

Survivalists ready for journey to the ISS

22 July 2014

Progress spacecraft carries blue-green algae and biofilms for DLR experiments into space

Tough, resilient and able to survive in the most inhospitable regions on Earth –now, they are being asked to show their strength in a space environment as well; blue-green algae (*cyanobacteria of the genus Nostoc*) and biofilms (*deinococcus geothermalis*) will depart for the International Space Station (ISS) at 23:44 CEST on 23 July 2014 on board a Progress spacecraft. These specimens from the German Aerospace Center (Deutsches Zentrum für Luft- und Raumfahrt; DLR) are housed in the EXPOSE-R2 system that will be fitted to the outside of the ISS during an extravehicular activity scheduled for 18 August. Then, the BIOMEX (Biology and Mars Experiment) and BOSS (Biofilm Organisms Surfing Space) experiments will analyse the microorganisms' capacity to withstand factors such as ultraviolet and cosmic radiation, temperature fluctuations and conditions intended to simulate a Martian environment. This will help determine whether they might be able to survive on other planets.

Jean-Pierre de Vera from the DLR Institute of Planetary Research travelled as far as Antarctica to collect specimens for their trip to space, also putting them through their paces in a Mars simulation chamber: "Cyanobacteria are true survivalists – at least here on Earth." The bacteria were also subjected to a rigorous series of tests involving radiation and vacuum in the facilities maintained by the DLR Institute of Aerospace Medicine. So the BIOMEX experiment, which will take the specimens into space, is simply the next logical step in an ongoing analysis of their remarkable ability to survive. Several hundred specimens – among them primitive bacteria, algae, lichens, fungi and mosses from national and international partners are on board for the series of tests and will spend over one year on the exterior of the ISS.

Scaled down Mars on the ISS

De Vera, a microbiologist and planetary researcher, is recreating a Martian environment on the ISS. To this end, he teamed up with the Natural History Museum MfN Berlin to create two soil types that nearly replicate those found on Mars. First, they took clay and sediment to produce a soil that simulates the epoch when rivers and lakes still criss-crossed Martian terrain; then the team took volcanic ash to recreate the volcanic age on Mars. In doing so, the scientists used data concerning the mineral constituents found on the Red Planet collected by Mars Rovers. Once they reach the test facilities, the bacterial samples and biological substances will be planted at different depths in the artificial material to discover whether Martian soil can protect the organisms – or even a few cellular constituents – against cosmic radiation. The systems will also be flushed with carbon dioxide to create an artificial Martian environment in the habitat. "This will help us identify whether the thin atmosphere and soil layers can provide protection and, therefore, whether the planet is at all suitable to sustain life," says de Vera. "We will also be able to determine whether the tested cellular fragments that are stable in a space environment are viable traces of emergent life. If this proves true, it would certainly help our future search for life on Mars." Space-tested and found stable, the biological substances could be used as reference markers for instruments deployed in other missions to the Red Planet.

Biofilms – a strategy for success

Petra Rettberg from the DLR Institute of Aerospace Medicine is using an entirely different kind of survivalist for the BOSS experiment – one found everywhere here on Earth, and sometimes even discovered in unwelcome places, such as in water pipes or on shower heads: "Biofilms are among the oldest of Earth's communities of organisms that we have been able to identify, and their chances of survival on other planets are most likely good," says Rettberg. So what strategy

for success does the selected organism, *deinococcus geothermalis*, employ? The bacterium exists in the form of multiple cell layers embedded within an extracellular envelope it produces itself, thereby remaining protected against harmful external influences. The radiation biologist exposed her test subjects to various cycles of extreme temperatures, stored them for weeks in a vacuum and irradiated them with a powerful ultraviolet lamp. The specimens survived. Now they are all set for the first experiment to be conducted in a space environment and involving a simulation of conditions found on Mars. To do this, an array of filters will be positioned above the specimens and a Martian atmosphere will be maintained in orbit. Parallel experiments will involve analysis of the same organisms as individual cells to identify the protective function fulfilled by the extracellular matrix. European and US cooperation partners are contributing other species of organisms known to produce biofilms to generalise the expected findings.

Greater effectiveness in the search for life in outer space

Four experiments will be conducted using the EXPOSE system on board the ISS. The two that DLR is set to complete in cooperation with international teams will provide the scientists with clear indications of the organisms that would have a chance of survival in space or on Mars. The results of these space experiments are important to help explain the emergence of life in the Solar System: "These space survivalists may well have transported life from one celestial body to another," says de Vera. The search for life on other planets could also become easier: "The range of conditions and variations we are testing on the outside of the ISS mean we are in a position to define where we should be looking for life on other planets such as Mars with far greater precision," Petra Rettberg and Jean-Pierre de Vera agree.

The specimens will remain exposed to the harsh conditions of space for at least one year before being transported back to Earth no later than August 2016. Then, the work will start for the scientists back on the ground – trying to identify which of the organisms are particularly resilient, which strategy offers the greatest protection in space, and which biological substances would be suitable as reference markers in the search for life on Mars.

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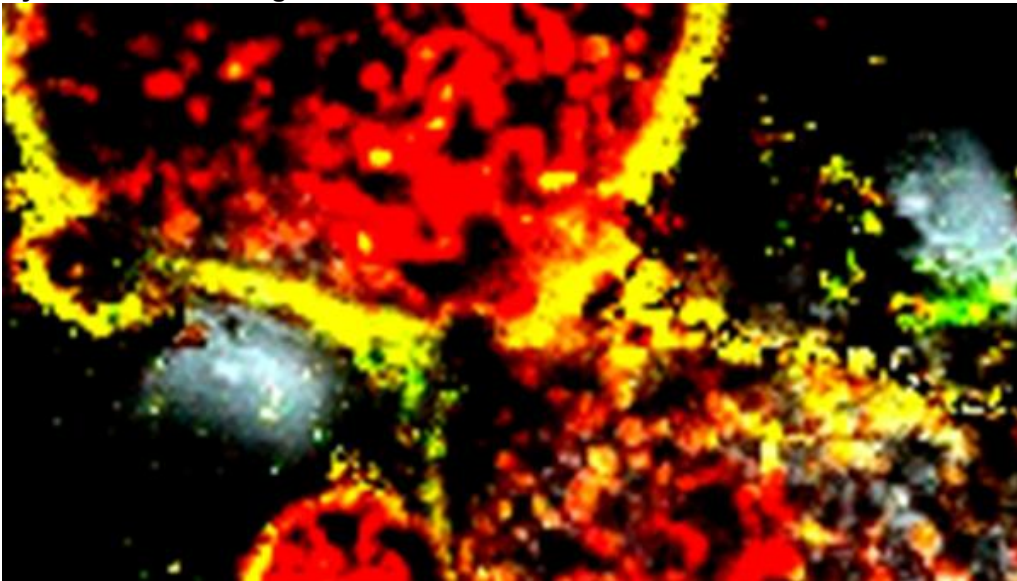
Cyanobacteria of the genus Nostoc



Cyanobacteria of the genus Nostoc (here imaged under an optical microscope) are among the organisms that the German Aerospace Center (DLR) will subject to a space environment in the EXPOSE-R2 facility to test their survival capacity.

Credit: DLR (CC-BY 3.0).

Cyanobacteria of the genus Nostoc



The cyanobacteria that the German Aerospace Center (DLR) is sending to the International Space Station as part of the BIOMEX experiment have already proven their tenacity and survival skills in a simulated Martian environment here on Earth. This image shows living cells, marked with a fluorescent dye, after undergoing a Mars simulation.

Credit: DLR (CC-BY 3.0).

EXPOSE-R2 on the outer shell of the Zvezda module



BIOMEX is starting in the summer of 2014 and is a part of the EXPOSE-R2 package of experiments. The specimens will be loaded on board a Progress spacecraft and transported to the International Space Station in July 2014, where they will be installed in the EXPOSE system on the URM-D platform, situated on the outside of the Russian Zvezda module as part of an extravehicular activity scheduled for August/September.

Credit: NASA.

Radiation test on Earth



Here on Earth, scientists from the German Aerospace Center (DLR) exposed the specimens to radiation in various forms and strengths; now they will be taken to the International Space Station, where the BIOMEX and BOSS experiments will analyse their survival capacity in a space environment.

Credit: DLR (CC-BY 3.0).

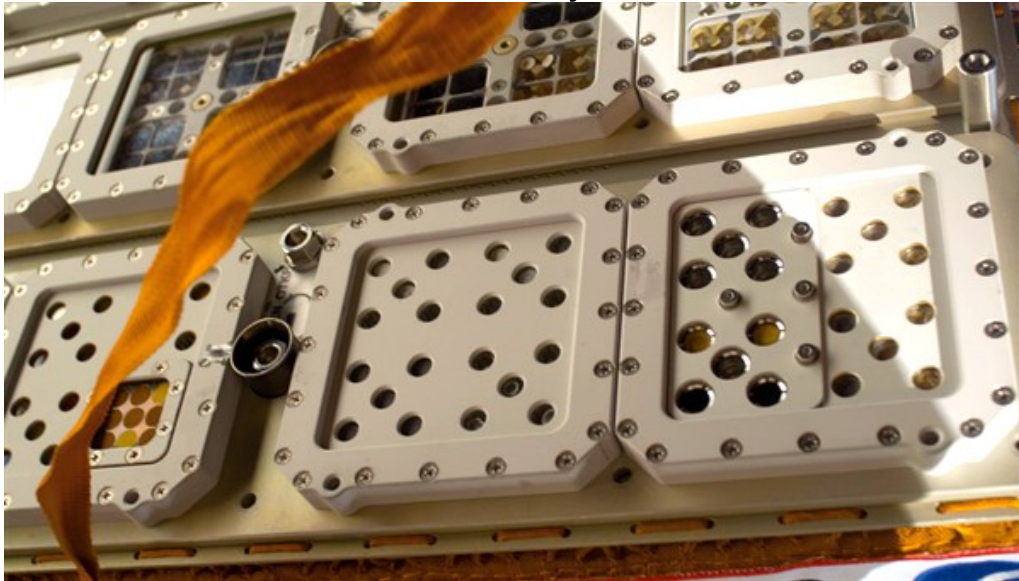
Preparation for tests in space



The specimens being prepared for the BIOMEX and BOSS experiments in the German Aerospace Center (DLR) laboratory. The organisms will be placed in a space environment in the EXPOSE-R2 system fitted to the exterior of the International Space Station.

Credit: DLR (CC-BY 3.0).

BIOMEX will be installed in the EXPOSE-R2 system



BIOMEX will be installed in the EXPOSE-R2 system on the exterior of the Zvezda Space Station module.

Credit: NASA.

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