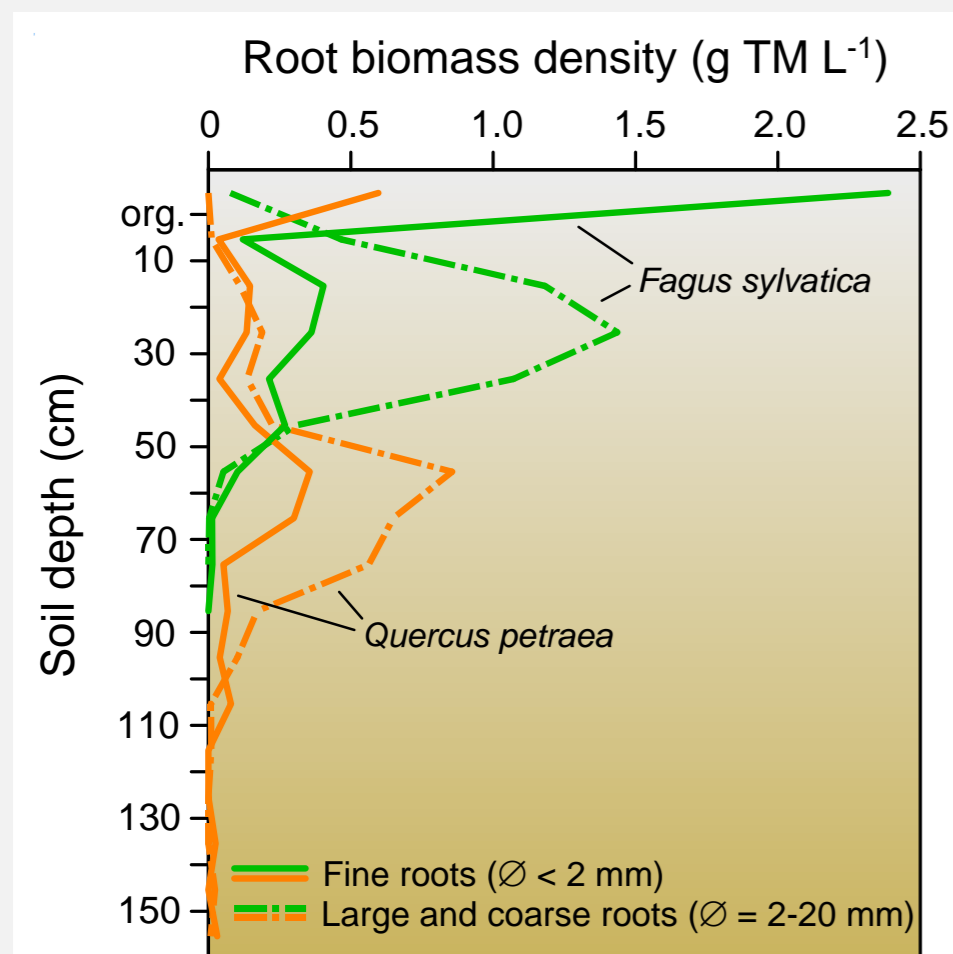




Background

The study of ecological and physiological processes in the root system of trees must base on the distinction of functionally different root fractions. Large and coarse roots (>2 mm in diameter) are essential for soil exploitation and anchorage of the tree. Fine roots (<2 mm diameter) are crucial for water and nutrient uptake and make a large contribution to the trees' carbon cycle through fine root growth and turnover. Fine roots are usually associated with mycorrhizal fungi, which are part of the complex and very species-rich rhizosphere community. Investigations on this highly dynamic part of the root system are still underrepresented and offer a promising research field for plant ecologists.

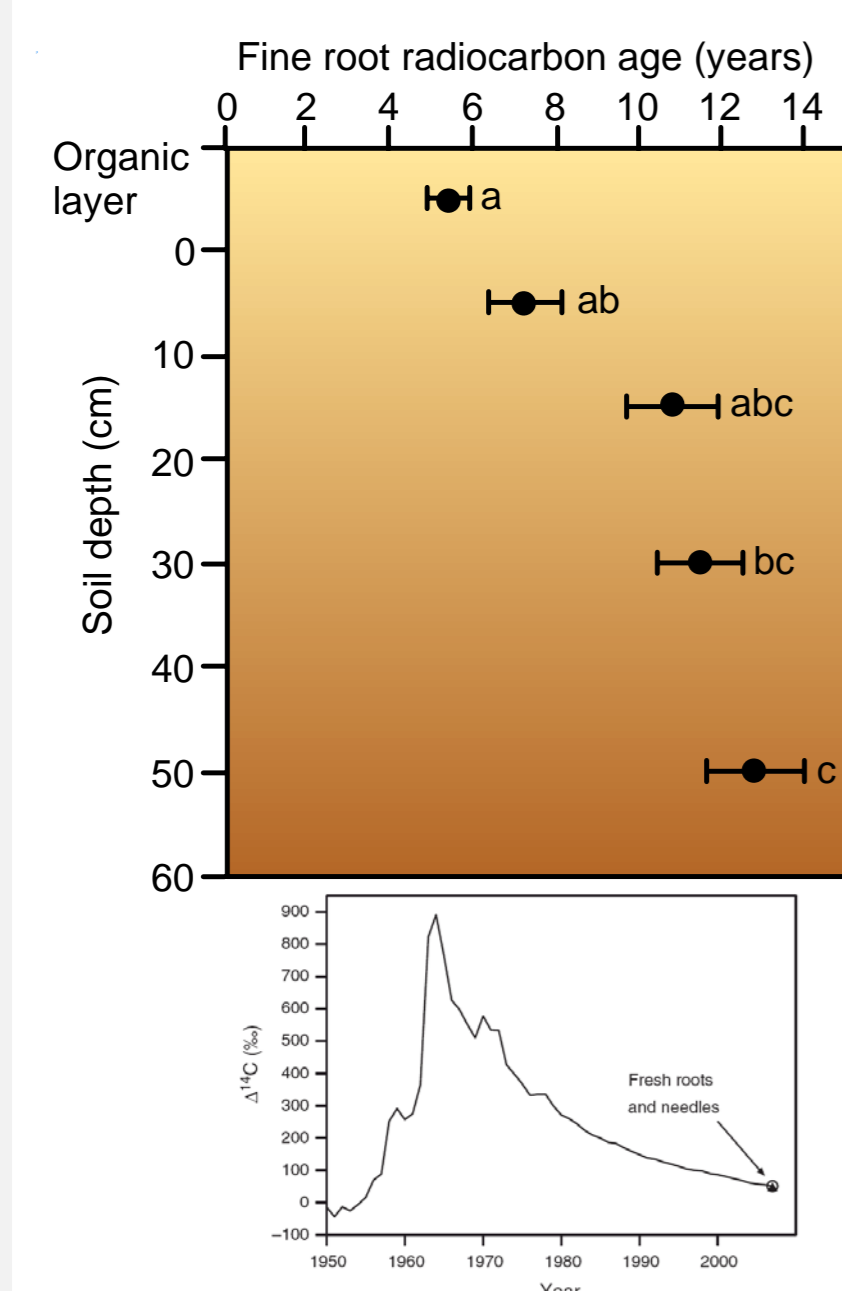
Research



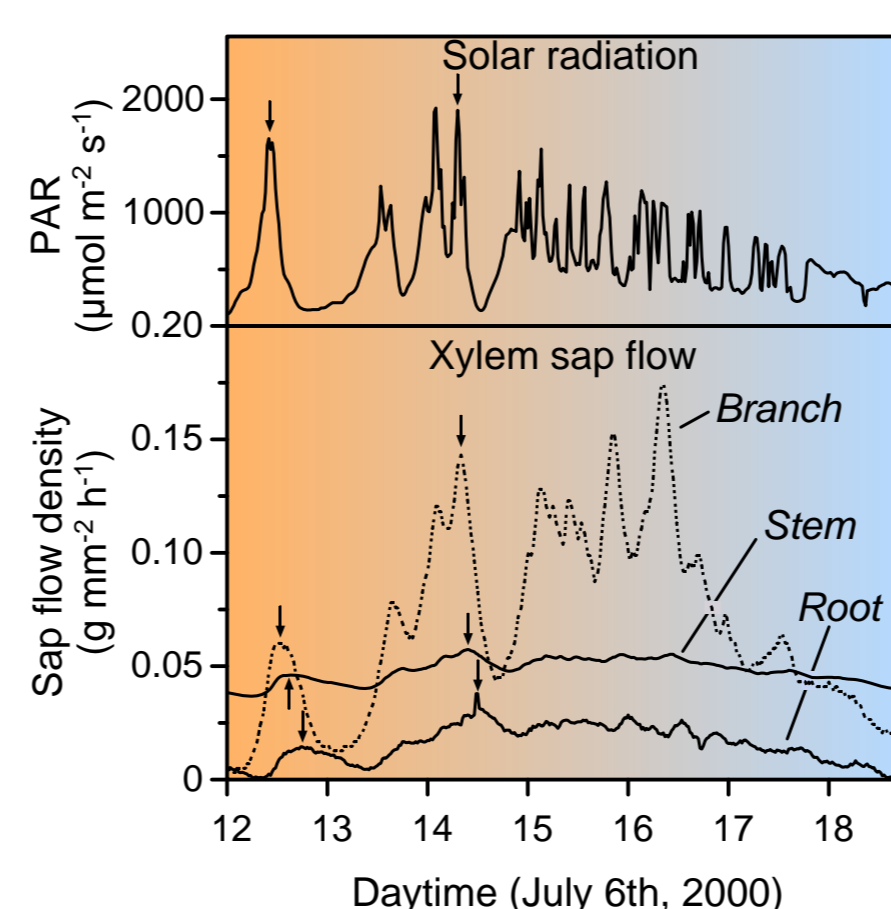
Large and coarse roots of European beech (*Fagus sylvatica*) and sessile oak (*Quercus petraea*) reveal species-specific differences in the vertical distribution pattern in the soil with oak showing a markedly deeper root distribution. However, fine roots of both species are mostly concentrated in the topsoil, where leaf and root litter decomposition results in higher nutrient availability.



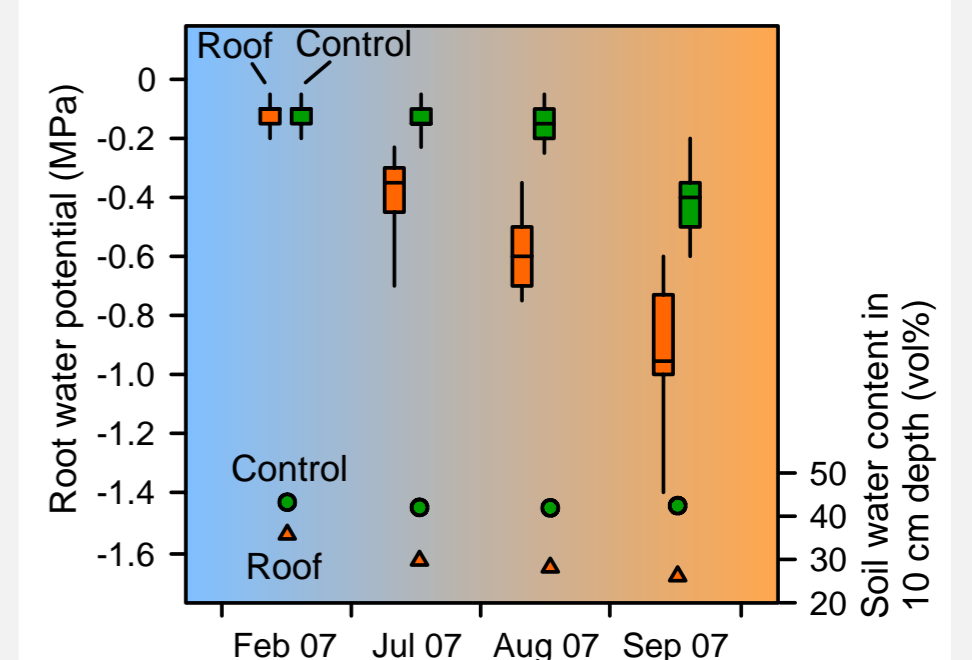
The "Göttingen RootLab" is a novel facility in the Experimental Botanical Garden in Weende that allows for experimental manipulation and observation of the rhizosphere. It gives the opportunity to monitor the birth, growth and death of fine roots of trees under experimentally altered soil conditions (see figure sequence below).



Analyses of the $\delta^{14}\text{C}$ signature in root tissue has been successfully applied to estimate (maximum) root age. The method makes use of the ^{14}C enrichment of the atmosphere due to nuclear bomb tests in the 1960ies, and the subsequent decline in $\delta^{14}\text{C}$. The $\delta^{14}\text{C}$ signature of spruce fine roots indicated that deeper roots are much older and thus are turned over less rapidly than roots near the soil surface.



By miniaturizing constant heat-sap flux gauges, we are able to monitor water flow in small-diameter roots (3-5 mm diameter) and to compare synchronous water flow in roots, stems, and branches of tall trees.



Cacao trees subjected to experimental drought in a throughfall displacement experiment on Sulawesi (Indonesia) decrease their root water potential, thereby improving the water uptake capacity of the roots.

Major projects: "Biodiversity Manipulation in Rhizosphere and Soil" - Cluster of excellence "Functional Biodiversity Research"
 "The rhizosphere of deciduous forests with contrasting tree species diversity" - DFG Research Training Group 1086
 "Growth and vitality of fine roots of Norway spruce - DFG Research Unit 562" "Soil Processes under altered climate"

Key results

- Fine roots of trees are highly dynamic and consume a notable percentage of the annually assimilated carbon in the crown.
- Tree fine roots may respond more sensitively to environmental stress (e.g. drought, low nutrient availability) than aboveground organs, thus representing a value stress indicator and also a large carbon sink.
- Interspecific competition between the fine roots of coexisting species may be just as important in mixed forests as is competition between aboveground tree organs.