M U N I

COMMENTARY TO HABILITATION THESIS[1]

A coexistence hotspot. From the extremely species-rich White Carpathian meadows towards the peri-Carpathian forest-steppe

Mgr. Jan Roleček, Ph.D.

The meadows of the White Carpathians have long been known as an extremely species-rich plant community and a natural phenomenon of international importance. Some of the specific features of the peri-Carpathian forest-steppe meadows, such as the frequent occurrence of otherwise rare species with disjunct distributions, are difficult to explain through fine-scale processes, thus we focused on the understudied large-scale aspects. In our initial studies we raised a hypothesis about the specific history and continuity of these grasslands on Holocene time scale. Further we focused on three main aspects of the peri-Carpathian forest-steppe meadows: i) species composition, its variability and relationship to other steppe vegetation types in Central and Eastern Europe; ii) extreme species richness of stands in landscape and biogeographical context; and iii) origin and dynamics on palaeoecological time scale.

The methods of species composition analysis involved vegetation sampling, database retrieval, analysis of similarity in species composition and vegetation classification, analysis of indicator, constant and dominant species, analysis of ecological species groups and ordination analysis. The analysis of extreme species richness was based on vegetation sampling, sampling of permanent plots, database and literature retrieval. The analysis of origin and dynamics on palaeoecological time scale was based on analysis of composition and diversity of fossil pollen, analysis of macroremains, soil charcoal, microcharcoal, pedological analysis, elemental analysis of fen sediments, radiometric analysis, analysis of species distributions and composition, analysis of archaeological data, genetic analysis and literature retrieval.

Our results show that although some authors considered the meadows of the White Carpathians unique, they are not unique in the geographical sense. The core of their species composition is the *Brachypodio pinnati-Molinietum arundinaceae* association, whose distribution has been documented on the margins of the Western and Eastern Carpathians and in some adjacent regions. Admittedly, the association is absent in large areas and rare elsewhere. Its most characteristic species include *Brachypodium pinnatum*, *Carex montana*, *Crepis praemorsa*, *Potentilla alba* and *Pulmonaria mollis* s.lat. Due to its distribution and the considerable representation of forest-steppe species, we refer to it as peri-Carpathian forest-steppe meadows. Our results also confirm that it is the most species-rich vegetation on plots sized 10–16 m^2 known worldwide, with up to 115 vascular plant species per 10 m^2 and 119 per 16 m^2. The causes of their extreme species richness are not yet fully understood, but it is clear that they are complex and factors operating at different spatial and temporal scales play a role. Peri-Carpathian forest-steppe meadows are part of habitat mosaics that we refer to as

[1] The commentary must correspond to standard expectations in the field and must include a brief characteristic of the investigated matter, objectives of the work, employed methodologies, obtained results and, in case of co-authored works, a passage characterising the applicant's contribution in terms of both quality and content.

peri-Carpathian forest-steppe. It is a non-equilibrium forest-steppe that is maintained in a non-forest state despite a climate suitable for forest vegetation due to periodic disturbances. At the same time, it is a relict forest-steppe, as light-demanding species have persisted here for millennia, in some places probably throughout the Holocene. They likely originate from the Late Glacial and Early Holocene hemiboreal forests, whose inherited large species pool may contribute to the species richness of the present-day forest-steppe meadows. These features place the peri-Carpathian forest-steppe in a group of specific non-forest ecosystems, scattered all over our planet, whose rich biodiversity is underpinned by the long-term continuity of non-forest habitats enabled by disturbance. Their loose analogy with collapsed Pleistocene ecosystems, whose openness was maintained by grazing of large herbivores and fire, is also suggested.

I have included 16 research papers related to the topic of the habilitation thesis. Their list and description of my contribution is included below.

Variability of steppe vegetation

[1][2] **Roleček, J.**, Hájek, M., Dřevojan, P., Prokešová, H., Fajmon, K., Těšitel, J., Daněk, P., Hájková, P., Jongepierová, I., Novák, P., Poluyanov, A. V., Shumska, N. V., & Chorney, I. I. (2019). Gradients, species richness and biogeographical links of steppe grasslands in Western Podolia (Ukraine). *Phytocoenologia*, *49*, 349-367.

Contribution: First and corresponding author, lead conceptualization, methodology design, data analysis, interpretation of the results, manuscript writing and editing, contributed to data acquisition. Total contribution approximately 60%.

[2] Willner, W., **Roleček, J.**, Korolyuk, A., Dengler, J., Chytrý, M., Janišová, M., Lengyel, A., Aćić, S., Becker, T., Ćuk, M., Demina, O., Jandt, U., Kącki, Z., Kuzemko, A., Kropf, M., Lebedeva, M., Semenishchenkov, Yu., Šilc, U., Stančić, Z., Staudinger, M., Vassilev, K., & Yamalov, S. (2019). Formalized classification of semi-dry grasslands in central and eastern Europe. *Preslia*, *91*(1), 25-49.

Contribution: Second author, contributed to data acquisition, data analysis, interpretation of the results and manuscript writing. Total contribution approximately 20%.

[3] Roleček J., Dřevojan P., Iakushenko D. & Hájek M. 2022: Tall herb-rich steppe in the peri-Carpathian region of Ukraine and Romania. *Phytocoenologia* 51: 95–109.

Contribution: First and corresponding author, lead conceptualization, methodology design, data analysis, interpretation of the results, manuscript writing and editing, contributed to data acquisition, project administration and funding acquisition. Total contribution approximately 60%.

[2] Bibliographic record of a published scientific result, which is part of the habilitation thesis.

Extreme species richness

[4] Roleček J., Čornej I. I. & Tokarjuk A. I. 2014: Understanding the extreme species richness of semi-dry grasslands in east-central Europe: a comparative approach. *Preslia* 86: 5–27.

Contribution: First and corresponding author, lead conceptualization, methodology design, data analysis, interpretation of the results, manuscript writing and editing and funding acquisition, contributed to data acquisition. Total contribution approximately 80%.

[5] Roleček J., Dřevojan P., Hájková P., & Hájek M. 2019: Report of new maxima of fine-scale vascular plant species richness recorded in East-Central European semi-dry grasslands. *Tuexenia* 39: 423–431.

Contribution: First and corresponding author, lead data analysis, interpretation of the results, manuscript writing and editing, co-lead conceptualization and methodology design, contributed to data acquisition. Total contribution approximately 40%.

[6] Hájek M., Hájková P. & **Roleček J.** 2020: A novel dataset of permanent plots in extremely species-rich temperate grasslands. *Folia Geobotanica* 55: 257–268.

Contribution: Senior author, co-lead conceptualization, methodology design and funding acquisition, contributed to data acquisition, manuscript writing and editing. Total contribution approximately 15%.

[7] Roleček J., Dřevojan P., Hájková P., Goia I. & Hájek M. 2021: Update on maxima of fine-scale vascular plant species richness in a Transylvanian steppe meadow. *Tuexenia* 41: 459–466.

Contribution: First and corresponding author, lead data analysis, manuscript writing and editing, co-lead conceptualization, methodology design and interpretation of the results, contributed to data acquisition. Total contribution approximately 35%.

History and palaeoecology of the Central European forest-steppe

[8] Hájková P., **Roleček J.**, Hájek M., Horsák M., Fajmon K., Polák M. & Jamrichová E. 2011: Prehistoric origin of the extremely species-rich semi-dry grasslands in the Bílé Karpaty Mts (Czech Republic and Slovakia). *Preslia* 83: 185–204.

Contribution: Second author, co-lead conceptualization, interpretation of the results, manuscript writing and editing, contributed to data acquisition. Total contribution approximately 30%.

[9] Roleček J., Hájek M., Karlík P. & Novák J. 2015: Reliktní vegetace na mezických stanovištích [Relict vegetation on mesic sites]. *Zprávy České botanické společnosti* 50: 201–245.

Contribution: First and corresponding author, lead manuscript writing and editing, co-lead conceptualization, methodology design, data analysis, interpretation of the results, contributed to data acquisition. Total contribution approximately 50%.

[10] Hájek M., Dudová L., Hájková P., **Roleček J.**, Moutelíková J., Jamrichová E. & Horsák M. 2016: Contrasting Holocene environmental histories may explain patterns of species richness and rarity in a Central European landscape. *Quaternary Science Reviews* 133: 48–61.

Contribution: Co-author, co-lead conceptualization, contributed to interpretation of the results, manuscript writing and editing. Total contribution approximately 15%.

[11] Těšitel J., Vratislavská M., Novák P., Chorney I. I. & **Roleček J.** 2018: Merging of *Pedicularis exaltata* and *P. hacquetii* in the Carpathians: from local history to regional phylogeography based on complex evidence. *Folia Geobotanica* 53: 301–315.

Contribution: Senior author, contributed to conceptualization, methodology design, data acquisition, data analysis, interpretation of the results, manuscript writing and editing. Total contribution approximately 25%.

[12] Novák J., **Roleček J.**, Dresler P. & Hájek M. 2019: Soil charcoal elucidates the role of humans in the development of landscape of extreme biodiversity. *Land Degradation & Development* 30: 1607–1619.

Contribution: Second and corresponding author, lead manuscript writing and editing, co-lead conceptualization, data analysis, interpretation of the results, contributed to data acquisition. Total contribution approximately 30%.

[13] Roleček J., Dřevojan P. & Šmarda P. 2019: First record of *Festuca amethystina* L. from the Transylvanian Basin (Romania). *Contributii Botanice* 54: 91–97.

Contribution: First and corresponding author, lead conceptualization, manuscript writing and editing, co-lead methodology design, data analysis, interpretation of the results, contributed to data acquisition. Total contribution approximately 50%.

[14] Roleček, J., Abraham, V., Vild, O., Svobodová Svitavská, H., Jamrichová, E., Plesková, Z., Pokorný, P., & Kuneš, P. (2021). Holocene plant diversity dynamics show a distinct biogeographical pattern in temperate Europe. *Journal of Biogeography*, *48*, 1366-1376.

Contribution: First and corresponding author, lead manuscript writing and editing, co-lead conceptualization, methodology design, data analysis, interpretation of the results and funding acquisition, contributed to data acquisition. Total contribution approximately 35%.

[15] Willner, W., Moser, D., Plenk, K., Aćić, S., Demina, O. N., Höhn, M., Kuzemko, A., **Roleček, J.**, Vassilev, K., Vynokurov, D. & Kropf, M. (2021). Long-term continuity of steppe grasslands in eastern Central Europe: Evidence from species distribution patterns and chloroplast haplotypes. *Journal of Biogeography*, *48*, 3104-3117.

Contribution: Co-author, contributed to conceptualization, data acquisition, interpretation of the results, writing and funding acquisition. Total contribution approximately 10%.

[16] Hájková P., Petr L., Horsák M., Jamrichová E. & **Roleček J.** 2022: Holocene history of the landscape at the biogeographical and cultural crossroads between Central and Eastern Europe (Western Podillia, Ukraine). *Quaternary Science Reviews* 288: 107610.

Contribution: Senior author, lead funding acquisition, co-lead conceptualization, methodology design, interpretation of the results, manuscript writing and editing, contributed to data acquisition and analysis. Total contribution approximately 30%.