



**Research on the ecology of plant ecosystems:
from community diversity to species functional traits and landscape
dynamics**

**SUMMARY
OF THE HABILITATION THESIS**

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This habilitation thesis summarizes the scientific, academic, and professional achievements of Dr. Pavel Dan Turtureanu, from the completion of his PhD to the present (2025). His research lies within the field of vegetation ecology across multiple spatial scales, at the interface between community diversity, intraspecific functional trait variability, and landscape dynamics in mountain ecosystems under changing land-use regimes. The thesis integrates original results published in international Web of Science-indexed journals and outlines the author's contributions to understanding how plant ecosystems respond to environmental gradients, from micro-habitat to regional scales.

The central part of the thesis is structured around **three main scientific directions**: (1) the organization of fine-scale plant diversity in herbaceous ecosystems, (2) the intraspecific variability of functional traits in dominant mountain (alpine) plant species, and (3) mountain landscape dynamics, with emphasis on the greening process and shrub expansion in the Carpathians as revealed by remote sensing.

1. Fine-scale diversity in forest-opening and grassland herbaceous communities

The first thematic domain addressed in the thesis examines how α and β plant diversity are structured at fine spatial scales in forest gaps and hilly grasslands of Transylvania. The scientific investigations led to several central findings:

- In the forest clearings of the Trascău Mountains (Apuseni), species richness and components of β -diversity respond differently to canopy openness, litter cover, and microrelief, highlighting the need to use multiple diversity metrics simultaneously to better understand community assembly processes.
- Dry grasslands (xero- and xero-mesophilous) of the Transylvanian Plateau reach exceptionally high diversity at small spatial grains, and species-area relationships as well as environmental effects are strongly scale- and taxon-dependent (vascular plants, bryophytes, lichens). These results emphasize the role of agro-pastoral practices in maintaining this remarkable plant diversity.

Accordingly, this line of research has contributed to demonstrating the importance of secondary vegetation patches (forest openings, semi-natural grasslands) for landscape-level biodiversity, providing recommendations for grazing management and selective silvicultural interventions aimed at conserving species typical of forest edges and dry grasslands in these regions.

2. Intraspecific variability of functional traits

The second major direction extends the analysis from community level to population level across a European biogeographical gradient, through studies on intraspecific variability of functional traits (ITV) in dominant subalpine and alpine species. The main findings of these analyses are:

- For *Nardus stricta*, a very high level of ITV was identified at the local scale, as well as a strong sensitivity of functional traits to the duration of the growing season, suggesting a fine ecological adjustment to mountain microclimatic conditions.
- In *Carex curvula*, analyses of morphological and anatomical traits were integrated with the genetic structure of populations, revealing distinct functional groups, particularly in marginal populations, associated with tolerance to summer drought stress. The study showed that marginal populations may maintain high ITV even under reduced genetic diversity, contradicting classical predictions of the central–marginal model and underscoring the role of ITV in the adaptive capacity of alpine populations facing climate change.

Overall, research within this direction demonstrates that intraspecific variability is a key component of the ecological plasticity of alpine species, significantly contributing to their ability to adapt to climatic constraints across the European geographical gradient.

3. Mountain landscape dynamics of the Carpathians revealed by remote sensing

The third research direction analyses mountain landscape transformations in the Carpathians by integrating multisatellite time series with detailed land-cover classifications. The analyses produced several essential results:

- Using four decades of Landsat time series combined with Sentinel-2-based land-cover classifications, it was estimated that more than 40% of mountain surfaces above 1500 m show significant positive NDVI trends, with the strongest signals associated with the expansion of shrublands dominated by Ericaceae and *Juniperus*.
- These greening trends were linked to the decline of grazing and broader land-use changes, corroborated by the interpretation of historical aerial imagery. The results reveal a clear relationship between pastoral management decline and ecological succession processes at the landscape scale.

Overall, this research direction shows that Carpathian greening is an extensive process strongly tied to recent shifts in land-use practices.

Beyond the scientific contributions, the thesis documents the development of an integrated academic profile centered around the “Alexandru Borza” Botanical Garden of Babeş-Bolyai University, where Dr. Turtureanu currently holds the position of Senior Researcher II. His professional trajectory spans from training in forest botany and phytosociology, through **postdoctoral stages in leading ecological research centers in Western Europe** (Hamburg, Grenoble), to the coordination of **competitive national research projects** (MEMOIRE, MUGO, GreenMount) and involvement as a **key member in biodiversity-focused Centres of Excellence**.

On the educational side, Dr. Turtureanu has developed and taught **master's and doctoral-level courses** on metacommunity ecology databases, biodiversity and climate-change assessment, remote sensing in ecology, and spatial data analysis in R, complemented by outreach activities and open educational resources (online tutorials). He **has supervised dissertation projects**, serves on doctoral advisory committees, participates actively in the **academic governance structures of**

UBB (Senate, thematic committees), and contributes to the organization of international conferences and workshops.

Looking ahead, Dr. Pavel Dan Turtureanu aims to consolidate within Babeş-Bolyai University a coherent line of training and research in ecology, centered on the integration of floristic and ecological databases, remote-sensing approaches, and dendroecology for investigating mountain ecosystem dynamics. The habilitation and assumption of the role of doctoral advisor naturally fit into this trajectory, with the goal of developing a research program in ecology capable of addressing the complexity of plant ecosystem responses to global change.

Dr. Pavel Dan Turtureanu