Europlanet TA Scientific Report

PROJECT LEADER

Project number: 20-EPN2-073	
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TA Facility visited: TA2 Facility 4 – AU Planetary Environment Facility	

Project Title: Assessment of the aeolian dispersion and wind effects on cryptoendolithic microorganisms in the Martian environment.

Scientific Report Summary.
(plain text, no figures, maximum 250 words, to be included in database and published)

The hostile current conditions on the surface of Mars entail that, if any form of life exists or ever existed on the planet, it may have adopted survival strategies like those evolved by terrestrial microorganisms inhabiting extremely harsh regions, such as Antarctic deserts. Here, one of the most common strategies observed is the cryptoendolithic growth, defined as the colonization of the small interstices inside rocks, where microorganisms are protected from external hostile conditions. However, endolithic microorganisms can break down the surrounding rock substratum, thus causing the exfoliation of the external layers of the colonized rocks. Consequently, exposure to wind and saltating sand can cause the dispersal of the shallow rock fragments and endolithic colonies to the environment. In this optic, this study aimed to examine the possibility of dispersal of hypothetical rock-dwelling microorganisms on the surface of Mars. To achieve this goal, colonized Antarctic sandstone rocks were exposed to simulated Martian and terrestrial windy environments at the Planetary Environment Facility in Aarhus University in four different simulations. Rock, sand, and dust samples were collected after each simulation to assess the survival and the variety of dispersed microorganisms in the two scenarios. Although biological data are not available at the moment of the draft of the report, remarkable differences were observed in the dispersal of dust and sand between the different conditions.

Full Scientific Report on the outcome of your TNA visit

We encourage you to add figures to your report, which should be approx. 1 page of text plus figures.

The current environmental conditions on the surface of Mars represent an obstacle to the survival and persistence of life as we know it. However, microorganisms isolated from polyextreme environments on Earth (i.e., extremophiles) show a few adaptive strategies which enable them to cope with several hostile environmental factors. Therefore, if life exists or ever existed on Mars, one can assume that it may have adopted the same strategies observed in terrestrial extremophiles to survive the harsh conditions occurring on the planet. One of these strategies is cryptoendolithism, which is the colonization of the pores inside the rocks, where they can be sheltered by harsh external conditions. Here, the interaction of endolithic microorganisms with the rock substratum can induce the exfoliation of rocks by the separation of mineral grains, which can be dispersed to the environment by the combined action of sand saltation and wind.
In this optic, the present study aims to understand whether hypothetical viable cryptoendolithic microorganisms may be dispersed by the wind from rocks on Mars and if any difference can exist with the microbial dispersal occurring on Earth. To test this hypothesis, the wind tunnel at the Planetary Environment Facility in Aarhus University was used for five days, during which the possible dispersal of endolithic fungi dwelling Antarctic rock samples was simulated in terrestrial and Martian conditions. The samples used in the study were represented by sandstone and basalt rocks (3-5 cm in diameter) colonized by cryptoendolithic fungi, collected in Trio Nunatak, in Victoria Land (Antarctica). The microorganisms isolated from the samples were the Antarctic cryptoendolithic black fungi *Cryomyces antarcticus* and *Extremus antarcticus*. All rocks were previously irradiated with γ radiation at a dose of 1 kGy to simulate the exposure to part of the Martian radiation environment and maintained under dry conditions throughout the experiments. In total, four different simulation experiments were performed by using the wind tunnel (one per day), two aiming to reproduce the wind effects in a Martian scenario and two in a terrestrial scenario (Table 1).

Table 1. Experimental setup for the performed experiments.

Parameters:	**Day 1 (Martian scenario)**	**Day 2 (Martian scenario)**	**Day 3 (Terrestrial scenario)**	**Day 4 (Terrestrial scenario)**
Average wind speed (m/s)	~18	~18	~10	~10
Pressure (mbar)	10	10	1000	1000
Atmosphere composition	CO_2	CO_2	Atmosphere of Earth	Atmosphere of Earth
Running time (min)	~25	~15	~25	~15

In each experiment, the experimental setup inside the wind tunnel was the following (Figure 1):

- Two lines of rocks (three rocks in each line) were arranged on a bed of sterilized quartz sand (grain size of ~125 μm). The size of the sand bed was about 90 x 40 cm.
- One sterilized steel plate was placed on one side of the wind chamber, close to the sand bed, for dust sampling, and one dust catcher was placed on the floor of the chamber, downstream of the sand bed.
- Two lines of sand traps were placed on the leeward side of the tunnel. Among these, one trap was sterilized to retrieve sand under sterile conditions.
- Two microscope cameras were placed on the side of the samples, separated from the inside of the tunnel by a plexiglass panel, and a webcam was placed above the sand bed.

The weight of each rock sample was measured before and after the running of the experiments to assess the loss of fragments by erosion due to wind and sand saltation. The weight of the total amount of the sand moved downwind and the sand retrieved in the traps were also measured after each experiment. Additionally, the dust lift-off during the wind experiments was measured as a function of the opacity inside the tunnel. The parameters set in each experiment are reported in Table 1. All data acquired during the four simulations were organized and transferred during the fifth day.
During the Martian and terrestrial simulation, the sand saltation was visible in the vicinity of the rocks through microscope cameras and the webcam. The saltation caused the movement of the sand downstream of the bed during all the simulations (Figure 2). However, a greater amount of moved sand was observed at the leeward part of the tunnel and inside the sand traps after the two experiments under Martian conditions. Similarly, the dust lift-off during the wind simulation was markedly greater under Martian conditions than terrestrial conditions. Furthermore, a little weight loss was detected in the rocks after all the simulations.

To assess the dispersal of endolithic microorganisms through wind and their survival under the simulated conditions, the following samples were retrieved under sterile conditions and stored in sterile bags and 50 ml conical tubes after each simulation: i) Colonized Antarctic rocks exposed to the Martian and terrestrial conditions; ii) sand close to the rocks from the leeward side of the bed; iii) sand from the sterilized sand trap; iv) the dust catcher; v) dust on the surface of the steel plate, retrieved through sterilized dust collectors.
SEM microscopy analyses, Propidium MonoAzide (PMA) assay, DNA metabarcoding characterization of the diversity of the dispersed microorganisms and survival analyses are underway on the mentioned samples at the Laboratory of Systematic Botany and Mycology, Department of Ecological and Biological Sciences (DEB), Tuscia University (Viterbo, Italy).

Figure 1. Experimental setup inside the wind tunnel.

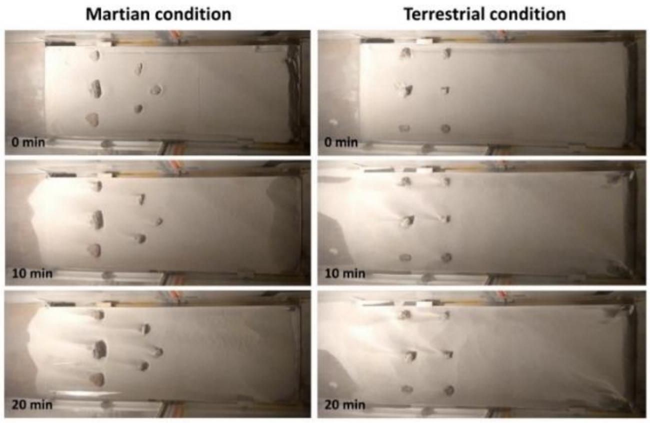

Figure 2. Sand movement during day 1 (Martian scenario, pictures on the left) and day 3 (terrestrial scenario, pictures on the right).

- Give details of any publications arising/planned (include conference abstracts etc)

Due to the time required for the analyses planned after the experiments at the facility, data are not yet available for publication. However, the results will be published in an international peer-reviewing journal as soon as available. Furthermore, part of the outcomes is planned to be presented at the Biennial European Astrobiology Conference (BEACON), scheduled for April 2022.

- Host confirmation

Please can hosts fill in/check this table confirming the breakdown of time for this TA project:

Dates for travel to accommodation for TA visit (if physical visit by applicant)	Start Date of TA project at facility	Number of lab/field days spent on TA Visit pre-analytical preparation	Number of days in lab/field site for TA Visit	Number of days spent in lab for TA Visit data analysis	End Date of TA project at facility	Dates for travel home (if physical visit by applicant)
Departed: 14-11-21 Arrived: 14-11-21	15-11-21	0	5	0	19-11-21	Departed: 24-11-21 Arrived: 24-11-21

The host is required to approve the report agreeing it is an accurate account of the research performed.

Host Name	**Jonathan Merrison**
Host Signature	
Date	**4/1/2021**

- Project Leader confirmation

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Project Leader Name	**Lorenzo Aureli**

Project Leader Signature	
Date	**20/12/2021**