UO‘K 582.570.2:581

THE DISTRIBUTION ALALYSIS OF THE SUBGENUS *MELANOCROMMYUM* (AMARYLLIDACEAE, ALLIOIDEAE) IN UZBEKISTAN

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This study examines the distribution of Melanocrommyum species in Uzbekistan, showing the highest species richness in the southern and southeastern regions, especially within the Central Asian Mountain Province. Areas like I-6 Western Hissar and I-1 Western Tian-Shan are biodiversity hotspots, while the Kyzylkum and Karakum deserts have lower species richness. The study highlights the role of elevation and diverse habitats, such as mid-mountains and foothills, in shaping the species' biogeographical distribution.

Key words: *Distribution patterns, Species richness, Biodiversity hotspots, Central Asian Mountain Province, Western Hissar, Western Tian-Shan, Kyzylkum desert*.

В представленном исследовании рассматривается географическое распределение представителей Melanocrommyum в Узбекистане. Показано, что наибольшее видовое разнообразие сосредоточено в южных и юго-восточных регионах, в частности в Центральноазиатской горной провинции. Выделены ключевые очаги биоразнообразия, такие как I-6 Западный Гиссар и I-1 Западный Тянь-Шань, в то время как пустынные регионы Кызылкум и Каракум характеризуются более бедным видовым составом. В работе подчеркивается значимая роль высотной поясности и специфики экосистем предгорий и среднегорий в формировании биогеографического распространения видов.

Ключевые слова: *распространение, видовое богатство, очаги биоразнообразия, Центрально-Азиатская горная провинция, Западный Гиссар, Западный Тянь-Шань, пустыня Кызылкум.*

Introduction

Uzbekistan, situated at the crossroads of Central Asia, harbors a rich and diverse flora, shaped by its varied climate and topography. Among the notable plant groups in this region is the genus *Allium* of the family *Amaryllidaceae* (Amaryllis family), known for its distinctive bulbous growth forms and ecological adaptability [1, 2]. Species of *Melanocrommyum* are an integral part of the region's flora, occurring predominantly in the arid and semi-arid zones, where they contribute to the ecological dynamics of the desert, steppe, and mountain ecosystems [3-6]. However, despite their significance, detailed studies on their distribution and the factors influencing their richness across Uzbekistan remain limited.

The subgenus *Melanocrommyum* includes species with specialized traits that enable them to thrive in Uzbekistan's harsh environmental conditions [1, 2]. These plants exhibit morphological diversity, especially in terms of their flower structures and bulbous growth patterns, which are adapted to the region's various ecological zones [7]. Though they are ecologically important, comprehensive studies on the species richness and distribution of *Melanocrommyum* species in Uzbekistan are lacking. This research aims to address this gap by focusing on several key aspects of the species' distribution and ecological relationships.

The primary objective of this study is to analyze the species richness of *Melanocrommyum* species in Uzbekistan. This includes mapping the geographic distribution of the species and examining their occurrence across different regions of the country [3, 8]. Additionally, the study will utilize a dendrogram to show the relationship between 38 phytogeo-

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graphical subdivisions in Uzbekistan, based on the species occurrences, using the WPGMA (Weighted Pair Group Method with Arithmetic Mean) method. This dendrogram will provide a better understanding of the spatial relationships and floristic similarity between different subdivisions [9]. This method has been widely used in plant geography for clustering related plant species and understanding spatial patterns in flora [10].

Furthermore, the study will explore the relationship between species richness and elevation, shedding light on how altitude influences the distribution and diversity of *Melanocrommyum* species. This aspect of the research will offer insights into the ecological factors that may drive species' adaptations and distribution patterns across Uzbekistan's diverse landscapes [8]. Elevation is known to be a key factor influencing plant species richness in arid regions, often leading to diverse flora at higher altitudes [11].

This research will not only enhance our knowledge of the distribution and species richness of *Melanocrommyum* in Uzbekistan but will also contribute valuable data for future ecological studies on the floristic diversity of Central Asia. By investigating the species' distribution in relation to elevation, phytogeographical subdivisions, and habitat preferences, the study aims to provide a comprehensive understanding of the factors shaping the biodiversity of this subgenus.

Materials and methods

All fresh materials collected beyond Uzbekistan during field trips (between 2019 and 2024) and herbariums collected from Uzbekistan were studied from National Herbarium of Uzbekistan (TASH). Distribution ranges of species were also reference to previous reports conducted by Fritsch [12], Khassanov [13]. Botany-oriented geographic regionalization of the study area follows the work of Tojibaev et al. [8]. The identification of species was confirmed by consulting the protologues and relevant literature [6, 12, 13]. ArcGIS software (version 10.8.1) was downloaded from the official website [14]; the base map was obtained from the National Meteorological Information Center. Data from herbarium vouchers were imported into an Excel document, georeferenced, and then converted to a point map layer in ArcGIS 10.8. We used Google Earth to georeference the locations where historical herbarium specimens were obtained. The WGS84 geographic coordinate system was used as a reference datum.

Result and Discussion

Based on the morphological examination of field and herbarium materials as well as literature reviews, 46 taxa of subg. *Melanocrommyum* are recognized in Uzbekistan. Seven taxa *A. tokaliense*, *A. habibii*, *A. majus*, *A. rhodanthum*, *A. decoratum*, *A. botschantzevii*, *A. cupuliferum* subsp. *nuratavicum* are endemic to Uzbekistan. The regions with the highest species richness are primarily concentrated in the southern and southeastern parts of Uzbekistan, particularly within the Central Asian Mountain Province (I) and certain subdivisions in the Turan Province (II). For instance, I-6 Western Hissar, I-7 Hissar-Darvaz and I-1 Western Tian-Shan show a significant concentration of species with a richness of 12-14 species, indicating it as a biodiversity hotspot for *Melanocrommyum* (Fig. 1). Other areas, such as the I-4 Nuratau region, including the Aktau and Nuratau Relic Mountains show moderate to high species richness, with 6-7 species per region. In contrast, the northern and central parts of Uzbekistan, particularly the Kyzylkum and Karakum regions, exhibit low species richness, with many areas showing only 0-1 species. The observed distribution of *Melanocrommyum* species aligns with the geographic and ecological diversity of Uzbekistan, as indicated by the phytogeographical subdivisions (Fig. 1). The high species richness in the southern and southeastern regions corresponds to areas that offer a variety of ecological conditions, such as the presence of mountainous terrain and higher elevations, which are conducive to the growth of bulbous and drought-adapted species like those in *Melanocrommyum*. For example, the I-4 Nuratau region is a known biodiversity hotspot, likely due to its varied topography and microclimates that support diverse plant life [15]. Additionally, the species richness observed in the I-6 Western Hissar, I-7 Hissar-Darvaz and I-1 Western Tian-Shan provinces may be influenced by the availability of specific ecological niches that cater to *Melanocrommyum*. These regions, with their more diverse habitats and altitudinal gradients, provide an array of microhabitats suitable for species persistence [3]. On the other hand, the lower species richness observed in the central and northern regions, such as the Kyzylkum and Karakum deserts (II-3 and II-5), reflects the harsher en-

vironmental conditions of these areas, where high temperatures, low rainfall, and extensive sandy or saline soils limit the establishment of species that require more specific ecological conditions [11]. These areas typically support fewer plant species, which is consistent with the distribution patterns of other desert-adapted flora in Central Asia.

Figure 2 presents a dendrogram based on the WPGMA to show the relationship of 38 phytogeographical subdivisions in Uzbekistan based on species occurrence. The dendrogram groups the subdivisions into clusters, which reflect the similarities in the species distribution across these regions. Notably, the subdivisions of the Central Asian Mountain Province (I) and certain regions of the Turan Province (II) tend to cluster together, indicating shared species distributions in these areas. The regions with more distinct and isolated species occurrences, such as the I-6 Western Hissar and I-7 Hissar-Darvaz subdivisions, are grouped further apart, reflecting their unique species composition. The dendrogram provides valuable insights into the floristic relationships among the phytogeographical subdivisions of Uzbekistan. The clustering of regions within the Central Asian Mountain Province (I) highlights the ecological connectivity of these areas. Subdivisions like I-4 Nuratau and I-5 Kuhistan share similar species distributions, suggesting that their ecological conditions such as elevation, topography, and microclimates support similar plant communities. These findings are consistent with previous studies that emphasize the role of mountainous regions in supporting biodiversity hotspots [16,17]. The grouping of the Turan Province (II) subdivisions such as II-3 Kyzylkum and II-5 Karakum in more isolated clusters reflects the ecological constraints in the arid and desert regions, where fewer species can thrive due to extreme climatic conditions. These findings align with the generally low species richness observed in these areas, as shown in Figure 1.

Figure 3 presents a scatter plot illustrating the relationship between the number of species of *Melanocrommyum* and elevation in Uzbekistan. The plot shows a clear, bimodal distribution of species richness concerning elevation. The number of species increases steadily with elevation up to approximately 1,500 meters, peaks around 2,000 meters, and then declines as elevation continues to rise beyond 2,500 meters. The plot indicates that the highest number of species is found at mid-elevations (around 2,000 meters), with a significant drop-off at higher elevations above 2,500 meters. The observed relationship between species richness and elevation reflects the complex interplay of ecological factors that influence plant distribution. The increase in species richness with elevation up to around 2,000 meters suggests that mid-elevation areas offer favorable conditions for the growth of *Melanocrommyum* species. These conditions may include moderate temperatures, adequate moisture, and diverse microhabitats that support a wide variety of plant species [18]. The relatively high species richness at these elevations can also be attributed to the availability of distinct ecological niches and more varied topography, which allow for a broader range of species to coexist. The peak in species richness at around 2,000 meters aligns with the typical elevation range where many Central Asian plant species are most abundant, as moderate altitudes often strike a balance between temperature and precipitation [19-20]. However, the decline in species richness above 2,500 meters may reflect the harsher conditions found at higher elevations, such as lower temperatures, stronger winds, and reduced growing seasons, which limit the number of species that can thrive. These factors are typical of alpine or sub-alpine zones, where plant communities are often dominated by hardier, drought-tolerant species with specialized adaptations [21].

The left diagram in figure 4 shows the distribution of *Melanocrommyum* species in four distinct habitats recognized by Sennikov et al. (2016), namely Alpine, Mid-mountains, Plains, and Foothills. The diagram shows that the majority of species are found in the Mid-mountains, with 25 species being exclusively present in this habitat. The Foothills and Plains habitats have fewer species, with only a few species being shared between these areas. The Alpine habitat shows the least overlap with other habitats, indicating that its species have more specialized environmental preferences.

The fight Venn diagram illustrates the blooming times of the *Melanocrommyum* species. The diagram shows that a significant portion of species bloom in May (14 species), with smaller numbers blooming in April (5 species), June (6 species), and July (5 species). The overlap between months suggests some species have overlapping blooming periods, but May is the most significant month for blooming among these species.

The distribution of *Melanocrommyum* species across habitats, as shown in Figure 4, reflects the ecological preferences and adaptations of these species to different environmental conditions. The concentration of species in the Mid-mountains (with 25 species) highlights this region as a key area for biodiversity, as it likely offers a variety of ecological niches that support diverse plant life.

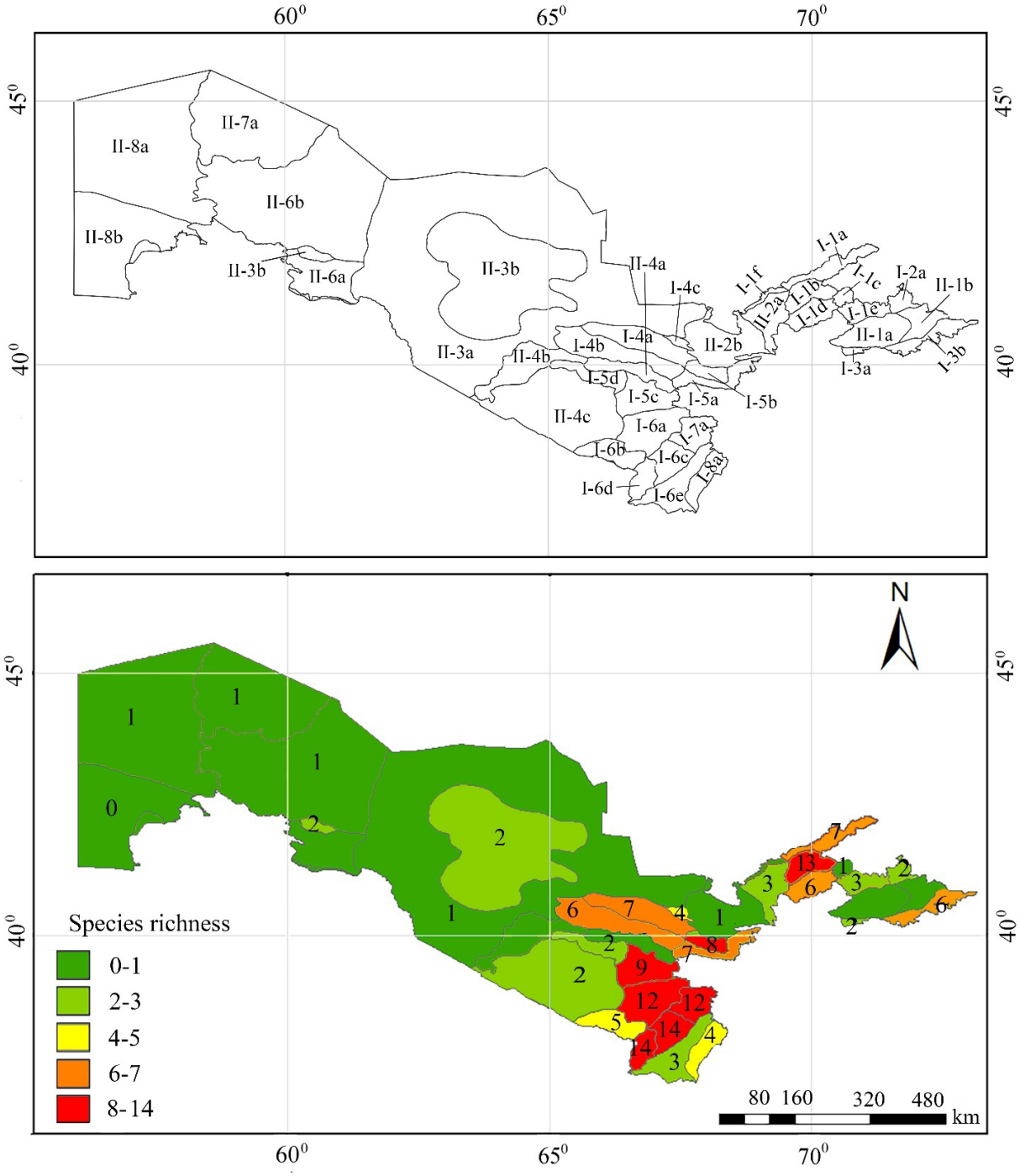


Figure 1. Phytogeographical subdivision of Uzbekistan (A) (according to Tojibaev et al 2016) and species richness of the species of subg. *Melanocrommyum* (B). I Central Asian Mountain Province: I-1 Western Tian-Shan (I-1-a Ugam-Pskem, I-1-b Western Chatkal (Chimgan), I-1-c Arashan, I-1-d Kurama (Akhangaran), I-1-e Chorkesar, I-1-f Tashkent), I-2 Fergana (I-2-a South Chatkal), I-3 Fergana-Alay (I-3-a Western Alay, I-3-b Eastern Alay), I-4 Nuratau (I-4-a Nuratau, I-4-b Aktau, I-4-c Nuratau Relic Mountains), I-5 Kuhistan (I-5-a North Turkestan, I-5-b Malguzar, I-5-c Urgut, I-5-d Ziadin-Zirabulak), I-6Western Hissar (I-6-a Kashkadarya, I-6-b Tarkapchigay, I-6-c Baysun, I-6-d Kuhitang, I-6-e Surkhan-Sherabad), I-7 Hissar-Darvaz (I-7-a Sangardak-Tupalang), I-8 Panj (I-8-aBabatag). II Turan Province: II-1 Central Fergana (II-1-a Kayrakum-Yazyavan, II-1-b East Fergana), II-2 Middle Syrdarya (II-2-a Chinaz, II-2-b Mirzachul), II-3 Kyzylkum (II-3-a Kyzylkum, II-3-b Kyzylkum Relic Mountains), II-4 Bukhara (II-4-a Middle Zeravsshan, II-4-b Lower Zeravsshan, II-4-c Karshi-Karnabchul), II-5 Karakum (II-5-a North-East Karakum), II-6 South Aral (II-6-a Khorezm, II-6-b Amudarya Delta), II-7 Aral (II-7-a Aral Sea Bottom), II-8 Ustyurt (II-8-a North Ustyurt, II-8-b South Ustyurt).

This is consistent with the earlier finding that mid-elevation areas, such as those around 2,000 meters, support the highest species richness [22] Figure 3). The lower number of species in the Foothills and Plains habitats suggests that these areas are less ecologically favorable for *Melanocrommyum* species, possibly due to more extreme climatic conditions such as higher temperatures and lower precipitation [23]. The minimal overlap between the Alpine habitat and the others suggests that *Melanocrommyum* species in this area are highly specialized, adapted to the cooler, more extreme conditions found at higher elevations. This supports the idea that high-altitude areas typically harbor fewer species due to harsher environmental conditions [24].

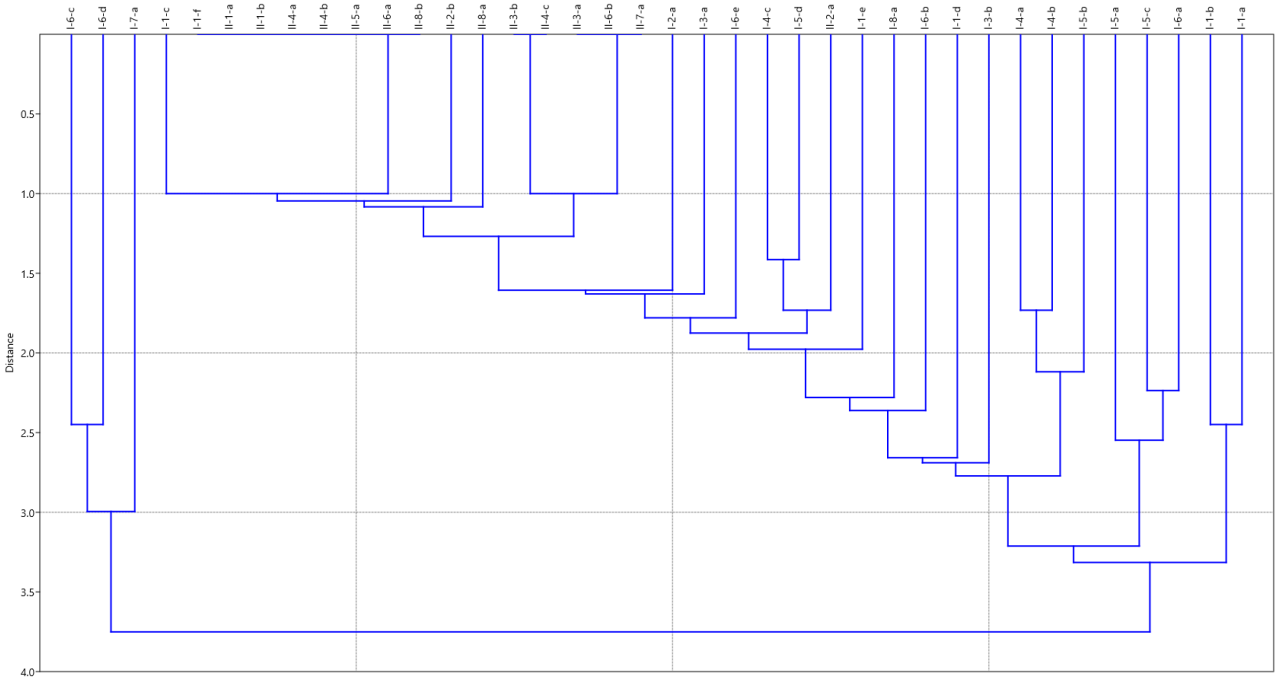


Figure 2. Dendrogram showing the relationship of 38 phytogeographical subdivisions in Uzbekistan based on the species occurrence (WPGMA method).

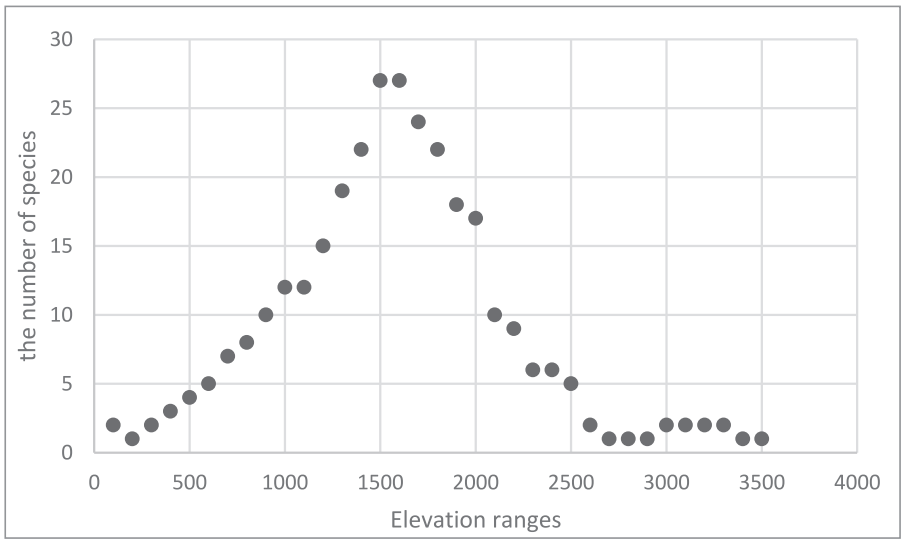


Figure 3. The relationship between the number of species and elevation.

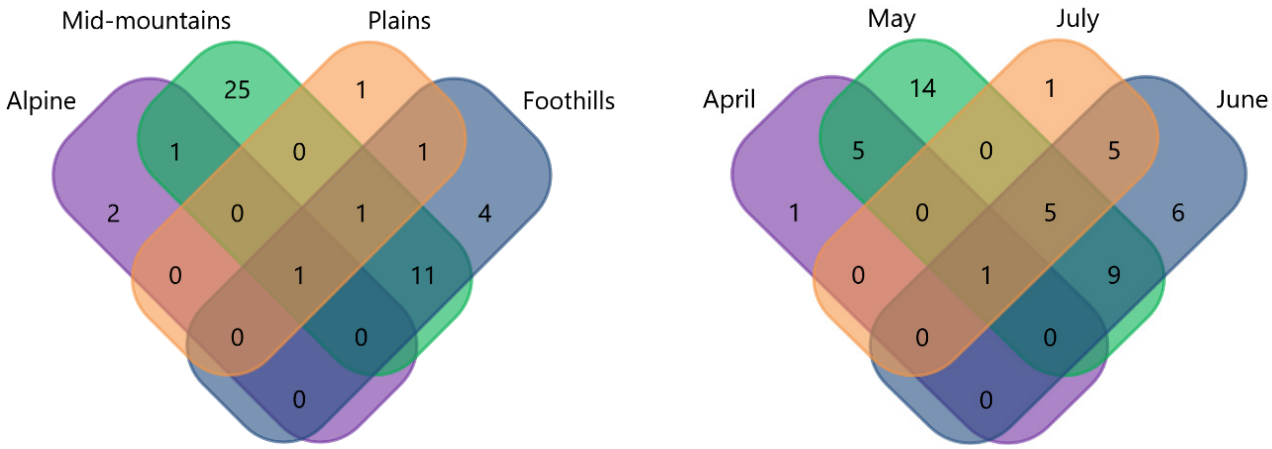


Figure 4. Venn diagrams showing the distribution of the species of subg. *Melanocrommyum* in Uzbekistan in four habitats recognized by Sennikov et al. (2016) (A) and blooming time of the species (B).

Conclusion

This study provides a comprehensive analysis of the distribution and species richness of the subgenus *Melanocrommyum* in Uzbekistan, offering valuable insights into the ecological dynamics of this plant group across the region. Our findings reveal that the southern and southeastern regions of Uzbekistan, particularly within the Central Asian Mountain Province and select subdivisions of the Turan Province, represent biodiversity hotspots for *Melanocrommyum*. These regions, characterized by diverse topography and varied ecological conditions, support a higher species richness, with species concentration peaking in areas like the Western Hissar, Hissar-Darvaz, and Western Tian-Shan. The observed patterns of species richness correlate with the availability of microhabitats and elevation gradients, which provide favorable conditions for bulbous and drought-adapted species.

The study also highlights a significant relationship between species richness and elevation, with mid-elevations (around 2,000 meters) showing the highest diversity, which likely results from favorable environmental conditions such as moderate temperatures, adequate moisture, and diverse habitats. In contrast, higher elevations above 2,500 meters show a decline in species richness, reflecting harsher climatic conditions. Additionally, the low species richness observed in the central and northern desert regions, such as Kyzylkum and Karakum, aligns with the extreme climatic conditions of these areas, which limit plant diversity.

The dendrogram analysis further emphasizes the floristic connectivity within the Central Asian Mountain Province and the isolated nature of desert regions. This clustering of regions based on species occurrence provides a clearer understanding of the spatial relationships and floristic similarities across Uzbekistan's phytogeographical subdivisions.

Overall, this research fills a critical gap in our knowledge of the distribution and ecological relationships of *Melanocrommyum* species in Uzbekistan. It underscores the importance of mountainous regions in fostering biodiversity and provides essential data for future ecological studies focused on Central Asia's floristic diversity. By examining species distribution across various habitats and elevations, this study contributes to a deeper understanding of the factors shaping the biodiversity of this unique plant group, emphasizing the need for further research to conserve and protect these ecologically significant species in Uzbekistan's varied landscapes.

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O‘ZBEKISTONDA *MELANOCROMMYUM* KENJA TURKUMI (AMARYLLIDACEAE, ALLIOIDEAE)NING TARQALISHI TAHLILI

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Ilmiy xabarnoma. Seriya: Biologik tadqiqotlar – Scientific Bulletin. Series: Biological Research. 2025. 4(88). 43-50.

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Kalit so‘zlar: tarqalish shakllari, Turlarning boyligi, biologik xilmaxillikning faol nuqtalari, O‘rta Osiyo tog‘li viloyati, G‘arbiy Hisor, G‘arbiy Tyan-Shan, Qizilqum cho’li.

Maqolada *Melanocrommyum* kenja turkumining O‘zbekiston hududida tarqalishi va turlar xilmaxilligi tahlil qilingan. Tadqiqot natijalari O‘zbekistonning janubiy va janubi-sharqiy qismlari, ayniqsa, Markaziy Osiyo Tog‘ tizmasi va Turon provinsiyasining ayrim bo‘linmalari *Melanocrommyum* bioxilmaxilligining eng yuqori tarqalish nuqtasi ekanligini ko‘rsatdi. Ushbu hududlar turli xil landshaft va ekologik sharoitlarga ega bo‘lganligi uchun tur xilmaxilligiga katta imkon yaratgan.

Maqolada tur xilmaxilligi va balandlik o‘rtasidagi aloqa ham o‘rganilgan. O‘rta balandliklarda (taxminan, 2000 metr) tur xilmaxilligining eng yuqori darajasi kuzatilgan, bu esa o‘rtacha harorat, yetarlicha namlik va xilma-xil yashash joylarining mavjudligi bilan bog‘liqdir. Bunga qarama-qarshi ravishda, 2500 metrdan yuqori balandliklarda tur xilmaxilligining kamayishi kuzatildi, bu hol hududlarning ancha qiyin ekologik sharoiti bilan bog‘liq. Shuningdek, Qizilqum va Qoraqum kabi markaziy va shimoliy cho‘l hududlarida tur xilmaxilligi pastligi aniqlandi, bu esa mazkur hududlardagi iqlim sharoiti bilan izohlanadi, bunday joylarda o‘simliklarning xilmaxilligi cheklangan.

Dendrogramma tahlili Markaziy Osiyo Tog‘ tizmasidagi hududlarning floristik bog‘lanishini, cho‘l hududlarining holati esa aksincha ekanligini yanada aniqroq ko‘rsatdi. Mazkur tahlil hududlardagi turlar tarqalishi asosida bo‘linmalarni guruhlash, O‘zbekistonning fitogeografik bo‘linmalari orasidagi makoniy munosabatlarni yaxshiroq tushunishga yordam beradi.

Umuman olganda, ushbu tadqiqot *Melanocrommyum* kenja turkumi turlarining O‘zbekistonda tarqalishi va ekologik munosabatlari haqidagi bilimlarni to‘ldirib, Markaziy Osiyo florasining xilmaxilligiga oid kelajakdagi ekologik tadqiqotlar uchun muhim asos bo’la oladi. Bu tadqiqot tur xilmaxilligini shakllantiruvchi omillarni yanada chuqurroq tushunishga hissa qo‘shadi va O‘zbekistonning turli landshaftlarida ekologik ahamiyatga ega bo‘lgan ushbu o‘simlik turlarini saqlash va himoya qilish zarurligini ko‘rsatadi.

Mualliflar haqida ma’lumot:

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