PIXE microanalysis of birch roots colonized by ectomycorrhizal fungi: New insights into metal distribution and potential tolerance mechanisms

ARNO MÄRTEN[1]*, DIRK MERTEN[1], STEFFI FORMANN[2], MITJA KELEMEN[3], PRIMOŽ VAVPETIČ[3], PRIMOŽ PELICON[3], KATARINA VOGEL-MIKUŠ[3,4]

[1] Institute of Geosciences, Friedrich Schiller University Jena, Burgweg 11, D-07749 Jena, Germany (*correspondence: arno.maerten@uni-jena.de)

[2] Institute of Microbiology, Friedrich Schiller University Jena, Neugasse 25, D-07743 Jena, Germany

[3] Jožef Stefan Institute, Jamova 39, SI-1000, Ljubljana, Slovenia

[4] Department of Biology, Biotechnical Faculty, University of Ljubljana, Jamnikarjeva 101, SI-1000 Ljubljana, Slovenia

Ectomycorrhiza (ECM) describes the mutualistic interaction between trees and fungi. It is known that ECM fungi may increase the tolerance of their host trees against high levels of bioaccessible metals in the soil. The interfaces for the ECM interaction are specialized organs called short roots. In our study short roots of birch (*Betula pendula* L.) growing into substrate originating from a reforestated uranium mining heap in eastern Thuringia (Germany) were analyzed for their metal distribution. Former metal mining sites are often affected by severe environmental degradation and plants growing there suffer from toxic effect induced by metal ions. Three different ECM species were identified as the dominant mycorrhizal partners of the investigated birches: *Meliniomyces bicolor*, *Pisolithus tinctorius*, and *Cenococcum geophilum*. Freeze-dryed specimens of 17 short roots were analyzed using a nuclear microprobe (micro-PIXE) located at the Jožef Stefan Institute in Ljubljana (Slovenia) with a minimum resolution of about 1 µm and detection limits for most of the elements in the lower ppm-range. From the obtained data quantitative elemental maps were calculated. A filter like function of the fungal sheath, a tissue formed by fungal hyphae working as an interface to the rhizosphere, concerning Al and other most abundant metals like Fe and Ti was observed. We assume that the ECM fungi serve as protective agents of the host trees from metal-excess-induced phytotoxic effects. In contrast to the aforementioned metals, Cu and Zn were taken up into the tree related tissues of the short roots probably due to their role as micro-nutrients and not-exceeding plant treshold levels. Moreover discriminant analyses of the PIXE data revealed that the ionome of the mycorrhizal roots was siginificantly affected by the species of the ECM fungi.