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Trancriptomics and spectroscopy provide novel insights into the mechanisms of litter decomposition by ectomycorrhizal fungi.

Anders Tunlid, Dept Biology, Lund University, Lund, Sweden.

Globally, soil organic matter (SOM) stores more carbon (C) than is present in the terrestrial biomass and the atmosphere combined. A large portion of the SOM is present in temperate and boreal forests. Whether this pool will capture, store or release C is highly dependent on the activity of microorganisms that decompose SOM. Traditionally, filamentous, saprotrophic fungi are thought to have a unique ability to degrade SOM including lignocellulose and they are considered to be the main decomposer of forest SOM. By contrast, biotrophic fungi, such as ectomycorrhizal (ECM) fungi are thought to have only limited capacity to decompose complex SOM. This view is supported by genome sequencing showing that ECM have lost many of the genes that encode hydrolytic plant cell wall-degrading enzymes in their saprotrophic species. Nevertheless, by using spectroscopic analyses and transcriptome profiling, we have demonstrated that the ectomycorrhizal fungus Paxillus involutus have a significant capacity to decompose organic matter when acquiring nitrogen from plant litter. The observed chemical changes were consistent with a hydroxyl-radical attack, involving Fenton chemistry similar to that of saprophytic brown-rot fungi. Further experiments showed that the decomposition of plant litter and assimilation of nitrogen in P. involutus are triggered by the addition of glucose, while the addition of ammonium, the most abundant inorganic N form in forest soils, had relatively minor effects on the decomposing activity. Taken together, these experiments suggest that at least some ECM fungi can decompose SOM using an oxidative mechanism present in brown-rot fungi. We propose that the primary function of the decomposing activity is not to assimilate the released C, rather to mobilize the organic N that is embedded in recalcitrant SOM complexes. The released C may either be further degraded by saprotrophic microorganisms or sequestered in stable SOM-mineral aggregates. The prospects of using spectroscopic methods and transcriptomic data to identify specific transcripts or chemical signatures that can be used as biomarkers for probing the decomposing activity of soil-living fungi will be discussed.