Species specific sporocarp N quality response to N fertilization

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Introduction

Relatively little is known about how global change factors, such as N deposition, will impact fungal N quality. Understanding these effects is important for determining future shifts in plant community structure and ecosystem function, as N-limitation often constrains ecosystem productivity and fungi play an essential role in N cycling and accessibility. This study investigates the effects of N addition on fungal N quality for a variety of species. N quality was characterized by measuring %N, %C and N and C stable isotopes of sporocarps collected from a N fertilization study in a Scots pine forest in northern Sweden. N fertilized plots in the Rosinedalsheden experimental forest mimic N deposition inputs in central Europe and future deposition in Scandinavia and are suited for studying the effects of N addition on fungal N quality.

Study Site

A total of 141 sporocarps were collected from the 70-yr-old Scots pine (*Pinus sylvestris* L.) Rosinedalsheden experimental forest. The site is located 50 km northwest of Umeå, northern Sweden. Three 15 ha plots were subjected to no (control), low (20 kg N ha^{-1} yr^{-1}) or high (100 kg N ha^{-1} yr^{-1}) NH_4NO_3 fertilization in 2006. Ambient N deposition rates are < 5 kg N ha^{-1} yr^{-1}. Mushrooms were collected in fall of 2011 and those collected from the high fertilized plot were excluded from this study. Understory plants of the Scots pine forest include dwarf shrubs *Vaccinium myrtillus* L. (bilberry), *Vaccinium vitis-idaea* L. (lingonberry), mosses *Pleurozium schreberi* (Bird.) Mitt. and *Hylocomium splendens* (Hedw.) Schimp, and lichens. The soil is a fine sand with a weakly developed podosol and 2-5 cm organic mor-layer with a C:N ratio of 40 ± 0.7. Mean annual temperature is 1.2°C and mean annual precipitation is 520 mm. Snow cover persists from late October to early May.

Results

Species variation in %N response to N fertilization: Species vary in N fertilization %N response, even within a genus and do not have consistent response trends by hydrophobicity.

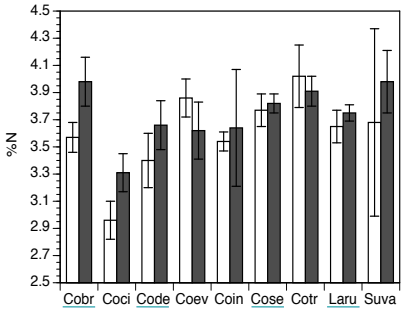


Figure 1: *%N of sporocarps.* Mushrooms were collected from the Rosinedalsheden experiment in Fall 2011 within N unfertilized and low N fertilized plots. Species significantly affects %N ($p < 0.001$) but hydrophobicity does not ($p = 0.3851$) Treatment effects do not affect %N ($p = 0.4321$. Species abbreviations and hydrophobicity are as follows:

Cobr- *Cortinarius brunneus* (hydrophobic), 10 mushrooms
Coci- *Cortinarius cinnamomeus* (hydrophobic), 14 mushrooms
Code- *Cortinarius delibutus* (hydrophobic), 5 mushrooms
Coev- *Cortinarius evernius* (hydrophobic), 14 mushrooms
Coin- *Cortinarius integerrimus* (hydrophobic) 4, mushrooms
Cose- *Cortinarius semisanguineus* (hydrophobic), 20 mushrooms
Cotr- *Cortinarius traganus (*hydrophobic), 10 mushrooms
Laru- *Lactarius rufus* (hydrophilic), 20 mushrooms
Suva- *Suillus variegatus* (hydrophobic), 10 mushrooms

Species %C response to N fertilization: N fertilization causes a general increasing trend in %C, but significance varies by species.

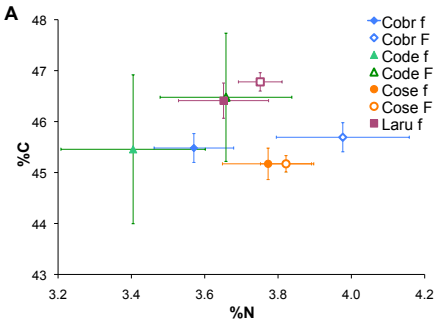
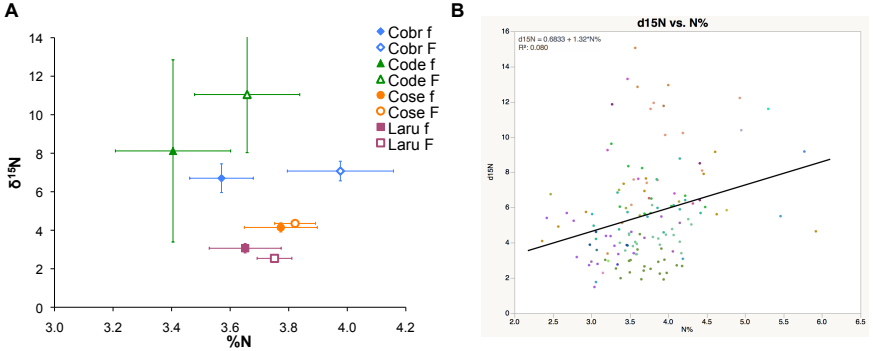


Figure 2: C:N of sporocarps. (A) Mean and standard error bars of mushroom %N and %C for species collected from unfertilized (solid symbols) and low fertilized (unfilled symbols) plots. Species significantly affects %N and %C (both $p < 0.001$). N treatment affects %C ($p = 0.0272$) and %N ($p = 0.0814$). **(B)** Fit line through all samples.

Results

$\delta^{15}N$ values for sporocarps collected in the Scots pine forest: $\delta^{15}N$ increases with %N increase for *Cortinarius* mushrooms and decreases with %N increase for *Lactarius rufus* mushrooms. The trend persists across genus but species type affects the degree of sporocarp $\delta^{15}N$ response.

Figure 3: $\delta^{15}N$ of sporocarps. (A) Mean and standard error bars of mushroom %N and $\delta^{15}N$ for species collected from unfertilized (solid symbols) and low fertilized (unfilled symbols) plots. Hydrophobicity affects $\delta^{15}N$ ($p < 0.001$). **(B)** All sporocarp data for all collected species. Species significantly affects $\delta^{15}N$ ($p < 0.001$). %N increases $\delta^{15}N$ (0.52 $\delta^{15}N$ / %N; $p = 0.0944$).



$\delta^{15}N$ and $\delta^{13}C$ for collected sporocarps: N fertilization increases sporocarp $\delta^{13}C$. The trend Persists across species but species type affects the degree of sporocarp $\delta^{13}C$ response.

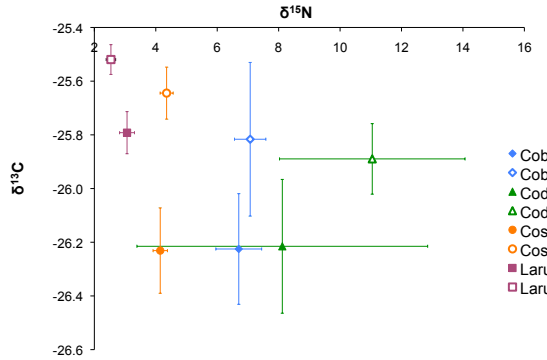


Figure 4: $\delta^{15}N$ and $\delta^{13}C$ of sporocarps. Mean and standard error bars of sporocarp $\delta^{15}N$ and $\delta^{13}C$ for species collected from unfertilized (solid symbols) and low fertilized (unfilled symbols) plots. Species significantly affects $\delta^{13}C$ ($p < 0.001$). N treatment affects $\delta^{13}C$ ($p = 0.0101$). %N does not affect δ13C (not shown; 0.12 $\delta^{13}C$ / %C; $p = 0.1785$)

Conclusions

- Increase in sporocarp %N with N fertilization suggests that fungi N quality is responsive to N availability and varies by species, even within a genus. This is because %N reflects the proportion of protein, chitin and carbohydrates.
- Hydrophilic mushrooms decrease $\delta^{15}N$ with N fertilization, suggesting a decrease in ectomycorrhizal transfer to plants with additional N inputs.
- Increases in sporocarp $\delta^{13}C$ with N fertilization suggests a shift in C source and/or quality. This could be due to a decrease in $^{13}CO_2$ discrimination in photosynthesis with additional N inputs or a decrease in photosynthate transfer to ectomycorrhizae.
- Mushroom N quality and $\delta^{13}C$ data suggests that N addition affects mycorrhizal mining of old organic N and plant C transfer to mycorrhizae.
- ^{14}C of mushroom protein and structural material will be analyzed to determine if N addition reduces mining of old organic N and whether there is a correlation between sporocarp ^{14}C and %N response to N fertilization.

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