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CyanoSpace: cyanobacteria form extreme deserts to space

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Abstract

Extreme-tolerant cyanobacteria belonging to the genus *Chroococcidiopsis* are suitable model organisms for space experiments. New isolates of *Chroococcidiopsis* were obtained from survivors scored after exposure to simulated space and Martian conditions. These new isolates offer the challenge to investigate the interconnection between desiccation and radiation resistance; at the same time they might represent improved, stress-selected cyanobacteria for space biotechnology.

1. Introduction

Desert strains of *Chroococcidiopsis* isolated from the Negev Desert and Atacama desert, can withstand prolonged desiccation, high doses of ionizing radiation, few minutes of unattenuated Martian UV flux [1-2, 4]. Furthermore, when overlain by sandstone dried cells of a Chilean strain survived prolonged Martian UV radiation and space simulations as expected for 1.5 year permanence in space [3]. More recently the survival of *Chroococcidiopsis* after 548 days low Earth orbit was reported [5]. In addition, the survival potential of dried cells of *Chroococcidiopsis* will be investigated in two international space research projects, BIOMEX and BOSS, which will take place on the exposure facility EXPOSE-R2 on the International Space Station, starting from 2012.

2. Space- and Mars-selected cells of *Chroococcidiopsis*

Cultures of *Chroococcidiopsis* were obtained from survivors which were able to escape and/or repair damage after exposure to space and Martian simulations (Billi et al. 2011). In fact, new cultures were obtained after selection with high vacuum (10^{-6} Pa), temperature fluctuations (-20/+20°C), UV-C (254 nm, at 10, 100 and 1000 J/m^2), total UV (200-400 nm, at 1.5, 1.5x10^3, and 1.5x10^5 kJ/m^2), CO2 Mars atmosphere alone or combined to UV (200-400 nm, at 1.5x10^5 kJ/m^2). Prior of being exposed to a second round of stresses, these space and Mars-selected cultures of *Chroococcidiopsis* were investigated for cellular structure and function. Particularly they were investigated by focusing on morphology, photosynthetic pigmnets, genome organization and photosynthetic activity. Confocal laser scanning microscopy was employed to perform spectral scanning analyses of the autofluorescent properties of phycobiliproteins and chlorophyll *a*. To gain an insight into the genome organization its polymorphism was investigated by PCR using primers derived from and highly iterated palindromic sequences, type1 (HIP1). Finally, the photosynthetic performance was assessed with a pulse amplitude modulation (Mini-PAM) fluorometer.

3. Summary and Conclusions

The characterization of the cellular structure and function of the new *Chroococcidiopsis* cultures selected following the exposure to space and Martian simulations identified new, suitable phototrophs for space experiments.

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