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The mineralosphere - Abundance and carbon partitioning of bacteria and fungi colonizing mineral surfaces in grassland soils

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The adsorption of bacteria and fungi on clay-sized minerals, which are the most active inorganic colloidal components in soils, is an important pre-requisite for the survival and function of soil microorganisms in ecosystems. Exposing mineral containers (illite/goethite/quartz plus labelled Dactylis glomerta and Lolium perenne roots) in grassland soils (five sites of low and five of high land use intensity) of the “Schwäbische Alb” (South-West Germany) provided novel insights into the microbial colonization of mineral surfaces. The concept of the mineralosphere as a specific ecological habitat was verified by group specific C enrichment of soil microorganisms over a time period of 31 months. The colonizing microbial groups associated with the pristine mineral surfaces differed from the surrounding soil in their functional traits: for example, pristine mineral surfaces were fast colonized by fungi. After 31 months, fungal biomass contained up to 75% C derived from the added root litter source. It can be assumed that fungal growth strategies gave these microorganisms a competitive advantage over bacteria, which relied mainly on passive transport processes during colonization of the pristine surfaces. Since bacterial and fungal growth rates were variable during the succession of microorganisms in the mineralosphere, we concluded that differences in life strategies (copio- versus oligotrophic microorganisms) were also an important criterion for the early colonization. The production of extracellular enzymes by mineral-associated microorganisms and their stabilization onto mineral surfaces were found to be an important pre-requisite for microbial decomposition of the added carbon source in the mineralosphere. Nevertheless, the local environment of the mineralosphere was less important than expected: the choice of the food source (either added root material or carbon sources derived from organic matter of the surrounding soil) was only important under low land use intensity, as fungi with their hyphal growth could re-allocate nutrients within their mycelium and depend to lower extent on external input of C and nutrients than bacteria. In conclusion, pristine minerals developed over a period of 31 months into specific mineralospheres colonized by a microbial community which differed from the surrounding soil.