biological remains could be revealed in future missions, including ExoMars (Rosalind Franklin rover) and the Mars Life Explorer, which will carry drills to extract materials from two meters below the surface.

Additionally, because this team of researchers demonstrated that certain microbes found in humans can survive in spite of Mars' harsh environment, they suggest future astronauts and space tourists traveling to Mars might inadvertently contaminate Mars with their own hitchhiking bacteria.

"Our model organisms serve as proxies for both forward contamination of Mars, as well as backward contamination of Earth, both of which should be avoided," said Daly.

In other words, an understanding of the astonishing radiation survivability of some common bacteria and fungi could help in developing countermeasures to prevent any Martian life from contaminating Earth, as set forth in Article IX of the United Nations Outer Space Treaty of 1967.

To simulate Mars during this study, the team of researchers used state-of-the-art technology to mimic a dry, frozen Martian environment that has been bombarded by galactic cosmic radiation and protons from the sun and has been subject to substantial internal planetary background radiation over eons. Then, they tested whether bacteria and yeasts would survive in such an environment over great lengths of time (also simulated by this technology). They chose to look at one microorganism in particular, Deinococcus radiodurans or D. radiodurans, known to survive extremely high levels of radiation. This

particularly robust microbe is known to be even more radiation-resistant than spores of Bacillus species, which have survived in some environments on Earth for millions of years. If Deinococcus has been on Earth for billions of years, something similar might have also evolved on Mars. In this study, the researchers dried and froze bacteria and yeasts as would occur on Mars (-80 °F) (~210 K, -63 °C). They found that this made them even more radiation-resistant, surviving much longer when desiccated and frozen, which would happen to cells naturally on Mars. This combination of conditions has not been tested before; previous studies have focused on how these cells survive in liquid states or when simply frozen. Instead, the researchers first very carefully dried the cells, followed by freezing them on dry ice, as reported by Horne et al. 2022.

Ultimately, the researchers inferred that if D. radiodurans were to be found 10 meters below the Martian surface, and not directly exposed to the elements, they likely would have survived to the present day, provided their habitats were occasionally melted and turned over by meteorite impacts. The researchers further suggest that even if viable lifeforms are not present on Mars today, given that whole viable D. radiodurans cells are projected to survive the equivalent of 280 million years in the frozen and desiccated Martian subsurface, then their large molecules (DNA and proteins) and their viruses could have survived on the planet even longer. This finding strengthens the probability that if life ever evolved on Mars, the biological remains will likely be found in future missions.

“The chances of finding life on Mars have increased as a result of our analysis,” said Daly, the study’s lead author. “Mars was once similar to Earth, billions of years ago, and if life ever evolved there, it is likely still there.”

Daly added that these findings also have implications for developing biodefense countermeasures, which is important to the Department of Defense, given the threat of biological agents, such as Anthrax (Bacillus spores), remains a concern to the military and homeland defense.

The project was supported by a Defense Threat Reduction Agency (DTRA) grant to Dr. Michael J. Daly and a National Institutes of Health (NIH) grant to Dr. Brian M. Hoffman. The team also included Dr. Igor Shuryak, Center for Radiological Research at Columbia University, New York, NY, and Dr. Peter Setlow at UConn Health, Farmington, CT; and international collaborators Drs. Cene Gostinčar and Nina Gunde-Cimerman at the University of Ljubljana, Slovenia, and Dr. Tine Grebenc at the Slovenian Forestry Institute, Ljubljana, Slovenia.

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