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First report on the survival of cyanobacteria in Mars simulation chamber in a Hungarian-DLR cooperation

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Abstract

First results of the survival tests of cryptobiotic crust samples realized in the Mars Simulation Laboratory (MSL) of DLR will be presented. The results show that several taxa survived the low pressure of CO_2 atmosphere, with and without diurnal cycles of martian temperatures (between -50 °C and +20°C) and martian relative humidity (between 0.1%RH and 100%RH), some UV irradiation. Some organisms survived nearly all tested environmental conditions.

1. Introduction

Cryptobiotic crust samples containing cyanobacteria were collected from hot and cold deserts in order to analyze their survival potential and extrapolate to their possible behaviour under Martian conditions, in connection with the Dark Dune Spots – Mars Surface Organism (DDS-MSO) hypothesis [1]. The tests were realized by using the Mars simulation facility in the MSL of DLR (Berlin). In the following the first and preliminary results are summarized.

2. Materials and Methods

The samples were collected during the last 6 years and stored at dry place and room temperature. The individual specimens were sized between 3 and 8 cm and contained the nearly intact (unweathered) rock, the cryptobiotic crust and endolithic ogranisms. The specimens were sliced into 1-2.5 cm pieces and prepared in 3 cm diameter petri-dishes with 2 samples in each dish (from two different locations), and they were fixed by glue or double sided duck tape.

Before the chamber test the state of the organisms in the samples were checked by Olympus BX51 microscope with Nomarski DIC epifluorescent illumination.

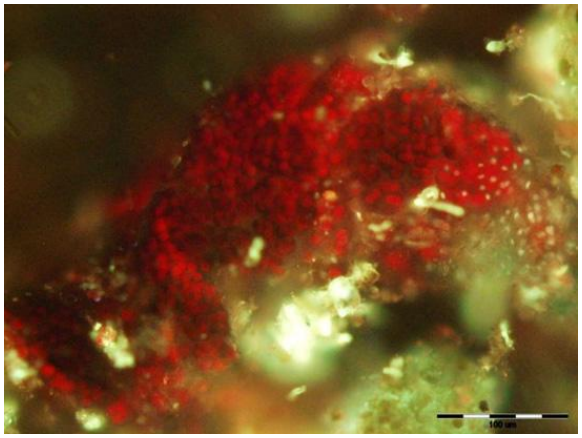

Fig. 1. Pre-test image of Gloeocapsa sp from close to Dubai in UV excitation light

2. Chamber simulation tests

With the 2x55 samples the following test types were realized in the Mars simulation chamber at DLR [2] down to from room temperature down to -50 °C:

1. CO_2 atmosphere + Earth pressure with high humidity 100%RH, LED-light (VIS/PAR), 1 day,
2. CO_2 atmosphere + Mars pressure with high humidity 100%RH, LED-light (VIS/PAR), 1 day,
3. CO_2 atmosphere + Earth pressure with low humidity 0.1%RH, LED-light (VIS/PAR), 1 day,
4. CO_2 atmosphere + Mars pressure with low humidity 0.1%RH, LED-light (VIS/PAR), 1 day,
5. CO_2 atmosphere + Mars pressure + UV and high humidity 100%RH, LED-light (VIS/PAR), 1 day,
6. CO_2 atmosphere + Mars pressure + UV and low humidity 0.1%RH, 1 day,
7. CO_2 atmosphere + Mars pressure, temperature down to -50°C + LED light (VIS/PAR) (4 days with diurnal temperature/humidity cycles 16 h light, 8 hours night).

3. Survival analysis

After the simulation tests the samples were stored at isolated closed boxes and dry places at room temperature. Survival tests were realized by two methods after 2-6 months of the simulation, when samples were rehydrated half an hour before the epifluorescence test and for 24 hours before measuring of pulse-amplitude modulated chlorophyll fluorescence yield using epifluorescence illumination by green excitation light, and PAM 101-103 chl. fluorometer (Walz, Effeltrich, Germany), at an intensity of 200 microeinstein m^{-2} s^{-1} white actinic light here, viewing only from 1 mm distance throught a fiber optic cable.

Among the 50 tests realized with different samples and conditions, in 29 cases the survival of samples was confirmed by both methods after simulation experiments. Both the epifluorescence and the chl. fluorence analysis demonstrated survival of substantial amount (roughly about 50%) of the organisms at several samples. Some examples are:

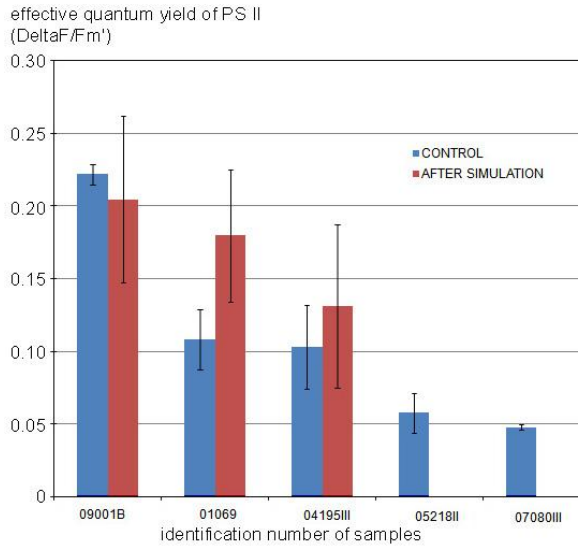

Figure 2. Example diagrams from the tests

sample 09001B: survival of 7 test types, sample form United Arab Emirates, Jebel Ali, 25 km SW of Dubai, coastal salty desert (sabkha) vegetation, dominated by *Chenopodiaceae*;

sample 01069: survival at 6 test types, sample from Australia, Northern Territories. W-Macdonnel Ranges. Open *Chenopodiaceae* semidesert in temporarily wet depression, 46 km WSW from Alice Springs, at 630 m alt. *Tolypothrix byssoidea* (dominant), *Gloeocapsopsis pleurocapsoides*, *Nostoc microscopicum* and *N. minutissimum* in the upper layer, in the -0.1-0.4 mm deep lower layer *Schizothrix* aff. *kialingensis* without UV screening pigment);

sample 04197: survival at 11 test types, sample from Western Australia. Dried out W branch of of the salt Lake Barley along Youani Road, at 409 m alt. Top layer: *Tolypothrix byssoidea*. Subsurface layer to -1mm: *Leptolyngbya* or *Symploca* sp. + mycelia of fungi.

4. Conclusion

The observations suggest there are the survival in general depends more on the type of sample analyzed here than on the conditions they witness.

The results show that in many cases the level of photosynthetic response was roughly at the same order for the control samples like those that faced the Mars simulation conditions. Interestingly there is no general tendency toward the decrease of response in most cases as it would be expected. Even more interesting in some cases the response was stronger after the simulation. Detailed analysis on the survival is going on and some of the results will be presented at the EPSC 2012 meeting.

Acknowledgements

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References

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