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Challenging the paradigm for plant-microbial resource partitioning in Antarctic ecosystems.

Investigators

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Introduction and objectives

Vascular plant cover is increasing in the maritime Antarctic. During this increase vascular plants must expand into areas previously dominated by other primary producers such as mosses, algae and lichens (Fig. 1). Nitrogen is a primary regulator of plant productivity in many polar regions and shifts in nitrogen availability combined with alterations in climate can be expected to have profound effects on the biodiversity and functioning of Antarctic ecosystems. Decomposition of organic matter derived from animals or primary producers in the Antarctic leads to the release of considerable quantities of organic nitrogen. Much of this may be composed of peptides generated during breakdown of proteins. It is known that plants have the ability to take up peptides. Consequently, the direct use of peptides as an available form of nitrogen before they have been converted to inorganic nitrogen compounds (nitrate and ammonium) by soil microbes, may provide plants with an important source of nitrogen. The roots of vascular plants provide them with an anatomical mechanism to exploit the availability of nutrients due to the decomposition of organic material in the soil. Due to the absence of roots, soil nutrients are less available to mosses, algae or lichens except during flooding events. This provides higher plants with a competitive advantage over other Antarctic primary producers and very likely contributes to the observed increase in their range. However, soil microorganisms also have the ability to utilise peptides as a source of carbon and nitrogen, so higher plants must compete for organic N with them. To determine the relative importance of peptide-N to the different organisms in the maritime Antarctic, our NERC-AFI project uses a combination of field measurements and controlled experiments:

Figure 1 Maritime Antarctic primary producers: lichens (on rocks), moss, algae, and grass growing on Signy Island.

Field measurements

All measurements and experiments were conducted on Signy Island in the Southern Orkneys (60°43' South 45°36' West). The vascular plant *Deschampsia antarctica* (Antarctic hair grass) is one of two higher plant species on Signy and is increasing in its range. *D. antarctica* was used as the example higher plant in all experiments.

In order to investigate the availability of peptides in the soils on Signy, the soil solution was sampled throughout the summer season, from mid November until early March. Soil solution samples were extracted under vacuum, with minimal disturbance to the soil, through small porous tubes (Fig. 2). A total of 19 sites across the island were sampled in areas dominated by all the major primary producers, vascular plants, mosses, algae and lichens. The collected soil solution samples will be analysed for different forms of nitrogen, including peptides. Concurrent measurements of soil temperature and moisture will help us to understand the effect of temperature and moisture on the availability of different nitrogen forms, and thus aid predictions of the effects of climate change on nitrogen cycling in the Maritime Antarctic.

Figure 2 A typical sward of the grass *Deschampsia antarctica* on Signy with a soil solution sampler inserted into it. It can be seen that the grass is competing for space with moss.

Controlled experiments

The field measurements described above were used to determine the availability of peptide nitrogen to photosynthetic organisms and soil microbes. In order to fully understand their significance in the Maritime Antarctic nitrogen cycle it was also necessary to examine the ability of organisms to utilise the available peptides. For this reason, isotopically-labelled (^{15}N and ^{13}C) nitrogen compounds, including various peptides, were used to determine their rate of uptake by soil microorganisms and plants. These experiments were carried out on Signy to minimise any changes to organisms during transit.

At the time of writing, samples are still in transit from Signy, but when analysed we hope that they will provide a valuable insight into the importance of organic nitrogen in the nitrogen cycle of the Maritime Antarctic, and future responses to climatic changes.