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Real time interactions between soil microorganisms and microplastics at microscale

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Terrestrial ecosystems are under threat due to the continuous accumulation of plastics in soils. Particularly, microplastics have been proven to negatively affect the performance of soil macrofauna such as earthworms, as well as soil mesofauna including springtails and nematodes. Unfortunately, two big groups remain largely unexplored: the soil microfauna and microflora.

Recent studies have shown that soil microbial community composition can significantly vary depending on the concentration and type of plastic, favouring some groups and disfavouring others. To have a better understanding of these relationships, it is necessary to study them at relevant scale: the microscale.

Considering that in situ observations are hard to achieve due to the opacity of soil and ever-changing soil architecture, we used transparent micro-engineered chips to study interactions between microplastics and soil microorganisms live. We hypothesized that different concentrations of microplastics interfere with a natural microbial community in terms of 1. Soil microbial colonization/succession of the chips and 2. Soil microbial growth inside the chips' pore space.

We fabricated chips containing different microstructures that simulate soil pore spaces. The chips were bonded to a glass slide and one side was opened to allow microbial colonization. Each chip was filled with a mix of liquid nutrient medium and 1.0 µm polystyrene microbeads at microplastic concentrations of 0.0, 0.006, 0.001 and 0.0005 mg/ml. The chip´s opening was inoculated with 5 g of soil and incubated in the laboratory at room temperature for one month. We documented the presence/absence and abundance of different soil microbial groups changing over time by using an inverted microscope.

Our preliminary study reveals that larger microorganisms are sensitive to the presence of microbeads 1.0 µm size. We found that all major soil microbial groups (fungi, bacteria, and protists) and nematodes colonized the chips. However, their abundance was affected by the presence of microplastics, irrespective of the concentration. Particularly protists and nematodes were lower in number during the first days of the exposure. The beads were clearly visibly taken up into the cells of the protists or the digestive tract of the nematodes.

We are now investigating what consequences the lower abundance of certain soil microbial groups have for the soil food web. As seen here, micro-engineered chips are useful tools to provide visual access at the scale where most cell-to-cell interactions occur.