**Extremophiles and Their Future in Space**

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**Abstract**

Missions to Mars is soon set to increase, followed by manned-missions to Mars. In preparation for determining if life-existed or can exist on Mars, experiments are being conducted using microorganisms of Earth to test their persistence in simulated space conditions here on Earth. One experiment in particular, “Extremophiles Survival to Simulated Space Conditions: An Astrobiology Model Study,” exposed extremophilic microorganisms of both *Archaea* and *Bacteria* to the extreme conditions space and Mars has to offer (Mastascusa et al. 2014). The extremophiles picked for the study were used to determine their potential for future astrobiology experiments. Since the publication of this study, further research using other microorganisms have been conducted in hopes of identifying life on Mars. The major problem the astrobiology field faces is experimenting in outer space. Most experiments are either simulated or conducted on the International Space Station.

**Introduction**

Astrobiology is a field that essentially investigates life and its potential to exist within the universe. Life has existed on Earth for billions of years as microorganisms, only recently did macroorganism arise. If the environment of early Earth is similar to present-day Mars, then organisms similar to Earth’s extremophilic microorganisms might have or still do exist on Mars. To test this idea, four extremophilic microorganisms: *Sulfolbus solfataricus*, *Haloterrigena hispanica*, *Thermotoga neapolitana*, *Geobacillus thermantarcticus*, were exposed to environmental conditions seen in space and Mars. Conditions include: temperature variation, Ultra-Violet radiation, and desiccation under Mars’ humidity and pressure. The extremophiles chosen for the experiment represent different extreme habitats found on Earth. The archaeon’s, *S. solfataricus* and *H. hispanica* were isolated from either a solfatara volcano or a salt lake in Spain. The two-bacterium chosen for the experiment are both thermophilic microorganisms. *T. neapolitana* was extracted from a black smoker (a geothermal vent that emits minerals of black color) off the coast of Naples, Italy, *G. thermantarcticus* was isolated from the soil of Antarctica’s active volcano, Mt. Melbourne (Matascusa et al. 2014). The results look promising in respect to their survivability in simulated space conditions.

 For the thermo-acidophile, *S. solfataricus*, when exposed to a wide range of temperature variation, which is commonly seen space environments, it proved to have a good resistance towards the temperatures with respect for its optimal temperature. The other microorganisms showed similar results. Under UV radiation exposure of 254 nm, three of the four microorganisms were used (Matascusa et al. 2014). The anerobic *T. neapolitana* was excluded because the exposure was performed in aerobic conditions. *S. solfataricus* showed the highest resistance of the three species. Which was of surprise, since it was believed that the *G. thermantarcticus* would have the highest resistance due to its ability to produce a spore. *S. solfataricus* and *T. neapolitana* were excluded in the simulation of Mar’s humidity and pressure, because they could not survive the initial steps of desiccation. The other two species, *G. thermantarcticus* and *H. hispanica*, were able to survive under the Mars’ simulated conditions. However, the later species showed a delay in growth after exposure (Matascusa et al. 2014). It was concluded that all four specimens would make excellent candidates for future space experiments. Nevertheless, it seems that there is yet to be any publications on these four specimens in the astrobiology field. On the other hand, there is astrobiology research involving other types of microorganisms, such as Cyanobacteria and types of *Bacillus.*

**Recent Progress**

A study was published in 2015 in which an experiment was conducted exposing types of spore-forming microorganisms (Bacillus), Fungi, and plant seeds to long-term exposure to outer space conditions outside the International Space Station. It concluded with that both spores and dormant plants can survive in outer space (Novikova et al. 2015). In 2016, another experiment was published in regard to a type of Cyanobacteria called *Chroococcidiopsis* species. The bacterium was mixed with two types of Mars’ regolith (soil) and exposed to UV radiation under a simulated Martian surface for 383 sols (Baqué et al. 2016). The experiment was conducted to determine detectability of biomarkers, such as photosynthetic pigments and DNA in Mars’ regolith.

**Discussion**

The results of the publications help scientists with understanding how Earth’s organisms can survive in outer space and on Mars. The experiments are important for future space experiments, because they help to lay a foundation in the astrobiology field. These experiments are useful in the quest of answering if we are alone in the universe, by looking at if organisms can even survive in such harsh conditions. Astrobiology is a new field and getting humans and subjects to outer space or Mars to conduct experiments is not only costly and time consuming, there is too many outside factors that could negatively affect an experiment being tested.

**References**

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