Surviving the conditions on Mars

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Alpine and polar lichens could also survive on Mars. Planetary researchers at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) simulated the conditions on Mars for 34 days and exposed various microorganisms to this environment. "During this period, the lichens and bacteria continued to demonstrate measurable activity and carry out photosynthesis," says Jean-Pierre de Vera, a scientist at the DLR Institute of Planetary Research in Berlin and head of the Mars simulation project. The microorganisms adapted to this environment, primarily in niches in rocks and in fissures and gaps in the simulated Martian soil. This might be an indication that such adaptation strategies would make life possible in niches on the actual surface of Mars as well.

Lichens from inhospitable parts of Earth have demonstrated their ability to survive even under the conditions on Mars – organisms that live at altitudes of up to 3500 metres, collected in Switzerland, and cyanobacteria and lichens from the Antarctic. "We observed these samples in a Martian climate for over a month in our Mars simulation chamber," says de Vera. The researchers recreated the Martian surface with various mineral constituents, using knowledge obtained from missions such as the NASA Mars rovers 'Opportunity' and 'Spirit'. In the chamber itself, they replicated the Martian atmosphere, which consists of 95 percent carbon dioxide, four percent nitrogen and trace gases such as argon and oxygen. A vacuum pump system then ensured six millibars of air pressure, which enabled the planetary researchers to simulate the Red Planet’s tenuous atmosphere. Special radiation sources ranging from the ultraviolet to the infrared replicated solar radiation on the surface of Mars. Finally, the organisms had to cope with temperatures that fluctuated between minus 50 degrees Celsius to plus 23 degrees Celsius.

Adaptation strategies for the Red Planet

According to astrobiologist Jean-Pierre de Vera, the results obtained showed that "the terrestrial microorganisms could carry out photosynthesis even under these harsh conditions." The water required for this process is present in the morning and evening of the Martian day, when humidity condenses as precipitation across the surface, and the organisms can absorb it. The lichens prove to be creative survivors, primarily in niches on the surface – in small cracks and gaps. They adapted to the artificial Martian environment and demonstrated the same activity that they would in their natural environment. "If life arose on Mars four billion years ago, it could have remained to the present day in niches."

Experiments where microorganisms are exposed to space conditions have already been conducted, for example outside the International Space Station (ISS). But the scientists want to use the tests in the Mars simulation chamber to investigate the specific conditions on a planet. "We now also have the opportunity to continuously observe the occurrence of activity and at what level it occurs in the lichens and bacteria."

Search for habitable planets

The 34-day test was conducted as an international project within the Helmholtz Alliance 'Planetary Evolution and Life'. "One of the questions to be answered is: how habitable is a planet, and what makes it that way?” explains Tilman Spohn, head of the DLR Institute of Planetary Research and scientific coordinator for the Helmholtz Alliance. "This long-term experiment in the Martian simulation chamber and its results are an important step forwards," says Spohn. "It makes the presence of life on Mars more plausible." And the existence of primitive life forms such as microorganisms that can be used to address this hypothesis is only

to be expected, in the planetary researcher's opinion: "Humans and fauna make up just a tiny proportion of the entire biomass – microorganisms, on the other hand, make up more than 80 percent of it."

The results obtained by Jean-Pierre de Vera's team present a significant challenge for future missions to Mars: "We must be extremely careful not to transport any terrestrial life forms to Mars," says de Vera. "Otherwise they might contaminate the planet." But there is yet another question facing the astrobiologist's team: "We know that lichens and bacteria could survive and remain active on Mars for 34 days. But could the organisms continue to live in these conditions beyond this period, for years or even centuries? Unfortunately, this question will remain unanswered, as such lengths of time would exceed the scope of this experiment."

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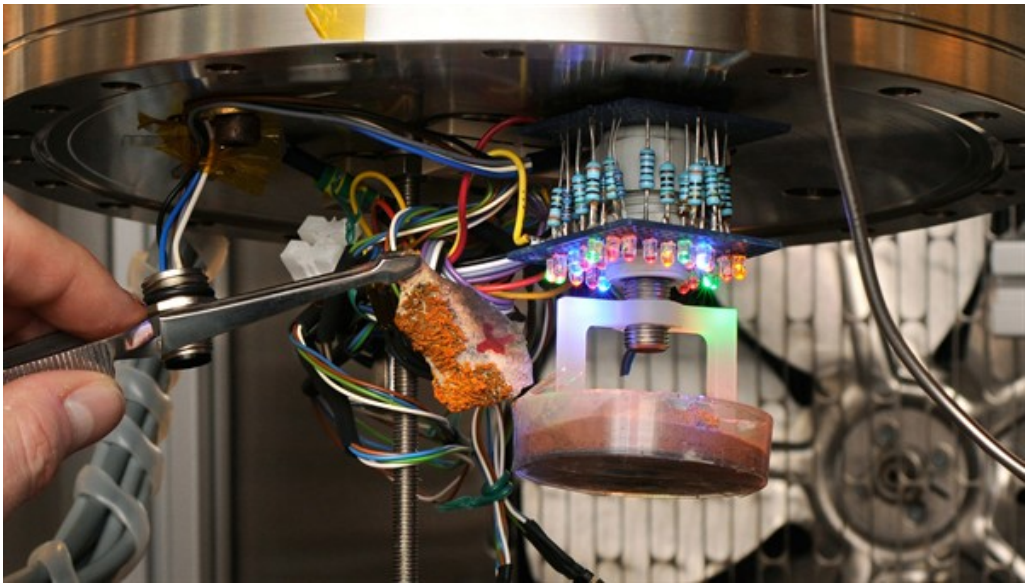
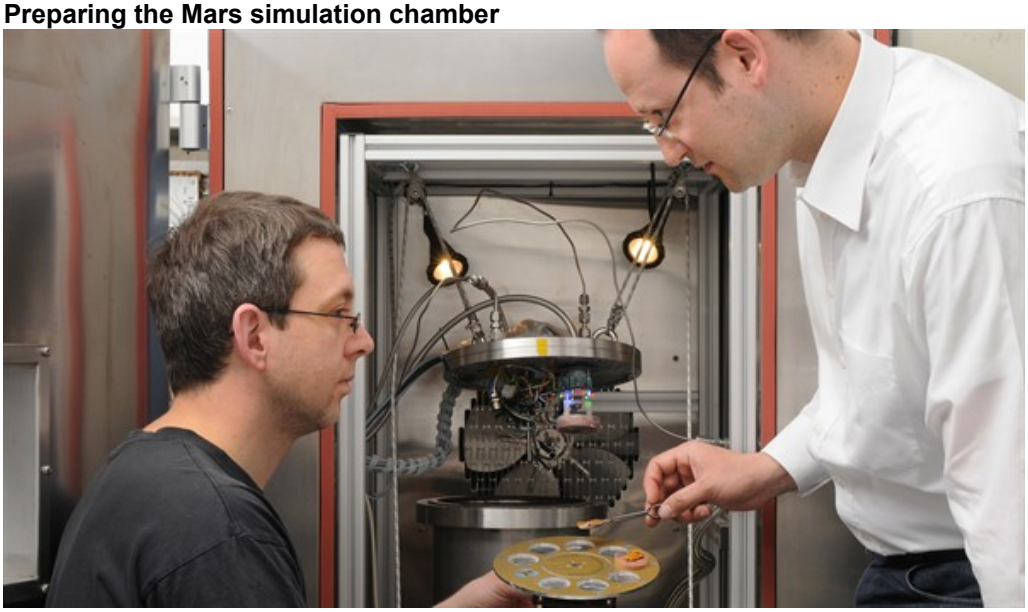
Martian conditions in miniature



In the Mars simulation chamber, DLR researchers recreated the atmospheric composition and pressure, the planet's surface, the temperature cycles and the solar radiation incident on the surface. The activity of polar and alpine lichen was investigated under these conditions.

Preparing the Mars simulation chamber



DLR researchers Jean-Pierre de Vera (right) and Andreas Lorek subjected the microorganisms in the Mars simulation chamber to the hostile conditions of Mars. The lichens and bacteria survived for 34 days and carried out photosynthesis.

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Polar lichen

Among the microorganisms that survived for 34 days in the Mars simulation chamber at the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) were polar lichens.

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Expedition to the Antarctic

In the Antarctic, Jean-Pierre de Vera, a scientist at the DLR Institute of Planetary Research in Berlin, collected polar lichens that were exposed in the Mars simulation chamber to conditions replicating those found on the Red Planet.

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