PROJECT TITLE: Microbial survival strategies during drought and fire

University of Bristol Research Theme(s): Climate/Environment

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Project keywords: Geomicrobiology, Microbe-mineral interactions, Extremophiles, Drought, Fire, Soils

Project Background:

Some microbes can use iron to generate energy and directly attack rocks and minerals as a by-product. These microbes play a key role in forming soil, facilitating the cycling of important plant nutrients and removing carbon from the atmosphere. Furthermore, due to their ability to survive on only rock-derived elements and carbon from the atmosphere, they play a critical role in the primary colonisation of fresh rocky habitats i.e. in the deep subsurface or on lava flows.

Despite the fundamental role of these microorganisms in the environment, most of what is known about their lifestyle comes from regions where water and organic matter are abundant e.g. tropical/temperate soils or sediments. It is much less clear how these microorganisms survive in particularly dry environments such as deserts; how they tolerate extreme climatic perturbations such as drought and fire; or what their role is in the recovery of soil microbial communities from such extreme events.

This project will seek to:

1) Probe the tolerance limits of known iron-utilizing bacteria using a combination of laboratory cultivation experiments and comparative genomics methods.

2) Experimentally investigate the role of symbioses in microbial survival in extreme environments i.e. the relationship between iron-utilizing bacteria and fungi on rock surfaces.

3) Assess the survival of iron-utilizing bacteria following simulations of drought and fire, as well as the impact of their recovery on availability of soil carbon and nutrients.

These insights will vastly improve our understanding of the resilience of soil microbial communities in extreme environments, with important implications for the response of soil ecosystem services to an increasingly unpredictable climate.

Figure 1. Climatic gradient along the Chilean coast from very wet to very dry, with pictures of the 4 national parks where we will investigate how drought and fire impact microbial survival in different climate regimes.
Project Aims and Methods:
As well as using available strains of bacteria and fungi to test the resilience of iron-metabolizing bacteria and their symbiotic interactions with other microbial community members, this project will also take advantage of a rare set of samples from a climatic gradient on the Chilean coastal cordillera which spans from humid rainforest to the Atacama Desert (Figure 1). Samples from along the gradient will be used to investigate the impact of drought on the identity and lifestyle of iron-metabolizing microbes. Small plots at these sites were also subjected to a controlled fire in January 2022. Samples from before the fire and during the recovery phase will be used to evaluate survival following these extreme events and the evolution of soil nutrient cycling post-fire (including the ability of the soil to store carbon).

Training:
This project will provide training in cutting-edge laboratory methods required for analyses of soils, microbial cultivation, comparative genomics, and characterization of minerals and organic matter. This will be supported by an international supervisory team with expertise in microbial cultivation, genomics, fungal physiology and soil biogeochemistry. The student will also be encouraged to participate in internal and external training courses to develop both technical and personal skills essential for a successful scientific career. Funding is also provided for the student to present their research at a major international conference such as Goldschmidt, and the student will be supported in applying for travel grants to support further travel opportunities. This project would be associated with the German research initiative “EarthShape: Earth Surface Shaping by Biota” and the student would also be encouraged to engage with this international network of over 100 researchers and PhD students during the project, primarily based in Germany and Chile.

Candidate requirements:
The ideal candidate will have a strong background (preferably MSc-level) in a related discipline e.g. Earth Science, Microbiology, Molecular Biology, Environmental Chemistry or Physical Geography, and a strong interest in Environmental Microbiology. Experience with wet chemical lab methods, microbial cultivation, molecular ecology and/or computational or programming skills would be highly beneficial, however training will be provided and the project can be directed towards the candidate’s strengths and interests. Good written and oral communication skills are required, as is the ability to work independently and in a team. Applications from UK and international students are equally welcomed, and applications from students in historically under-represented groups particularly encouraged.

Background reading and references:
More on the climatic gradient and related projects can be found here:
https://esdynamics.geo.uni-tuebingen.de/earthshape/index.php?id=129
A video showing some of the field sites can be found here:
https://www.youtube.com/watch?v=4dlU8v9ulRo&list=PLTx3jCvV_WdcI308uAC6QaBPIWuhj9G2D&index=1

Useful links
For more information on studying at Bristol:
http://www.bristol.ac.uk/earthsciences/courses/postgraduate/
How to apply to the University of Bristol: http://www.bristol.ac.uk/study/postgraduate/apply/
The application deadline is Monday 14 February, 2022 at 2359 GMT. Interviews will take place during the period 10 March – 18 March 2022.

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