

# Life on ice

Against all expectations, glaciers harbour a highly active community of bacteria, viruses and microscopic plants, say **Alexandre Anesio and Andrew Hodson.**

**D**o you think that walking on a glacier is like walking into a big freezer? It's certainly a very cold environment, although since the glacier is an open environment, it is also exposed to solar radiation and debris from the air. In fact, between one and six percent of the surface of a glacier may be covered by inorganic and organic particles. These are darker than the surrounding white icy surface and so absorb solar radiation better than ice. The heated debris melts into the ice forming features called cryoconite holes – small water-filled depressions typically less than one metre in diameter and less than 0.5m deep.

Life exists wherever there is water and cryoconite holes are no exception. These holes are colonised by a diverse range of microorganisms, including viruses, bacteria and microscopic plants. The main objective of our project was to investigate whether these microorganisms are active during the warmest part of the year, despite temperatures as low as 0.1°C.

We used three independent methods to measure microbial activity in both the melt-water and the bottom debris on three glaciers in Svalbard, an archipelago between Norway and the north coast of Greenland (NERC has a base on the islands).

As suspected, the microbial activity in the melt-water was very low – comparable to an extremely clear lake. But the microbial activity associated with the cryoconite debris was similar to that found in very rich ecosystems from warmer regions. In fact, microbial activity in one gram of cryoconite debris was roughly the same as in one gram of soil from the Mediterranean. Unlike low-latitude soil ecosystems, microbial activity in these cryoconite ecosystems is very tightly constrained by the short-lived summer melt period.

## HighSpy

The team are pioneering the use of remote-controlled helicopters to survey microbial life on glaciers. Watch a movie about Andy Hodson's NERC Connect award, showing how they mapped cryoconite cover across a Svalbard glacier: [www.sheffield.ac.uk/geography/staff/hodson\\_andy/ecology.html](http://www.sheffield.ac.uk/geography/staff/hodson_andy/ecology.html)



PhD student Tristram Irvine Fynn, and undergraduate Emma Goodfellow, observing the extent of debris cover on the surface of the glacier.

We also tested whether the tremendous amount of microbial activity in cryoconite holes is self-sustaining by comparing the amount of photosynthesis (when plants convert carbon dioxide to biomass, releasing oxygen) with the amount of respiration (when plants absorb oxygen and turn organic matter back to carbon dioxide). An ecosystem can only be self-sustained if photosynthesis is equal to or higher than respiration.

Many lakes worldwide have photosynthesis lower than respiration rates which indicate that they must receive inputs of organic matter from outside the lake. We are accumulating evidence that photosynthesis in the cryoconite holes is usually higher than respiration, which could easily sustain the high bacterial activity found by our studies. The consequences of these findings are many. Firstly, these results indicate that the combined activity of microscopic plants and bacteria in cryoconite holes results in accumulation of organic matter (darker in colour), which may contribute to further solar radiation absorption and thus enhance glacial melting. Secondly, excess organic matter can move to other ecosystems including the oceans in the summer months, sustaining life elsewhere.

Most interesting, however, is the contention that since photosynthesis exceeds respiration, glacial ecosystem activity represents a negative feedback – the ecosystem is a net absorber of carbon dioxide. Considering that glaciers cover a surface area of 15 million square kilometres of our planet (equivalent of 61 United Kingdoms), microbial activity in these ecosystems may have great potential to influence the global carbon cycle. ■

Alexandre M. Anesio is a lecturer in Low Temperature Biogeochemistry at the Bristol Glaciology Centre, School of Geographical Sciences, University of Bristol. Andrew Hodson is a Reader in Cold Regions Biogeochemistry in the Department of Geography, University of Sheffield. Email: [a.j.hodson@sheffield.ac.uk](mailto:a.j.hodson@sheffield.ac.uk)

### More information

'Viral dynamics in cryoconite holes on a high Arctic glacier (Svalbard)', *Journal of Geophysical Research – Biogeosciences*, (in press).