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Humus Forms as an Early Warning System for Soil Degradation

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Both atmospheric deposition and large scale draining programs over the last decades have seriously affected soil organisms and processes that control nutrient cycling in ecosystems of the Netherlands. The organic matter cycle and ecosystem development consequently are largely controlled by site characteristics such as soil acidity, moisture conditions and nutrient availability. We assumed that environmental stress might have resulted in disturbed balances between litter input and decomposition through a range of soil organisms. The balance shows up in the extent to which organic matter is incorporated in the soil (endorganic) or accumulates on top of the mineral soil.

We state that the humus profile of a given soil, positioned between the abiotic and biotic component of ecosystems, might provide field information on soil degradation processes as triggered by environmental stress in early phases of monitoring programs. Consequently humus forms might be considered an interface linking soil biodiversity and ecosystem functioning and indicators for soil quality.

To underpin our statement we will present the results of a study comparing humus form development and functioning in both degraded and non degraded fen ecosystems. The vegetation and the humus forms of fifteen sites in eight nature reserves were described. Individual layers of the humus profile were sampled and analyzed on N- P- and K availabilities some general soil characteristics. Dry matter, N-, P- and K-contents of the crop were determined. The assessment of nutrient availabilities was tested by modeling crop production with nutrient availabilities as predictors.

It appeared that degraded sites were characterized by sequestration of poorly decomposed fibric and mesic organic matter, high acidity and distinct horizon differentiation by decreased bioturbation. Surprisingly, fibric and mesic horizons showed significantly higher net nitrogen mineralization rates than mesic and well decomposed humic humus horizons. We hypothesized that a decline of earthworm activity due to acidification and aluminum toxicity might be responsible for organic matter sequestration and horizon differentiation. Earthworms do incubate fresh litter with intestinal bacteria to stimulate digestion of litter and element mineralization for their own profit. At the same time a strong N immobilization by the intestinal microbial biomass takes place. Upon acidification and the cessation of earthworm activity the strong demand of the intestinal microbial population for nitrogen to incorporate in their biomass will disappear, which will result in an increased net N mineralization rate. So, soil degradation by acidification results in a shift of nitrogen immobilization to net nitrogen mobilization. This shift is in favor of the nitrogen availability of the crop, which indeed responded with higher production levels than in the non degraded fens. Our results illustrate the competitive power of soil organisms in their struggle with higher plants for nutrient sources in non degraded soils.