All mycorrhizas are not equal

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Van der Putten *et al.*[1] present a thought-provoking critique of the interactions between above- and below-ground organisms. This review highlights the complexity of the interactions involved. However, for mycorrhizal fungi, we believe that the complexity is far greater than that described. Appreciating these interactions is critical if the paper is to be successful in one of its aims, namely identifying areas for future research.

Firstly, it is important to distinguish between different types of mycorrhiza. For example, ectomycorrhizal and arbuscular mycorrhizal (AM) fungi may have differing effects on plant morphology and physiology[2] and, as a consequence, their interactions with insect herbivores may differ[3]. Furthermore, effects of AM fungi on host plants may not always be positive, as van der Putten *et al.* seem to imply. There are many examples of AM fungi being plant antagonists[4].

Secondly, we believe that a problem with many mycorrhizal-higher trophic level organism experiments in the past is that the system studied may not be representative of field conditions. Indeed, with AM-Collembola experiments, the vast majority of studies have simply selected organisms easy to culture[5]. A critical point, not stressed by van der Putten *et al.*, is that future experiments must involve combinations of organisms known to co-occur in the field. Few such experiments exist and many more are needed[6].

Thirdly, it is imperative that we recognize that different mycorrhizal species can have different effects on insects and plants and also that herbivores can have differential effects on different mycorrhizal species. Herbivory can dramatically change the species composition of ectomycorrhizal communities, even of non-defoliated neighbouring plants[7]. If such effects also occur with AM fungi, then herbivores could indirectly alter the species richness of plants in natural communities, because plant species diversity is linked to AM fungal diversity[8].

Fourthly, while agreeing that mycorrhizal effects may be mediated through plant defence, we believe that AM effects on pathogens are better known than van der Putten *et al.* suggest[9]. These effects are likely to result from changes in the availability of carbon and it has been shown that AM effects on insects can be explained by the mycorrhizal-induced production of carbon-based defences[10].

In summary, we totally agree that there are important gaps in our understanding of multitrophic interactions. However, we urge future workers to use realistic experimental systems, so that these gaps are filled by meaningful, rather than misleading, information.

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