The role of heterotrophs in glacier surface ecosystem productivity

Supervisors

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Project description

Glacier surfaces support a variety of ecological niches which are home to a diverse array of microbial life, generally concentrated around debris blown onto the ice from surrounding environments (Figure 1). These debris accumulations absorb sunlight and melt down into the ice, providing the microorganisms contained therein with liquid water, nutrients from melting ice, and light during the summer months. Rates of photosynthesis and respiration in these niches, which include cryoconite holes, cryolakes and distributed debris, are equivalent to temperate sediments and soils and sustain a surprisingly large biomass (of the order 10^5cell/ml).

Contemporary research has demonstrated that these communities can fix carbon and nitrogen, and that they may accumulate organic carbon over time[1]. When the systems are flushed by meltwater, the organic material is redistributed to downstream ecosystems. Since the fixed carbon is present in bioavailable forms, it has an important role in stimulating biological activity in otherwise nutrient-poor landscapes[2]. Recent research efforts have focused on measuring the magnitude of carbon production and/or consumption, but the mechanisms which maintain these processes are as yet, unknown. Despite the important contribution of these systems to productivity in polar regions, they remain poorly understood.

This project will examine the role of aerobic and anaerobic heterotrophic organisms in glacier surface productivity. Molecular ecological and metagenomic analyses have been conducted on some glacier surface samples, and helped to reveal the microbial community composition, but there has been very little study of the role and specific function of individual microbial species within the community as a whole. However, preliminary studies have shown that prolonged primary production is only possible with the support of the heterotrophic community. This exciting project will isolate the organisms responsible and seek to understand how the heterotrophic community is adapted to one of the most extreme environments on earth and how it helps to maintain the biogeochemical processes that enable primary production.

A range of cutting-edge laboratory techniques will be used to understand these unique ecosystems. The student will work with samples from both the Arctic and Antarctica, using multidisciplinary methods which draw on expertise in geomicrobiology/microbial ecology, low temperature biogeochemistry and glaciology at Cardiff and Bristol. There may be opportunity to collect additional samples from polar fieldsites. He/she will undertake skilled laboratory analyses and leave equipped with a range of sought-after interdisciplinary skills.

1. Anesio and Laybourn-Parry 2012, Trends in Ecology and Evolution, doi: 10.1016/j.tree.2011.09.012

2. Bagshaw et al. 2013, Arctic, Antarctic and Alpine Research, doi: 10.1657/1938-4246-45.4.440

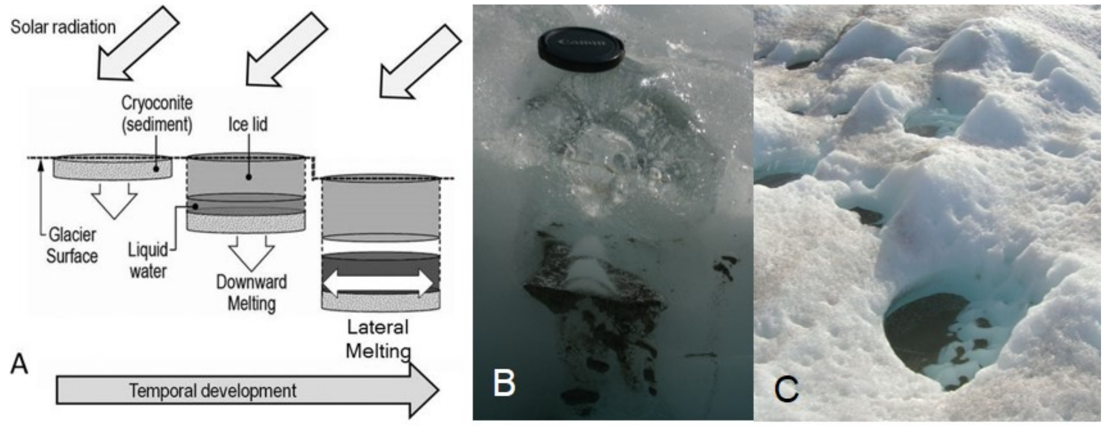

Figure 1: An illustration of the formation of a key glacier surface ecological niche, the cryoconite hole (A), showing examples from the Antarctic (B) and Greenland (C).