Europlanet TA Scientific Report

PROJECT LEADER

Project number: 22-EPN3-011
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TA Facility visited: Matís, Iceland TA1.01

Project Title: Phototrophic microorganisms in cold deserts of Iceland - diversity and ecophysiology of potential Analogues

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

The research project was conducted by Daniel Remias (project leader; University of Salzburg, Austria) and Lenka Procházková (co-applicant; Charles University, Prague, Czech Republic).
Geology and climate of inland regions at Iceland are ideal prerequisites for exploring microbial adaptation to cold and dry habitats. Bare terrestrial ground surfaces and high-altitude melting snowfields represent niches at the edge of life on Earth. Soil samples were harvested at altitudes from almost at sea level up to more than 1000 m.
Additionally, red snow caused by cryoflora (snow algae) from permanent snow packs in the Kerlingarfjöll Mountains were collected, and photosynthetic uptake rates were measured *in situ* with labelled carbon (^{13}C). Red snow was transported to the lab and the pigments extracted and the UV-protecting pigments characterized by HPLC.
Main aim was the molecular characterization of the phototrophic microbial community for evaluation of abundance and diversity of terrestrial and frozen habitats. Barren, desert-like sites will be compared with vegetated ones. Microalgae marker DNA will be extracted with dedicated kits for environmental soil samples.
This study aims to shed light on how photoautotrophic microbial life could work at Earth analogues with likewise or even worse climatical or edaphic conditions.
Finally, Icelandic terrestrial microalgae will be tested as potential Analogues compared to other worlds like Mars or icy moons.

Full Scientific Report on the outcome of your TNA visit

During the stay, which lasted seven field days, 20 surfacial samples of soil were collected reaching a depth of 2 cm, either barren spots or close to the roots of vascular herbal plants, furthermore one red snow and two glacier ice samples were collected. The sites were located either in the contemporarily volcanic influenced Southwest of Iceland or in the desert-like highlands around the Langjökull and Hofsjökull ice caps. Sites were carefully selected to exclude potential anthropogenic impact. The new volcanic eruptions at Iceland started by chance during our stay, but unfortunately, due to security reasons the region around Fagradallsfjall was closed for access by local authorities when we wanted to go there for very volcanic influenced sites.
Biodiversity and abundances of microalgae will be evaluated by metagenomics (High-throughput-sequencing) using Illumina MiSeq 2x300 bp for selected marker sequences such as 18S rRNA gene or ITS2. This will be performed with a dedicated DNeasy PowerMax Soil Kit for difficult matrixes. Molecular results will be blasted with public databases to evaluate and identify the phototrophic communities on a gradient from coastal to high alpine habitats. Also, for each site, results for barren soil samples will be compared with those close to herbs, where we expect enhanced growth of microalgae in the vicinity of roots. The soil samples will also be available for students performing cultivation experiments on inorganic media. If some species will grow in the illuminated climate chamber, the isolated microalgae will be later available for physiological experiments including abiotic stress, e.g. under a Martian-like atmosphere, as demonstrated earlier (Cycil et al. 2021; https://doi.org/10.3389/fmicb.2021.733244).
The second kind of investigated extremophilic terrestrial habitat on Iceland were high-altitude glaciers and permanent snow fields harbouring cryoflora. Regarding glaciers, we harvested ice on the western and eastern margin of Langjökull, and cells of the glacial ice alga *Ancylonema* were successfully found. Cultivation experiments with these striking brownish pigmented green algae are currently running. In the case of permanent snow fields, a prominent site in the Kerlingarfjöll Mts. causing a red snow bloom was investigated. Some cells had a *Smithsonimonas*-like morphology, others resembled *Sanguina* (both Chlamydomonadales). In this case, we performed an *in situ* experiment of inorganic carbon uptake using a ^{13}C label. Results will be obtained after analysis in an isotope laboratory in Austria. Ambient irradiance levels were recorded during noon with hemispherical photon sensors: PAR = 1420 µmol photons m^{-2} s^{-1}, UV-A = 4.104 W cm^{-2} and UV-B = 271.2^{-3} W m^2. We expect that carbon-fixation can take place under conditions at snow surfaces, representing a habitat of both low water availability and high UV exposure. Next, the field cells were fixed for scanning and transmission electron microscopy. Chemical composition of snowmeltwater will be analysed in an analytical lab in the Czech Republic. Finally, the secondary red pigments of this green alga were characterized by HPLC, showing a complex chromatogram made of derivatives of the carotenoid astaxanthin (see figure).

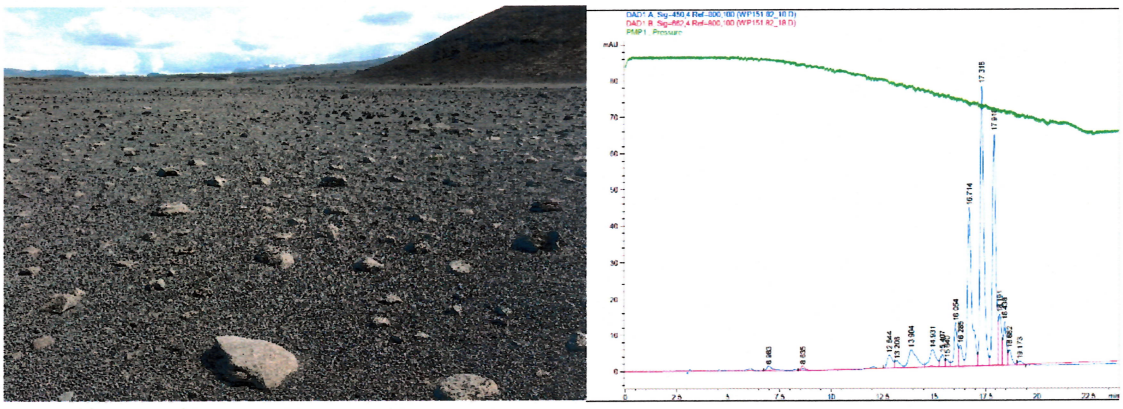

Figure (left): Overview of desert-like sampling sites WP331 and WP332 close to Sandfell Mt. (accessed via F338). **(Right):** HPLC of organic extract of red snow microalgae from Snoekollur, Kerlingarfjöll Mts, showing several peaks of the protective carotenoid astaxanthin at 440 nm (blue graph).

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

Currently, at least two publications in indexed, peer-reviewed journals are intended:

- Soil microalgae communitiy evalution and comparison at Iceland (metagenomics/HTS)
- Red snow caused *Smithsonimonas*-like cells at Iceland : morphology, identity, photosynthetic performance, primary and secondary cellular pigments

- 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: 06.07.23 Arrived: 06.07.23	07.07.23	0	7	0	13.07.23	Departed: 14.07.23 Arrived: 14.07.23

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

Host Name	**René Groben / Matís**
Host Signature	
Date	**09.08.23**

- Project Leader confirmation

Do you give permission for the full version of this TA Scientific Report (in addition to the 250 word summary) to be published by Europlanet 2024 RI on its website and/or public reports? YES!

Project Leader Name	**Daniel Remias**

Project Leader Signature	
Date	**08 August 2023**