



REVIEW ARTICLE

Morphology and distribution patterns of *Tulipa fosteriana* and *Tulipa ingens*

Shukrullozoda Roza Shukrullo qizi¹, Dekhkonov Davron Burxonovich^{2*}, Khaydarov Khislat Kudratovich³, Kadirov Bakhtiyor Esanovich⁴ & Tojibaev Komiljon Sharobitdinovich⁵

¹Department of Genetics and Biotechnology, Samarkand State University, Samarkand, 140162, Uzbekistan

²Department of Biology, Namangan State University, Namangan, 716019, Uzbekistan

³Department of Botany, Samarkand State University, Samarkand, 140104, Uzbekistan

⁴Uzbekistan In vitro laboratory of Sag Agro "Bog'bon", Samarkand, 140100 Uzbekistan

⁵Institute of Botany Academy Sciences of the Republic of Uzbekistan, Tashkent, 100125, Uzbekistan

*Email: davron-b@bk.ru



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Abstract

Tulips are bulbous geophytes with high ornamental value. Species of *Tulipa* L. are distributed along western China to Eastern Europe. Central Asia including Uzbekistan is considered as the hotspot center of tulips where over 80 and 34 taxa are described. The current work presents morphology of the species from fresh materials, regional distribution and assessment of the area (AOO) and extent (EOO) of occurrence of the ancestor of cultivated tulips, *Tulipa fosteriana* and *Tulipa ingens* from Samarkand region (Uzbekistan). Illustrations of the species from fresh materials are also provided.

Keywords

general distribution, distribution in Uzbekistan, fresh material morphology, plant illustration, plant gene.

Introduction

Tulips are taxonomically complex and the reasons for this complexity are possibly numerous (1–5). Many tulips grow in non-native places on remote hills and valleys where winters are harsh and summers are long and dry. There they can bloom only for a short time before going underground. Local botanists are well aware of the flora of their own country (5), but to get a general idea of a species or group of closely related species, they need a broad geographical perspective, which is not easy as one species can be found on a vast territory covering several countries (6–8).

The problem of protecting the biodiversity including flora is of great and vital importance for all mankind. Using natural resources, people negatively affect the natural age-old landscapes. The increased development of industry and agriculture, extensive re-cultivation of natural areas etc., have led to a violation of the ecological balance. As a result, there is always a risk of impoverishment of the species composition of the flora and there will be increased deterioration of the plant gene pool (6).

About 4,500 species of wild higher plants and more than 2,000 species of fungi grow on the territory of Uzbekistan (5). About 400 of them are rare, endemic and relict species (10–12% of the flora). Effective measures are needed to ensure their protection (9). The disappearance of even a single species can lead to irreversible consequences, as wild plants serve as raw

materials for the creation of valuable varieties of many crops. Uzbekistan, located in the heart of the Eurasian continent, has a high level of plant diversity and endemism, especially in the case of certain genera, including the tulips (10,11).

The areas where most tulip species live are described in the Flora of the former USSR (including Russia, Central Asia and the Caucasus) (11), the Flora of Iran (including Iran, Afghanistan, west Pakistan, northern Iraq, Azerbaijan, Turkmenistan), Kazakhstan, Tajikistan and Uzbekistan (10). The study and assessment of the current distribution of tulip species, the number and causes of their disappearance in the Central Asian region are very important. Wild tulips are a national treasure not only of Uzbekistan, Kazakhstan and Kyrgyzstan, but also of all mankind, since they have long been used in decorative gardening all over the world, especially in the Netherlands (9).

Wild tulips are the most impressive plants from the whole variety of flora of Uzbekistan. In recent decades, as a result of intensive anthropogenic impact, the range and the number of populations of many species of tulips have significantly decreased (12). Realization of socio-economic reforms have led to a reduction and destruction of tulip growing habitats considerably. Uncontrolled pasture, fragmentation and overexploitation of rare medicinal and edible plants are taking on an increasingly threatening scale, causes great damage to wild flora. Thus, all the studied populations are viable with a sufficient number of generative individuals providing seed reproduction (9).

The present work demonstrates analysis of the species richness and morphological characteristics from fresh materials of *Tulipa fosteriana* and *Tulipa ingens*.

Materials and Methods

Study area

The study area is the Republic of Uzbekistan with 447,400 km² area (land 425,400 km² and water 22,000 km²). The area is situated in the heart of Central Asia and bordered by five countries. Approximately, 12% of total area occupied by mountains and foothills and 85% covered by plains. The highest point in Uzbekistan is Khazret Sultan at 4643 meters above sea level, in the southern part of the Hissar Range in the Surkhondaryo region on the border with Tajikistan, just northwest of Dushanbe. The climate is continental, with little precipitation expected annually (100–200 millimeters). The average summer temperature tends to be +40 °C, while the average winter temperature is around – 23 °C (1).

Field surveys

Extensive field surveys were conducted during April-May in 2022. Photographs used in the morphologic illustration were taken with a Canon EOS 4000D and Nikon D7500 digital cameras. Morphologically examined fresh materials and specimens collected during field expeditions. According to observations of fresh materials in wild habitats and the study of herbarium specimens, the authors made

changes and additions. In addition, data from Wilford (2006) and Everett (2013), who also observed living plants in various botanical collections, were taken into account. The identification of species was confirmed by consulting the protologue, relevant literature (3, 13, 14). Herbarium voucher data were inserted into an Excel document, georeferenced, imported into ArcGIS 10.3, and then converted to a point map layer. For the purpose of georeferencing the places where historical herbarium specimens were collected, we employed the Google Earth software. As a reference datum, the WGS84 geographic coordinate system was employed.

Taxonomy and nomenclature

Classification of taxa is by Angiosperm Phylogeny Group (15). The nomenclature of taxa (was critically cross-checked against information in International Plant Name Index (www.ipni.org), The Plant List (www.theplantlist.org), World Checklist of Selected Plant Families (<http://wcsp.science.kew.org>), Plants of the World (16), Global Biodiversity Information Facility (www.gbif.org), and concurred to Zonneveld (13) and Tojibaev & Beshko (14).

Results and Discussion

Morphological evaluation

Tulipa ingens Hoog.

Specimen data

The describing herbarium specimens were collected from vicinities of Sangartak, Surkhondarya region (by D. Dekhkonov, D. Makhmudjanov, 31.03.2021, voucher numbers: DD 310320210026, DD 310320210027, DD 310320210028. Coordination: N 38.536109924, E 67.56722259.

Bulb

Elongated ovoid, 2–4 cm thick and long; tunics blackish-brown or brown, thinly subcoriaceous, rather profusely lanate with long silky brown hairs on the inside.

Stem

15–40 cm long, pale green, the upper part of stem and peduncle pubescent; usually the upper part of the stem long than the underground part (30x10 cm - DD310320210028).

Leaves

3-5, spreading, scattered, slightly crisp, glaucous, pubescent, more or less ciliate-margined, progressively decreasing in size up the stem, not surpassing the flower; lowest leaf lanceolate, 2–5(10) cm broad and 20-30 cm long.

Flower

Solitary, opens widely to a loose cup; perianth segments red, 4–11 cm long (7.5 cm - DD310320210027), more or less acuminate to a pubescent point, the black obtuse or emarginate blotch not margined (1/4 - DD310320210026 or 1/6 - DD310320210028 part of the perianth); outer segments (6x3 cm - DD310320210026) oblong-rhomboidal, slightly broader than the oblong to oblong-

elliptic inner segments; stamens (23 mm - DD310320210028) one third to two-fifths the length of perianth; filaments (10 mm - DD310320210028) naked, black; anthers 13 mm - DD310320210028) blackish purple or yellow; pollen black or yellow; ovary (14 mm - DD310320210028) columnar, pale green, slightly longer







than filaments, with sessile stigma; capsule ca. 2 cm broad, 3–6 cm long.

***Tulipa fosteriana* W.Irving.**

Specimen data

Morphologically investigating specimens were collected from Zarafshan ridge, Taxtakaracha pass, vicinities of

Kyzylbel by U.Kadirov (16.04.2021). Voucher numbers: UK16042021001, UK16042021003, UK16042021005. Coordination: N 39.310062, E 66.896534.

Bulb

Ovoid, 2–5 cm thick, 2.5–3 cm long; tunics black-brown, sometimes brown, coriaceous, densely lined with silky hairy at the summit and the base and middle part of the





bulb covered (very sparsely) with long silky hairs; bulb with few tunic layers (4-7).

Stem

15–40 cm long, glabrous, the upper part of stem and peduncle pubescent; always upper part of the stem is longer than underground part (for example 8x22 cm - UK16042021003).

Leaves

3–4, spreading, scattered, slightly crisp, glaucous or green, pubescent, ciliate, not surpassing the flower, rapidly decreasing in size up the stem; lowest leaf oblong to elliptic, 3–15 cm broad and 12–22 cm long.

Flower

Solitary, large, saucer-shaped; perianth segments red,



4.5–12.5 cm long and 2.0–4.0 cm thick, commonly obtuse with a very short pubescent point, the basal blotch black margined with yellow or yellow throughout; outer segments oblong-elliptic to oboblong; inner segments obovate to oboblong; stamens one third to two-fifths the length of the perianth (2x6 cm - UK16042021001); filaments naked (0.5–0.8 mm - UK16042021001, UK16042021003), black, sometimes yellow; anthers violet, twice the length of the filaments (7x15 cm - UK16042021001 and 6x13 mm - UK16042021003); pollen purple-brown or yellow; ovary green, bottle-like, slightly shorter than anthers, with sessile stigma; capsule 2.5–3 cm broad, 5–7 cm long.

Distribution patterns

Tulipa ingens Hoog.

Distribution in Central Asia

Western Pamir-Alai (Tajikistan, Turkmenistan, Uzbekistan) (Fig.3).

Mt. Kuhisurkh, the gorge Dzhankara, wet meadow among rocks and springs near the village Ishan, 17 May 1936, Gnezdillo 68 (TASH!); Urgut, surroundings of Samarkand, 18–19 April 1940, Popov, Zakirov s.n. (TASH!); Zeravshan Range, near the top of the pass Amankutan, 28.04.1965, Pryakhin (TASH, LE); Tersaksy, village Ukarytersak, 1330 m, 15 April 2017, Kodyrov s.n. (TASH!); mountains Kurgantau, Sevazsay, north slope, 1250–1300 m, 14 April 2018, Kodyrov, Juramurodov, Makhmudjanov s.n. (TASH!); Zeravshan Range, near the village Amankutan, southern slope, 1750–1800 m, 15 April 2018, Kodyrov, Juramurodov, Makhmudzhanov U138 (TASH!); Dzhindydyarya, near the village Madmon, 10 April 2019, Kodyrov, Juramurodov, Akbarov 2019104040; Dzhindydyarya, near the village Madmon, southern slope, 12 April 2019, Kodyrov, Juramurodov, Akbarov 20191204026 (TASH!); surroundings of the village Saygus, 1400 m, 12 April 2019, Kodyrov, Juramurodov, Akbarov 20191204002, 20191204037 (TASH!); Western Hissar district, Kashkadarya region,

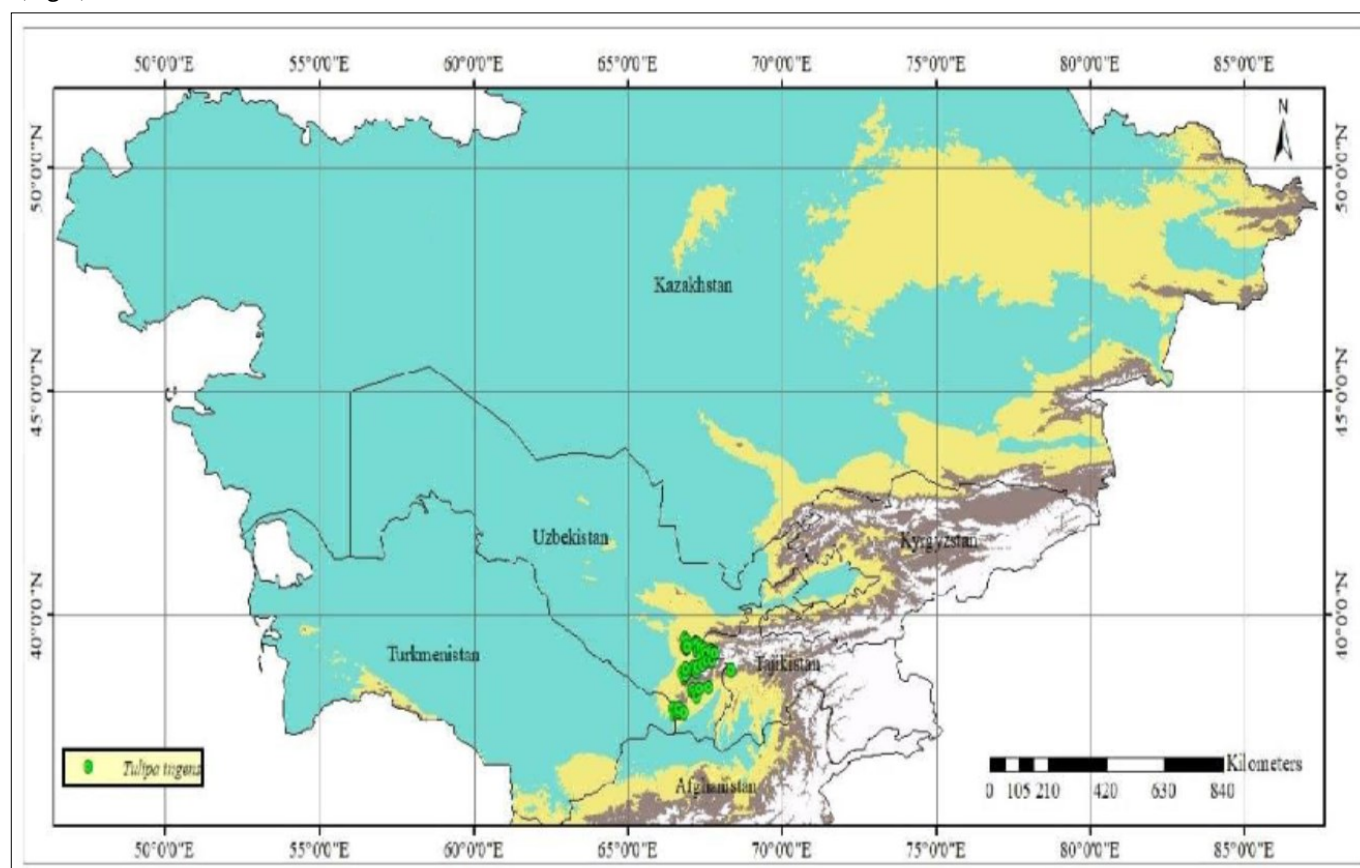


Fig.3. Distribution of *Tulipa ingens* in Central Asia.

Distribution in Uzbekistan

Kuhistan district, Urgut region, Zarafshan Range, Samarkand Province, Samarkand district, northern slope of Zeravshan Range, Amankutan, the pass Takhta-Karachay, 1676 m, 20 April 1913, Michelson 992 (LE); Samarkand Province, Amankutan, forestry farm, on the way to the nursery, 19 April 1915, Fedtschenko 356 (LE); Uzbek SSR, surroundings of Samarkand, Agalyk, 7 April 1934, Butkov s.n. (MW, LE, NY); Western Pamir-Alay, Zeravshan Range, surroundings of the village Urgut, the top of the mountain Karakurgan, in the shadow of rocks, 3 May 1936, Gnezdillo 52 (TASH!); Western Pamir-Alay, Zeravshan Range,

Hissar Range, Kitab, near the village Shut, 18 May 1916, Popov 795, 796 (TASH!); Yakkabag, near the village Bova-Shady, 1 June 1916, Popov 1172 (TASH!); mountains to the south of Yakkabag, juniper zone, eastern slope of the gorge, 12.06.1927, Kultiasov, Granitov 496 (TASH!); Western Pamir-Alay, upper reaches of the river Yakkabagdarya, surroundings of the village Tashkurgan, descent from the pass Chekmen-Kuydy to the village Tashkurgan, stony slopes, in juniper forest, 17 May 1936, Gnezdillo 68 (TASH!); Western Pamir-Alay, upper reaches of the river Yakkabagdarya, surroundings of the village Tashkurgan, descent from the pass ChekmenKuydy to the village Tashkurgan, stony slopes, in juniper forest, 18 June 1936, Botschantzev,

Butkov 4 (TASH!); Western Pamir-Alay, upper reaches of the river Yakkabagdarya, surroundings of the village Tashkurgan, left bank of Yakkabagdarya west of the village Tashkurgan, fallow lands, on the red clays, 27 June 1936; Botschantzev, Butkov 462 (TASH!); Western Hissar, upper part of the slope, near the pass Chekmen-Kuydy (SE of the village Tatar), 15 May 1961, Abdukhmidov s.n. (TASH, LE); Yakkabag, mountains Kyzyl-kishlak, 3 May 1964, Kholikov 65 (TASH!); Kashkadarya Province, Western Hissar, basin of the river Kyzyl-darya, gorge Zarmas, between the villages Tatar and Zarmas, on gravelly and stony slopes and rocks in the middle mountain belt, 7 April 1977, Malakhov s.n. (TASH!); UzbekSSR, Kashkadarya Province, Kamashi district, mountains Maydanak between the villages Urta-Dara and Kan, above Lyangar, 2 May 1979, Pimenov, Kljuykov, Borjaev, Baranova 271 (MW); Uzbekistan, Kashkadarya Province, Hissar ridge, mt. Maydanak, near observatory

Popov 400 (TASH!); Baysun Mts., Ketmen-Chapty, stony slope, 2600 m, 19 June 1935, Gordienko 235 (MW); UzbekSSR, SW spurs of the Hissar Range, above the village Machay, NW slope of the range Baysuntau, slope to the river Machaydarya, 4 May 1979, Pimenov, Kljuykov, Borjaev, Baranova, Vassiljeva 388 (MW); South-western Hissar, Baysuntau, Zovboshi, juniper forest, 5 May 2013, Turginov s.n. (TASH!); Kuhitang region: Kuhitang Range, Mts. Kuhitang, 06.05.1915, Popov 489 (TASH!); Kuhitangtau, surroundings of the village Shalkan, 1 July 1966, Dzhumayev s.n. (TASH!); Kuhitang Mountains, Kampyrtepa, 18 April 2008, K. Tojibaev s.n. (TASH!). Hissar-Darvaz district, Sangardak-Tupalang region, Hissar Range, UzbekSSR, Hissar Range, Chulbair, the watershed between rivers Sina and Bolungur, in juniper forests among *Ungernia victoris*, 27 May 1960, Korotkova 8137 (TASH!). (12) (Fig.4).

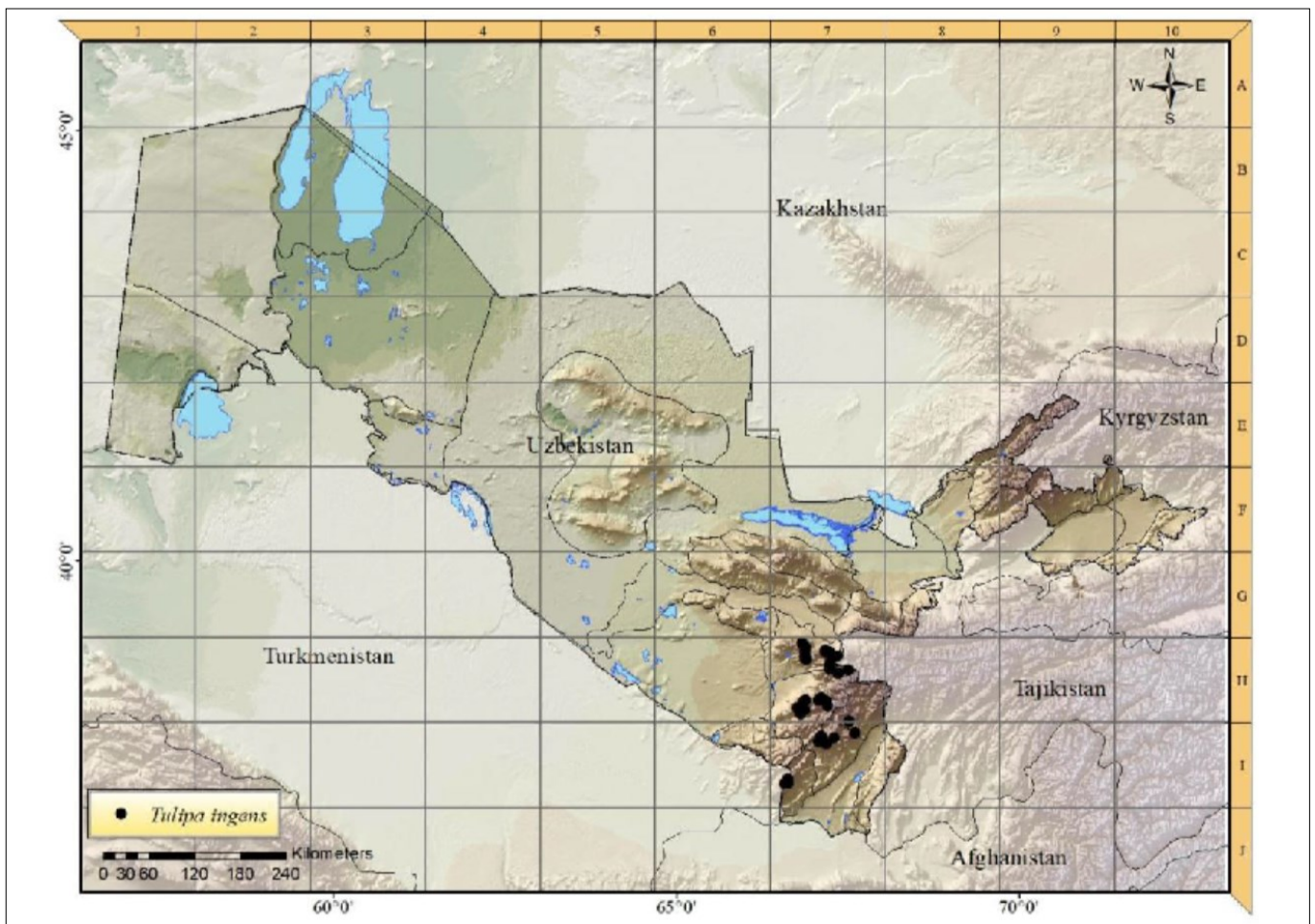


Fig.4. *Tulipa fosteriana* W.Irving.

Maydanak, ca. 2550 m, 9 April 2015, Jang, Choi, Beshko et al. s.n. (TASH!); Kitab Nature Reserve, near village Khodzha-kurgan, north slope, 11 April 2019, Kodyrov, Juramurodov, Akbarov 20190411064 (TASH!); Uzbekistan, Kashkadarya Province, Hissar Range, near the village Langar, 12 April 2019, Maltzev 17 (TASH!); Uzbekistan, Kashkadarya Province, Hissar Range, Kitab Nature Reserve, 12 April 2019, Maltzev 18, 19 (TASH!); Uzbekistan, Hissar Range, basin of the river Kashkadarya, valley of the river Aksu between the villages Hissarak and Ghilan, 4 May 2019, Beshko NB2019024 (TASH!); Baysun region, Hissar Range, mountains near the town Baysun, 27 May 1916,

Distribution in Central Asia

Western Pamir-Alai (Tajikistan, Uzbekistan), Afghanistan (probably introduced)(Fig.5)(16)

Distribution in Uzbekistan

(Fig.6). Kuhistan district, Urgut region, Zarafshan Range, Samarkand Mts., near the pass Takhta-Karacha, 16 April 1915, Popov 133 (TASH!); near the pass Takhta-Karacha, 14 May 1916, Popov 707 (TASH!); Samarkand Mts., near Agalyk, 8 April 1925, Repnikov s.n. (TASH!); Samarkand Province, near the village Alla-Irishan, granite mountains,

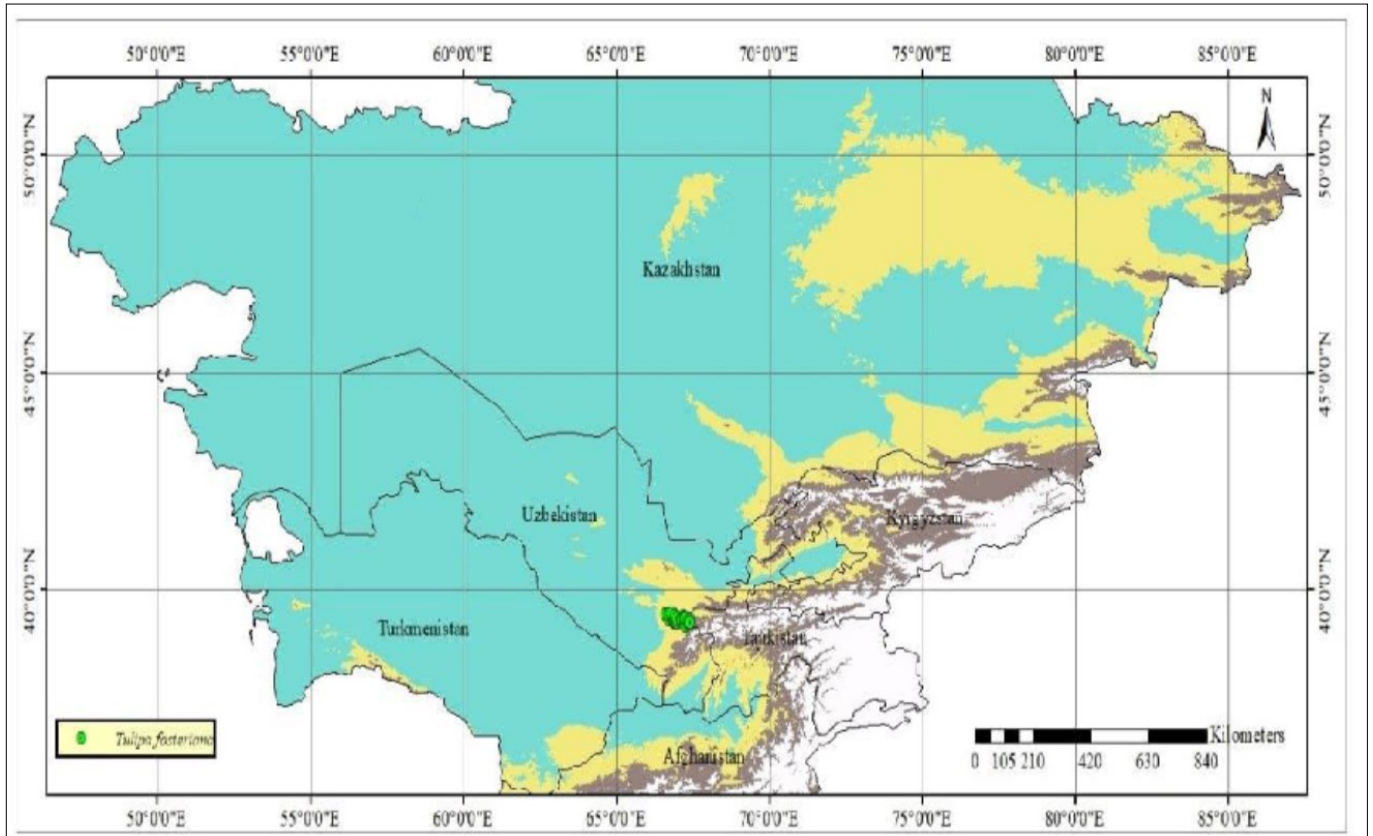


Fig.5. Distribution of *Tulipa fosteriana* in Central Asia.

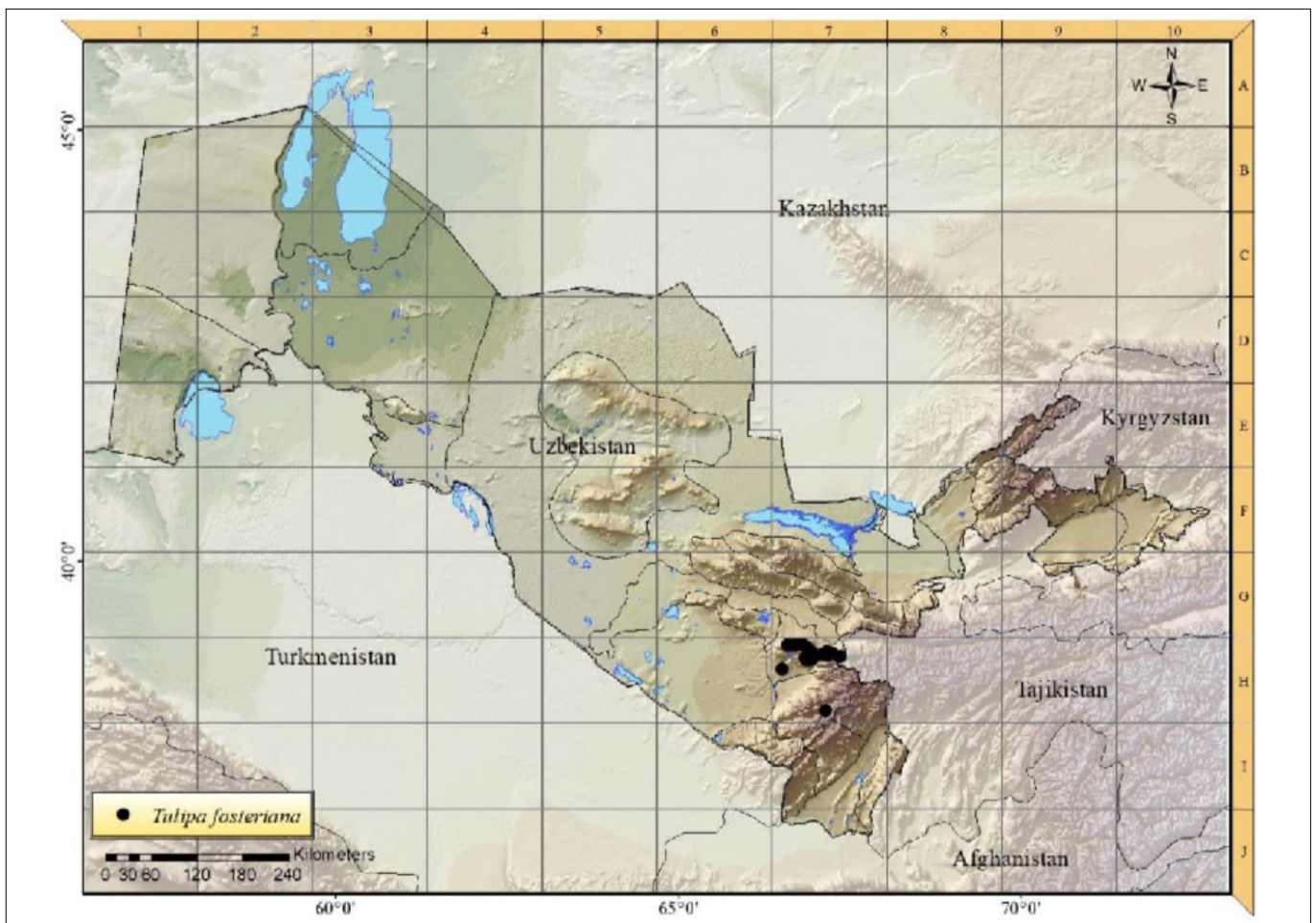


Fig.6. Distribution of *Tulipa fosteriana* in Uzbekistan.

10 May 1925, Popov 120, 125, 134 (TASH!); Samarkand Province, near the village Sazagan, under the pass Urtabel, 14 May 1925, Popov 226 (TASH!); surroundings of Samar-

kand, Urgut, 5 April 1930, Merkulowich s.n. (SAM); Amankutan, Yulsay, on stony slope, 6 April 1931, Nikanorov 3 (TASH!); Amankutan, watershed between Yulsay and

Khodzhisay, 9 May 1931, Nikanorov s.n. (TASH!); Samarkand Mts., surroundings of the village Aksay, upper reaches of the river Aksay, fine earth slopes, 7 May 1931, Butkov 42 (TASH!); Samarkand Mts., surroundings of the village Aksay, among rocks in the upper reaches of the river Aksay, 15–20 May 1931, Butkov 218 (TASH!); Uzbekistania, inter rupes solo argilloso sub cacumine Aktag in montibus Samarkandicis, 20 May 1931, 173 Butkov s.n. (MW); Amankutan forestry, 24 June 1935, Negmatov s.n. (SAM); pass Kamangaran, north slope, 29 June 1935, Smirnova s.n. (SAM); surroundings of Urgut, wet meadow near snow, below the top of Mts. Saryk-tau, 2 May 1936, Gnezdillo 33 (TASH!); surroundings of the village Urgut, the ravine of the river Saylyk, eastern slope, 2 May 1936, Gnezdillo 26 (TASH!); surroundings of the village Urgut, the top of Mt. Kara-kurgan, 3 May 1936, Gnezdillo 47 (TASH!); Mt. Kuhi-Surkh, the gorge Dzhan-kara, wet meadow among rocks near the springs, near the village Ishan, 17 May 1936, Gnezdillo 64 (TASH!); mountains Kyr-tau, Mt. Kuhi-Surkh, on sceleron soil in the gorge Baltydivana, 19 May 1937, Gnezdillo 58 (TASH!); Sangi-dzhuman, eastern slope, 27 May 1937, Fayziev s.n. (TASH, SAM); spurs of Zeravshan Range, mountains Kyr-tau, south-east of the village Kudya-Dag, near the pass, 2 July 1937, Granitov, Dolgikh 321 (TASH!); Urgut, April 1940, Popov, Zakirov s.n. (SAM); surroundings of Urgut, upper mountain zone, July 1952, Khalmatov 52 (TASH!); surroundings of Samarkand, Amankutan, 10 May 1940, Chugavaeva s.n. (TASH, SAM); Amankutan, 6 April 1947, Proskoriakov s.n. (SAM); Amankutan forestry, 28 April 1965, Pryakhin s.n. (TASH!); above the pass Takhta-Karacha, limestones, 3 June 1986, Kazakbaev, Levichev 45 (TASH!); watershed of the Zeravshan Range, ca. 2 km west of the pass Takhta-Karacha, 1878 m, 2 May 2017, Shomurodov, Beshko, Kodyrov s.n. (TASH!); mountains Aktash, village Kaynar, Kaynarsay, 1700–1750 m, Kodyrov, Juramurodov, Makhmudzhanov s.n. (TASH!); above the pass Takhta-Karacha, limestones, 14 April 2018, Kodyrov s.n. (TASH!); mountains Kurgantau, Sevazsay, north slope, 1250–1300 m, 14 April 2018, Kodyrov, Juramurodov, Makhmudjanov U062 (TASH!); southern slope of the Zeravshan Range, upper reaches of the river Kashkadarya above the village Khazrat-Bashir, 21 June 2018, Tojibaev, Beshko, Kodyrov s.n. (TASH!); above the village Saygus, 12 April 2019, Kodyrov 20191204001 (TASH!); surroundings of the village Tersak, Kyzylbel, north slope, 1871 m, 23 April 2019, Kodyrov 20190423012 (TASH!). (6) .

Conclusion

Understanding the distribution patterns, morphological evaluation of wild tulips in critical hotspots and identifying key threats can give a significant insight into their conservation status and help ensure their survival. Due to the high number of tulip species in different regions of Uzbekistan, attempts were made to analyze the distribution of species diversity in the context of regions densely populated with tulip species. Such regions were the Nuratau ridge and its surroundings (15), the Kyzylkum Desert (17), the Fergana Valley (12,14) and the Surkhandarya Province (4). Despite the importance of analyzing the distribution of

tulip species, only very limited attempts have been made to understand the natural requirements of tulip species and the reasons for their rarity(3). Presented species are listed in the Red Data Book of the Republic Uzbekistan (2) and need to develop special legislative acts and effective control over their implementation.

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Compliance with ethical standards

Conflict of interest: The authors declare that there are no conflicts of interest.

Ethical issues: None

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