INTERACTIONS BETWEEN ATMOSPHERIC NITROGEN DEPOSITION AND CARBON DYNAMICS IN PEATLANDS

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1. INTRODUCTION

- Atmospheric deposition remains an important source of nitrogen in terrestrial ecosystems.
- Excess nitrogen supply has been shown to cause acidification and eutrophication of many ecosystems, and is likely to have greatest impact on oligotrophic environments such as ombrotrophic peatlands.
- Peatlands are important stores of carbon and enhanced N availability has the potential to alter processes influencing carbon accumulation.

2. AIMS

Test the hypotheses that atmospheric nitrogen deposition affects:

a) Vegetation composition and subsequent inputs of carbon into soil
b) The fate of photosynthesized carbon and its allocation into different carbon pools
c) The activity of soil enzymes involved in organic matter turnover and soil respiration rates

3. RESULTS

➤ Plant response: ^{13}C pulse chase experiment

Two peatland plant species (*Eriophorum vaginatum* and *Calluna vulgaris*) were labelled with 99% ^{13}C-CO_2 air for 5h at Whim Moss Experimental Site (near Edinburgh). These plants received 56 kg N ha^{-1} yr^{-1} since 2002 to simulate high amendment in atmospheric nitrogen deposition. Leaf, soil, and dissolved organic carbon (DOC) samples and respiration measurements were taken 7 times within 3 weeks of labelling.

Fig.1

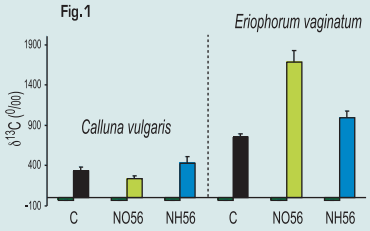


Fig.2

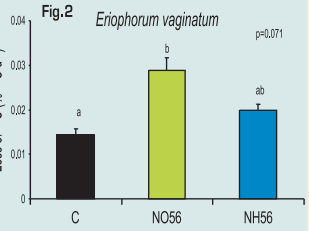
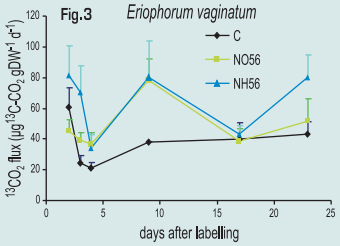


Fig.3



Main results

- Higher ^{13}C uptake in nitrogen amended *Eriophorum* (Fig. 1)
- The rate of loss of ^{13}C was faster in N amended *Eriophorum* while no significant change was seen with *Calluna* plants (Fig. 2)
- $^{13}CO_2$ fluxes were increased with N amendments (ammonium had a stronger effect) at most sampling dates, for both *Calluna* and *Eriophorum* (Fig. 3)

➤ Plant waxes: Good biomarker of vegetation changes in peat?

Litter from 5 species of peatland plants (*Calluna vulgaris, Eriophorum vaginatum, Hypnum jutlandicum, Molinia caerulea, and Sphagnum capillifolium)* was collected and 31 artificial mixtures of increasing richness were produced. Plant wax profiles were analysed to test the prediction accuracy of vegetation community composition profiling.

Fig.4 Principal Coordinate Analysis on wax alcohol profiles

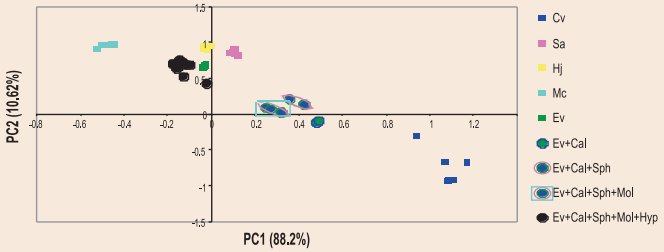
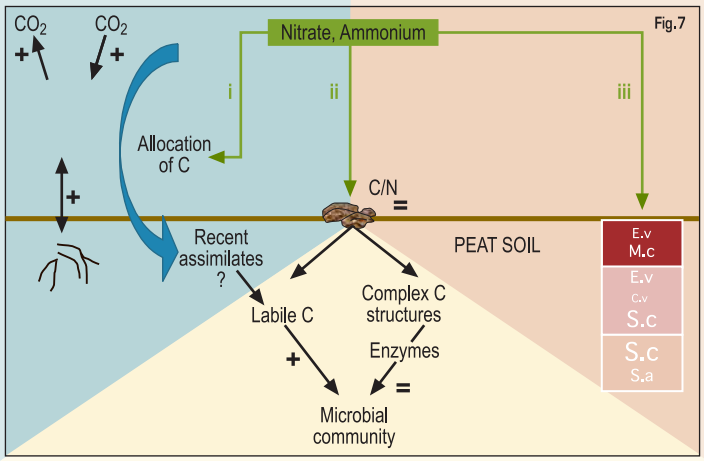


Fig.7



Main results

- Good differentiation of individual peatland plant species (Fig. 4)
- Mixture profiles were very close to expected theoretical profiles, especially with less complex mixtures
- "Woody" species had a stronger pull on the profiles than "leafy" species (*Calluna* = *Eriophorum* > *Sphagnum* > *Molinia* = *Hypnum*)
- Alkane and alcohol profiles gave similar community results

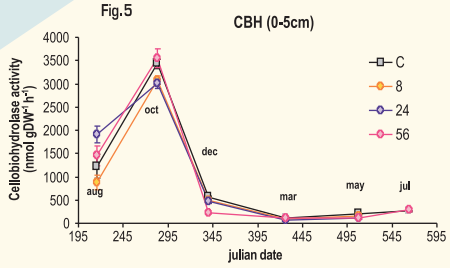
Potential applications

- Quick way to determine the composition of a mixed litter sample
- Can give valuable historical data, ie. could be used to find out past vegetation changes through analysis of a peat core

➤ Microbial response

Three key soil enzymes (cellobiohydrolase, N-acetyl-glucosaminidase, and acid phosphatase) were assayed in peat where plots have received 8, 24, and 56 kg N ha^{-1} yr^{-1} since 2002, in the form of both nitrate or ammonium. C-substrate induced microbial respiration was also measured in July 2007 using MicroResp© analysis.

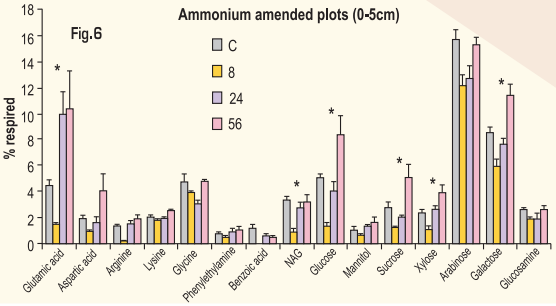
Fig.5



Main results

- No significant effect of N load or form on cellulolytic and nutrient releasing enzymes involved in breakdown of complex forms of carbon (Fig. 5)
- Significant effect of N form on C-induced respiration
- No effect of N load on C-induced respiration when nitrate was added but,
- Significant effect of N load for several simple sugars and 1 amino-acid when ammonium was added (Fig. 6)

Fig.6



4. CONCLUSIONS

- Some plants have altered the way they allocate their recently photosynthesized carbon (higher uptake, faster re-allocation and higher respiration rates) (i)
- Turn-over of recalcitrant carbon does not seem affected while labile carbon turn-over was increased, especially with ammonium supply (ii)
- Plant wax analysis promises to be a useful tool for future studies of vegetation composition changes due to nitrogen deposition (or other pollution) (iii)
- Thus, atmospheric nitrogen deposition simulations at Whim Moss have affected both plant and soil carbon dynamics in this ombrotrophic peatland

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