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**A neonative plant species in Romania:
traits, impact and dynamics of
Xeranthemum cylindraceum Sm.
in temperate grasslands
– PhD THESIS SUMMARY –**

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Summary of the thesis

Chapter I. - Introduction

Species are shifting their distributions across the globe as a consequence of recent environmental changes. The global redistribution of species can result in novel biotic communities and changes in ecosystem functioning, with impacts also on human well-being. The response of species to environmental changes and consequences of redistribution are difficult to predict, thus studies focusing on range-expanding species are needed to improve further projections.

Neonative species, by definition, are native species that expand their native range tracking human-induced environmental changes, colonizing disturbed habitats, such as those affected by climate change, pollution, eutrophication, or altered land use. Drivers and impacts of range-expanding species on newly inhabited ecosystems are not well understood. Evidence suggests that expanding native species can have similar negative impacts on plant communities as invasive species. Thus, case studies addressing species traits, potential drivers of expansion, the impact of these species on the recipient ecosystems, along with monitoring programs would improve further projections and the theoretical background of range-expanding species.

Chapter II. - Drivers and mechanisms behind range-expansion: methodological concerns

While it is important to be cautious when applying concepts from invasion ecology to range-expanding native species – particularly in terms of their perception in conservation policy, and in legal frameworks – the invasion literature still provides valuable foundations for understanding this group of species. The impact of range-expanding native species in many cases can be analogous to that of invasive species, as factors influencing the invasibility of alien species can be responsible for the spread success of native species too (i.e. propagule pressure, the resistance of recipient communities, and disturbances affecting ecosystems). For this reason, it is worth drawing on the theories and findings of invasion ecology.

In this chapter, after a methodological overview we present the application of specific methods of invasion ecology on an invasive species, *Gaillardia aristata*. Further, we present how can be these methods applied on the neonative species *Xeranthemum cylindraceum*, which has started to expand its range in Romania.

Chapter III. - Ecological attributes promoting intra-continental range-expansion of a native annual forb triggered by intensified land-use

Intra-continental range-expansion of native species tracking human-induced environmental changes has become an important phenomenon, and recently has been suggested to be recognized as a distinct biogeographic category, namely neonative. However, it remains difficult to analyze how range-expansions are triggered by certain environmental changes and which biological and ecological species attributes are involved. We compared biological and ecological attributes and the performance in different test environments during the entire life cycle of a range-expanding neonative in Romania, *Xeranthemum cylindraceum*, with a congeneric resident native, *X. annuum*, through a series of controlled experiments.

Both species proved to share several biological and ecological attributes, e.g. high potential for long-distance dispersal by multiple vectors, biochemical defence against herbivores by means of cyanogenic compounds, and surprisingly, they were found to have similar germination and performance niches throughout the range of climatic environments tested by us. Differences between the two species, a broader climatic and habitat niche, higher germination rate and viability of seeds can give explanation to the successful spread beyond the historical range of *X. cylindraceum*. However, based on shared biological attributes between the two species, which confer the potential to spread, and the considerably higher seed output found in the case of the resident native, *X. annuum* is equally prepared to expand its range. With changing climate and persisting human-induced disturbance, in this case intensive grazing by sheep, we may expect the spread of this species after passing the presumed migration lag phase.

Chapter IV. - In the footsteps of sheep herds: smooth integration of a neonative plant species into pastures of the new range

Intra-continental range-expansion of organisms is expected to be more and more frequent due to anthropogenic climate- and land-use changes, but its impact on recipient ecosystems and consequences to nature conservation or economy are not well understood. Our study focuses on a range-expanding neonative plant species, *Xeranthemum cylindraceum*, with an accentuated occurrence in pastures. We aimed to assess the potential negative impact of this species on recipient grassland communities in the new range, and to compare its behaviour between the native and neonative range. In order to treat mass effect, we surveyed plots from very low to very high abundances of the target species in grassland stands.

Our results show that species richness and diversity does not decrease in the presence and neither with the increasing abundance of *X. cylindraceum* in recipient grasslands. Cover of

specialist and long-lived species was lower, while that of ruderal and short-lived species higher in vegetation patches with medium to high *X. cylindraceum* abundance. In the neonative range, this pattern overlapped with an increased disturbance severity and soil nitrogen content indicated by community composition, which bears clear signs of an external factor forcefully transforming plant composition and causing ruderalisation. We conclude that the range-expanding *X. cylindraceum* does not raise conservation problems, since it is not impacting recipient grassland communities in its neonative range, but taking advantage of grazing disturbance. As a toxic, unpalatable species, it decreases the economic value of intensively used grasslands, pointing out the need for decreasing stocking rates in intensively used pastures.

Chapter V. - Population dynamics of a neonative plant species in the context of land-use and fluctuating weather

Human-induced environmental changes have accelerated the redistribution of species worldwide. The range-expansion of species results in altered community structures, with mechanisms and consequences that are still poorly understood. We monitored the population dynamics of a Mediterranean-origin neonative plant species, *Xeranthemum cylindraceum* in its new area over a four-year period to assess its integration into recipient disturbed semi-dry plant communities and to understand the drivers behind its population dynamics. We hypothesized that (1) the intensity of grazing disturbance is responsible for changes in the abundance of the target species; (2) *X. cylindraceum*, being a Mediterranean-origin species, can resist dry summers, and the survival of its seedlings is facilitated by mild winters; (3) between year fluctuations in climatic conditions have a smaller influence on the abundance of *X. cylindraceum* compared to resident species of its guild (short-lived, forb and generalist species). For these purposes, we used permanent plot method in grasslands inhabited by the focal species in Central Romania.

X. cylindraceum, had high abundance in the first year of the study, but its abundance decreased significantly in the following year, and it remained low in the subsequent years. While its decrease in abundance can strongly be linked to drought, its slow recovery after the dry year may be due to the trampling impact of grazing animals on the species' seedlings or to the low seed availability and lack of seedbank. Resident species of the same guild showed a remarkable regeneration after the dry year, while *X. cylindraceum* was unable to recover in the following years, indicating that a single dry year can have long-lasting suppressive effect on this species' abundance.

Chapter VI. - Assessing plant species in their new range

In this chapter we revised the applied methods on invasive species *G. aristata* and the obtained results. Methods of invasion ecology adapted to the neonative *X. cylindraceum* allowed us to compare the two successfully expanding species. Based on our knowledge, our study series on *X. cylindraceum* is the first to explore the biological and ecological attributes, behaviour and the impact on recipient plant communities of a range-expanding native (neonative) plant species.

List of publications included in the thesis

Ruprecht, E., Essl, F., Moř, C.A., Balaji, B., Kuhn, T., Fenesi, A, Mardari C., **Miholcsa, Z.**, 2024. Ecological attributes promoting intra-continental range-expansion of a native annual forb triggered by intensified land-use. *Flora*, 310. <https://doi.org/10.1016/j.flora.2023.152416> [Q2, Web of Science JIF: 1.7]

Süle, G., **Miholcsa, Z.**, Molnár, C., Kovács-Hostyánszki, A., Fenesi, A., Bauer, N., & Szigeti, V., 2023. Escape from the garden: spreading, effects and traits of a new risky invasive ornamental plant (*Gaillardia aristata* Pursh). *NeoBiota*, 83: 43–69. <https://doi.org/10.3897/neobiota.83.97325> [Q1, Web of Science JIF: 3.8]

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