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Metabolic responses to hotspot-forming processes: growth modes and their ecological consequences

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Hotspots are characterized by an increased availability of nutritional elements compared to the surrounding bulk soil, which enhances microbial activity. However, the shifts in nutrient stoichiometry, when hotspot formation is initiated by a non-microbial organic matter source (rhizodeposits, litter, feces & mucus, percolating dissolved organic matter), are highly hotspot-specific. This results in contrasting microbial dynamics in the rhizo-hyphosphere, the detritusphere, the drilosphere and further biopores of soil animals, and in preferential flow pathways.

Experiments and models of microbial growth-death dynamics have recently improved our understanding of how element stoichiometry shapes element allocation in microbial metabolism. This holds specifically true for to the two contrasting pathways of microbial growth – intracellular element storage versus the investment of C, nutrients and energy in replicative microbial growth. Both growth modes involve synthesis of organic polymers – either storage or structural cellular polymers. However, the nature of these two types of polymers is highly contrasting with regards to their elemental but also their molecular diversity, such that the two growth modes generate distinct differences in the molecular compositon of the cellular biomass. We can therefore expect that the stoichiometric differences of nutrient hotspots will drive differences in the molecular diversity of the microbial biomass, and so ultimately the successively accumulating necromass.

Whereas controlled incubation experiments demonstrate how element allocation to storage and replicative growth depends on nutrient stoichiometry, we lack an understanding of how growth modes are distributed among hotspots *in situ*. Besides developing this conceptual understanding, we aim to shed light on the implications of differences in cell physiology among hotspots, which includes i) the turnover rate of microbial biomass due to contrasting resistance to stress (e.g. starvation), ii) the molecular composition of the microbial cells and iii) the resulting chemical properties and molecular diversity of necromass. These factors strongly influence the formation rates, qualities and persistence of necromass-derived soil organic matter arising in these hotspots. Furthermore, the accrual of organic matter shapes microbial resource availability, including element stoichiometry, in the hotspot, as well as the physico-chemical microbial habitat properties. In consequence, a feedback loop between microbial growth- and turnover-based organic matter formation and the initial processes, that trigger the hotspot formation elaborates. Thus, although hotspot formation is always initiated by non-microbial organic matter input, the characteristics of the established soil hotspots are ultimately linked to the microbial necromass' molecular and elemental diversity, which is the direct product of the hotspots' microbial metabolism and growth mode. This study aims to relate the nutrient enriching processes (rhizodeposits, litter, feces & mucus, percolating DOM) and soil-intrinsic feedbacks to the dominant microbial growth modes and resulting properties of the organic matter in soil hotspots.