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Landscape context, ecosystem engineering, and factors influencing grassland biodiversity

Remnant grassland fragments are usually restricted to places unsuitable for agricultural cultivation. Embedded in the heavily transformed landscapes kurgans often serve as refuges for rare and endangered plant species. Our findings revealed that the activity of ecosystem engineering species increases local environmental heterogeneity of dry grasslands by disturbance. Ecosystem engineering species created microhabitats by changing the soil nutrient availability and reducing total vegetation and litter cover. Several grassland specialist species, mostly grasses established in the newly created microhabitats, although the cover of noxious species was also considerable. Thus, we demonstrated that kurgans has a crucial role in preserving the diversity and restoration potential of grassland ecosystems.

In the Palaearctic steppe zone overgrazing was regarded as one of the key drivers of declining grassland biodiversity, which underlines the necessity of the functional evaluation of increased grazing pressure on grassland vegetation. In biodiversity conservation of agriculture-driven landscapes grasslands have an outstanding importance; their conservation became a top priority. In many regions, sheep or cattle grazing are the best options for biodiversity conservation. We found lower taxonomic and functional diversity, and lower cover of forbs in sheep-grazed steppes compared with cattle-grazed ones. Grazing intensity had a significant effect only on species richness, while on Shannon diversity and evenness, only livestock type had a significant effect. While most single trait indices were affected by the type of the grazer, significant effect of intensity was detected only in few cases. These findings indicated that the selection of the livestock type is the most crucial in conservation; however, for proper ecosystem functioning and high trait variability, the suitable grazing intensity should also be carefully adjusted.

To maintain the desirable ecological value of ecosystems it is necessary to manage them in a way which maintains their structure and their long-term functioning. In the European grasslands extensive grazing plays a crucial role in biomass removal; thus it prevents both litter accumulation and shrub encroachment. These are the main threatening factors for grasslands. Defoliation and biomass removal are among the most important effects of grazing on vegetation. We explored the direct effects of grazing on the main biomass fractions (litter, moss, forbs and graminoids). We found that the reduction of the live biomass of vascular plants was considerable, while the consumption of the litter and moss biomass was negligible. Grazing also significantly decreased the flowering success of plants. Based on our observations it is recommended to use grazing in a mosaic spatial and temporal pattern. Studying sustainable rangeland utilization we demonstrated that the effects of cattle grazing on habitat conservation values and forage quality depend on the grazing breed, because breeds differ in selectivity, body size and trampling effect.

Agricultural intensification has resulted in severe declines in the extent and diversity of seminatural habitats in Europe. We compared the diversity patterns of secondary dry and wet grasslands on river embankments with those of seminatural dry and wet grasslands. The cover of generalist species, cosmopolitan species, weeds and nonindigenous plant species were high in the secondary grasslands. We also found significant differences in phylogenetic diversity between the secondary and seminatural grasslands: secondary grasslands showed significantly lower mean nearest taxon distances than the seminatural grasslands. We found higher community-weighted means of specific leaf area, plant height and flowering period in the secondary grasslands, which are related to important ecosystem services via biomass production and pollination.

Disturbance induced dynamics, and functional responses

Urbanization causes considerable alteration across a wide range of ecosystem functions at regional and global scales. These changes are key drivers of habitat stability and ecosystem services in urban greenspaces. We studied predator spiders, polyphagous rove beetles, and decomposer woodlice along a rural-suburban-urban gradient. We pointed out that trophic levels may be a crucial driver of the responses to urbanization. Our findings suggest that urbanization has a less harmful effect on predator spiders, as they can easily recolonize the managed urban greenspaces. However, the recolonization of arthropods at lower trophic levels (rove beetles and woodlice) into the urban habitats is considerably restricted.

Even in urban parks ticks are frequently causing serious infections transmitting diverse microbial assemblage including bacteria, virus, and fungi. In this study we explored taxonomic and functional profiles of bacterial assemblage of Ixodes ricinus nymphs and females. We found by taxonomic profiling that diversity was higher in nymph than in female ticks. We recognized a remarkable difference in the composition of bacterial assemblages between the life stages. Functional annotations revealed higher metabolic activities of bacterial assemblage in nymph compared to females. We found that changes in environment, and in host conditions after metamorphosis cause a shift in bacterial assemblage of ticks influencing both the metabolic activity and the pathogen occurrence within ticks.

Novel ecosystems formed by invasive plants provide an excellent opportunity to get insight into early dynamics and pattern formation of new ecosystems. The invasive black locust as host plant, and Bruchophagus robiniae as host-specific seed predator, and its parasitoids were the components of the studied tritrophic system. We found that in the studied new ecosystem the top-down control was strengthened by the disturbance. Since the host plant of the tritrophic system is an invasive species, partial habitat disturbance of such species may increase the severity of parasitoid top-down control, which may reduce seed predation by the herbivores.

Urban health, trace elements, bioindication and remediation

Monitoring air pollution and environmental health are crucial to ensure viable cities. We

assessed the usefulness of Air Pollution Tolerance Index (APTI) as a composite index of environmental health. We found that fine and coarse dust and elemental concentrations of *Celtis occidentalis* and *Tilia europaea* leaves were correlated between APTI values. Fine dust, total chlorophyll, and elemental concentrations were the most sensitive indicators of pollution. Based on the high chlorophyll and low elemental concentration of tree leaves, the rural site was the least disturbed by anthropogenic activities. We demonstrated that fine and coarse dust amount and elemental concentrations of urban tree leaves are especially useful for urban air quality monitoring. Our findings suggest that APTI is an especially useful proxy measure of air pollution, as well as environmental health. During a meta-analysis we compared APTI values among various global cities and land use types (industrial, roadside, and urban area). We demonstrated that APTI is an efficient tool in air pollution monitoring and in decision making during urban development and urban greening.

We assessed the remediation potential of two weed species (*Chenopodium album* and *Tripleurospermum inodorum*) in a moderately metal-contaminated area. Metal concentrations were studied in roots, stems and leaves to assess correlations in metal concentrations between those in soil and plants. We also calculated bioaccumulation factor (BAF), bioconcentration factor (BCF) and translocation factor (TF) values to estimate the accumulation of metals from soil to plants and translocation within plants. We found correlation in metal concentrations between soil and plants. The metal accumulation potential was low in both species, indicating low BAF and BCF values. In contrast, high TF values were found for Mn, Ni, Sr, Zn, Ba, Fe, Cu and Pb in C. album, and for Fe, Mn, Ni, Zn and Sr in *T. inodorum*. Our results demonstrated that the potential of these species might be limited in phytoextraction processes; however, when accumulated, metals are successfully transported to aboveground plant organs. Thus, to achieve the efficient remediation of metal-contaminated soils, removal of the aboveground plant organs is recommended, by which soil disturbance can also be avoided.

Survival of organisms in polluted habitats is a key factor regarding their long-term population persistence. To avoid harmful physiological effects of pollutants' accumulation in organisms, decontamination and excretion could be effective mechanisms. Among invertebrates, ground beetles are reliable indicators of environmental pollution. Using ground beetles as model organisms, we tested our pollution intensity-dependent disposal hypothesis for five pollutants (Cd, Cu, Mn, Pb, and Zn) among four soil pollution intensity levels (low, moderate, high, and extreme) by categorical meta-analysis. According to our hypothesis, decontamination and excretion of pollutants in ground beetles are effective in lowly or moderately polluted habitats, while disposal is ineffective in highly or extremely polluted ones, contributing to intense accumulation of pollutants in ground beetles. In accordance with the hypothesis, we found that in an extremely polluted habitat, accumulation of Cd and Pb in ground beetles was significantly higher than in lowly polluted ones. These findings may suggest the entomo-remediation potential of ground beetles in an extremely polluted environment.

To explore ecosystem health we tested the usefulness of exuviae as an environmentally friendly method for exploring the variability of the trace element contents of protected insect populations without killing specimens. It is a notable characteristic of dragonflies that they are good ecological indicators for both aquatic and terrestrial habitat quality. Thus, we

investigated the trace element accumulation in different stages of dragonflies: larva, exuvia, and adult. We used microwave plasma atomic emission spectrometry (MP-AES). We found that the trace element contents of exuviae are a good proxy of the trace element contents of both the larvae and the adults. We conclude that exuvia is useful for assessing the environmental health of aquatic ecosystems. It is an environmentally friendly method and it can be used even in the case of protected dragonfly species