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Protists and protist-microbe interactions in soil chips

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Soil organisms live and interact in the intricate soil pore space labyrinth, but their natural habitat and natural interactions are difficult to study because of the opaqueness of the soil. We recently developed microfluidic model systems that simulate the spatial microstructure of soil microbial habitats in a transparent material, which we call *Soil Chips*. They allow us to study the impact of soil physical microstructures on microbes, microbial behavior and realistic microbial interactions, live and at the scale of their cells.

Using soil inocula, we get a large proportion of the natural microbial community into our chips and can study soil bacteria, fungi and smaller protists and nematodes in their food webs and in different spatial habitats. We were especially interested in soil protists that are generally understudied in their diversity and ecosystem functions. We were able to observe a large variety of flagellated, ciliated and amoeboid protists in the chips, predating on the bacterial populations and even on fungal hyphae. Some larger amoebae only entered the chips with their pseudopodia for predation. The colonization succession pattern of the chips showed predator-prey oscillations, with periodically high levels of different protists, followed by retreat or encystation. In chips that were containing initially dry pore spaces, colonization success of protists was strongly increased by the presence of fungal hyphae, which paved the way for protists by wetting pore spaces.

The soil chips enable us to study the influence of trophic interactions such as the presence of predators on bacterial and fungal nutrient cycling. Disturbances that stronger influence protists than bacteria may have a pronounced effect on bacterial population sizes and their organic matter degradation activities. Beyond the scientific potential, the chips can also bring soils closer to people and hopefully increase engagement in soil health conservation.