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Morphologic Issues of Some Red-Listed Species of Section Kolpakowskianae (Tulipa, Liliaceae)

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Abstract: The current work demonstrates morphologic characteristics of close and red-listed species of the sect. Kolpakowskianae based fresh plant specimens. Similar and distinct characters were listed and sixty-nine new characters will be recommended for the forthcoming issue of “Flora of Uzbekistan”. Also, results of molecular investigations related to the species was discussed.

Keywords: Morphologic evaluation, identification, fresh plant specimen, Kolpakowskianae, morphology of tulips, distinct characters, taxonomic status.

Introduction:

Tulipa L. is one of the ornamental and taxonomically complex genera of monocots. Morphology of Tulipa is often obscured and different. In some cases, it is impossible to verify the original description of a supposed species from the type specimen, or from the evidence it supplies to assign its name to other specimens, alive or preserved, with any degree of confidence (Hall, 1940). As Elwes wrote in 1879 "It seems to me very difficult, if not impossible, to understand the characters and affinities of these numerous forms, without having seen and compared these plants in a living state" (Elwes, 1879).

Up to present morphology and taxonomy (Vvedensky, 1941; 1971; Botschantzeva, 1962; Pratov, et al., 2006; Zonneveld, 2009; Tojibaev and Kadirov, 2010; Dekhkonov et al., 2022; Tojibaev, et al., 2022) of the species of Tulipa L. including the sect. Kolpakowskianae investigated efficiently. Although, results of fresh specimen-based morphological investigations are not enough. Especially, counting account into occurrence of the investigating species in similar altitude, habitat and area (Dekhkonov, 2023).

In some cases, high rate of interspecific hybridization and polymorphism lead to confusion or difficulties in the taxonomy of the genus. Especially, the species of the sect. Kolpakowskianae occur in various geographical and ecological niches (Asatulloev et al., 2022; Dekhkonov et al., 2023) which led to variability in morphology. However, color (yellow) of the flower and slender stem are visually similar.

Currently, ten species of the sect. Kolpakowskianae distributed in Uzbekistan (Tajibaev, et al., 2022; Dekhkonov, 2023). The habitats of the species of this section stretch from the western Tien-Shan and Pamir-Alai mountains systems in the east side of study area to the deserts of Kyzylkum in the middle of the Republic of Uzbekistan. Notably, main part of species occur in the mountainous regions or foot of the mountains of the study area except for T. lehmanniana and T. borszczowii which are mainly occur in the deserts.

The current contribution presents morphologic evaluation of close and red-listed (Khasanov, 2019) species (T. korolkowii, T. intermedia, T. scharipovii, and T. feganica) of the sect. Kolpakowskianae based on living specimens and demonstrated similar and distinct characters of the specimens.

METHODS

Study area. Uzbekistan with 448 900 km2 area (fig. 1) located in the heart of Central Asia which considered as a nature imperiled area (Asatulloev, et al., 2023). Approximately, 12% of total area the area are mountains and foothills and the rest of the territory is

plains (Kuchkarov et al. 2018). Main mountainous regions are situated in the north-eastern (Ugam, Chatkal, Kurama, Fergana ranges), south-eastern (Turkestan and Alay), and southern (Hissar, Zeravshan, Babatag ranges) parts of the country. The climate is continental. The average summer temperature is around +40°C, while the average winter temperature is around −23°C (Baratov, et al. 2002).

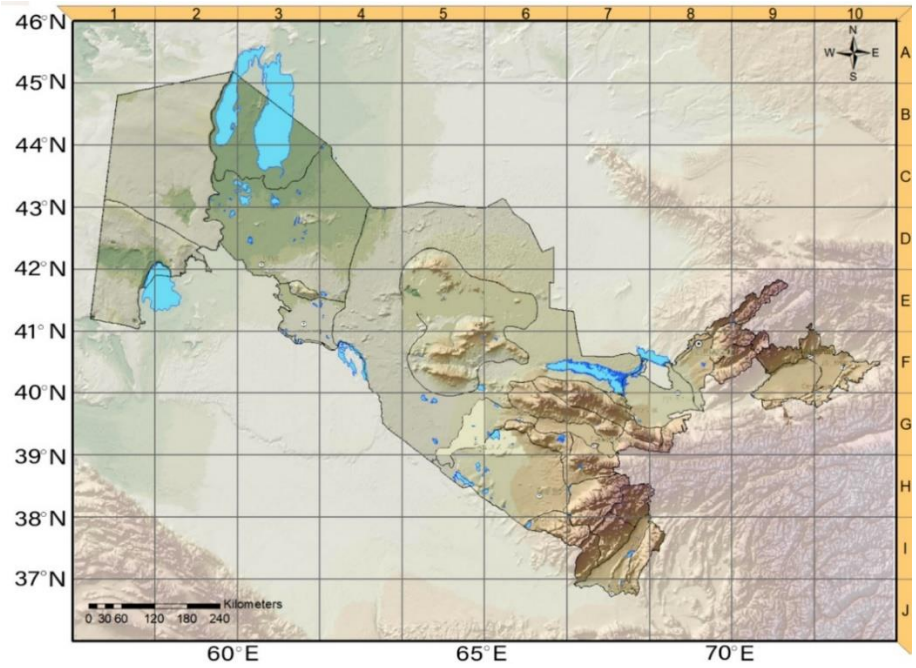

Figure 1. Spatial view and Grid map of Uzbekistan

The most hotspot of tulip diversity of the Republic located in Ferghana valley (Dekhkonov et al., 2021; Dekhkonov et al., 2023). The valley situated at the eastern part of the Republic and bordered by Chatkal range on the northwest side. The eastern side of the valley gradually decreases in latitude and increases in altitude (between 41.41 E–73.32 N and 40.48 E–74.73 N) and includes parts of the Kurama range and it stretches from the west to the north, bordering northern Tajikistan and Uzbekistan and mountain ranges in the Kamchik pass of Uzbekistan.

Field surveys. Extensive field surveys were conducted during the tulip growing season from mid-March to May between 2020 and 2025. The global positioning system coordinates of the specimens and their habitats were recorded by Google Earth software. As a reference datum, the WGS84 geographic coordinate system was employed.

Species identification and taxonomy. The identification of species was confirmed by consulting the protologues and relevant literatures (Zonneveld, 2009; Tojibaev et al., 2022). Taxonomic status was checked by the Plants of the World Online (2023).

Morphological descriptions. According to observations of living plant specimens in wild habitats, changes and additions were made. Photographs used in the morphologic illustration were taken with a Canon EOS 4000D and Nikon D7500 digital cameras.

RESULTS

Morphologic evaluation of selected species fulfilled by use of fresh materials and obtained results presented as follows.

1. Tulipa korolkowii Regel

Bulb ovoid, 1.5–2 cm thick and 2-3 cm long; tunics tough strong and scaly, coriaceous, black (outer) and brown (inner); old tunics form prolonged part at the summit of the bulb (1-2 cm); the apex of the old (outer) tunics lined with plentiful hairs and sparse at base; the inner tunic covered with sparse hairs and the base part is almost glabrous; stem 10–20 cm long, the stem and peduncle glabrous, greenish blue; the underground part is longer (7x5 cm) or equal (4x4 cm) to the upper part of the stem; leaves 3, closely set to more and less widely spaced, glaucous, channeled, progressively decreasing in size up the stem, commonly surpassing the flower; lowest leaf linear-lanceolate or strap-shaped, 0.5–1 cm broad, upper leaf narrowly linear; flower solitary, (red, sometimes yellow) opens to a neat cup progressing to a wide star; perianth segments either red, sometimes yellow or mottled, 1-4.5 cm long, commonly obtuse, sometimes with a very short pubescent point, with a small black blotch without a yellow margin (1/10 of

perianth segment); outer segments rhomboidal (40x22 mm) or obovate; inner segments (35x17 mm) obovate to triangular obovate; stamens (12 mm) two-fifths the length of perianth; filaments (6 mm) bicolored: the lower half black, the upper red or red-purple, thick to the base part; anthers (6 mm) yellow, equal or one half to two-thirds as long as filaments; pollen commonly yellow; ovary greenish, bottle-like, one and a half times shorter than the stamens, stigma sessile, overlapping the ovary, pale yellow; capsule 2-5 cm long, cylindrical with sloping shoulders ending in a small snout (fig. 2B).

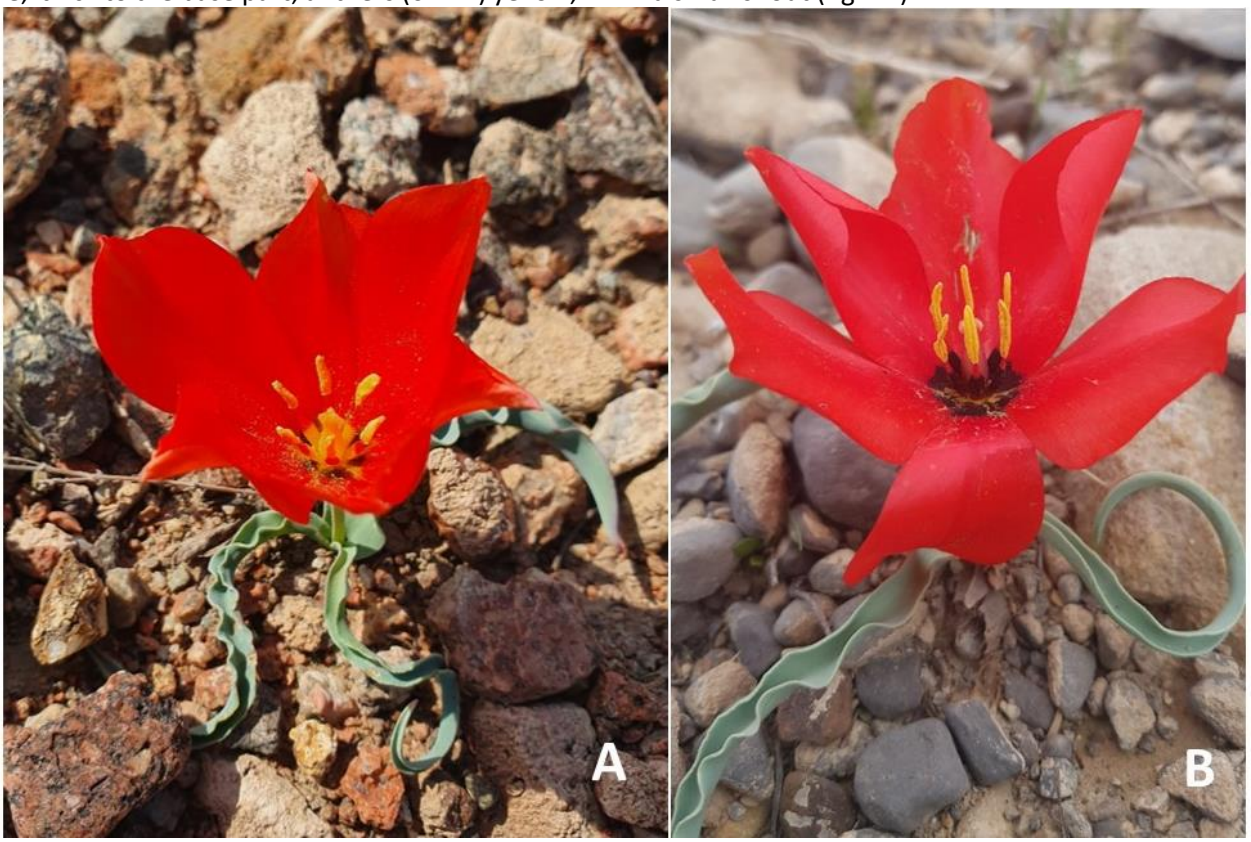

Figure 2. Overall view of *T. intermedia var korolkowoides* (A) and *T. korolkowii* (B). Photos by D.Dekhkonov

2. Tulipa intermedia Tojibaev & J.de Groot

Bulb ovate, 1.5–3.0 cm thick and 2.5-3.0 cm long; tunics thin coriaceous, darkish brown, sometimes old tunics black; old and middle-aged tunics form a set of fibers that protrude to the soil surface; the upper part of the bulb densely covered with brownish-gold appressed hairs; the base of the bulb covered sparsely with short hairs; the middle part glabrous; stem 6-15 cm tall (peduncle included), smooth; the underground part (5-10 cm) of the stem longer than the upper part (2-4 cm); the underground part covered with a set of prolonged tunic fibers which protect from the physical interaction of stones and gravels; occurring in one population, usually, red form (6 cm) is shorter than yellow form (15 cm); leaves 3, nearly verticillate, 5–7 cm long, 0.5-10 mm wide, smooth, lanceolate, curled, with undulate margins; flower solitary; perianth segments yellow, orange or red (fig. 2A); sometimes at the base small brownish spots (2-4 mm) in yellow forms and darker-brownish blotch (2-3 mm) in red forms; acute or with a small cusp at apex, sometimes obtuse, 1.0–1.5 cm wide, 3 cm long; outer segments rhomboidal, with both surfaces similar, curving inwards (concave) instead of curving inside; inner segments are curving inwards (concave) instead of curving inside; stamen 1.0–1.3 cm long, half of the perianth; filaments 6–7 mm long, yellow, smooth, from the base with almost parallel margins, but with a slightly inflated part in the middle; anthers yellow, almost equal to the filaments; ovary bottle-like, pale yellow, shorter than stamen; pollen yellow; in orange form outer perianth forms triangle separation from inner perianth segments (fig. 3).

Figure 3. Overall view of *T. intermedia.* Photo by D.Dekhkonov from the *locus-classicus* of the species

3. Tulipa scharipovii Tojibaev

Bulb ovoid, 1.5-3 cm long and 1.0-2.5 cm wide, outer tunics coriaceous, darkish brown, non-prolongated; looks like that the upper end of tunics cut rectilinear or brownish woolly hairs can be found visually; old tunics form some (over 20) defending the bulb layers; the upper part of the tunic is densely covered with brownish-yellow long hairs; pubescence level is intensive on the upper surface of old tunics than middle-aged and young tunics; the middle part of the bulb is glabrous; the base of the bulb is covered with long milky-yellow hairs that are very sparse in old tunics; the color of the tunic to the inside changes from dark brown to light brown; stem glabrous 6–20 cm long; sometimes upper part of the stem is equal (5x5 cm) to the underground part or slightly shorter (8x6 cm); leaves 3, 7–10 cm long, glabrous, lanceolate, nearly verticillate, curled in the living stage with undulate margins; lowest leaf 0.5–1 sm thick; flower solitary; perianth segments yellow without spots; outer segments elliptic or prolonged in the upper part obtuse or emarginated, 2 cm width; inner segments elliptic in the upper part emarginated with single hairs, 2 cm width, 2.5 cm long; stamen 9–10 mm long, 2–2.5 times shorter than perianth; filaments yellow, glabrous; anthers yellow as long as filaments; ovary greenish, bottle-like, shorter than stamen (fig. 4A).

3. Tulipa ferganica Vved.

Bulb ovoid, 1.5–3 cm thick and 1.5-3 cm long; tunics black to brownish, tough coriaceous; the surface of apex densely covered with long and brownish-yellow hairs where the hairs are sparsely at the base; old tunics have more intensive pubescence than youngers; the middle part of the bulb is glabrous; stem 10–40 cm long, the upper part of stem and peduncle pubescent; the ratio of upper and underground part is different; leaves 3, sometimes 4(5), commonly spreading, approximate, rarely scattered, more or less pubescent, ciliate, crisp, rather abruptly decreasing in size up the stem; usually leaves do not surpass the flower but a contrary situation can be observed; lowest leaf lanceolate or oblong, 7-20 cm long and 1.5–4 cm broad; the upper leaves 5-17 cm long; flowers solitary, opening to a wide reflexing star; perianth segments 2.5–5 cm long, yellow, on the outside bluish pink; outer segments (30x12 mm) violet-tinged outside, oblong to oblong-rhomboidal, gradually acuminate or acute and pubescent tip; inner segments (32x12 mm) oblong with the acuminate top terminating in a slightly pubescent or naked tip; stamens (12 mm) two or three times shorter than the perianth; filaments (6 mm) naked, bright yellow; anthers (6 mm) bright yellow, oblong, broader at the base, equal or slightly shorter (5x3 mm) than filaments; ovary yellowish-green, slightly shorter (10 mm) than stamens, with subsessile stigma; capsule 1.5–2 cm broad, 2.5–4 cm long (fig. 4B).

Figure 3. Overall view of *T. shcaripovii* from *locus-classicus* (A)and *T. ferganica* (B). Photos by D.Dekhkonov

DISCUSSION

Comparison of morphologic characters of tulips evaluated using 22 most important features (table 1). Our morphologic analysis showed resemblance of morphologic characters of T. korolkowii and T. intermedia where 16 characters were similar out 22 characters. The difference of between species can observed in the tunic fibers that protrude to the soil surface and color, color of blotch and filaments, position of anthers to filaments and color of ovary. However bicolored filaments which is in T. korolkowii (red-black) occur in red form of T. intermedia (yellow-red or reddish) also.

Table 1

Morphologic characters of the species of sect. *Kolpakowskianae*

Species **Characters**	***Tulipa korolkowii***	***Tulipa intermedia***	***Tulipa ferganica***	***Tulipa scharipovii***
Bulb shape	ovoid	ovoid	ovoid	ovoid
Bulb type	coriaceous	coriaceous	coriaceous	coriaceous
Tunic prolongation	no	prolonged	no	no
Tunic color	black	darkish brown	black	darkish brown
Pubescence of tunic apex	densely	densely	densely	densely
Pubescence of tunic base	sparse	sparse	sparse	sparse
Peduncle length	short	short	long	long
Peduncle pubescence	glabrous	glabrous	pubescent	glabrous
Stem pubescence	glabrous	glabrous	pubescent	glabrous
Leaves number	3	3	3, 4(5)	3

Leaves pubescence	glabrous	glabrous	pubescent	glabrous
Flower shape	cup	cup	star	cup
Color perianth	red, yellow	red, yellow	yellow	yellow
Color of blotch	black	brown	no	no
Filaments	bicolored	yellow	yellow	yellow
Filaments pubescence	glabrous	glabrous	glabrous	glabrous
Color of anthers	yellow	yellow	yellow	yellow
Position of anthers to filaments	long	equal	equal	equal
Color of pollen	yellow	yellow	yellow	yellow
Color of ovary	greenish	yellow	yellowish-green	greenish
Shape of ovary	bottle-like	bottle-like	bottle-like	bottle-like
Position of ovary to stamen	shorter	shorter	shorter	shorter

Notable, T. ferganica and T. scharipovii visually close, however color of tunic, pubescence of vegetative parts and form of flower considered as different characters. But pubescence of the vegetative parts of T. ferganica differs the species from T. scharipovii, T. korolkowii and T. intermedia.

The taxonomy and morphology of the species of Kolpakowskianae section is very complex. Hall (1940) stated the section that the species may “not belong to the same natural group or subgenus”. Many molecular phylogenetic research results revealed that representatives of Kolpakowskianae don’t form a single clade (Christenhusz 2013; Wilson 2023; Dekhkonov 2025)

Many research results showed close location of T. intermedia with T. korolkowii and some authors synonymized (Wilson 2023) or gave the subspecies status to T. intermedia (Dekhkonov 2025). Despite of the species status of these works, the ststus of the species is accepted in POWO (Plants of the World Online, https://powo.science.kew.org/taxon/urn:lsid:ipni.org:names:77143360-1/general-information).Taking account into some differences in morphology, restricted geographic area and habitat (Chap badlands), the species status of T. intermedia requires detailed genome investigations.

Despite of close location of T. scharipovii and T. ferganica in the cp tree (Dekhkonov 2025), the species have some significant distinct characters. The habitat of T. scharipovii and T. ferganica is fully restricted where the first species distributed in saline loess soils of small and restricted area of Chap foothills and the latter species mainly grows in stony slopes of middle mountains belt of Kurama, Ferghana, Alay and Turkestan ranges. Morphologically T. scharipovii differs from T. ferganica by the bulb color and pubescence, pubescence of stem, leaves and tepals, form of tepal and leaves, anther position than filaments and shape of ovary. Analyzing of morphologic and molecular data, we consider T. scharipovii and T. ferganica as a separate species completely.

CONCLUSION

Four species of the sect. Kolpakowskianae based on fresh plant specimens was investigated by the use of 22 most morphologically important characters. Similar and distinct characters of the selected species are presented for the easy identification of investigators. Sixty-nine new characters will be recommended for the forthcoming issue of “Flora of Uzbekistan”. The taxonomic status of the species of the section is very complex which the status of T. intermedia should be defined by the use of detailed genome investigations further.

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