Case study 25. Above-ground multitrophic interactions mediated by soil invertebrates and summer drought

Among the expected effects of climate change is the increase of summer drought in some areas that will affect above- and below-ground multi-species community interactions. An extended period of summer drought is predicted in southern Europe. Under drought conditions earthworms can reduce assimilation, transpiration and stomatal conductance of Poaceae species, probably due to reduced soil water storage capacity in the presence of earthworms. In a large-scale study the interactive effects of earthworms (*Aporrectodea caliginosa* (Savigny); Lumbricidae) and summer drought affected multi-species plant communities (*Hordeum vulgare* (Poaceae), *Capsella bursa-pastoris* (Brassicaceae) and *Senecio vulgaris* (Asteraceae)) and how these effects affected number of aphids (*Rhopalosiphum padi* (L.)) and its parasitoid (*Aphidius ervi* Haliday; Hymenoptera: Braconidae).
Summer drought had a very strong negative impact on plant production, especially on *S. vulgaris* shoot and root biomass, but was ameliorated when earthworms were present. This may also indicate that this plant benefits most from any impact of earthworms as it is the plant most severely affected by drought. In general, nitrogen concentration increased in the leaves during drought. Summer drought decreased aphid number by 50 percent, with nearly 10 percent being parasitized. The interaction was moderated by earthworms which caused declines in *R. padi* populations under drought conditions. The interactive effects of earthworms and summer drought affected plant biomass, with an increase of 11 percent when earthworms were present and had the largest impact in monocultures compared to multi-species communities.

This case study shows how plant-mediated effects of summer drought and earthworms on R. padi had cascading effects on the parasitoid A. ervi. These interactions need to be understood as climate change may induce important changes in the interaction between earthworms and above-ground multitrophic groups. Below-ground interactions can mitigate the effects of climate change-related factors, like increased summer drought.

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