Heading to the herbarium

A trip to the British Antarctic Survey herbarium in Cambridge marked the beginning of a journey into the Earth's ultraviolet-B history for Barry Lomax and colleagues.

What was the objective of the work?
Our ultimate aim was to find a biological proxy for stratospheric ozone, and hence surface ultraviolet B radiation, which could be used to assess the response of the stratospheric ozone layer to important geological events. But our first aim was to see whether the concentration of ultraviolet-B-absorbing compounds found in plant spore walls varies with ultraviolet-B history in a suitably sensitive manner to form the basis of a biological proxy.

Why did you choose this particular species?
Clubmoss (*Lycophyta*) was an obvious choice — it has a wide geographic distribution, a long evolutionary history dating back to the Early Devonian period around 416 million years ago and, perhaps most importantly, each individual plant produces many tens of thousands of spores, making collection relatively straightforward.

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Clubmoss specimens.

What sort of samples were you after?
We set out to analyse herbarium samples of clubmoss. Herbariums are the botanist's equivalent of the geologist's rock store. They archive materials collected during previous botanical expeditions, usually with meticulously detailed notes about the site, including habitat, soils, aspect and so on. These detailed histories enabled us to relate changes in plant biochemistry to environmental conditions at the time of collection. We wanted samples, ideally covering the past century and from a variety of locations, that had experienced a different ultraviolet-B radiation history owing to natural variations in the Earth's ozone layer and anthropogenic ozone depletion.

How did you choose your regions of investigation?
Initially we set out to test if clubmosses had responded to the anthropogenic ozone depletion seen over Antarctica. After examining the satellite ozone record and contacting the British Antarctic Survey herbarium in Cambridge, UK, the sub-Antarctic island of South Georgia seemed the ideal place to start. The herbarium is close to our base in Sheffield so arranging a visit was simple. Once we had established that plants responded as predicted we wanted to test the response over a wider range of ultraviolet-B doses. To do this we needed clubmoss samples of the same species from a low-latitude location. After searching through online herbarium databases we finally settled on the Ecuador clubmoss collection held at the University of Aarhus, Denmark as the herbarium has excellent records of our study species from very high ultraviolet-B radiation environments. The final piece of the jigsaw was to find a herbarium record that was long enough in duration to attempt an ozone column and ultraviolet-B reconstruction. The Greenland clubmoss archive held at the University of Copenhagen, Denmark proved ideal for this.

What was the highlight of the research?
Visiting the herbarium in Cambridge, laying all the samples out, and reading through the collection notes really helped place the samples in their geographic context and set the tone for the entire project. It was certainly the next best thing to visiting South Georgia. From a scientific point of view, one of the highlights of the research was combining satellite data with biochemical data obtained from the herbarium. Being able to correlate plant responses to natural and anthropogenic environmental change by looking at herbarium specimens allowed us to bridge the gap between our experimental results and the real world. Our research highlights the importance of herbaria around the world, and the short-sightedness of funding agencies that aim to cut support and investment in these resources.

Did this work give you ideas for future research projects?
Our next goal is to understand the extent to which the ultraviolet-B/ozone signal is retained in ancient fossil spores, such as those from the last ice age 21,000 years ago that have been found in ice cores and sediment records. If it is, stratospheric ozone and ultraviolet-B changes can, perhaps, be linked to geological and biological events over key intervals in Earth's history.

Did you have encounters with dangerous animals?
No. An advantage of working with herbarium samples is that you can be almost certain you won't encounter any dangerous wild animals.

This is the Backstory to work by Barry Lomax and colleagues, published on page 592 of this issue.