Geophysical Research Abstracts
Vol. 13, EGU2011-3256, 2011
EGU General Assembly 2011

Microbial biomass – a significant source for soil organic matter

Matthias Kaestner and Anja Miltner

Helmholtz Centre for Environmental Research UFZ, Dpt. of Environmental Biotechnology - UFZ, Leipzig, Germany (matthias.kaestner@ufz.de, +49 341 235 1471)

The formation of soil organic matter (SOM) has long been a dominating topic in soil science because the amount and composition of SOM determines soil quality but the processes are still not yet really understood. However, proper management of soil organic matter (SOM) is needed for maintaining soil fertility and for mitigation of the global increase of the atmospheric CO2 concentration. It needs to be based on knowledge about the sources, the spatial organisation and the stabilisation processes of SOM. On the molecular level, the degraded plant-derived organic material in soil is considered to be self-assembled and arranged to macromolecular complexes. Both easily degradable and refractory compounds are stabilised in these aggregates. In addition, the so-called humic substances were regarded for a long time as a novel category of cross-linked organic materials.

Recently, microbial biomass residues have been identified as a significant source for SOM [1]. We incubated 13C-labelled bacterial cells in an agricultural soil and traced the fate of the 13C label of bacterial biomass in soil by isotopic analysis [2-6]. In this study, we summarise the mass balance data and visualise the microbial biomass and its residues by scanning electron microscopy (SEM). Our results indicate that a high percentage of the biomass-derived carbon remains in soil, mainly in the non-living part of SOM after extended incubation. The SEM micrographs only rarely show intact cells. Instead, organic patchy fragments of 200-500 nm size are abundant. These fragments are associated with all stages of cell envelope decay and fragmentation. Similar fragments develop on initially clean and sterile in situ microcosms during exposure in groundwater providing evidence for their microbial origin. Microbial cell envelope fragments thus contribute significantly to SOM formation. The results provide a simple explanation for the development of the small, nano-scale patchy organic materials observed in soil electron micrographs. They suggest that microstructures of microbial cells and of small plant debris provide the molecular architecture of SOM adsorbed to particle surfaces. This origin and macromolecular architecture of SOM is consistent with most observations on SOM, e.g. the abundance of microbial-derived biomarkers, the low C/N ratio, the water repellency and the stabilisation of microbial biomass [1]. The specific molecular architecture determines carbon mineralisation and balances as well as the fate of pesticides and environmental contaminants.

References:

1. Miltner A., Bombach P., Schmidt-Brücken B., Kästner M. (2011). SOM genesis – Microbial biomass a significant source. Biogeochemistry, submitted.

2. Miltner, A., Richnow, H.H., Kopinke, F.-D., Kästner, M. (2004). Assimilation of CO2 by soil microorganisms and transformation into soil organic matter. Organic Geochemistry, 35: 1015 – 1024.

3. Kindler, R., Miltner, A., Richnow, H.H., Kästner, M. (2006). Fate of gram-negative bacterial biomass in soils - survival of cells, carbon balance and persistence of the lux gene as genetic label. Soil Biology and Biochemistry, 38; 2860-2870.

4. Lueders, T., Kindler, R., Miltner, A., Friedrich, M.W., Kaestner, M. (2006). Bacterial micropredators and fungi distinctively active in a soil food web. Applied and Environmental Microbiology, 72; 5342-5348.

5. Kindler. R., Miltner, A., Richnow, H.H., Kästner, M. (2009). Fate of microbial biomass compounds (fatty acids) in soil and their contribution to soil organic matter. Organic Geochemistry, 40; 29-37.

6. Miltner, A., Kindler. R., Richnow, H.H., Kästner, M. (2009). Fate of microbial biomass-derived amino acids in soil and their contribution to soil organic matter. Organic Geochemistry, 40, 978–985.