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Resistance of lichens and endolithic microorganisms during a simulated interplanetary transfer on board of Biopan (Foton-M Satellite)

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Abstract

Hypothesis: According to the Lithopanspermia theory, life could possibly be transferred from one planet to another by means of meteorites. This process (phase 2) would take place after the impact ejection process from the planet of origin (phase 1), and before capture and landing on the receptor planet (phase 3). *Methods*: To demonstrate the feasibility of phase 2, two astrobiology experiments, LICHENS-II and LITHOPANSPERMIA, have been performed on board of the Biopan, facility, integrated on the Foton-M recoverable capsule. The LICHENS II experiment (Biopan-5, 2005), demonstrated for the first time, that eukaryotic symbiotic organisms can survive a 16 days flight in LEO, exposed to the harsh space conditions. LITHOPANSPERMIA (Biopan-6, 2007) was a more complex experiment with eukaryotic and prokaryotic symbiotic systems, which were tested for 10 days in LEO. For LICHENS-II we selected the bipolar epilithic lichen species *Rhizocarpon geographicum* (Central Spain) and *Xanthoria elegans* (South Spain), on their natural rock substrate. *R. geographicum* and *X. elegans* were once more selected for LITHOPANSPERMIA, but this time accompanied by their fruiting bodies (reproduction structures), crytoendolithic communities of cyanobacteria with cyanobacterial akinetes of *Anabaena* (U.K.), endoevaporitic microbial communities from halite rocks (Atacama Desert) and the vagrant lichen species *Aspicilia fruticulosa* (Central Spain). The samples were exposed to solar extraterrestrial UV-radiation, simulated Mars UV climate, UV-B radiation and PAR (through different UV cut-off filters), to space vacuum at 10^{-6} mB, and to temperatures between -22ºC and +30ºC. Dark controls were exposed to the same conditions, but not to UV-radiation.
Tests of simulated conditions (UV-solar extraterrestrial radiation, vacuum 10^{-5} mB, temperature +33ºC) performed before flight at DLR and INTA, showed the high resistance of the different species. *Results*: Post-flight analysis of the LICHENS-II samples with chlorophyll-a fluorescence (Mini-Pam 2000, Heinz Walz, G.m.b.H), demonstrated a fast recovery of the photosynthetic activity of the epilithic lichens. These results were later confirmed by the LITHOPANSPERMIA experiment. In addition, LITHOPANSPERMIA delivered new results: a) *Aspicilia fruticulosa* showed a high activity of PSII, without significant differences in the gas interchange- and maximum quantum yield values before- and after flight; b) the germination capacity of the ascospores of *Rhizocarpon geographicum* and *Xanthoria elegans* was increased after flight; c) resting state cells of *Anabaena* survived; c) endoevaporitic microbial communities from halite rocks (Atacama Desert) also survived. *Conclusions:* These organisms, adapted to tolerate extreme conditions on Earth, can survive for a significant period of time when exposed to the harsh space conditions. They could possibly resist conditions of an interplanetary transfer through space and cope with conditions on other habitable planets.