Understanding the limits of microbial life

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Summary:

This project will focus on the understanding how microorganisms survive in extreme environments using both culture dependent and independent techniques.

Project Highlights:

- Pioneering work to study the limits of life.
- Isolation of novel poly-extremophiles
- Training in interdisciplinary techniques including microbiology, bioinformatics and geochemistry.

Overview:

Extremophilic microorganisms live in some of the most extreme environments on Earth. They can thrive in conditions that were previously deemed inhospitable for life, including extremely high temperatures, high concentration salt solutions, acidity or alkalinity. Extremophilic microorganisms are also thought to have been the first representation of life on early Earth and may have played an important role in the evolution of the Earth's atmosphere. Studying extremophilic microorganisms is important in order: 1) to characterise the physical and chemical boundaries of life on Earth; 2) to understand how life may have evolved on early Earth; 3) to identify potential enzymes that can be used in biotechnology; 4) to understand potential life elsewhere in the Solar System.

As part of this grant, we will be carrying out field work in some of the most extreme environment on Earth (e.g. Figure 1). The actual destinations will be defined as part of this project. This studentship will focus on 1) understanding how microbial communities survive in an extreme environment using a metagenomic approach; 2) isolating novel extremophiles to understand thei physiological requirements for survival. The project will use a combination of state-of-the-art molecular techniques and microbiology.

Methodology:

To understand how life exists within such an extreme environment a culture-independent approach will be used. This will involve extracting DNA from the samples and identifying 1) the microbial species within the environment and 2) the mechanisms that they employ to survive and 3) for metabolism. It will involve culturing and isolating (both aerobic

Figure 1: *Hydrothermal pool in Dallol crater in the northern part of the Danakil Depression. The water is extremely acidic and the coloured surrounding deposits are mainly salts, sulfur and iron crust.*

and anaerobic) microorganisms and investigating their limits of habitability.

Training and skills:

The student will gain training in specific techniques in molecular biology and microbiological. The Open University has comprehensive laboratory facilities for all required analyses.

The student will benefit from a diverse training programme, ranging from skills that support their PhD studies, e.g., writing skills, time management, presentation skills, research skills and thesis writing, and skills that prepare them for the future after graduation, e.g., CV writing, and networking, including making active contact with to industry and academic partners.

Partners and collaboration:

Sophie Nixon (Manchester University) has expertise in analysing environmental metagenomics data. Barbara Cavalazzi (University of Bologna, Italy) has extensive expertise in field work in extreme environments. Eric Bapteste (Université Pierre et Marie Curie) has expertise in evolutionary bioinformatics.

Possible timeline:

Year 1: Perform a literature review and carry out field work and initial training in metagenomics. Set up cultures for isolation.

Year 2: Submit manuscript regrading microbial diversity. Perform metagenomics analyses and prepare manuscript regarding metabolism. Isolate and characterise extremophiles. Present results at a national conference.

Year 3: Submit manuscript regarding mechanisms of survival. Write and submit thesis. Present data at an international conference

Further reading:

Makris, J.; Ginzburg A. The Afar Depression; transition between continental rifting and sea-

floor spreading. *Tectonophysics*, **1987**, 141:199-214.

Mesbah NM.; Wiegel J. Life under multiple conditions: diversity and physiology of a halophilic alkalithermophiles. *Appl. Environ. Microbiol*, **2012**, 78: 40740-40782.

Further details:

Students should have a strong background in environmental microbiology and/or molecular biology. The student will join a research team that has extensive experience working with extremophilic microorganisms at the Open University, as well as working with an active team of geochemists.

Please contact Karen Olsson-Francis (karen.olsson-francis@open.ac.uk) for further information.

Applications must include:

- a cover letter outlining why the project is of interest and how your skills are well suited to the project
- an academic CV
- an application form and an Open University application form, downloadable http://www.open.ac.uk/students/research/system/files/documents/Application%20form%20-%20uk-eu_0.docx
- contact details of three academic references

Applications should be sent to STEM-EEES-PhD@open.ac.uk by 5pm on 30th September 2019.

About us:

AstrobiologyOU has recently been awarded a £6.7m 'Expanding Excellence in England' award by Research England to grow capacity and capabilities. This will allow us to expand and bring together expertise in technology, international development and governance to address the scientific and governance challenges associated with the advancement of astrobiology and related space exploration missions. As part of this expansion we will be recruiting new PhD students who will span these discipline areas. Each studentship will play an important role in the growth of AstrobiologyOU.

The PhD candidate joining us for this project will be working in a vibrant interdisciplinary environment, alongside PhD students from STEM, Law and Governance, and Social Sciences. They will also be part of the wider OU student community, which is a friendly and supportive cohort, with regular social events organised through groups such as RocSoc, HookeSoc and the OU Club.