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Functional Ecology of Ectomycorrhizal Fungi. Peroxidases, Decomposition, Spatial Community Patterns

Inga Bödeker

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Opponent: Professor Rytas Vilgalys, Department of Biology, Duke University, Durham, NC, USA.

Betygsnämnd: Professor Martin Hofrichter, International Graduate School Zittau, Zittau, Germany
Professor Sara Hallin, Institutionen för Mikrobiologi, Sveriges Lantbruks Universitet, Uppsala
Docent Lars Högbom, Skogforsk, Uppsala Science Park, Uppsala

Handledare: Docent Björn Lindahl, Institutionen för Skoglig Mykologi och Växt Patologi, SLU, Box 7026, 750 07 Uppsala. *E-post:* Bjorn.Lindahl@.slu.se

Biträdande handledare: Docent Åke Olson, Institutionen för Skoglig Mykologi och Växt Patologi, SLU, Box 7026, 750 07 Uppsala. *E-post:* Ake.Olson@slu.se
Doktor Karina Clemmensen, Institutionen för Skoglig Mykologi och Växt Patologi, SLU, Box 7026, 750 07 Uppsala. Karina.Clemmensen@slu.se

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SLU, Department of Forest Mycology and Plant Pathology, P.O. Box 7026, SE-750 07 Uppsala, Sweden

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Abstract

Boreal forest ecosystems constitute a globally important carbon (C) sink, due to accumulation of complex organic matter, persistent to decomposition. Nitrogen (N) is immobilized in these complex compounds and, thereby, unavailable to the plant community. Fungal peroxidases (ClassII) are oxidative enzymes, predominantly studied in white-rot wood decomposers and known to efficiently mineralize phenolic complexes, such as lignin, to CO_2. Peroxidase activity is also commonly measured in forest soil, where typical white-rotters are absent and ectomycorrhizal fungi predominate. Peroxidase activity is known to increases under low inorganic N availability. The aim of this study was to explore the ectomycorrhizal decomposer potential in boreal forest ecosystems. The central hypothesis is that ectomycorrhizal fungi produce ClassII peroxidases to mobilize N, bound to phenolic complexes in boreal forest litter and humus.

Genes coding for ClassII peroxidases were found to be widely spread among ectomycorrhizal taxa, particularly within the genus of *Cortinarius*. Gene transcription of peroxidases in forest humus could be linked directly to the species *Cortinarius semisanguineus*. In a field experiment, colorimetric enzyme assays showed a halving of peroxidase activity in short-term response to N-amendment. In non-treated control samples, *Cortinarius* species and other rhizomorph forming ectomycorrhizal fungi were co-localized with peroxidase activity hotspots. Ectomycorrhizal *Cortinarius* species may, thus, be key players in N-acquisition, from organic macromolecules, and central decomposers of complex organic matter in boreal forest ecosystems.

Root-associated fungi, including ectomycorrhizal ones, were able to compete with free-living saprotrophs for colonisation of litter. However, they were less efficient decomposers than specialised litter saprotrophs.

It is concluded that some mycorrhizal fungi may release C while foraging for N. They may also indirectly act to preserve soil C by suppressing more efficient saprotrophic decomposers. The findings highlight ectomycorrhizal fungi as central regulators of C dynamics in boreal forests. Ectomycorrhizal symbiosis, thus, constitutes a direct link between above-ground photosynthesis and below-ground decomposition.

Keywords: Boreal forest ecosystem, ectomycorrhizal fungi, ClassII peroxidases, soil organic matter, decomposition, nitrogen acquisition, carbon sequestration.

Author's address: Inga Bödeker, SLU, Department of Forest Mycology and Plant Pathology, P.O. Box 7026, SE-750 07 Uppsala, Sweden.
E-mail: Inga.Bodeker@ slu.se