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ECOLOGICAL OVERVIEW OF HAPLOPHYLLUM JUSS. SPECIES IN THE NURATAU MOUNTAINS
ЭКОЛОГИЧЕСКИЙ ОБЗОР ВИДОВ HAPLOPHYLLUM JUSS. В НУРАТИНСКИХ ГОРАХ
NUROTA TIZMASIDA HAPLOPHYLLUM JUSS. TURLARINING EKOLOGIK TAHLILI

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Annotation. The genus Haplophyllum represents a significant component of arid and semi-arid ecosystems, exhibiting notable ecological adaptability and phytogeographic diversity. This study is focused on the distribution, ecological preferences, and conservation status of Haplophyllum species, which occur in the Nuratau Mountain Range, Uzbekistan. In total, five species (H. acutifolium, H. latifolium, H. pedicellatum, H. robustum, and H. versicolor) are

reported for this region based on herbarium specimens, literature review, and geospatial analysis, their habitat characteristics and phytogeographic patterns are revealed. The findings indicate a decline in herbarium collections over recent decades, suggesting a lack of targeted field studies and potential conservation concerns. Given the ecological and medicinal significance of Haplophyllum, further systematic investigations, population assessments, and conservation strategies are essential for ensuring their long-term sustainability in the Nuratau Mountain Range.

Keywords: distribution, ecology, flora, geospatial analysis, Haplophyllum, herbarium, Nuratau Mountains, Uzbekistan.

Аннотация. Род Haplophyllum представляет собой значимый компонент аридных и семиаридных экосистем, демонстрируя заметную экологическую адаптивность и фитогеографическое разнообразие. Данное исследование посвящено распространению, экологическим предпочтениям и охранному статусу видов Haplophyllum, обитающих в Нуратауском горном хребте (Узбекистан). Всего для данного региона зарегистрировано пять видов (H. acutifolium, H. latifolium, H. pedicellatum, H. robustum и H. versicolor), установленных на основе гербарных образцов, анализа литературных данных и геопространственного анализа, а также выявлены их характеристики местообитаний и фитогеографические закономерности. Полученные результаты указывают на сокращение количества гербарных сборов за последние десятилетия, что свидетельствует о недостатке целенаправленных полевых исследований и возможных угрозах сохранению данных видов. Учитывая экологическую и медицинскую значимость Haplophyllum, необходимы дальнейшие систематические исследования, оценка популяций и разработка стратегий охраны для обеспечения их долгосрочного устойчивого существования в Нуратауском горном хребте.

Ключевые слова: распространение, экология, флора, геопространственный анализ, Haplophyllum, гербарий, Нуратауские горы, Узбекистан.

Annotatsiya. Haplophyllum turkumi qurg‘oqchil va yarim qurg‘oqchil ekotizimlarning muhim komponenti bo‘lib, ekologik moslashuvchanligi va fitogeografik xilma-xilligi bilan ajralib turadi. Ushbu tadqiqot O‘zbekistonning Nurota tog‘ tizmasida tarqalgan Haplophyllum turlarining tarqalishi, ekologik afzalliklari va muhofaza holatiga qaratilgan. Mavjud ma’lumotlarga ko‘ra, ushbu hududda besh tur (H. acutifolium, H. latifolium, H. pedicellatum, H. robustum va H. versicolor) qayd etilgan bo‘lib, ularning tarqalishi gerbariy namunalari, adabiyot tahlili va geofazoviy tahlil asosida aniqlangan, yashash muhitining xususiyatlari va fitogeografik qonuniyatlari ochib berilgan. Tadqiqot natijalari so‘nggi o‘n yilliklarda gerbariy yig‘indilarining kamayganini ko‘rsatib, bu sohada maqsadli dala tadqiqotlari yetishmayotganini va potensial muhofaza muammolarini anglatadi. Haplophyllum turkumining ekologik va dorivor ahamiyatini inobatga olgan holda, ushbu turlarni uzoq muddatli barqarorligini ta’minlash uchun tizimli tadqiqotlar, populyatsiyalarni baholash va muhofaza strategiyalarini ishlab chiqish zarur.

Kalit so‘zlar: tarqalish, ekologiya, flora, geofazoviy tahlil, Haplophyllum, gerbariy, Nurota tog‘lari, O‘zbekiston.

Introduction. The genus Haplophyllum Juss. (Rutaceae) represents a significant taxonomic group within arid and semi-arid ecosystems. According to Ashfaq et al. (2020), the genus comprises approximately 70 species globally [1], while the taxonomic database Plants of the World Online (POWO 2025) currently contains 71 accepted species [2]. Jansen et al. (2006) delineated the biogeographic range of Haplophyllum, documenting its occurrence across Central Asia, Eastern Siberia, Russia, Mongolia, and China. Furthermore, contemporary analyses of floristic databases confirm extensive distribution of this genus in regions surrounding the Caspian and Black Seas, the Mediterranean Basin, North Africa and South Asia. The highest species richness is concentrated within the Irano-Turanian phytogeographic region [3].

Representatives of the genus Haplophyllum predominantly are perennial herbaceous plants or dwarf shrubs adapted to xerophytic conditions and exhibiting morphological and ecological plasticity [4]. Extensive floristic investigations have clarified the biogeographical distribution of Haplophyllum species in different regions. Notably, Iran harbors 25 species (Zohary, 1973) [5], while Afghanistan supports 12 species (Podlech, 2012 [6]. The genus is also well-represented within Central Asia, encompassing 20 species (Vvedensky, 1983) [7]. Within the Central Asian national floras, Uzbekistan hosts 16 species (Vvedensky, 1959) [8], Tajikistan – 14 (Ovchinnikov, 1981) [9], Turkmenistan – 12 (Shishkin, 1950) [10], Kazakhstan – 10 (Pavlov, 1963) [11], and Kyrgyzstan – 6 species (Nikitina, 1957) [12]. These records collectively underscore substantial presence and adaptive potential of this genus across diverse ecological gradients.

The Nuratau is a medium-altitude mountain range located in central Uzbekistan and extending on approximately 200 km from the western spurs of Turkestan Range to the Kyzylkum Desert. Its unique geographic and climatic conditions support diverse plant life, including several species of Haplophyllum, which hold a distinctive position in the local flora due to their adaptation to arid and rocky habitats. To date, targeted scientific studies on the distribution of the Haplophyllum genus within the flora of the Nuratau Mountain Range have been insufficient. The first comprehensive study focused on the analysis of the spatial distribution of the Haplophyllum genus in the flora of the Nuratau Mountain Range was conducted within the framework of the of state research program the Institute of Botany of the Academy of Sciences of the Republic of Uzbekistan “Digital Nature. Development of a digital platform for the flora of Central Uzbekistan”.

MATERIAL AND METHODS.

A comprehensive geographical and taxonomic analysis of Haplophyllum species in the Nuratau Mountain Range was conducted based on herbarium specimens, geobotanical descriptions and literature sources. A total of more than 40 specimens representing five species,

collected from this region between 1950 and 2020, were examined from the National Herbarium of Uzbekistan (TASH).

The taxonomic composition, nomenclature, and biogeographical distribution of the genus were analyzed using authoritative botanical references, including Determination Key of Plants of Central Asia (1983) [7], Flora of Uzbekistan (1959) [8], Flora of Central Asia: The Nuratau Mountains [13], Cadastre of the Flora of Uzbekistan: Samarkand Region [14], Cadastre of the Flora of Uzbekistan: Navoi Region [15], and Cadastre of the Flora of Uzbekistan: Jizzakh Region [16].

To determine the precise geographic distribution of the studied species, the collection site coordinates of herbarium specimens from the Nuratau region were georeferenced using Google Earth software. Spatial analysis and species distribution mapping were performed using ArcGIS 10.8 to visualize the range and ecological preferences of Haplophyllum species within the study area.

RESULTS

The distribution of Haplophyllum species within the Nuratau Mountain Range was assessed based on herbarium specimens, geobotanical descriptions and literature sources. These species exhibit adaptation to diverse edaphic conditions, predominantly occurring in sandy, gravelly, and clayey soils across various elevations of the mountain range. The analysis of the National Herbarium of Uzbekistan (TASH) and relevant botanical literature confirmed the presence of five Haplophyllum species in the region (Table 1). Geospatial analysis was conducted to determine the precise distribution of these species, and a GIS-based distribution map was generated to visualize their spatial patterns and ecological preferences (Fig. 1).

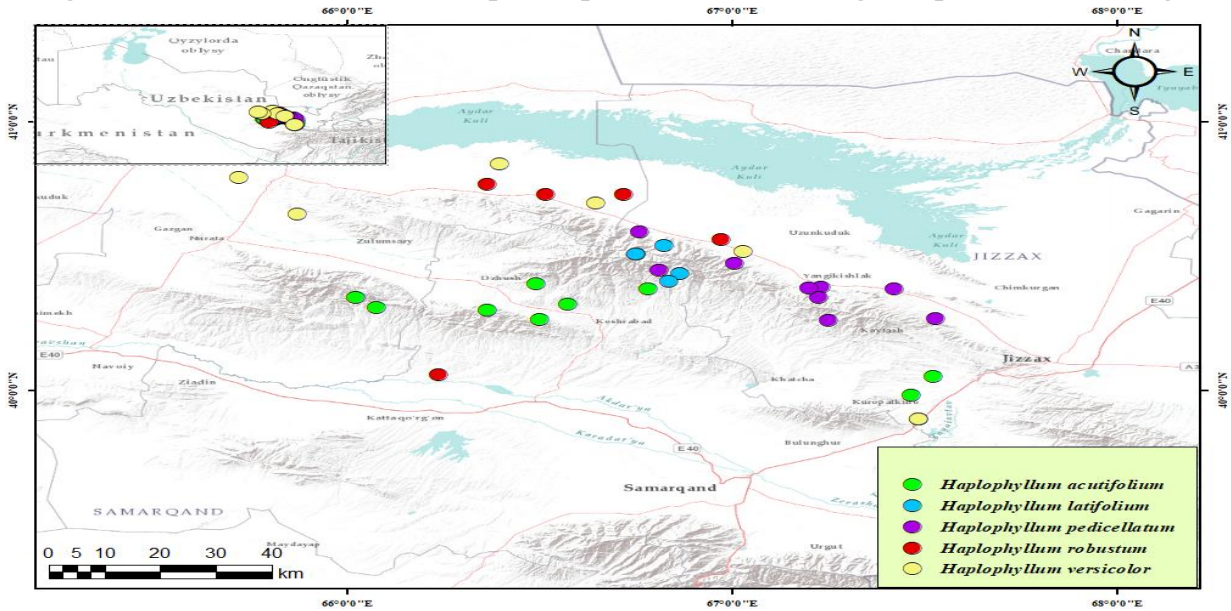

Figure 1. Distribution map of Haplophyllum Juss. species in the Nuratau region.

The most significant publications on the plant diversity of the Nuratau Mountains include P.K. Zakirov's monographs "Vegetation Cover of the Nuratau Mountains" (1969) [17] and

"Botanical Geography of the Low mountains of Kyzylkum and the Nuratau Range" (1971) [18], which provide essential insights into the ecological role of Haplophyllum species in local plant communities.

Historical field records indicate that Haplophyllum species contribute notably to the vegetation structure in specific locations. According to the data provided by P.K. Zokirov, in the Adyr and Desert regions of the Nuratau area, Haplophyllum species are found within the florocoenotypes of gypsophilous semi-shrub vegetation, ephemeroid semi-desert vegetation, and xerophytic shrubs. These include the plant associations (Artemisietum diffusae ephemeroso-phlomidosum, Cousinietum resino-sae-iridoso a poosum, and Amygdaletum spino-sissimae artemisiosum). Within these plant communities, Haplophyllum species coexist with Artemisia diffusa, Poa bulbosa, Cousinia radians, Phlomis thapsoides, Artemisia tenuisecta, and Iris songarica. It has been noted that in these communities, Haplophyllum species primarily occupy an accompanying role[17]. In 1958, Zokirov reported that in the plant cover of Quyi Uchma village, H. acutifolium and H. latifolium accounted for 1–10% of the total plant composition. Similarly, on June 23, 1956, surveys on the southern slopes of Saurbel Pass documented H. versicolor occupying 1–10% of the plant cover. On May 16, 1958, records from Tegirman-Aul village showed that H. acutifolium comprised 10–30% of the vegetation. More recent observations by N. Beshko on May 15, 2024, in Hayatsay, confirmed that H. acutifolium and H. latifolium accounted for 1–10% of the plant cover. Additionally, in 2024, field records from Karatau Range identified H. versicolor and H. robustum as contributing species within the plant community.

These findings underscore the role of Haplophyllum species as integral components of the Nuratau Mountain Range flora. A total of more than 40 herbarium specimens, representing five species collected between 1950 and 2020, are preserved in the National Herbarium of Uzbekistan (TASH). Analysis of collection trends revealed a significant decline in specimen acquisition over time. From 1954 to 1990, 32 herbarium specimens were documented, whereas only 8 specimens were collected between 1990 and 2020. This decline suggests a lack of systematic field studies on Haplophyllum species in the region in recent decades (Fig. 2).

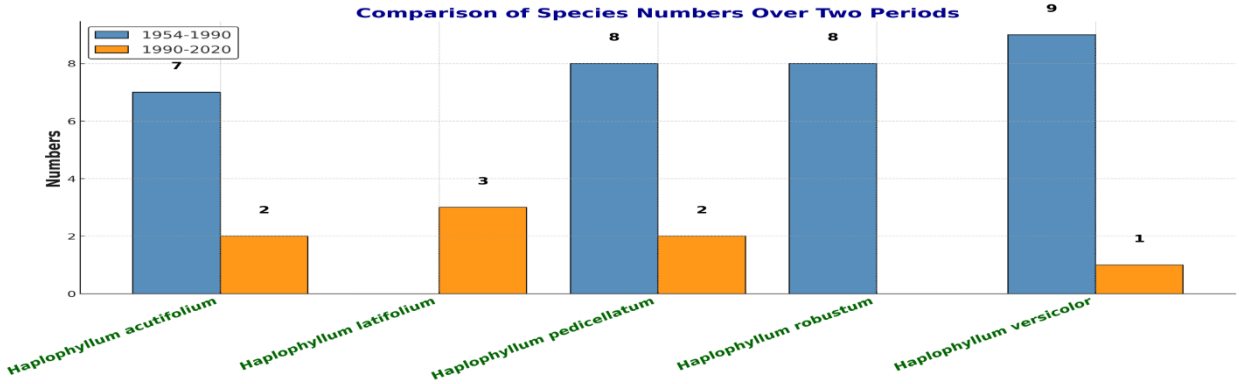

Figure 2. Number of herbarium specimens collected between 1954 and 2020.

Species	Species description	Usage	Habitats of species	Distribution areas and growth coordinates	IUCN Status
Haplophyllum acutifolium (DC.) G. Don.	Perennial (Hemicryptophyte), 30-70 cm tall	Unidentified	Sandy and clay deserts, fine-grained, gravelly, and rocky slopes, gravels, rocks, fields. Plains, foothills, lower and middle mountain belts.	Langar village: E-66.020044, N-40.349151 Maydon village: E-66.074465, N-40.310725 Khobduntau Mts.: E-66.782404, N-40.380136 Lanak village: E-66.571905, N-40.323746 Koytash: E-66.499771, N-40.265431	VU B1b(iii)
Haplophyllum latifolium Kar. & Kir.	Perennial (Hemicryptophyte), 25-60 cm tall.	Medicinal	Foothills and mid-mountain zones, rocky and fine-textured soils. Shrublands and juniper forests.	Nuratau Reserve: E-66.749507, N-40.510605 Ukhum village: E-66.749507, N-40.510605 Ulfatan village: E-66.822178, N-40.542911 Turkmanovul village:E-66.863048, N-40.437668 E-66.833901, N-40.408786	VU B2b(ii)
Haplophyllum pedicellatum Bunge ex Boiss	Perennial (Hemicryptophyte), 20-50 cm tall.	Medicinal, toxic	Plains and foothills, sandy and fine-textured soils. Shrublands and juniper forests.	Quvkala village: E-66.809952, N-40.448289 Yangiqishloq: E-67.231146, N-40.387619 Asmansoy village: E-67.223840, N-40.348609 Narvan village: E-67.529354, N-40.263275 Quyi Uchma village: E-67.422123, N-40.379540	VU B2b(iii)
Haplophyllum robustum Bunge	Perennial (Hemicryptophyte), 30-80 cm tall.	Medicinal	Plains and foothills, loamy and gravelly soils. Grows in dry, compacted sandy soils.	Langar village: E-66.237109, N-40.061181 Sop village: E-66.718039, N-40.732591 Forish: E-66.970313, N-40.564736	VU B1b(iii)

				Temirkavuk village: E-66.515599, N-40.731080 Additional location: E-66.361379, N-40.769475	
Haplophyllum versicolor Bunge	Perennial (Hemicrypto phyte), 10-25 cm tall.	Medicinal, dye-producing.	Plains and foothills, sandy and gravelly soils.	Baltasadur village: E-66.394975, N-40.846436 Simbuloq village: E-66.645778, N-40.699230 Uzunquduq: E-67.027268, N-40.520980 Qaraquduk village: E-65.866837, N-40.660439 Terakquduk village: E-65.716846, N-40.794410 Lalmikor: E-67.483390, N-39.896044	VU B1b(iii)

Table 1. Distribution of Haplophyllum species in the Nuratau mountain range

The earliest herbarium specimens from the Nuratau Mountains were collected in 1954 by Zaprometova N.S., including Haplophyllum acutifolium (DC.) G. Don, H. robustum Bunge, and H. pedicellatum Bunge ex Boiss, from the Sentobsoy and Gachasoy valleys. Specimens from this region constitute only 1.6% of the total Haplophyllum collections preserved in the National Herbarium of Uzbekistan (TASH), indicating a significant underrepresentation of the genus from this area.

Several factors may account for the limited number of Haplophyllum herbarium specimens from the Nuratau Mountain Range:

— A restricted distribution range of certain species, limiting their collection frequency.

— A low phytocenotic role and relatively low abundance within plant communities.

— The absence of specialized research focused on the Haplophyllum genus in recent decades.

— A lack of systematic and targeted field expeditions aimed at collecting new herbarium specimens.

To assess the completeness of available herbarium records, databases from other major collections were examined. However, a review of the herbarium databases of Moscow State University (MW) (https://plant.depo.msu.ru/) and the Herbarium of Higher Plants (LE) of the Komarov Institute of Botany, Russian Academy of Sciences (https://en.herbariumle.ru/) revealed no recorded specimens of Haplophyllum from the Nuratau Mountains. These findings

highlight that further field studies are required to enhance the documentation and conservation of Haplophyllum species in the region.

CONCLUSION

The Haplophyllum species of flora of the Nuratau Mountains are not only important for plant diversity but also hold significant ecological value. This study, conducted within the framework of the "Digital Nature" state program (2025–2029), confirms the presence of five Haplophyllum species in the region, emphasizing their adaptability to arid and semi-arid environments. However, herbarium analysis reveals a decline in specimen collection over recent decades, indicating a lack of systematic field studies. Furthermore, the absence of Nuratau specimens in major external herbaria highlights the need for comprehensive research to better understand their distribution and ecological roles.

The study also raises conservation concerns, as all five recorded species are classified as Vulnerable (VU) under IUCN criteria, making them highly susceptible to habitat degradation and environmental changes.As part of the ongoing five-year research initiative, a detailed assessment of their conservation status and population dynamics will be completed. Future studies should prioritize conservation strategies, molecular analyses, and investigations into adaptive traits to support the long-term sustainability of these species. The findings of this research will serve as a critical foundation for evidence-based conservation measures and biodiversity management policies in Uzbekistan.

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