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Ectomycorrhizal fungi and mobilisation of organic phosphorus from forest soil: Novel data and actual role

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It has been demonstrated that forest soils contain a high proportion of phosphorus (P) in organic form (Po) that is represented by phosphomonoesters (such as glucose1-P, ATP, phytic acid, …) or phosphodiesters (such as nucleic acids or phospholipids). To be used by trees, the phosphate group (Pi) must be released by the hydrolysis of the strong ester bond by enzymes that are phosphatases (Pases). We are currently working on the hypothesis that phosphatases released by ectomycorrhizal (ECM) fungi play an important role in the recycling of P in forest soil, thus contributing to plant P nutrition. We addressed this question in the context of spodosoils of "Landes de Gascogne" as these soils, ensuring around 40% of conifer wood production in France, are very poor in Pi and high in Po contents relative to total P contents, making P limiting for maritime pine (Pinus pinaster) growth.

We worked on (i) Hebeloma cylindrosporum, a model fungal ECM species able to release huge amounts of Pase activity when grown in vitro in P-starved conditions, and (ii) on native ECM species. We found that H. cylindrosporum released 4 acid Pase isoforms able to hydrolyse a broad range of phosphate monoesters and to a low extent, the phosphodiester bis-pNPP. However, the efficiency of each isoform to release Pi from Po extracted from spodosoils was low. The role of native species was studied by cultivating P. pinaster seedlings in intact soil samples from plots of different ages or fertilisation design.. Despite a high pNPPAse activity in ECM tips, P mobilisation from soil Po, measured by plant P accumulation, was very low in those soils with the lowest mineral P availability and the highest Po concentrations. Surprisingly, we found a significant decrease in Po fractions in soils that were annually fertilised and irrigated. Finally, based on our findings, we will propose a novel scheme of the possible role of ECM fungal Pase in Po mobilisation from forest soil.