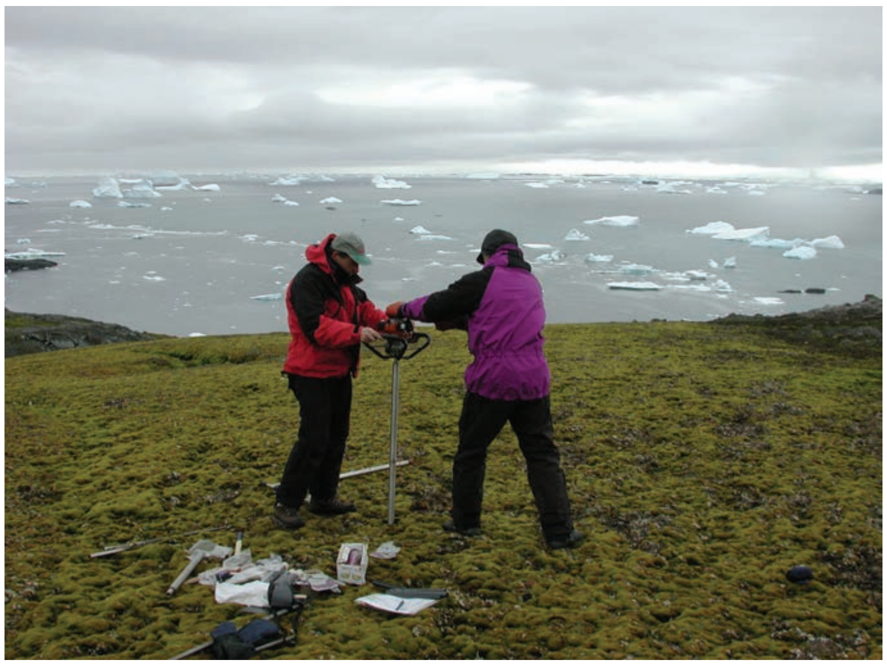
Moss Brought Back to Life After 1,500 Years Frozen in Ice


Lazarev moss Banks (credit Peter Convey BAS)

Researchers from the British Antarctic Survey and Reading University have demonstrated that, after over 1,500 years frozen in Antarctic ice, moss can come back to life and continue to grow. For the first time, this vital part of the ecosystem in both polar regions has been shown to have the ability to survive century to millennial scale ice ages. This provides exciting new insight into the survival of life on Earth.


Drilling Peat core (credit Peter Boelen)

The team observed moss regeneration after at least 1,530 years frozen in permafrost. This is the first study [1] to show such long-term survival in any plant; similar timescales have only been seen before in bacteria. Mosses are known to have survived environmental extremes in the short-term with previous evidence confirming up to a 20 year timescale for survival. Their potential to survive much longer timescales had not previously been examined.

Mosses are an important part of the biology of both polar regions. They are the dominant plants over large areas and are a major storer of fixed carbon, especially in the north.

Co-author Professor Peter Convey from the British Antarctic Survey explained:

"What mosses do in the ecosystem is far more important than we would generally realise when we look at a moss on a wall here for instance. Understanding what controls their growth and distribution, particularly in a fast-changing part of the world such as the Antarctic Peninsula region, is therefore of much wider significance."

The team took cores of moss from deep in a frozen moss bank; this moss would already have been at least decades old when it was first frozen. "We've known about these moss banks since the 1960s, but early work on them, other than noting they are exceptional for the Antarctic, concentrated on their age, ie when they might have started forming, and the oldest ones have been aged to 5-6,000 years at the base. The particular bank we are working on is about 2000 years at the base," Professor Convey explained.

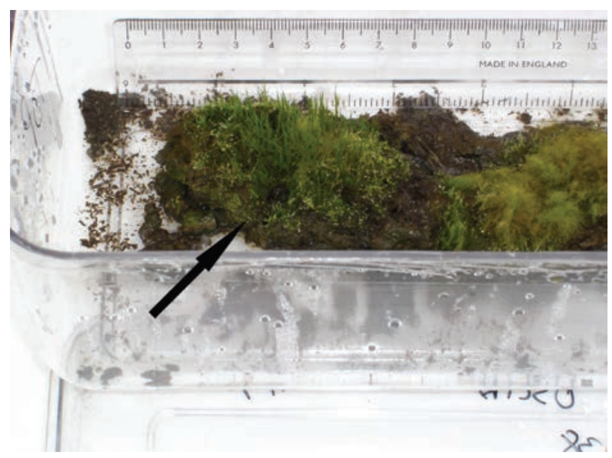
"In the early 2000s, we started a series of projects, that are still ongoing, that are looking not only at the overall age of the banks, but at what we can learn by looking in detail through the bank profile to try and obtain clues (proxies) for how the local climate has changed throughout the life of the bank.

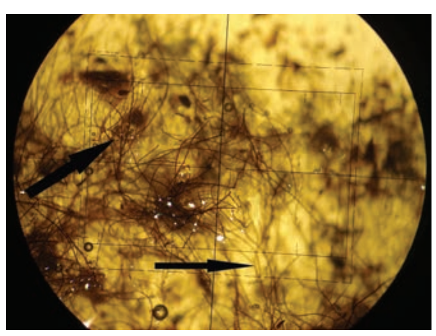
"This was the stimulus for the actual field project within which we were able to obtain this 'bonus' core that we worked on in this study - we had a collaboration with a Dutch group at the time (Free Univ of Amsterdam) that obtained several cores in order to search through them for plant protective pigments (sunscreen pigments) that they produce in response to UV-B stress, in other words we were looking for clues to whether there was any evidence for something like the ozone hole having occurred before. At the time, by examining cores closely, this already had told us the moss material was very well preserved within them (ie good stem and leaflet structure, etc), and it let us ask the simple question of how far down the core from the living surface could we find any evidence of ability to re-grow, ie living moss shoots. Hence we were able to ask that field group to obtain for us an extra core on which to try out some re-growth studies - true 'blue sky' science. When we obtained these cores and got them back to UK, we undertook the re-growth work with collaborators at the University of Reading, as they had the facilities and an RA available supporting Royce Longton (one of the 'founding fathers' of bryophyte studies in the polar regions) to support the work. The growth study itself was in reality very simple, and relied heavily on simple observation, including under the microscope, of the occurrence of new growth and where it derived from."

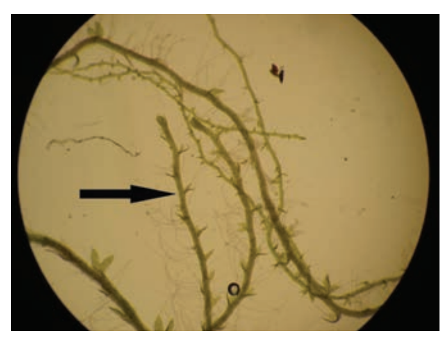
The research team has since moved on to a series of projects looking in great detail at age profiles through moss cores in order to reconstruct growth rates and infer environmental conditions over the last several thousand years. These studies [2] amongst other things have shown that the acceleration in warming over recent decades has not been seen previously. The techniques used also involved a lot of old fashioned microscopy simply in quantifying the microscopic fauna of testate amoebae," said Professor Convey.

The frozen moss cores were sliced very carefully, keeping them free from contamination, and placed in an incubator at a normal growth temperature and light level. After only a few weeks, the moss began to grow. Using carbon dating, the team identified the moss to be at least 1,530 years of age, and possibly even older, at the depth where the new growth was seen.


(A) Site of new growth emerging from existing gametophytes on the fresh-cut face of the core at 110 cm depth (arrow).


(B) Extensive regrowth of Chorisodontium aciplyllum from the basal section of the core at 121–138 cm depth.


(C) Regrowth from the basal section of the core, showing preserved brown rhizoids (thick arrow) and new protonemal growth (thin arrow).


(D) New shoots of the liverwort Cephaloziella sp.

Micrographs Figs a-d (credit Esme Roads)

According to Professor Convey: "This experiment shows that multi-cellular organisms, plants in this case, can survive over far longer timescales than previously

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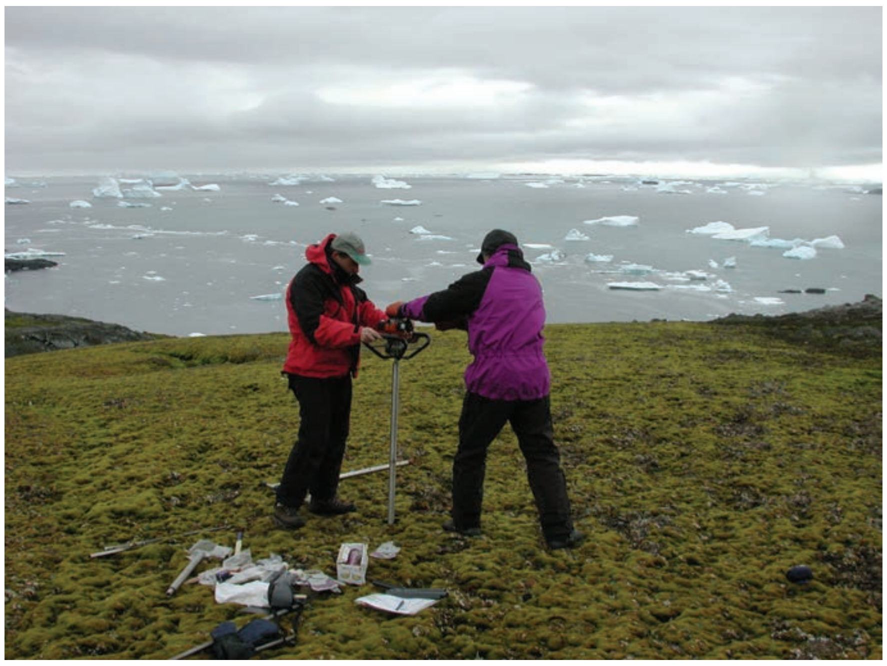

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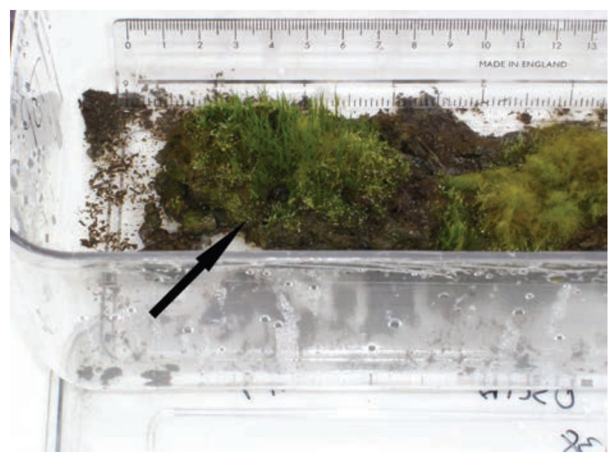

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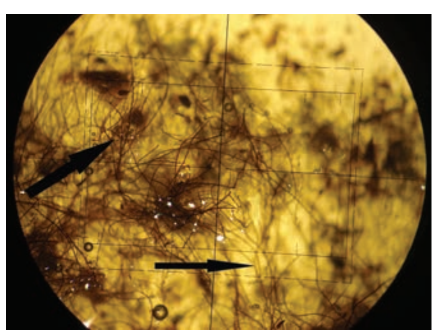

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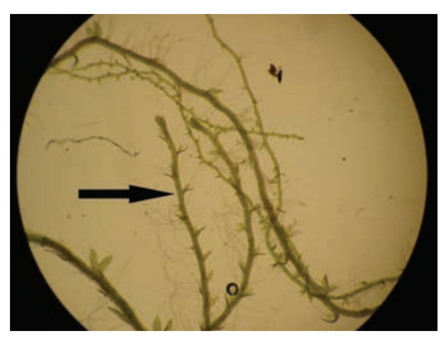

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Moss core frozen (credit Esme Roads)

thought. These mosses, a key part of the ecosystem, could survive century to millennial periods of ice advance, such as the Little Ice Age in Europe.

"If they can survive in this way, then re-colonisation following an ice age, once the ice retreats, would be a lot easier than migrating trans-oceanic distances from warmer regions. It also maintains diversity in an area that would otherwise be wiped clean of life by the ice advance.

"Although it would be a big jump from the current finding, this does raise the possibility of complex life forms surviving even longer periods once encased in permafrost or ice."

"Finally, my current PhD student Elise Biersma is also looking at the cores in the context of attempting to measure rates of mutational change (evolution) over time, building on the idea that in principle you are looking at one or a very small number of plants growing over a very long time. A moss shoot grows from the tip, and leaves a progressively longer shoot behind it. Until our current study we had assumed this shoot was dead after a few cm, but now we know it can remain alive. Hence it provides us potentially with a record of the genetic history of the shoot and bank. Again, a blue sky question, but if it works it could give a really fun result." added Professor Convey.

1. *Roads et al Millennial timescale regeneration in a moss from Antarctica, Current Biology Vol 24 No 6 R222*
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