

A TAXONOMIC AND HISTORICAL ASSESSMENT OF *TAMARIX* L. (TAMARICACEAE) BASED ON THE TASH HERBARIUM (UZBEKISTAN)

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Abstract. This study provides a taxonomic and historical assessment of the genus *Tamarix* L. (Tamaricaceae) based on herbarium materials preserved in the National Herbarium of Uzbekistan (TASH). A total of 2,765 herbarium sheets collected between 1906 and 2026 were critically examined and taxonomically verified using major international databases and authoritative regional floras. Of these, 2,566 specimens (92.8%) were reliably identified to species level and included in quantitative analyses, while 185 sheets (7.2%) were excluded due to incomplete or ambiguous taxonomic information.

Twelve species currently recognized in the flora of Uzbekistan were confirmed in the TASH collection. The species structure reveals marked representation imbalance, with *Tamarix ramosissima*, *T. hispida*, and *T. arceuthoides* comprising the majority of specimens. Temporal analysis indicates peak collecting activity during the mid-20th century, followed by a decline and renewed accumulation in recent decades. These trends primarily reflect historical research intensity rather than intrinsic biological distribution patterns.

The results strengthen the scientific value of the TASH *Tamarix* collection and establish it as a key resource for taxonomic revision, floristic research, and biodiversity assessment in Uzbekistan.

Keywords: *Tamarix*, herbarium revision, TASH, Central Asia, floristics, taxonomic verification, biodiversity collections.

INTRODUCTIONS

Herbaria represent long-term scientific repositories that preserve plant specimens together with essential metadata, including locality, date of collection, collector identity, and taxonomic determination. These collections function as permanent documentary records of species distributions across spatial and temporal scales and constitute a foundational resource for taxonomic, floristic, biogeographic, and evolutionary research [1,2]. In recent decades, herbarium specimens have increasingly been recognized as historical biodiversity archives that enable analyses of distributional shifts, phenological change, and long-term ecological dynamics [3].

The genus *Tamarix* L. (Tamaricaceae) comprises 73 currently accepted species worldwide [4] and represents a taxonomically complex group widely distributed across arid and semi-arid regions of Eurasia and North Africa. Species of *Tamarix* are key structural components of desert, semi-desert, saline, and riparian ecosystems and are characterized by high ecological plasticity and salt tolerance [5,6]. In Central Asia, the genus plays an important role in stabilizing sandy substrates, regulating riverine systems, and forming halophytic vegetation communities. However, species delimitation within the genus remains challenging due to morphological overlap, historical synonymization, ecological variability, and uneven collecting intensity across regions.

Despite the recognized ecological and floristic importance of *Tamarix* in Central Asia, a comprehensive herbarium-based revision of the genus within the National Herbarium of Uzbekistan (TASH) has not previously been undertaken. Given that TASH represents the largest and most historically continuous botanical repository in the region, its collections provide a unique opportunity to assess species representation, nomenclatural consistency, temporal accumulation patterns, and geographic sampling structure within the genus.

The National Herbarium of Uzbekistan (TASH), established in 1937, functions as the country's central national scientific collection and currently operates under the Institute of Botany of the Academy of Sciences of Uzbekistan. The TASH holdings comprise nearly one million herbarium sheets, including approximately 1,500 type specimens [7]. The collection is annually enriched by an average of 1,500–3,000 new accessions. TASH represents the most comprehensive herbarium resource not only for the flora of Uzbekistan but also for that of Central Asia as a whole. This repository serves as a primary source for the taxonomic revision of the flora of Uzbekistan and for the preparation of the new Flora of Uzbekistan project [9,10].

At present, the National Herbarium of Uzbekistan houses more than 66,000 digitized herbarium specimens representing over 2,300 species and 330 genera. Geographic coordinates have been determined for more than 1,000 species, and distribution maps have been generated using international geographic information systems (GIS). In particular, distribution maps have been prepared for numerous taxa of the Uzbek flora, including the genera *Acer*, *Allium*, *Tulipa*, *Caragana*, *Calophaca*, *Chesneya*, *Crocus*, *Cousinia*, and *Thermopsis*, as well as many species of *Astragalus* and numerous Red Data Book plants. More than 5,700 herbarium sheets (2–3 representative specimens per species) and 815 type specimens have been electronically databased. Based on literature and herbarium evidence, a modern conspectus of the flora of Uzbekistan has been developed, comprising 4,326 wild vascular plant species. The resulting electronic database FLORUZ (Flora of Uzbekistan Database) provides comprehensive information on taxonomic status, nomenclature, life forms, distribution, conservation status, and digital images of plant species [11].

Accordingly, the present study aims to conduct a critical taxonomic revision and temporal–geographic assessment of *Tamarix* specimens preserved in TASH. Specifically, the study evaluates species-level representation, examines nomenclatural consistency, analyzes historical collection dynamics, and assesses geographic distribution patterns within the herbarium framework. By integrating taxonomic verification with quantitative analysis of collection structure, this work provides a clarified and systematized foundation for future floristic, biogeographic, and conservation-oriented research on the genus in Uzbekistan.

MATERIALS AND METHODS

The material examined in this study comprised herbarium specimens of the genus *Tamarix* L. preserved in the collections of the National Herbarium of Uzbekistan (TASH). All available sheets attributed to the genus were critically reviewed. Based on these materials, a structured electronic database was developed to systematize specimen-level information. The database included taxon name (as indicated on the original label), currently accepted name, collection locality, administrative region, geographic coordinates (when available or subsequently determined), collection date, collector name, accession number, and barcode identifier (if present).

Nomenclatural verification and synonymy assessment were conducted using international and regional taxonomic resources, including Plants of the World Online (POWO; www.plantsoftheworldonline.org), Plantarium (<https://www.plantarium.ru>), the Global

Biodiversity Information Facility (GBIF; <https://www.gbif.org>), the Moscow State University Herbarium database (<https://plant.depo.msu.ru/>), and the Komarov Botanical Institute Herbarium (LE; <https://en.herbariumle.ru/>). Accepted names and synonymic treatments were aligned with currently recognized international standards.

For the evaluation of diagnostic morphological characters and regional species concepts, authoritative floristic treatments were consulted, including the 11-volume *Определитель растений Средней Азии*, the 6-volume *Флора Узбекистана*, and the 30-volume *Флора СССР* [4, 12–18].

Geographic coordinates of collection localities were obtained directly from specimen labels when available. For historical records lacking explicit coordinates, georeferencing was performed using Google Earth Pro 7.1 based on locality descriptions provided on the labels and corroborated with information from GBIF and Plantarium databases. This approach enabled standardized spatial localization of natural occurrence sites within the study region.

RESULTS

General information. A total of 2,765 herbarium sheets of the genus *Tamarix* preserved in the TASH collection were critically examined. Verification of specimen data revealed several categories of metadata inconsistency. Twelve sheets (0.43%) contained outdated or synonymic names. In addition, 14 specimens bore the name *Tamarix karataviense* Russanovitch on their original labels. This name was not found in the consulted regional floras or monographic treatments and is currently absent from major international taxonomic databases, including Plants of the World Online (POWO) and the International Plant Names Index (IPNI). The status of this name therefore remains unresolved and may represent either an unpublished designation, a nomen nudum, or a historical misapplication. Further archival and typification-based investigation is required to clarify its nomenclatural validity.

In 185 cases (6.7%), specimens could not be confidently assigned to species level due to incomplete, illegible, or missing label information, or because they were recorded only as *Tamarix* sp. Geographic data were absent in 21 specimens (0.76%), collection dates were missing or partially illegible in 27 cases (0.98%), and collector names were unreadable or absent in 69 sheets (2.49%). Additionally, 50 specimens (1.81%) lacked barcode identifiers.

Of the total examined material, 2566 specimens (92.8%) were reliably identified to species level and included in the quantitative analysis (Table 1). This proportion indicates a relatively high overall taxonomic resolution of the collection.

Historical floristic accounts report the occurrence of 12 species of *Tamarix* in the flora of Uzbekistan (Vvedenskiy, 1959). The present revision confirms the representation of all 12 species within the TASH collection. In addition, specimens of three species not occurring in the flora of Uzbekistan (*T. gracilis*, *T. kotschyi*, and *T. passerinoides*) are preserved in the herbarium, reflecting the broader Central Asian geographic scope of the collection.

Table 1. The number of specimens of the genus *Tamarix* L. preserved in the National Herbarium of Uzbekistan

№	Species	Number of herbarium specimens
1	<i>Tamarix androssowii</i> Litv, Fl.Bot.Muz.Imp.Akad.Nauk 5:41 (1905)	10

2	<i>Tamarix arceuthoides</i> Bunge, Fl. Russl.:119 (1952)	287
3	<i>Tamarix aralensis</i> Bunge, Tent.Gen. Tamar.: 59 (1852)	42
4	<i>Tamarix elongate</i> Ledeb, Fl.Altaiv. 1:421(1829)	100
5	<i>Tamarix florida</i> Bunge, Tent. Gen. Tamar.:37 (1852)	60
6	<i>Tamarix hispida</i> Wild, Abh. Konigl.Akad.Wiss.Berlin 1812-1813:77 (1816)	480
7	<i>Tamarix hohenackeri</i> Bunge, Tent. Gen. Tamar.: 44 (1852)	140
8	<i>Tamarix laxa</i> Wild, Abh. Konigl.Akad.Wiss.Berlin 1812-1813:82(1816)	183
9	<i>Tamarix lepostachya</i> Bunge, Beitr,Fl.Russl: 117(1852)	49
10	<i>Tamarix litvinovii</i> Gorschk, Spisok Rast. Gerb. Fl. S.S.S.R. Bot. Inst. Vsesojuzn. Akad. Nauk 10(61-64: 24 (1936)	72
11	<i>Tamarix meyeri</i> Boiss, Diagn. Pl. Orient. 10: 9 (1849)	61
12	<i>Tamarix ramosissima</i> Ledeb, Fl. Altaic. 1: 424 (1829)	1022
	Species occurring in the floras of other regions	
13	<i>Tamarix gracilis</i> Wild, Abh. Königl. Akad. Wiss. Berlin 1812-1813: 81 (1816)	43
14	<i>Tamarix kotschyi</i> Bunge Tent. Gen. Tamar.: 30 (1852)	7
15	<i>Tamarix passerinoides</i> Delile ex Decne. Ann. Sci. Nat., Bot. 4: 349 (1825)	10
	Total number of specimens	2566

The quantitative structure of the collection reveals pronounced species dominance. *Tamarix ramosissima* represents the most abundant taxon (39.8% of identified specimens), followed by *T. hispida* (18.7%) and *T. arceuthoides* (11.2%). Together, these three species account for nearly 70% of the identified material, indicating substantial representation inequality within the collection.

In contrast, several taxa are represented by low frequencies (<2%), including *T. androssowii*, *T. kotschyi*, and *T. passerinoides*. Such limited representation may reflect either genuine ecological rarity or historical collecting bias associated with uneven sampling intensity.

Species not occurring in the flora of Uzbekistan collectively constitute 2.3% of the identified material, further illustrating the interregional exchange and broader geographic coverage of the TASH herbarium.

The specimens of the genus preserved in the TASH collection were collected predominantly from the countries of Central Asia. The distribution of all examined specimens by country is presented below (Fig. 1).

The country-level distribution of *Tamarix* specimens demonstrates a clear predominance of material originating from Uzbekistan (55.15%), followed by Turkmenistan (20.47%) and Kazakhstan (14.10%). Tajikistan (6.94%) and Kyrgyzstan (2.57%) are comparatively underrepresented. Only 0.76% of specimens lack country information.

The earliest specimen identified in the collection corresponds to *Tamarix ramosissima*, collected in 1906 by A. Badin from the Syrdarya region, Chimkent uyezd (currently within Kazakhstan). This record represents the oldest documented *Tamarix* specimen preserved in TASH (Fig. 2).

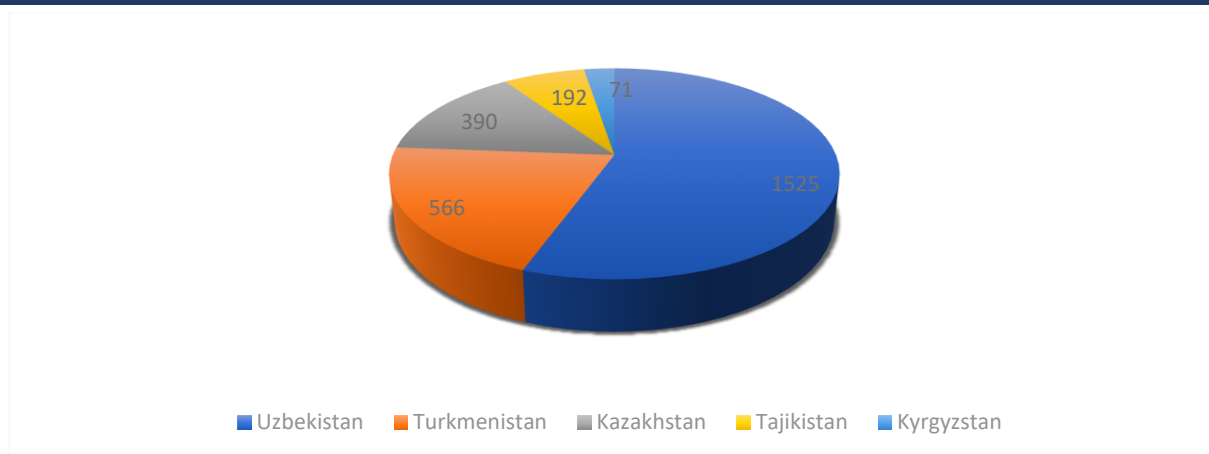
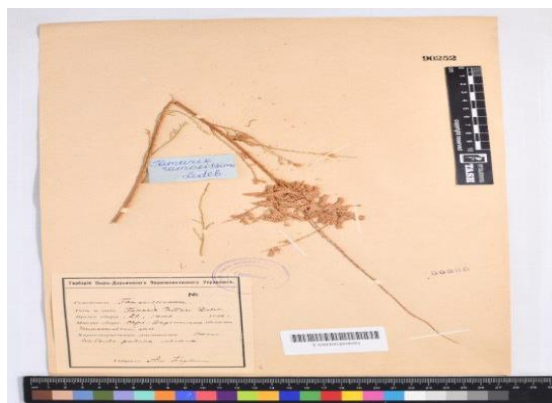


Fig.1. Distrubition of *Tamarix* specimens preserved in the TASH herbarium across Central Asian countries.

In contrast, the most recent specimen examined belongs to *Tamarix arceuthoides*, collected in 2024 by N.Yu. Beshko and I.I. Maltsev from the Angren River floodplain near Almalyk. The coexistence of these temporally distant specimens within the same collection reflects more than a century of continuous floristic documentation (Fig. 3).



2. Figure *Tamarix ramosissima* Ledeb collected in 1906.



3. Figure *Tamarix arceuthoides* Bunge collected in 2024.

The decadal distribution of *Tamarix* specimens (1906–2026) reveals a markedly uneven temporal accumulation pattern (Fig. 4).

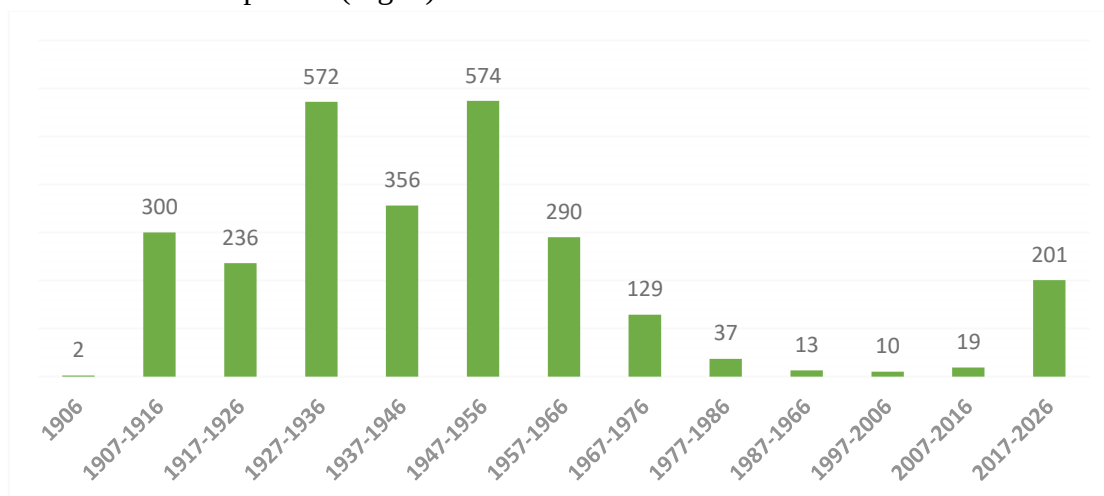


Figure.4 Decedal distribution of *Tamarix* herbarium specimens preserved in TASH 1906-2026.

The principal accumulation phase occurred between 1940 and 1960, corresponding to intensified botanical exploration and large-scale floristic surveys in Central Asia. The lowest accumulation period was recorded between 1997 and 2006, likely reflecting a temporary decline in field-based floristic research and possible delays in integrating newly collected materials into the central repository.

A renewed increase in specimen accumulation is observed during 2017–2026, coinciding with revitalized national inventory programs, systematic digitization initiatives, and expanded biodiversity documentation efforts. Overall, the temporal structure primarily reflects shifts in institutional research activity rather than intrinsic biological fluctuations within the genus.

The *Tamarix* collection was assembled through the substantial contributions of botanists from the former USSR as well as contemporary Uzbek researchers (Table2).

Table 2. Leading collectors of *Tamarix L. specimens preserved in the TASH herbarium, with collection periods and geographic coverage*

Collectors	Number of herbarium specimens	Years	Regions
A.A. Ashirova	266	1947-1975	Uzbekistan and Turkmenistan
A.D. Pyataeva	115	1940-1956	Uzbekistan Turkmenistan and Tajikistan
I.I. Granitov	91	1919-1945	Uzbekistan Kazakhstan and Tajikistan
E.E. Korovin	84	1913-1941	Uzbekistan Turkmenistan Tajikistan Kazakhstan and Kyrgyzstan
M.G. Popov	82	1910-1962	Uzbekistan Turkmenistan Kazakhstan and Tajikistan
N.Daminova	82	2022-2023	Uzbekistan
E.E.Korotkova	72	1935-1971	Uzbekistan Turkmenistan Tajikistan and Kazakhstan
I.A. Raykova	61	1916-1958	Uzbekistan Turkmenistan Tajikistan and Kazakhstan

The most productive collectors include A.A. Ashirova (266 specimens), A.D. Pyataeva (115), and I.I. Granitov (91), whose field activities were concentrated primarily between 1910 and 1975.

The distribution of collector activity across decades further supports the observed temporal accumulation peaks and underscores the role of coordinated botanical expeditions in shaping the current structure of the collection.

DISCUSSION

In contemporary biodiversity science, digitized biological collections increasingly function as foundational research infrastructure, enabling large-scale, data-driven analyses across spatial and temporal scales [19]. Over the past decade, coordinated digitization initiatives across major herbaria have transformed traditional specimen repositories into globally interconnected research platforms [4]. This transition has substantially enhanced data transparency, reproducibility, and international scientific collaboration.

Within this global transformation framework, the National Herbarium of Uzbekistan (TASH) has initiated systematic digitization and cataloguing of its collections in accordance with international standards. Since 2020, the Institute of Botany of the Academy of Sciences of

Uzbekistan, in collaboration with international partners, has implemented progressive digitization procedures, including high-resolution imaging of historical and recent specimens, standardization of specimen metadata (locality, collector, collection date, identifier, herbarium code), and integration with global biodiversity databases [7]. These efforts significantly increase accessibility and analytical potential of Uzbekistan floristic data.

As emphasized by Tojibaev et al. (2020), the TASH collection holds fundamental importance for understanding the flora of Central Asia, and its digitization substantially strengthens the region's integration into the international scientific community [7]. The practical implications of digitization are multidimensional. First, integration with global open-access platforms such as GBIF, JSTOR Global Plants, and iDigBio facilitates broader international engagement with Central Asian biodiversity data [20]. Second, digital georeferencing enables refined comparisons between historical and contemporary distribution patterns, improving regional biogeographic assessments. Third, temporally explicit herbarium records provide critical input for phenological and ecological modeling, particularly in evaluating plant responses to climate change [21]. Finally, high-resolution digital images enhance taxonomic precision by allowing remote comparison with type materials and historical collections, thereby supporting synonym resolution, species delimitation, and taxonomic revision [1].

The pronounced dominance of *Tamarix ramosissima* within the collection likely reflects a combination of ecological amplitude and historical sampling bias. As a widely distributed and morphologically variable species, *T. ramosissima* is frequently encountered in riparian and desert ecosystems, which were focal targets of early botanical expeditions in Central Asia. However, the possibility of historical over-identification or taxonomic broad interpretation cannot be excluded, particularly given the known morphological overlap within the genus. Consequently, species representation in the collection should be interpreted as an outcome of both biological distribution patterns and collector-driven sampling dynamics.

The digitized and structured presentation of *Tamarix* data significantly expands the potential for interdisciplinary applications, including ethnobotany, phytogeography, conservation planning, and regional taxonomic revision. In this sense, the TASH *Tamarix* collection evolves from a static archival repository into a dynamic biodiversity knowledge platform capable of supporting long-term ecological, biogeographic, and evolutionary research in Uzbekistan.

CONCLUSION

This study provides a comprehensive and critically structured assessment of 2,765 herbarium sheets representing species of the genus *Tamarix* collected over more than a century. Through quantitative evaluation, taxonomic verification, and historical contextualization, the research establishes a robust empirical framework for future taxonomic revision, biogeographic analysis, and provenance-based investigations within the genus.

The systematic analysis not only clarifies species-level representation and temporal accumulation patterns but also enhances the scientific reliability and analytical utility of the *Tamarix* holdings preserved in the TASH herbarium. Consequently, the collection emerges as a strategically important biodiversity resource, supporting long-term floristic research, regional conservation planning, and integrative botanical studies in Uzbekistan.

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