De-novo synthesis versus recycling: Relevance under disturbed and steady-state conditions in soil

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In the past decades the biogeochemists' view on microbial biomass formation was mainly based on the idea that microbial C is derived from degraded plant-derived organic matter (OM). Awareness of the importance of microbial OM recycling in terrestrial and marine C cycle just emerged within the last years. Long term incubation experiments with frequent disturbances gave first indications that recycling plays a fundamental role in microbial biomass turnover. Recent study observed microbial metabolic adaptation to applied toxins and subsequent recovery of the microbial population. Under such circumstances, recycling is of highest relevance for the formation of microbial biomass of this re-establishing community.

However, proofing recycling not after a disturbance event but under steady state conditions is one of the intriguing challenges biogeochemistry is faced to. To meet this challenge, biomolecules have to be chosen that display another molecular speciation in the living cells, than they show in non-living soil and sedimentary OM. The alkyl chains of phospholipids fulfill this requirement, as they are present as phospholipid in the membranes of living cells but get rather fast cleaved off from the phosphate and head group after cell death. So, the alkyl chains are the dominant form in non-living soil OM. Applying position-specifically ^{13}C labeled alkyl chains, we quantified that under steady state conditions 75% of the newly incorporated alkyl chains in microbial membranes are derived from intact metabolite recycling and that this is a rather general observation over bacterial and fungal microbial groups. Thus, the frequently ignored process of metabolite recycling plays a crucial role in terrestrial ecosystems and has to be taken into account interpreting biomarker as well as isotopic signatures in soil and sedimentary samples.