EGU26-6787, updated on 18 Nov 2026
https://doi.org/10.5194/egusphere-egu26-6787
EGU General Assembly 2026
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Evidence for resource transfer via common endophytic networks

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Fungal symbionts play essential roles in ecosystems by shaping plant development and biodiversity. Among these, mycorrhizal fungi can form common mycorrhizal networks (CMNs) where a single fungus connects the roots of two or more plants through a continuous extraradical mycelium, facilitating transfer of resources, including nitrogen and carbon, between the connected plants.
Remaining understudied, there is another group of fungal mutualists known as endophytes, which are relatively phylogenetically and morphologically distinct from mycorrhizal fungi. Endophytic fungi also support plant development and may form common endophyte networks (CENs). Whether endophytes can transfer soil resources like nitrogen, carbon, and water through such networks remains an open question. To test this, we established a CEN experiment in split petri dishes using *Arabidopsis thaliana* hosts and three phylogenetically diverse endophytes (*Trichoderma viride*, *Mucor hiemalis*, and *Fusarium temperatum*) to test if isotopically labelled amino acid ^{15} nitrogen (N), amino acid ^{13} carbon, ^{15} N-ammonium, or deuterated water can be transferred from a donor plants soil to receiver plants connected via a CEN. We show that the tested endophytes can form CENs and transfer growth limiting resources from donor plant soil to receiver plant tissues. *F. temperatum* boosted plant growth by 38% relative to the uninoculated control, and it enriched plant ^{15} N content derived from amino acids by 55%. Surprisingly, we also observed amino acid-derived ^{13} carbon transport from donor plant soil to receiver plant tissues by *T. viride* (+ 2.83% > control). We also demonstrate that soil resource transfer by all three endophytes shifted in the presence of two versus a single host plant even when root systems were physically separated to avoid competition, underscoring that endophytic functioning, not just that of plants, also shifts when CENs are formed. Our results demonstrate that non-mycorrhizal fungi, in particular endophytes, can form networks similar to the idea of CMNs and transfer plant growth relevant resources. Endophytes display a broad array of symbiotic functions with their hosts, and formation of CENs may be a newly discovered component of their symbiotic tool kit.