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Interconnected Microbial Communities in Alpine Grassland Ecosystems

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Soil is a complex ecosystem, including an abiotic fraction and thousands of bacterial and fungal taxa, but also many plant and animal species that themselves host microorganisms. However, traditional perspectives often examine soil microbial diversity separately from those of the organisms that inhabit it. Here, we seek to challenge such view and propose an alternative and holistic interpretative framework in which the soil meta-community is the combined set of different microbial communities belonging to various organisms found within the soil or interacting with it.

Applying this comprehensive view, this study explores soil prokaryote and fungal diversity and associated microbiota in mammals, invertebrates, and plants in alpine pastures. The study comprises more than 900 samples of soil, rhizosphere (*Carex* spp. and *Festuca* spp.), invertebrates (nematodes, collembolans, earthworms, and beetles) and vertebrates (feces of hares, wild ungulates and livestock) along an elevational gradient (which is used as a proxy for climate change) in the European Alps.

We found that, in addition to climatic and soil properties, biotic factors, especially the presence of living organisms, shapes soil microbial communities. Analyses of fungal and bacterial taxa shared between sample types revealed greater overlaps between soil, rhizosphere, and soil-dwelling invertebrates, compared to other invertebrates and vertebrates, although a core microbiota for all organisms also exists.

This finding highlights the central role of soil microbiota and the above/belowground and host/habitat-specific associations in the alpine meta-community. Our data reveal the common characteristics of microbial communities from different organisms interacting with the soil and underline their intricate connections in alpine pastures, even across a 1500 m elevation gradient.