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Author: Prof. Daniela Billi
University of Rome Tor Vergata, Italy

DESERT CYANOBACTERIA UNDER NON-EARTH CONDITIONS: IMPLICATIONS FOR ASTROBIOLOGY AND LIFE SUPPORT

Abstract

The astonishing capability of life to adapt to extreme conditions provides a new perspective on what habitable means. Desert cyanobacteria of the genus Chroococcidiopsis have been used in several laboratory simulations of space and planetary conditions as well as in real space exposure and Martian conditions simulated in low Earth orbit. When exposure conditions did not exceed repair capabilities, insights were gained on the constraints that life can withstand. Investigations of the molecular response upon recovery shielded light on their potential adaptability to non-Earth conditions. When the accumulated damage exceeded the survival potential, the biomarker persistence contributed to the search for life. Results obtained from the Biology and Mars Experiment (BIOMEX) and Biofilm Organisms Surfing Space (BOSS) space missions, performed outside the International Space Station, showed that ultraviolet radiation is the factor that mostly affects survival and biomarkers detectability. On the contrary, high doses of ionizing radiation did not impair biomarker detectability both when considering Raman spectra signals, or fluorescence sandwich microarray immunoassay, the latter tested in the context of the Bio-Signatures and habitable Niches (BIOSIGN) by using the Signs of Life Detector (SOLID)-LDChip system. The capability of Chroococcidiopsis strains to repair accumulated DNA damage upon rehydration after 1.5-year exposure in LEO provided new insights into the resilience of a putative dormant life in the Martian subsurface. During the project Life in Space the survival potential of dried Chroococcidiopsis exposed to salty-ice conditions simulating the environment of icy worlds was reported as well. It was also reported the capability of this cyanobacterium d to modify its photosynthetic apparatus and harvest near-infrared with implications for the possibility of oxygenic photosynthesis on exoplanets. Such a capability will be father investigated in the on-going ASTERIA (Adaptability of cyanobacteria from extreme environments to stellar UV radiation) project. In the overall, the gathered knowledge will contribute to advance the scientific utilization of exposure platforms that are under development or in advanced planning stage for the exposure of extremophiles beyond the low Earth orbit. In the context of long-term deep space expeditions and human settlement on the Moon and Mars, the gathered knowledge on the endurance of desert cyanobacteria under space and Martian conditions contributes to the development of life support systems as addressed in the ReBUS (In-situ Resource Bio-Utilization for life support in Space).