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Changes in the composition of ectomycorrhizal fungal communities and the water uptake of European beech forests across a natural precipitation gradient

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In temperate forests, ectomycorrhizal fungi (EMF) form the dominant mycorrhizal symbiotic association. EMF increase root uptake of nutrients and water in exchange for carbohydrates. The composition, structure and abundance of EMF communities are shaped by abiotic factors such as soil water availability, chemical and physical properties. Biotic factors also play a strong role especially tree species identity and plant physiological activity. Water availability affects both biotic and abiotic factors and thus is a major driver of EMF community structure and function. Under current climate change scenarios, seasonal drought risk is predicted to expand into areas where ecosystems may not be adapted to limited water availability. This is the case of European beech (*Fagus sylvatica*) forests growing along their southern distribution limit, in the Iberian Peninsula. Here, we characterized the abundance and composition of the EMF community and the patterns of root water uptake, in forests along a precipitation gradient (2500, 1100 and 900 mm/year), in northern Spain. We sampled soil, wood and fine roots in three mature pure beech forests at two times during the growing season, with contrasting soil water availabilities. DNA was extracted from EMF tips for molecular analyses (DNA meta-barcoding) to estimate species richness and diversity for each site and sampling campaign. Root colonization by EMF decreased in the late part of the growing season, when soil water availability was lower and this decline was larger at the rainiest site. We found that EMF species richness and diversity were similar across sites and sampling campaigns, irrespective of soil water availability. Yet, across sites, EMF communities were distinctly separated in the multidimensional space and did not change over the season, suggesting that EMF communities would be adapted to the local climatic and abiotic conditions. Analyses of water isotopic composition showed that root water uptake relied on upper soil moisture at the rainiest site, whereas it relied on deeper water reservoirs at the sites with more limiting water availability. Taken together our results suggest that EMF communities of *F. sylvatica* forests along their southern distribution limit would be adapted to low seasonal water availability, provided that trees had access to deep soil water. Also, at sites where water availability was more limiting, roots would

take up water from deeper soil horizons, whereas nutrients and EMF would still concentrate in the shallower soil layers, which could suggest a spatial decoupling between nutrient and water uptake. Meanwhile, at sites with abundant rainfall, both nutrient and water uptake would be strongly linked to water availability in the upper soil and thus these functions could be potentially more vulnerable to changes in precipitation patterns, mainly increased frequency and duration of rainless periods.