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## S-17.4

### **Soil fauna during various restoration practices**

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Ecosystem restoration plays a crucial role in fighting with consequences of climate change that we experience nowadays, but it is even more important for maintaining biological diversity for future generations. Achieving of functioning soil food web is as important as restoring plant community above it, however, driving processes belowground are different and more complex than aboveground.

We investigated soil biota and plants colonization in three different anthropologically disturbed soils. In the first case soil fauna was studied during various treatments (soil and plant material addition) used for heathland restoration in Netherlands; similar design was used also in reforestation of former quarry in the Czech Republic and in the last case we examined impact of soil block introduction into bare substrate in post-mining spoil heaps also in the Czech Republic.

The results using all groups studied (microbial community, nematodes, mesofauna, macrofauna, plant communities) show that soil transplant and in some cases also transplant of plant material increased soil biota densities and made their communities more similar to target plants. However, these effects are typically restricted on places where soil or plant material has been applied. Inoculation effect even in close surroundings is typically much smaller.

We can conclude from all three projects that the soil addition is crucial for both above- and belowground ecosystem restoration and therefore for proper soil functioning. However, it seems that effectivity differs amongst soil fauna groups depending on body size, and also according to dilution of soil added into substrate and the substrate quality itself.

## S-17.5

### **Earthworms and ecosystem restoration - starting from zero.**

John Scullion

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Earthworms have a central role in the functioning of temperate ecosystems, with the exception of those based on very acid or wet soils. Their activities promote soil development, affecting physical, chemical and biotic characteristics. These activities affect root development, and thus the supply of water and nutrients to plants. Plant growth and inter-species competition in turn feedback as the amount and chemical composition of residues that form the substrate that supports earthworm communities.

Earthworm species vary in their life styles, support requirements and impacts on soil processes. Some are early colonisers of primitive ecosystems, are well adapted to the stress conditions typical of these ecosystems and are less demanding in relation to conditions needed to sustain their population. Others require more stable conditions, in terms of food supply and an ability to avoid stress. The latter have a greater impact on soil conditions.

This paper will explore interactions between ecosystem status and associated earthworm populations. Based on an understanding of these interactions, strategies for manipulating earthworm populations for ecosystem restoration will be discussed.

## S-17.6

### **Ecological restoration of acidified heathlands: fauna response to rock powder versus lime application**

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Soil acidification due to air pollution (ammonia, sulphur dioxide emissions) is a major problem in Dutch heathland ecosystems. This has resulted in biodiversity loss of bryophyte, lichen and vascular plant species richness. Recently, there is increasing evidence that soil acidification also leads to reduced invertebrate species richness and/or abundance. The causal links work either indirectly through reduced plant species richness, or more direct through reduced plant nutritional quality (increased plant N:P ratio) or hampered soil organic matter decomposition rates. Traditionally, the main restoration tool to counteract soil acidification in the Netherlands is the application of dolomite lime. Although proven effective in restoring soil buffer capacity and vascular plant species richness, invertebrate response is mixed, often even showing negative effects on characteristic heathland fauna species. These negative side-effects are thought to arise from shock effects of adding large quantities of quickly dissolving Ca and Mg to the soil, resulting in newly introduced nutrient imbalances at the micro-nutrient level and/or temporarily increased P-limited conditions as a result of lime application.

In order to reduce the risk of introducing new nutrient imbalances for fauna, as well as providing a working

restoration tool aimed at restoring habitat quality for all heathland biota, we tested an alternative restoration method using slow release soil buffering agents. These slow release agents consist of finely ground igneous rocks (rock powder) and release a broader spectrum of cations and micro-nutrients to the soil via mineral weathering. In a number of field trials in Dutch heathlands, we investigated and contrasted the faunal response to addition of several slow-release agents with both the original control situation as well as traditional liming. In this oral presentation we present the first promising results regarding fauna response after three years of experimental application.

## **S-18 -Trait-based ecosystem engineering-using plant traits in recovery of ecosystem functions & services, cont.**

### **S-18.1**

#### **Detection of changes in assembly rules during spontaneous grassland recovery**

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Detailed knowledge on the presence and changes of trait-based assembly rules in spontaneous succession can help planning and evaluating active restoration interventions in similar environments. Therefore, we studied the changes of trait composition and assembly rules in the secondary succession of old-fields in order to describe successional pathways. We expect that non-random patterns are present in succession, and these patterns show significant changes from convergence to divergence.

We conducted our study on abandoned agricultural fields in the forest-steppe zone of Hungary, on sand soil, with Pannonic sand steppes as target vegetation.

Community trait composition and trait-based assembly rules were assessed based on 40 permanent vegetation plots on old-fields resampled in 2000, 2008, 2010, and 2015. The dispersion of eleven traits was compared with a null-model and the effect of time since abandonment on the departure from random expectation was tested with linear mixed effect models.

No changes were found in the dispersion of two traits: seed weight and pollination type showed divergent pattern for the whole time. In case of three traits there were differences only among the studied years, which suggest fluctuation in the dominant process. There were significant changes with time in case of six traits. In case of seed bank type, dispersal type, flowering start and leaf dry matter content the changes followed the expectation: from convergence to divergence through random pattern, while in case of specific leaf area and life form the direction of changes were opposite.

Our results show that environmental filtering (causing convergence) and limiting similarity (causing divergence) act together, but through different traits. Assembly rules change during succession: at the start of the succession environment filtering is important and processes causing divergence became important later. However, some traits connected to regeneration are already divergent at the beginning of succession.

### **S-18.2**

#### **Succession in sand grassland: trait-based view of spontaneous grassland recovery**

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There are several contrasting views of species assembly and ecological succession in the literature. Neutral theory of species assembly suggest that species assembly is a stochastic process and it is governed by dispersal processes and stochastic fluctuations in established populations. Another approach suggests that community assembly is determined by functional trait filtering governed by more or less predictable abiotic and biotic filtering processes selecting species from the available local species pool. We analysed functional diversity patterns using vegetative and regenerative traits in four replicates (sites) using 20 permanent plots (4m<sup>2</sup> each) during the first 12 years of secondary succession after heavy goose grazing in a sand area in Hungary. We addressed the following hypotheses using trait-based analyses: (i) At the beginning of succession we expected high fluctuations in the trait values. (ii) Various temporal patterns are expected in functional diversity of regenerative and vegetative traits. Our findings suggest that the first few years' vegetation development can be explained by the trait neutral theory of vegetation development. This was diminished later on, and an effect of filtering was detected. There were convergent change of some traits like clonal spreading, plant height, leaf area, terminal velocity, or pollination types in sites with similar vertical but different topographical position. Our findings weekly supported the second hypothesis, while there were some distinct patterns found for the functional richness of vegetative and regenerative traits. For functional divergence and evenness no clear distinctive pattern was detected. For both vegetative and regenerative trait groups an overall increase in functional divergence was detected. The increase in functional divergence usually considered as a signal of increased niche differentiation and increased rate of competition.

### **S-18.3**

#### **How objectively do we interpret plant traits?**