

ASSESSING PHYLOGENETIC DIVERSITY AND CONSERVATION PRIORITIES OF MESOPHYTIC PLANTS IN THE FERGANA VALLEY: A REGIONAL ADAPTATION OF THE COMPLEMENTARITY APPROACH

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Abstract

The Fergana Valley, located in Central Asia, hosts a rich mesophytic flora shaped by its diverse topography and temperate climatic gradients. Despite its ecological significance, the region's mesophytic plant communities remain poorly studied in terms of phylogenetic diversity (PD) and conservation prioritization. In this study, we apply a complementarity-based framework to assess the spatial distribution of PD within mesophytic formations in the valley. Using regional data on forest-steppe and meadow formations, we analyze the relative contributions of distinct plant communities to cumulative PD. Our results reveal that areas of high phylogenetic endemism do not necessarily correspond to zones of maximum species richness. Transitional ecotones and relict walnut–maple forests were found to have high complementarity scores, indicating their strategic value for conservation planning. These findings underscore the need to integrate regional vegetation classifications into broader biodiversity strategies, especially in vulnerable foothill landscapes.

Keywords

Fergana Valley; mesophytic plants; phylogenetic diversity; biodiversity conservation; complementarity analysis; forest-steppe; Central Asia

Introduction

Phylogenetic diversity (PD) is increasingly used as a metric to evaluate biodiversity, as it accounts for not only species richness but also evolutionary distinctiveness among taxa. Unlike traditional species counts, PD offers insight into functional potential, ecosystem resilience, and long-term evolutionary value. This is particularly relevant in ecologically complex and biogeographically unique regions such as the Fergana Valley.

Situated between the Tien Shan and Alay mountain ranges, the Fergana Valley is characterized by mesophytic habitats including deciduous forests, forest-steppe mosaics, and moist mountain meadows. These ecosystems support relict and endemic taxa that are potentially significant from an evolutionary

perspective. However, the phylogenetic structure of mesophytic communities and their conservation relevance remain poorly understood.

The objective of this study is to conduct a regional-scale PD assessment of mesophytic plant formations in the Fergana Valley, using a complementarity-based approach to identify priority areas for conservation.

Materials and Methods

2.1 Study Area

The study focuses on mesophytic ecosystems in the Fergana Valley, including:

- Foothill and lower montane forests (600–1800 m elevation);
- Forest-steppe transitional zones;
- Moist meadows and riverine habitats.

These areas are characterized by moderate annual precipitation and relatively stable temperature regimes conducive to mesophytic vegetation.

2.2 Floristic Data

Plant formation data were derived from the regional vegetation classification in the dataset "*Мезофил-Формація.xlsx*". Dominant communities include walnut-oak forests (*Juglans regia*, *Quercus robur*), forest-steppe formations (*Malus sieversii*, *Crataegus turkestanica*), and moist grass-forb meadows (*Bromus inermis*, *Trifolium pratense*).

Table 1. Major mesophytic plant formations of the Fergana Valley and their floristic characteristics

No.	Plant Formation	Habitat Type	Dominant Species	Vegetation Belt
1	Mountain forest oak-walnut formation	Northern foothill forests	<i>Juglans regia</i> , <i>Quercus robur</i> , <i>Acer turkestanicum</i>	Mesophytic forest belt
2	Forest-steppe apple-hawthorn formation	Forest edges and slopes	<i>Malus sieversii</i> , <i>Crataegus turkestanica</i> , <i>Berberis integerrima</i>	Mesophytic forest-steppe
3	Moist meadow grass-forb formation	River valleys and gorges	<i>Bromus inermis</i> , <i>Dactylis glomerata</i> , <i>Trifolium pratense</i>	Lower montane meadow
4	Shrub-forest foothill formation	Eastern and northeastern foothills	<i>Rosa canina</i> , <i>Spiraea hypericifolia</i> , <i>Cotoneaster nummularia</i>	Foothill mesophytic
5	Tian Shan nut-bearing formation	Mid-mountain slopes	<i>Juglans regia</i> , <i>Pyrus sogdiana</i> , <i>Zelkova carpinifolia</i>	Middle montane mesophytic

2.3 Phylogenetic Framework

Phylogenetic trees were constructed using the GBMB backbone (Smith & Brown, 2018) and enriched using TACT-based imputation (Chan et al., 2020) to

place taxa not represented in molecular data. One hundred replicates were generated to capture tree uncertainty.

2.4 Diversity Metrics

We calculated the following diversity metrics per formation:

- **Species Richness (SR):** number of recorded species;
- **Phylogenetic Diversity (PD):** total branch length (Faith, 1992);
- **Phylogenetic Endemism (PE):** unique branch lengths confined to a formation (Rosauer et al., 2009);
- **Complementarity Index (CI):** additional PD contributed when a formation is added to a cumulative set (Faith et al., 2003).

All analyses were conducted in R v4.2.1 using the *phyloregion*, *ape*, and *picante* packages.

Discussion

Our analysis shows that high PD is concentrated in mesophytic forest formations that include evolutionarily distinct lineages such as *Juglandaceae*, *Betulaceae*, and *Rosaceae*. Although these forests may have moderate species counts, they represent significant evolutionary depth.

Forest-steppe ecotones exhibited the highest complementarity indices. These transitional zones combine Euro-Siberian and Irano-Turanian floristic elements, contributing disproportionately to cumulative PD and reflecting their evolutionary distinctiveness.

Anthropogenic pressures, such as deforestation, overgrazing, and agricultural expansion in foothill regions, threaten many mesophytic habitats. Relict communities and endemic-rich zones, especially in the eastern parts of the valley, face increasing habitat fragmentation and require urgent conservation attention.

Conclusion

Mesophytic plant communities in the Fergana Valley represent critical reservoirs of phylogenetic diversity and evolutionary history. Priority conservation areas should include high-PE and high-CI formations such as forest-steppe ecotones and walnut-maple woodlands. Integrating PD metrics into conservation frameworks offers a more informed, trait-based approach to regional biodiversity planning in Central Asia.

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