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Fungal decomposition of dissolved organic matter from forest soils

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Introduction

Boreal forest soils serve as an important terrestrial C sink, containing ca. 16% of global soil C stock in total [1, 2]. Soil C cycling and stabilization are governed by soil microbial activities. A major source of SOM in boreal forests is plant litter which has high concentrations of lignin and other phenolic compounds [3]. Filamentous saprotrophic fungi are thought to have a unique ability to degrade such compounds and are considered to be the main decomposers of forest SOM [4]. Recently ectomycorrhizal fungi (ECM) was found to show capacity to degrade and transform humus-rich SOM [5, 6]. However, the mechanisms involved in fungal decomposition of SOM are still poorly investigated, which hinder the prediction of response of soil C dynamics to environmental change [7].

Dissolved organic matter (DOM) represents one of the most actively cycling organic matter pools in soils [8, 9], which has been used as an index of soil microbial activities [10] and litter decomposition [11]. It is formed by the decomposing activities of microorganisms. In these processes, hydrolytic depolymerizations and oxidative modifications of biomolecules like lignocellulose, lipids, polyphenols play a key role because they could decrease the size and increase the polarity/ionization states of the litter derived molecules, which in turn enhance their water solubility and reactivity toward mineral surfaces [12]. DOM is essential in the transportation of C and N from forest floor to mineral soils, where DOM can be further decomposed by soil microorganisms and/or stabilized via interactions with soil minerals [13].

In this study, we have compared the capacity and mechanisms by which a saprotrophic fungus (*Hydnomerulius pinastri*) and an ECM fungus (*Paxillus involutus*) decompose DOM extracted from forest soils. The fungi are closely related species within the Boletales clade.

Recent genome sequencing have shown that the two species have distinctive differences in the content of genes predicted to encode hydrolytic and oxidative enzymes predicted to act on plant cell wall material [14]. When compared to *H. pinastri*, *P. involutus* lack many genes encoding glycoside hydrolases and carbohydrate esterases that are likely involved in the hydrolysis of cellulose and hemicellulose, while both species have a large, but distinct array of genes encoding oxidative enzymes.

Objectives

The objective of this research is to answer the following research question:

- Do saprotrophic and ectomycorrhizal fungi modify DOM present in forest soils to products of different sizes and functional group chemistry?

Materials & methods

A soil sample was collected from an *Oa* layer of a forest soil profile in south Sweden. Dissolved organic matter was extracted by boiling the soil with a solid to Milli-Q water ratio of 1:5 for one hour and filtrated through a 0.22 um PES Membrane (Millipore Inc.). Glucose was added into the DOM samples (2.5 g L^{-1}) and they were sterilized by another filtration (0.22 um). The fungi *P. involutus* and *H. pinastri* were grown axenically in Petri dishes on a layer of glass beeds [5]. The cultures were incubated for 5 days (DOM5) and 10 days (DOM10). The initial DOM sample was designated DOM0.

Samples of DOM0, DOM5 and DOM10 were fractionated according to a modified Leenheer procedure [15] into two major fractions, a hydrophobic and a hydrophilic fraction, respectively. Molecular sizes of the DOM and its fractions were determined using size exclusion chromatography (SEC). Alterations of functional groups were examined by FTIR and Raman techniques. The contents of proteins, sugars, lipids and phenolic compounds were assayed using colorimetric methods.

Results

This is an ongoing study, and data will be collected shortly. The results will be analyzed in terms of changes, as a result of fungal decomposition, in: i) changes in the proportions of

hydrophilic and hydrophobic compounds; ii) chemical composition of DOM; iii) molecular sizes of DOM and its fractions; and iv) functional groups of DOM and its fractions. Changes will be compared for the two fungi with an emphasis on their capacity to depolymerize and oxidize the DOM.

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