activity (β-GL) and arginine ammonification (ARG) were highly correlated to the C_{bioorg}, but not to the Oil-C. The absolute data of both enzymes are also not appropriate indicators for the assessment of soil microbiology damage by crude oil. Using β-GL relative to C_{bioorg} (β-GL/C_{bioorg}) a weak negative correlation was found (r = -0.53) with the Oil-C. Beyond this in the peat soils β-GL was highest with the lowest C_{bioorg} and simultaneously the lowest Oil-C. For the ARG nothing similar was found. Comparing soil 1 and 2 the oil-contaminated one showed the lowest values, whereas the opposite behaviour was observed for the soil pair 5 and 6. Due to the limited data source for the arylsulfatase activity (ARYL, not enough soil material) statements for the ARYL are of limited use. However, the data suggest that the reaction of the ARYL was similar to that of the DHA.

Conclusions

One biomass determination and some of the enzyme activities were enhanced with the occurrence of crude oil in soil, whereas others show the opposite pattern. Only with extremely high crude oil contaminations could we document a negative impact on these microbial indicators.

The CFE-biomass (CFE-C_{mic}), the dehydrogenase activity (DHA) as well as the arylsulfatase activity (ARYL) estimation are correlated positively with the crude oil content up to values which are much higher than any European remediation threshold value. Currently it is not possible to distinguish between the effect of Oil-C and soil-derived biogenic C on soil microbial parameters during the processes of remediation and recultivation. Beyond this the observed level of these microbial parameters in the cold tundra soils was similar to those known from temperate soils. Therefore CFE-C_{mic}, DHA and ARYL are not appropriate for the assessment of soil quality of oil-spilled soils in general and especially for the investigated subarctic tundra soils. To us it seems questionable to use these laboratory methods for the characterization of the microbial properties of the cold soils.

In contrast, the metabolic quotient (qCO_2) calculated from the microbial basal respiration (R_{mic}) and the SIR-biomass (SIR-C_{mic}) estimation is an appropriate indicator reflecting high oil contaminations in soil. The same was observed for the specific β-glucosidase activity (β-GL/C_{bioorg}), which is correlated negatively with the oil content. The indication of soil damage using the stress parameter qCO_2 (Beyer, 1998) or the specific enzyme activities (activity/C_{bioorg}) (Tscherko et al., 2001) minimizes the impact of the native soil organic matter content on soil microbial properties.

Both tested biomass methods (SIR, CFE) may be influenced by methodological problems with their application to crude-oil contaminated and subarctic soils. The interpretation of the results may also be influenced by the soil material (mineral or organic materials), by degree of oil pollution, by the age of the contamination, the age of the oil products and by the method used itself.

Before any microbial investigation of cold tundra soils or other polar soils we urgently recommend testing the method for its suitability prior to any data collection in series. Our data suggest that not all the commonly used microbial parameters are appropriate for application in cold soils and/or oil contaminated soils. Beyond this the application of ecophysiological ratios between two microbial parameters or the specific enzyme activities should be given preference instead of using single parameters.

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