Influence of minerals, charcoal and litter on microbial response to phenanthrene in artificial soils

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Polycyclic aromatic hydrocarbons (PAHs) are important environmental pollutants which often persist in soil. The biochemistry of microbe-driven degradation of PAHs is well-studied though less is known about abiotic soil environmental factors influencing the microbe-phenanthrene interaction. Since minerals and charcoal are major soil components we matured different microbial communities in artificial soils based only on variation in the mineral content (montmorillonite, illite, ferrihydrite) and presence of charcoal for 2 years after addition of Luvisol microorganisms and sterile manure. Established microbial communities in soils were exposed to PAHs' model compound phenanthrene (2 mg/g) to study microbial functionality depending on soil composition. Furthermore, litter which was previously shown to enhance microbial activity was added to the soils (1 wt%). Both treatments with corresponding controls were further incubated for 63 days with sampling on day 0, 7, 21 and 63. A natural Luvisol soil was treated similarly for control. Fingerprints by denaturing gradient gel electrophoresis (DGGE) based on 16S rRNA or ITS gene fragments, respectively, amplified from extracted total community DNA were generated. The presence of phenanthrene-degradative genes was screened by PCR-Southern Blot detection and soil treatments were subjected to a chemical phenanthrene analysis. DGGE fingerprints revealed that the addition of phenanthrene and litter caused a shift in microbial community composition. Differences in bacterial response to phenanthrene were seen depending on litter addition and soil composition. The incubation time was determined as additional influencing factor. Furthermore, a dominance of a specific genotype for phenanthrene degradation is assumed based on PCR-Southern Blot analysis.

In conclusion, microbial response to phenanthrene was shown to be soil composition-, litter- and time-dependent. Hence, this study provided new insights into the complex soil interaction network.