SOIL BIOLOGICAL AND BIOCHEMICAL INVESTIGATIONS ON DECEPTION AND SIGNY ISLANDS

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During an eight-week stay on Deception Island with Dr J. Smellie in the 1987–88 austral summer I studied *in situ* biological nitrogen fixation of geothermic soils using a portable gas chromatograph. Mineralization experiments were begun, and these, along with the isolation of thermophilic microbes, were finalized at the BAS Signy Island station laboratories.

The hot soils on Deception Island are very similar to those on Mt Erebus and Mt Melbourne in the Ross Dependency. Fixation rates of 80–230 nmol g^{-1} dry weight soil or plant tissue were recorded and over a six-week period 8% of the total soil nitrogen was converted to mineral ammonium; nitrate was not detected. The percentages of Deception hot soil nitrogen in the form of amino and hexosamine-N were similar to those found in similar soils on Erebus and Melbourne, although these latter soils contain more total nitrogen. Several thermophilic microbes were isolated using yeast glucose and one of the isolates is *Malbranchea*, a fungus also found on Erebus and Melbourne.

Additional work included the collection and mapping of plants over the whole of Deception Island to complement the ecological survey undertaken in 1986–87 (Smith, 1988), and the determination of temperature profiles in cold and hot, plant-dominated, soils. From this work it has become clear that the most diverse and luxuriant flora occurs at Crater Lake, and this area, together with the hot soils and associated plants on Mt Pond (see Smith, 1988) are worthy of special protection. The Mt Pond hot site is at a lower altitude (450 m) than similar sites on Mt Erebus (4000 m) (e.g. Broady, 1984) and Mt Melbourne (3000 m) (e.g. Broady and others, 1987) but constitutes possibly the largest area of geothermal ground in Antarctica. We also experienced high air temperatures on 11 December 1987 of around 13°C for 5 h on the summit of Mt Pond and about 17°C for 4 h at sea level.

A further eight weeks was spent at Signy Island examining nitrogen transformations in the Fellfield Ecology Research Programme sites at Jane Col and Factory Bluffs. Only weak and sporadic biological nitrogen fixation was observed in soils and plants at these fellfield sites, although occasional strong fixation was recorded from cryoconite algae in pools on the ice slopes surrounding Jane Col. With the melting back of the ice slope large amounts of snow and cryoconite algae (and hence of potential nutrients) are being deposited on this primitive community of primary colonists.

In situ decomposition experiments using these algal deposits showed that up to 13% of algal nitrogen could be converted to mineral-N, and similar studies conducted at 14°C revealed that up to 34% of algal nitrogen could be mineralized over the same time period. Moisture rather than temperature most affected the amount of nitrogen mineralized.

Experiments to examine the effects of freeze–thaw/wet–dry cycles on mosses, lichens and algae indicate that, on average, 14% of dry weight and 25% of the total nitrogen of these organisms could be solubilized by three such cycles. No doubt this constitutes a further nutrient source for fellfield organisms.

Additional work determined the amount of mineral-N in bulk precipitation over 30 days and it was found that 1.1 kg ha^{-1} of mineral-N, mainly as NH_4-N, could enter the fellfield sites each year. It was further shown that several mosses, lichens and peats have the capacity to chemically convert precipitation NH_4-N into a form where it cannot be leached out, whilst mica-schist rock could retain added NH_4-N against water, but not against KCl leaching. Mica-schist rocks on fellfield sites contain high levels of fixed or non-exchangeable NH_4-N which has a structural role. Levels of this type of NH_4-N reach 250 ppm in coarse rock particles but when these are ground, to crudely simulate weathering, considerable amounts of this form of NH_4-N are converted to water-soluble NH_4-N.

The results from the experiments conducted at Deception and Signy Islands are similar to those obtained in the Ross Dependency. Overall, nitrogen is not limiting for plants and microbes in these areas of Antarctica, and it is concluded that mainly abiotic factors not only determine nutrient supply but also determine the growth and development of soils and of the plant biota.

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