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PAPER

WILD FLORA OF FERGANA CITY (UZBEKISTAN): A FLORISTIC ANALYSIS OF THE FAMILY BORAGINACEAE JUSS

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Abstract

This paper presents a comprehensive floristic analysis of the family Boraginaceae Juss. within the urban and peri-urban territories of Fergana City (Uzbekistan). A total of 22 wild species belonging to 11 genera were identified. Field studies, herbarium data, and records from international databases (GBIF, Plantarium, iNaturalist) were used to verify species presence. The life-form spectrum, ecological group composition, and dominant genera were analyzed. The results show that therophytes dominate (72 %), followed by chamaephytes (18 %) and hemicryptophytes (10 %). Xerophytes make up 45 % of the flora, mesophytes – 32 %, and ruderals – 23 %. The most species-rich genera are Heliotropium (5 species), Lappula (4), and Arnebia (3). These findings provide a baseline for understanding the ecological diversity of Boraginaceae species in Fergana and their adaptation to urban and semi-arid conditions.

Key words: Boraginaceae, Fergana City, Uzbekistan flora, wild species diversity, ecological adaptation, life-form spectrum, xerophytes, mesophytes, ruderals, Central Asia.

Introduction

The family Boraginaceae Juss. (commonly known as the borage or forget-me-not family) is one of the important families of angiosperms, comprising approximately 140 genera and more than 2,000 species distributed throughout the world, mainly in temperate and subtropical regions. The family is represented predominantly by herbaceous plants, although a number of subshrubs and small shrubs also occur. Morphologically, members of the family are characterized by alternate leaves, usually covered with rough, stiff trichomes, and by their distinctive scorpioid or helicoid cymes. Flowers are mostly actinomorphic, bisexual, with five-lobed corollas and a deeply divided ovary forming four nutlets in fruit. These features make Boraginaceae one of the most morphologically recognizable

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families among the eudicots.

Globally, Boraginaceae species play significant ecological roles as pioneer plants in dry and disturbed habitats. Many species are xerophytic, possessing adaptive traits such as reduced leaves, thickened cuticles, and dense indumentum that reduce transpiration. Several genera, including Heliotropium, Arnebia, Anchusa, and Nonea, are important indicators of arid and semi-arid ecosystems, often contributing to soil stabilization and pollinator support in degraded landscapes.

In Uzbekistan, the Boraginaceae family is well represented, with more than 100 species belonging to over 30 genera recorded across the country's diverse ecological zones—from the Kyzylkum Desert and Turanian steppes to foothill and montane areas of the Tien Shan and Gissar mountain ranges. The family is particularly abundant in semi-desert and foothill ecosystems, where species such as Heliotropium dasycarpum, Arnebia obovata, Lappula microcarpa, and Nonea caspica are common. The flora of Uzbekistan exhibits both cosmopolitan and regional endemic representatives of Boraginaceae, reflecting the country's complex biogeographic history.

Within the Fergana Valley, which is among the most densely populated and agriculturally developed regions of Central Asia, the Boraginaceae family constitutes a notable element of the steppe and ruderal flora. The valley's unique topography—surrounded by the Alay and Chatkal mountain systems and enclosed in a semi-arid basin—creates a mosaic of microclimates favoring both xerophytic desert species and mesophytic foothill taxa. In the Fergana Region, common genera include Heliotropium, Lappula, Arnebia, Rochelia, and Nonea, several of which display remarkable ecological plasticity and tolerance to human disturbance.

Despite the long botanical research tradition in Uzbekistan, urban floras, especially that of Fergana City, have received comparatively little scientific attention. Rapid urbanization, industrial development, and expansion of agricultural lands have caused significant habitat fragmentation and floristic homogenization in recent decades. However, remnants of natural and semi-natural vegetation persist along roadsides, canals, wastelands, and urban parks, providing valuable refuges for wild Boraginaceae species. These habitats are of increasing interest for urban ecology and biodiversity studies, as they demonstrate how native elements of steppe and desert floras adapt to anthropogenic environments.

This study therefore aims to provide a comprehensive floristic and ecological assessment of the family Boraginaceae within the boundaries of Fergana City, focusing exclusively on wild (non-cultivated) species. The main objectives are to:

Compile a verified list of wild Boraginaceae species recorded in the city;

Analyze their life-form structure according to the Raunkiaer system;

Characterize their ecological grouping (xerophytic, mesophytic, or ruderal); and

Evaluate the dominant genera and adaptation patterns of these species within urbanized semi-arid conditions.

By documenting the species composition and ecological distribution of Boraginaceae in Fergana City, this study contributes to a deeper understanding of urban floristic diversity in Uzbekistan and serves as a reference for future conservation and environmental monitoring programs in Central Asian cities.

Materials and Methods

Field investigations were carried out continuously between 2023 and 2025 within the administrative boundaries of Fergana City, located in the eastern part of the Fergana Valley (Uzbekistan). The study area lies at an altitude of approximately 430–480 m a.s.l. and is characterized by a continental climate with hot, dry summers and cool winters. Average annual precipitation is around 160–180 mm, most of which occurs during spring and early autumn. The natural vegetation has been heavily transformed by urbanization, but remnants of steppe, meadow-steppe, and ruderal communities still persist along roadsides, vacant lots, and irrigation channels.

Field sampling and herbarium materials

The field surveys were conducted systematically during the main vegetation periods (March–June and September–October) across various ecological zones of Fergana City – including urban green areas, peri-urban wastelands, industrial margins, roadside verges, and canal banks. Each

site was georeferenced using a Garmin GPSMAP 64s unit, and for each species, habitat characteristics, associated flora, soil type, and phenological state were recorded. Plant specimens were collected using standard botanical techniques, pressed in the field, and later dried under controlled conditions. All voucher specimens were deposited in the Herbarium of Fergana State University (FAFU) for long-term storage and verification.

Use of digital data sources

To complement the field observations, verified occurrence data of Boraginaceae species were retrieved from several international biodiversity databases, including the Global Biodiversity Information Facility (GBIF), Plantarium – Electronic Plant Atlas of Russia and Neighboring Countries, and iNaturalist. Each digital record was cross-checked for taxonomic accuracy, date of observation, and spatial reliability (restricted to coordinates within the Fergana City administrative limits). Duplicates and records with uncertain identification were excluded from analysis.

Taxonomic identification and nomenclature

Species identification followed regional floras and standard monographs of the family Boraginaceae. Nomenclature and synonymy were standardized according to Plants of the World Online (POWO, Royal Botanic Gardens, Kew) to ensure consistency with the current international taxonomy. For ambiguous taxa, herbarium comparisons and morphological confirmation were performed using diagnostic features such as corolla shape, nutlet structure, inflorescence type, and indumentum morphology.

Classification of life-forms and ecological groups

Each species was assigned a life-form category according to the Raunkiaer (1934) classification system:

Therophytes – annual herbs completing their life cycle in one season;

Hemicryptophytes – biennial or perennial herbs with buds at the soil surface;

Chamaephytes – low shrubs with perennating buds above ground level.

Ecological grouping was based on observed and reported habitat preferences:

Xerophytes – adapted to arid, sandy or rocky soils;

Mesophytes – typical of moderately moist soils;

Ruderals – species thriving in disturbed or anthropogenic habitats.

Data processing and analysis floristic data were entered into Microsoft Excel 2021 for numerical processing. The relative abundance and proportion of species in each life-form and ecological group were calculated and visualized through bar and pie charts. Statistical summaries were derived to evaluate the dominance structure and ecological spectrum of the Boraginaceae flora within Fergana City. Comparative interpretation was made with published data from nearby cities (e.g., Andijan, Namangan, and Bukhara) to contextualize regional similarities and differences.

Results

The family Boraginaceae in Fergana City includes 22 wild species belonging to 11 genera. Dominant genera include Heliotropium (5 species), Lappula (4), and Arnebia (3). The life-form structure is heavily dominated by annuals (therophytes, 72%), indicating adaptation to arid and disturbed conditions.

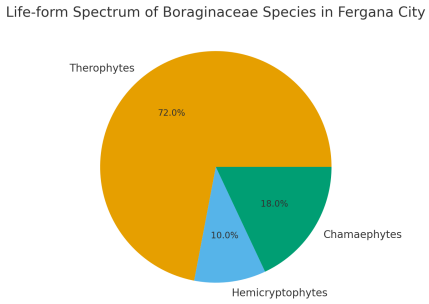

Figure 1. Life-form spectrum of Boraginaceae species in Fergana City.

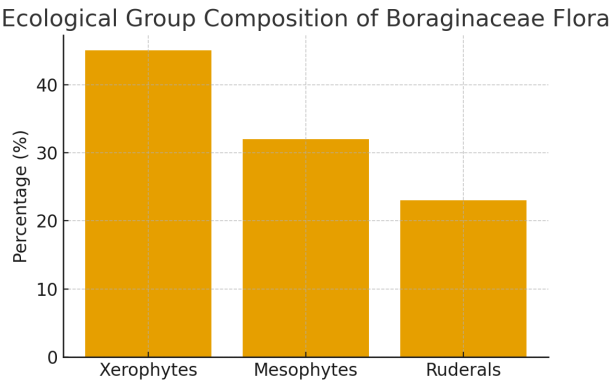

Figure 2. Ecological group composition of Boraginaceae flora in Fergana City.

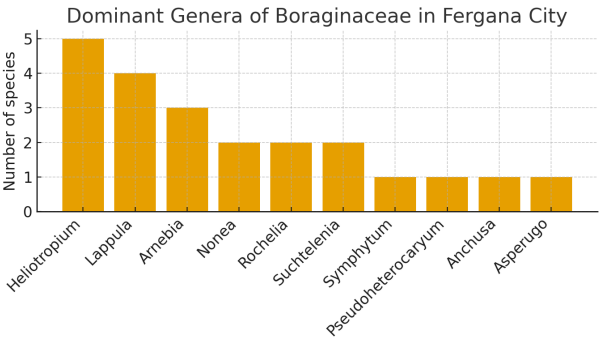

Figure 3. Dominant genera of Boraginaceae family in Fergana City.

Discussion

The predominance of therophytes and xerophytes reflects adaptation to Fergana's continental climate and anthropogenic influence. Annual species complete their life cycle before the onset of summer droughts. Chamaephytes such as Arnebia and Suchtelenia stabilize sandy soils, while ruderal taxa like Asperugo and Anchusa colonize disturbed areas. The genus Heliotropium shows ecological plasticity, occurring across diverse microhabitats. Comparative analyses with other Uzbek cities (Bukhara, Andijan) reveal similar patterns, confirming that Boraginaceae species are typical colonizers of Central Asian urban ecosystems.

Conclusion

This research confirms the presence of 22 wild Boraginaceae species across 11 genera in Fergana City. The flora is dominated by annual xerophytic herbs with significant ecological adaptability. The study highlights the role of Boraginaceae in maintaining biodiversity and stabilizing vegetation in semi-arid urban ecosystems. Further monitoring of these taxa can aid in assessing urban ecological resilience under climate stress.

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