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Elaborate differences between trees and understory plants in the deployment of fine roots

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Spatially segregating root systems is a fundamental mechanism by which plants can avoid competition for resources. Understory roots contribute substantially to total forest fine-root biomass, but the strategy of function-based fine root placement between trees and understory species at the plant community level is unknown. We collected fine roots of trees and understory species in two subtropical coniferous forests, sorted the fine roots into absorptive and transport roots, determined the vertical placement of these two types of fine roots, and examined the abiotic and biotic factors that may regulate the horizontal allocation of fine roots. We found that the contribution of absorptive shrub roots to absorptive roots of the woody plants was higher than the contribution of total shrub fine roots to the total fine roots of the woody plants in the topsoil. Understory plants allocated a greater proportion of their absorptive roots to transport roots than trees in the topsoil, but had less plasticity of the ratio of absorptive roots to transport roots (RatioA/T) along the soil profile. Trees had a lower proportion of total fine roots and a lower RatioA/T in the topsoil; but increased the total fine root biomass and RatioA/T with depth. The proliferation of shrub fine roots in the topsoil was affected more by soil structure (rock-fragment content and bulk density) than by nearby stems, and the growth of tree fine roots was inhibited by nearby dense and/or large stems. Our results provide evidence of an elaborate differentiation of root deployment between trees and understory plants. The roots of understory plants dominated the topsoil by possessing a higher branching capacity of absorptive roots than trees, filling the readily occupied macropores and being less affected by nearby stems. Trees enhance their resource foraging towards deeper soil by increasing their branching capacity of absorptive roots with depth. We also suggested that the roots of understory plants may affect ecosystemic carbon and nutrients cycling more than expected because of the disproportionately higher investment of absorptive roots in the topsoil.