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Short communication

Litter type, but not plant cover, regulates initial litter decomposition and fungal community structure in a recolonising cutover peatland

Clare J. Trinder [a,b,*], David Johnson [a], Rebekka R.E. Artz [b]

[a] Institute of Biological and Environmental Sciences, University of Aberdeen, Cruickshank Building, St Machar Drive, Aberdeen AB24 3UU, UK
[b] The Macaulay Institute, Soils Group, Craigiebuckler, Aberdeen AB15 8QH, UK

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ABSTRACT

Cutover peatlands are often rapidly colonised by pioneer plant species, which have the potential to affect key ecosystem processes such as carbon (C) turnover. The aim of this study was to investigate how plant cover and litter type affect fungal community structure and litter decomposition in a cutover peatland. Intact cores containing *Eriophorum vaginatum*, *Eriophorum angustifolium*, *Calluna vulgaris* and bare soil were removed and a mesh bag with litter from only one of each of these species or fragments of the moss *Sphagnum auriculatum* was added to each core in a factorial design. The presence or absence of live plants, regardless of the species, had no effect on mass loss, C, nitrogen (N) or phosphorus (P) concentrations of the litter following 12 months of incubation. However, there was a very strong effect of litter type on mass loss and concentrations of C, N and P between most combinations of litter. Similarly, plant species did not affect fungal community structure but litter type had a strong effect, with significant differences between most pairs of litter types. The data suggest that labile C inputs via rhizodeposition from a range of plant functional types that have colonised cutover bogs for 10–15 years have little direct effect on nutrient turnover from plant litter and in shaping litter fungal community structure. In contrast, the chemistry of the litter they produce has much stronger and varied effects on decomposition and fungal community composition. Thus it appears that there is distinct niche differentiation between the fungal communities involved in turnover of litter versus rhizodeposits in the early phases of plant succession on regenerating cutover peatlands.

1. Introduction

Plants have key roles in the regulation of net decomposition rates through direct effects on litter quality, but also by altering the soil physicochemical environment through, for example, root structures and inputs of more labile C via rhizodeposition. In ecosystems at the early stages of succession, rhizodeposition is likely to be particularly important. One such an example is the case of previously harvested peatlands, as the C in the residual soil organic matter pool of cutover peatlands is largely unavailable for biological transformation. Rhizosphere soils in peatlands support larger populations of micro-organisms than those found in bulk peat (Trinder et al., 2008a). Root exudates, comprising sugars, amino acids and organic acids with low molecular weight (Jones et al., 2004) are easily available to micro-organisms and inputs of labile C from rhizodeposition have sometimes been observed to result in increased decomposition of recalcitrant plant litter and soil organic matter. This is known as the 'priming effect' (Kuzyakov et al., 2000). Different plant species secrete different C compounds through their roots (e.g. Crow and Wieder, 2005) which can in turn affect the composition of microbial communities (Yan et al., 2008) and thus present a feedback on decomposition rates and extent. The presence of different plant species may, therefore, be important in regulating resource turnover from plant litter via microbial communities associated with roots or through the nature of the litter they produce. Some studies have shown that the chemical composition of the litter can be an important control on the rate of its decomposition (e.g. Aerts et al., 1999). Thus, both the direct (litter) and indirect (rhizosphere) controls of plants on decomposition processes can have potentially large importance in the turnover of terrestrial C. It is essential to further our understanding of these processes in general, but for peatlands there could be major implications for the management and rehabilitation of these ecosystems as they constitute a major terrestrial C store (Gorham, 1991).

* Correspondence to: Clare J. Trinder, Institute of Biological and Environmental Sciences, School of Biological Sciences, University of Aberdeen, Cruickshank Building, St Machar Drive, Aberdeen AB24 3UU, UK. Tel.: +44 1224 272700; fax: +44 1224 272703.
E-mail address: c.j.trinder@abdn.ac.uk (C.J. Trinder).

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In a 12 month factorial experiment, we therefore investigated the effect of three peatland plant species on rates of decomposition of four plant litter types and used molecular fingerprinting techniques to investigate changes in the community structure of fungi colonising the litter bags; fungi are the predominant microbial group initially able to utilise structurally intact plant litter. We hypothesised that the presence of plants would increase mass losses and decrease final C, N and P concentrations in the plant litter and cause a significant shift in the community composition of fungi associated with litter. Further, based on previous investigations of below-ground allocation of recent plant assimilates (Trinder et al., 2008a), we hypothesised that *Calluna vulgaris* and *Eriophorum vaginatum* would have a greater effect on fungal community structure and litter decomposition than *Eriophorum angustifolium*.

The experiment used material collected from Middlemuir Moss (57°36′ N, 02°09′ W, 110 m asl), a former raised mire site in NE Scotland, described in more detail in Trinder et al. (2008b). Similar to many abandoned peatlands, the vegetation at the site comprises patches of *C. vulgaris* (L.) Hull., E. *vaginatum* (L.) and *E. angustifolium* (Roth.) and *Sphagnum* spp. amongst extensive areas of bare peat due to the nature of seed dispersal and/or clonal growth in the initial phases of recolonisation. Twenty peat cores containing a single plant of *C. vulgaris*, *E. vaginatum* or *E. angustifolium* of approximately the same size were collected from the colonising edge of one peat baulk. An additional 20 cores of bare peat were also collected from the same peat baulk (within a few metres) to act as controls. Cores were immediately inserted into plastic drain pipes measuring 15 cm diameter by 30 cm depth. During the experiment, the cores were maintained, uncovered, in a tank in Aberdeen where the water-table was maintained 16–22 cm below the top of the cores using locally collected rainwater. The average temperature over the experiment was 8.8 °C, varying between −7.5 and 29 °C The cores were equilibrated for 4 months, before the experiment started.

Plant material from *E. vaginatum*, *E. angustifolium*, *C. vulgaris* and *Sphagnum auriculatum* (Schimp.) was collected from the same site. Plant material was treated and litter bags prepared as described in Trinder et al. (2008c), with 20 replicate litter bags for each litter type ($n = 80$ in total). Each litter bag contained a single litter type (4 g (dwt equivalent)) of *C. vulgaris* and *Eriophorum* spp. and 2 g of *S. auriculatum*. One litter bag of each species was randomly assigned to one peat core containing each growing plant species and inserted vertically into the pot, with its edge flush with the peat surface. Cores were arranged in 5 blocks, each block containing all combinations of litter type and plant species. The litter bags were removed after one year. Any roots of *E. angustifolium* and *E. vaginatum* that had entered the litter bags were removed, but hair roots of *C. vulgaris* were too fine (~10 μm) for removal. Material in the litter bags was removed and weighed and a subsample (~0.8 g) for DNA extraction was immediately frozen at −20 °C. Remaining material from the litter bags was oven dried at 105 °C to constant weight for analysis for C, N and P. Change in mass was expressed as a percentage of starting weight. Mass loss and concentrations of C, N and P in litter at the end of the experiment were analysed on transformed data where necessary, using ANOVA in Minitab with block as a fixed factor and where results were significant, pair-wise post hoc Bonferroni tests were carried out. Variance partitioning was calculated from the Sum of Squares (SS) from ANOVA. DNA extraction and amplification of fungal internal transcribed spacer (ITS) fragments were carried out as described in Artz et al. (2007). The relative effects of plant species and litter type on the fungal DGGE fingerprints were visualised following a principal coordinates analysis (PCoA) on the binary data matrix. Tests for significance and variance partitioning of the effects of plant

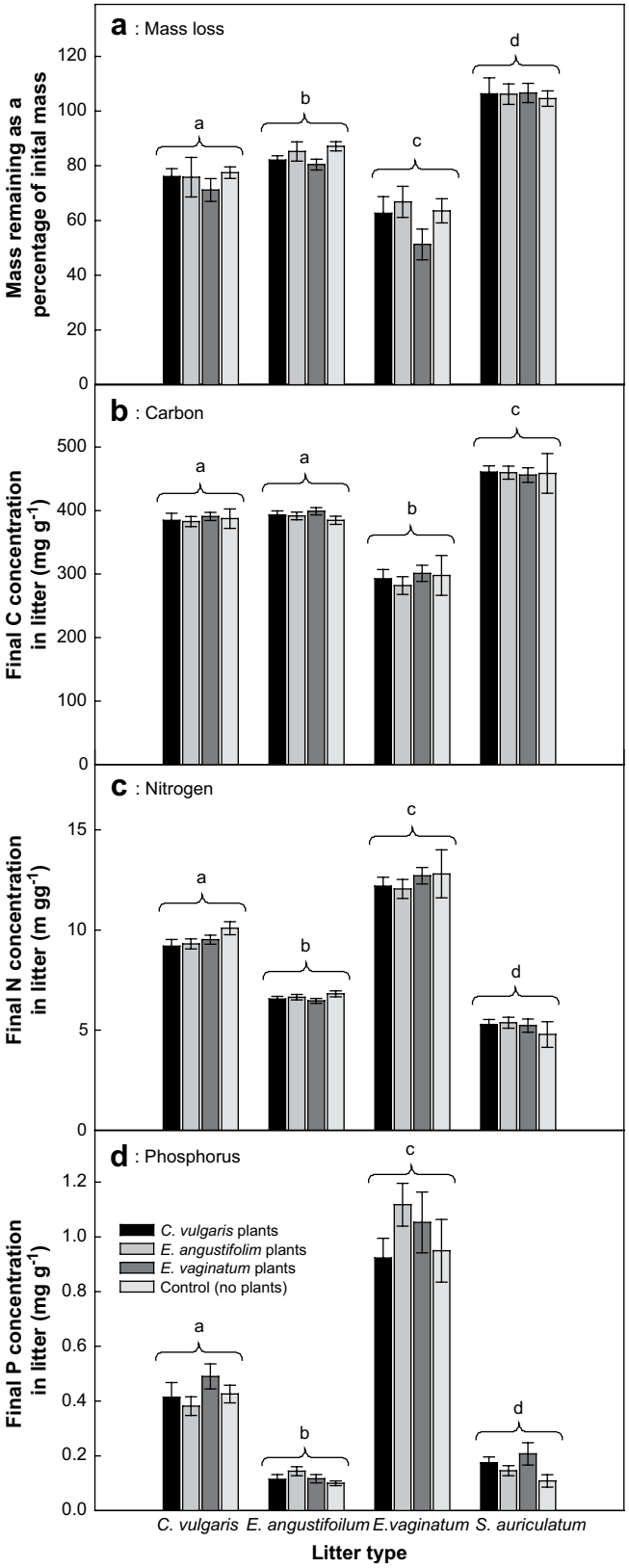

Fig. 1. (a) Mass loss of litter as a percentage of original mass and (b) final concentrations of C, (c) N and (d) P in four litter types buried adjacent to three species of live plant or a control without plants, after 12 months' incubation. Means ± SE, $n = 5$. Sets of bars sharing the same letter are not significantly different from each other. Plant species effects were not significant (Table 1) and have therefore not been reported again here.