Losing diversity with abandonment: does identity of dominant species matter? Evidence from species-rich hay meadows of the Carpathian Mountains

Anna Mária Csergő[1,2], László Demeter[2] and Roy Turkington[1]

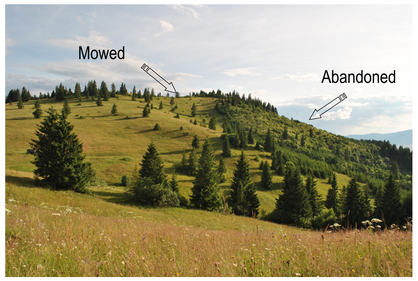
[1]University of British Columbia, Department of Botany and Biodiversity Research Centre, [2]Sapientia Hungarian University of Transylvania, Romania

Background & Questions

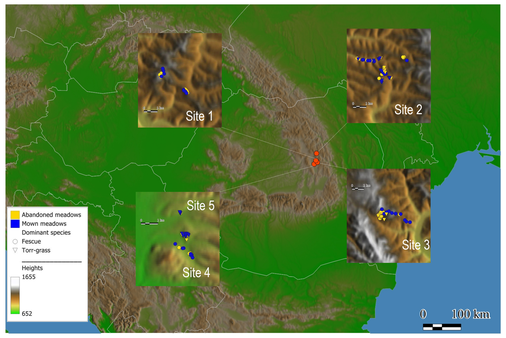
There has been an enormous loss of biodiversity in meadows in the Carpathian Mountains that historically were mowed using traditional haymaking methods and have been subsequently abandoned in recent years (Taff et al. 2010). Much effort is being made to understand biodiversity maintenance processes in mowed meadows and species depletion mechanisms following abandonment (Aavik et al. 2008).

Questions:

- Are changes in diversity determined by abandonment rather than by the meadow type?
- Does abandonment affect differentially the abundance of dominant species of meadows? If so, how does that affect species diversity?



Methods



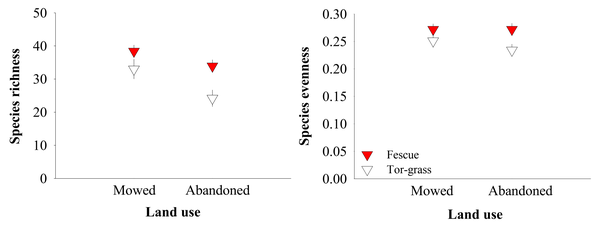
The Carpathian Mountains in Southeastern Europe, the study sites and 1 m² subplots within each site.

Species diversity: species richness (number of species/m² subplot) and species evenness (E_{var}, Smith and Wilson 1996).

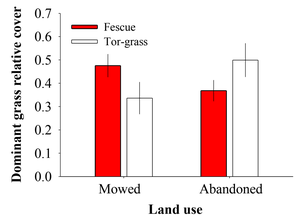
Question 1: Two-way ANOVA: dependent variable = species richness, species evenness; factor 1 = land use (mowed, abandoned); factor 2 = dominant species (fescue, tor-grass). ANCOVA (with elevation and potential incident solar radiation).

Question 2: One-way ANOVA: dependent variable = dominant species cover; factor = land use (mowed, abandoned). ANCOVA (with elevation and slope). Multiple linear regressions and partial regressions: dependent variable = species richness, regressors = dominant species cover, elevation, slope.

Results

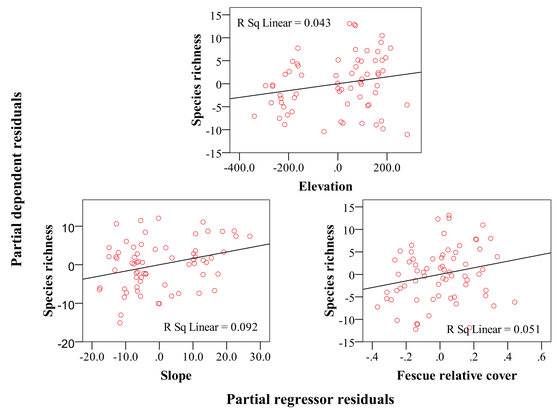


Abandonment resulted in lower species richness and species evenness of tor-grass than fescue meadows ($p < 0.032$). When mowed, the diversity of the two meadow types differed less ($p < 0.201$) (lsmeans ± 1 SE). ANCOVA for species richness: $F_{[16,111,0.05]} = 9.53$, $p<0.001$ and ANOVA for species evenness: $F_{[14,113,0.05]} = 2.36$, $p = 0.007$.



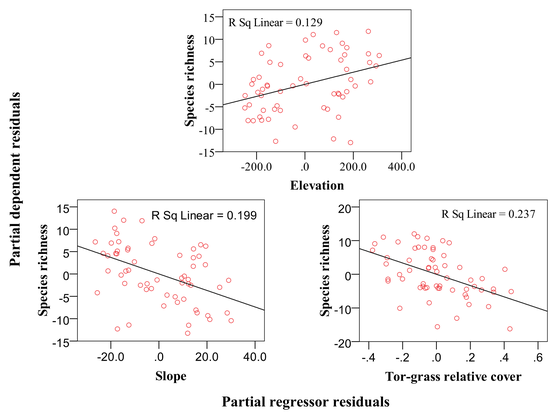
The relative cover of tor-grass generally tended to be higher, and that of fescue to be lower in abandoned plots, yet changes were not consistent across localities ($p<0.245$) (lsmeans ± 1 SE). ANOVA $F_{tor\text{-}grass[5,\ 46,\ 0.05]} = 4.51$, $p = 0.002$ and $F_{fescue[7,\ 59,\ 0.05]} = 3.08$, $p=0.008$.

Species richness = 22.382**** + 0.007 × Elevation# + 0.165 × Slope* + 7.319 × Fescue relative cover# ($R^2 = 0.166^{**}$)



Species richness increased with elevation, slope and relative cover of fescue (partial regressions, $p<0.01$). Symbols represent significance levels: #p<0.1, *p<0.05, **p<0.01, ***p<0.001.

Species richness = 28.803*** + 0.014 × Elevation** – 0.185 × Slope*** – 16.757 × Tor-grass relative cover*** ($R^2 = 0.497^{***}$)



Species richness increased with elevation and decreased with slope and relative cover of tor-grass (partial regressions, $p<0.01$). Symbols represent significance levels: **p<0.01, ***p<0.001.

Mowing with a scythe: the first step of traditional haymaking in the Carpathian Mountains (Romania)

Species rich mountain hay meadow (50 vascular plants / m²)

Discussion

- Mowing maintains high and comparable levels of diversity in different types of grasslands. It increases abundance of disturbance-tolerant, less aggressive dominant species (fescue) and decreases that of aggressive, stress-tolerant dominant species (tor-grass).

- In abandoned meadows, the less aggressive dominant species decrease abundance while only few better competitors gain cover, and species loss rate is slow. Dominants which are aggressive competitors reach even higher dominance and eliminate subordinate species, with a subsequent high diversity loss.

- Abiotic conditions are additional determinants of diversity. Higher elevation meadows were more diverse because of more endemic, forest and acidophilous species. Moderately steep slopes added xero-termophilous species to both meadow types, but the steepest ones filtered out mezophilous species from the tor-grass meadows.

Conclusions

Identity and abundance of the dominant species of grasslands is critical for species depletion rate following abandonment. Abiotic conditions may result in different diversity patterns depending on the type of meadow being managed. Traditional land use practices are vital for maintaining high levels of plant diversity in grasslands of the Carpathian Mountains.

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