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A synthetic soil approach to link microbial community composition to soil functions

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Linking soil functions to microbial community structure is arguably one of the greatest challenges in soil ecology, presumably due to the structural complexity and heterogeneity of soil across scales and time, as well as the large number of microbial taxa present. To overcome these impediments, we here introduce a model soil ecosystem - the “Synthetic Soil” - which allows soil structure and microbial community composition to be varied separately, to disentangle the complex relationship. The Synthetic Soil consists of a mixture of sterilized primary and secondary soil minerals and organic matter of plant and microbial origin, which together constitute the artificial soil matrix. This abiotic soil matrix is then inoculated with an *in-silico* designed, minimal microbial community, composed of 12 selected soil bacteria and fungi.

We demonstrate the applicability of the approach, by incubating the Synthetic Soil in a sterile environment for five weeks. During this period, an actively growing soil community established, indicated by stable respiration rates, increasing DNA- and ammonium concentrations, depletion of dissolved organic carbon, and by changes in relative abundances of the community members. Additionally, the minimal community was actively decomposing soil organic matter by the production of extracellular enzymes. In conclusion, the Synthetic Soil approach developed in this study, allows the construction of powerful and modifiable model ecosystems, which will make it possible to link soil functions to microbial community structure and thus to address fundamental questions of soil ecology.