Functional Ecology

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Soil diversity promotes plant diversity

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A long-standing question in ecology is how biodiversity is maintained. While there are many hypotheses, recently plant ecologists have focused their attention on the diversity of organisms in the soil as a key mechanism. The idea is simple and elegant: each plant species has its own specific enemies in the soil. When a plant becomes too dominant in a community these soil-borne enemies will find it and reduce its abundance, thus restoring the balance among the plant species. This balance is called 'community evenness'.

Directly testing this idea is not straightforward, because there are many thousands of species in the soil (e.g. bacteria, fungi, protists, roundworms, springtails etc.) and we don't know which soil organism affects which plant species. To get around this, researchers started using plant-soil feedback experiments. When a plant grows in the soil it changes the species composition in the soil, because some organisms are attracted (e.g. its enemies) and other repelled. We call this 'soil conditioning'. When we next grow a new plant in that conditioned soil we can measure what the net consequences of this shift in soil species are for the performance of that plant (i.e. the feedback). To date, the results of plant-soil feedback experiments are consistent with the hypothesis that the soil community (at least partly) regulates the diversity of plants. However, a direct experimental test was hitherto lacking.

We conducted a plant-soil feedback experiment with plant communities of four species. We exposed these communities to soils that were conditioned by either one or four plant species. In addition, we varied the spatial configuration of these conditioned soils to simulate how plant communities respond to having different neighbours that condition the soil community.

A community of four plant species growing on soil conditioned by four species three weeks into the experiment. Photo: E.R.J. Wubs.

We found a high plant community evenness (the balance among the species) when four species conditioned the soil, while when one species conditioned the soil the plants became more dominated by a single species. This pattern was not affected by the spatial configuration of the soils. This suggests that when all plants in the community conditions the soil, they each attract their own soil-borne enemies, who then ensure that no species becomes dominant. So when the soil is diverse, due to a diverse soil conditioning, this will keep the plant community even and thus diverse as well. Future experiments are now needed to test whether this mechanism holds over multiple plant generations, and to quantify the strength of this mechanism relative to environmental influences.