Drivers of decomposition in forest soils: insights from a transeuropean experiment

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DRIVERS OF DECOMPOSITION IN FOREST SOILS: INSIGHTS FROM A TRANS-EUROPEAN EXPERIMENT.

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1 INTRODUCTION

Meta-data analyses and the model based hypotheses state that global soil C storage is controlled by microbial scale processes of fungal competition for available nitrogen (N) (Averille *et al.,* 2014). Experimental evidence for the microbe-dependent feedback mechanisms on N and C dynamics in European forest soils is generally lacking and is therefore contentious. Global trends of increasing atmospheric N deposition and the continuing use of inorganic N fertilizer in both agriculture and forestry mean that the soils vital function as a carbon sink is potentially under threat.

Changes in nutrient status could result in a chain reaction of interacting microbial mechanisms which in turn could lead to the shifts in underlying ecosystem biogeochemical process rates. It is suggested that plant fungal symbiont community structure, exerts a greater fundamental control over soil C storage than temperature, precipitation or net primary production. The hypothesis being that plant associated fungi effectively scavenge all available organic and inorganic N, leaving little for the growth of the free-living decomposer microbial community and preventing further breakdown of SOM.

To experimentally investigate these possible effects we have buried bespoke dual stable isotope labelled soil/litter bags in forests across a trans-European gradient (selected from the ALTER-net-MSII network) which have received additional inputs of inorganic nitrogen fertilizer over a medium term period and measured a suite of parameters to elucidate drivers of decomposition.

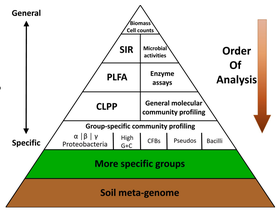
2 MATERIALS & METHODS

- C-Unfertilized plot (control; de-ionized water only)
- N-(NH_4NO_3) -fertilized plot (80-100 kg N ha^{-1} a^{-1}) started in 2010

- Five replicate plots per site
- ^{13}C and ^{15}N labelled *Abies alba*-litter –soil bags deployed Autumn 2015
- Fine and coarse litter bags

A selection of soil response parameters analysed so far.
- Enzyme activity
- Soil respiration *in-situ* and in-growth bag specific.
- PLFA's (Phospholipid Fatty Acids)

In progress: soil meta-genome, C and N cycling data.



* Kowalchuk 2003 Framework for assessing soil response.

Table 1. Characteristics of labelled *Abeis alba* litter material used in experiment.

sample		δ ^{13}C	% C	δ ^{15}N	% N
New fir 3	24.09.2015	10.03	55.89	325.63	0.98

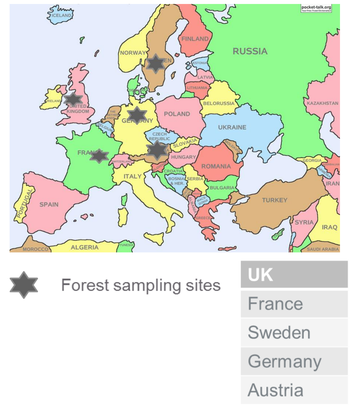


Fig. 1. ^{13}C labelling chamber (left). Sampling at forest site Zöbelboden Austria (middle). Distribution of sampling sites (right).

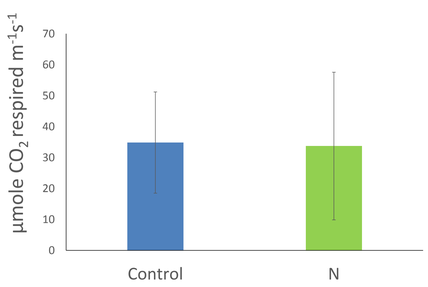


Fig 2. Soil respiration rate (field) n=5. P:NS, Soil temperature 14.5°C.

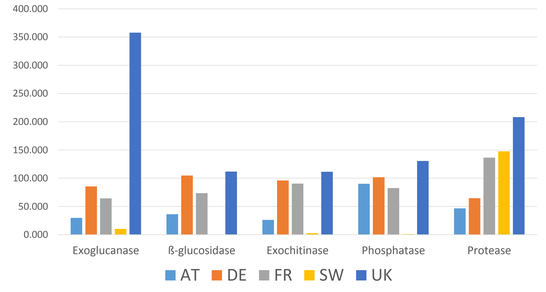


Fig 3. Mean % enzyme activity of N treatment compared to controls n=5, (100% = no difference).

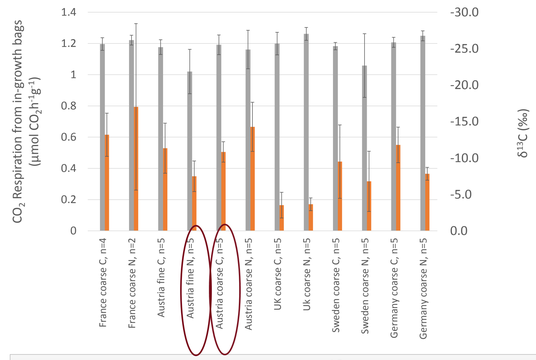


Fig 4. Mean respiration rate and ^{13}C of CO_2 respired measured from the in-growth bags.

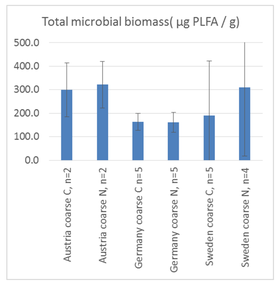


Fig 5. Mean microbial biomass µg PLFA g^{-1} dry soil.

3 RESULTS

No significant differences in respiration rates of treated soils were measured *in-situ* (Fig.2).

β–Glucosidase, exochitinase and phosphatase, enzyme acitvities were significantly reduced as a result of N treatment ($p<0.001$, two way-ANOVA), despite significant country differences in all enzyme activities measured (Fig.3).

Only in the Austrian fine mesh-N treatments were soil respiration rates significantly lower than in the control and the δ ^{13}C of the CO_2 higher (Fig.4).

No significant changes in the microbial biomass pool size based on total PLFA values were observed (Fig. 5). Although there were significant treatment differences in individual PLFAs:15:0, 16:1w6, 16:1w7, 18:1w5.

4 Conclusions.

- External reactive-nitrogen inputs applied to soil alone had little overall impact on commonly measured soil response parameters such as respiration and microbial biomass pool size.
- However it was clear there was a down regulation in enzyme activities and significant changes in microbial community structure, as evident from the change in individual PLFA profiles. Which could have major affects on C and N cycling.
- Coupling these data with proposed ecosystem function measurements of microbial communities, gross mineralization, nitrification and medium term carbon storage, we will yield a better understanding of whether these forest soil systems are really so resistant to reactive nitrogen perturbation.

[1.] Averille *et al.,* (2014) Mycorrihiza mediated competition between plants and decomposers drives soil carbon storage Nature. 505:543-545
[2] Kowalchuk, et al., (2003). Assessing responses of soil microorganisms to GM plants. Trends Ecol. Evol. 18: 403–410.