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SYSTEMATIC STUDY OF ARID TERRITORIES

The Current State of Cenopopulations of Some Endemic and Rare Species of the Genus *Tulipa* L. (Liliaceae) in the Tashkent Region (Uzbekistan)

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Abstract—The study of the ontogenetic structure of the coenotic populations of vulnerable, endemic, and rare plant species makes it possible to assess their state under the conditions of anthropogenic transformation of ecosystems and develop the scientific basis for their protection. Central Asia is one of the centers of origin and species diversity of the genus *Tulipa* L. In the flora of the Republic of Uzbekistan, there are 34 species of tulips, of which 19 species (55.88%) are endangered due to the collection of flowers and bulbs and overgrazing and habitat destruction. These are listed in the national Red Book. This article is devoted to the assessment of the current state of 13 coenotic populations of five rare and endemic species of the genus *Tulipa* (*T. borszczowii, T. butkovii, T. dubia, T. greigii, T. korolkowii*), growing in the Tashkent region of Uzbekistan in areas with different environmental regimes and levels of anthropogenic pressure. It has been established that eight studied cenopopulations are normal and full-membered; five populations are incomplete, they lack senile individuals, which is a biological feature of the genus *Tulipa*. Six cenopopulations belong to the left-sided type, their ontogenetic spectrum coincides with the characteristic spectrum of the genus *Tulipa*; four coenopopulations have a centered type of spectrum, while three are bimodal. The low proportion of juveniles in some of the cenopopulations studied is due to the influence of overgrazing, as well as high competition with other species in the community. It is recommended that a rare endemic of the Central Asian deserts be included in the next edition of the Red Book of Uzbekistan *Tulipa borszczowii* and national endemic, narrow-local endemic of the Chatkal ridge *Tulipa butkovii*. It is recommended to create a protected area (zakaznik or natural monument) to preserve the relic sandy massif Dalverzinskie sands in the Tashkent region.

Keywords: anthropogenic press, Red Data Book, ontogenetic structure, rare species, Uzbekistan, cenopopulation, endemic, Liliaceae, Tulipa L.

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In connection with the growing anthropogenic impact on ecosystems, the targeted study of vulnerable endemic rare species and plant communities is becoming increasingly important (Denisova, Guseva, 2016). The ontogenetic structure is one of the key parameters of a population; this side structural organization provides the ability of the population for self-maintenance and determines its stability (Zaugolnova, 1994; Zhukova, 1995). An analysis of the ontogenetic structure makes it possible to predict the future the fate of populations of plant species (Cheremushkina, 2004; Osmanova, 2007).

The genus *Tulipa* L. is one of the largest, most taxonomically complex, and intensively studied genera in the family Liliaceae Juss. and in the class of monocots as a whole (Hall, 1940; Bochantseva, 1962; Baranova, 1999; Ivashchenko, 2005; Pratov et al., 2006; Zonneveld, 2009; Tozhibaev and Kadyrov, 2010; Christenhusz et al., 2013; Everett et al., 2013; Tojibaev and Beshko, 2015; Wilson et al., 2021; Dekhkonov et al., 2021). The unrelenting interest of researchers in the genus *Tulipa* is associated with the decorative qualities, wide distribution, and species diversity of tulips. Wild tulips play an important role in the ecosystems and cultures of many peoples and represent a valuable genetic resource for cultivar breeding. At the same time, many types *Tulipa* are under the threat of extinction due to the massive collection of flowers and bulbs, overgrazing, anthropogenic degradation of habitats and their economic development, as well as climate aridization. In the IUCN Red List (2022), four species of tulips are classified as globally threatened, including three with CR (Critically Endangered) status: *Tulipa albanica* Kit Tan & Shuka (Albania), *T. gumusanica* Terzioglu (Türkiye), *T. akamasica* Christodoulou, Hand & Charalambous (Cyprus); in one view *T. cypria* Stapf ex Turrill (Cyprus) is categorized as EN (Endangered). Many types of wild tulips are listed in national or regional Red Books.

Central Asia, especially its mountainous part, is the center of origin and species diversity of the genus *Tulipa* (Bochantseva, 1962; Ivashchenko, 2005; Tojibaev and Kadyrov, 2010; Tojibaev and Beshko, 2015). The "Key to Plants of Central Asia" (Vvedensky and Kovalevskaya, 1971) lists 63 species, and 12 more species were described after the publication of this fundamental summary. According to modern information, there are 34 species of the genus in the flora of Uzbekistan. *Tulipa* (Tojibaev, Beshko, 2015), of which 19 species (55.88%) are listed in the new edition of the National Red Data Book of the Republic of Uzbekistan (2019). Unfortunately, despite the fact that legislation establishes a special legal status that provides a ban on their removal from nature and destruction of habitats for species listed in the Red Book, many tulip populations are subject to significant anthropogenic pressure, especially outside protected areas. One serious problem is the massive illegal collection of wild tulips for bouquets. In this regard, studies on the distribution and condition of populations of wild-growing tulips in Uzbekistan and the assessment of the impact of anthropogenic factors on them are of great relevance (Abduraimov, 2017; Shomurodov, Abduraimov, 2017; Abduraimov et al., 2020; Shomurodov et al., 2021; Dekhkonov et al., 2021).

The purpose of this work was to assess the current state of coenotic populations of some endemic and rare species of the genus *Tulipa* L. growing in the Tashkent region of the Republic of Uzbekistan in areas with different environmental regimes and levels of anthropogenic pressure.

MATERIALS AND METHODS

The Tashkent region is located in the northeastern part of Uzbekistan and borders on Kazakhstan in the north and northwest, Kyrgyzstan in the northeast, Namangan region in the east, Tajikistan in the south, and Syrdarya region in the southwest. Its area is about 15 300 km^2, its population is more than 2.9 million people, and the average population density is about 173 people/km^2. In physical and geographical terms, the study area is located in the middle part of the Syrdarya river basin and includes the basins of its two large right-bank tributaries, the Chirchik and Akhangaran rivers. Geomorphologically, there is a flat part, which occupies the western and central parts of the region, and a mountainous part, represented by the ranges of the Western Tien Shan. The absolute height of the area lies in the range from 250–260 to 4395 m above sea level. According to its natural and climatic conditions, the territory of the Tashkent region belongs to the continental semi-arid climate zone (Aramov, 2012). Most of the ecosystems characteristic of Uzbekistan are represented within the region, from tugai and sandy desert, which are currently preserved only fragmentarily, to alpine and subnival ones. Anthropogenic landscapes predominate in the plains and foothill areas.

As a result of studies conducted in 2021, 13 cenopopulations of five types of tulips were studied: *Tulipa korolkowii* Regel (CPU 1, 2, 3), *T. borszczowii* Regel (CPU 4), *T. butkovii* Botschantz. (CPU 5, 6), *T.greigii* Regel (CPU 7, 8, 9, 10, 11, 12) and *T. dubia* Vved. (CPU 13; Fig. 1). Data on the studied cenopopulations are given below in Table 1. The projective coverage of species of the genus *Tulipa* in cenopopulations was 1–5%.

***Tulipa korolkowii* Regel** is endemic to mountainous Central Asia with a scattered range and declining numbers. The range covers the Southwestern Tien Shan, Western and Southern Pamir-Alai (Uzbekistan, Kazakhstan, Kyrgyzstan, Tajikistan, Turkmenistan). On the territory of Uzbekistan it is found in Tashkent, Jizzakh, Samarkand, Navoi, Kashkadarya and Surkhandarya regions. It grows in single specimens or scattered populations on stony and rubbly slopes, from foothills to the middle belt of mountains. It flowers in March–April and fruits in June–July. It is protected in the Nurata, Zaamin, Kitab, Gissar and Surkhan reserves, Zaamin national park. It is listed in the Red Book of the Republic of Uzbekistan (2019) with status 3 (vulnerable, declining species). The species is also listed in the Red Books of the Republic of Kazakhstan (2014), the Kyrgyz Republic (2006) and the Republic of Tajikistan (2015). The state of populations of this species in the Western Pamir-Alai was previously studied by O.S. Abduraimov et al. (Abduraimov et al., 2020); however, the populations growing in the Western Tien Shan have not been previously studied. During expeditionary research in 2021, three *T. korolkowii* cenopopulations were described in the Tashkent region (TP 1, 2, and 3). CP 1 was noted in the forb-ephemeral-ephemeroid community (*Carex pachystylis* + *Poa bulbosa* + *Alyssum desertorum* + *Holosteum umbellatum* + *Ixiolirion tataricum* + *Tulipa bifloriformis*), CP 2 was found as part of the forb-ephemeroid community (*Carex pachystylis* + *Poa bulbosa* + *Achillea wilhelmsii* + *Ixiolirion tataricum* + *Centaurea virgata* subsp. *squarrosa*), and CP 3 is part of the ephemeral-eremurus-grass community (*Poa bulbosa* + *Bromus tectorum* + *Taeniatherum caput-medusae* + *Thinopyrum intermedium* subsp. *intermediate* + *Eremurus sogdianus* + *Alyssum alyssoides*). All of them grow in an unprotected area (Fig. 1) and experience significant anthropogenic pressure. The main negative factors affecting the studied cenopopulations are listed in Table 1.

***Tulipa borszczowii* Regel** is endemic to the northern deserts of Central Asia; it grows in small scattered populations in sandy and rocky deserts, as well as in remnant low mountains. It blossoms in late March–April and bears fruit in May. Its range covers the Kyzylkum, the Betpakdala desert and the Aral Sea region (Vvedensky, Kovalevskaya, 1971; Ivashchenko, 2005). The

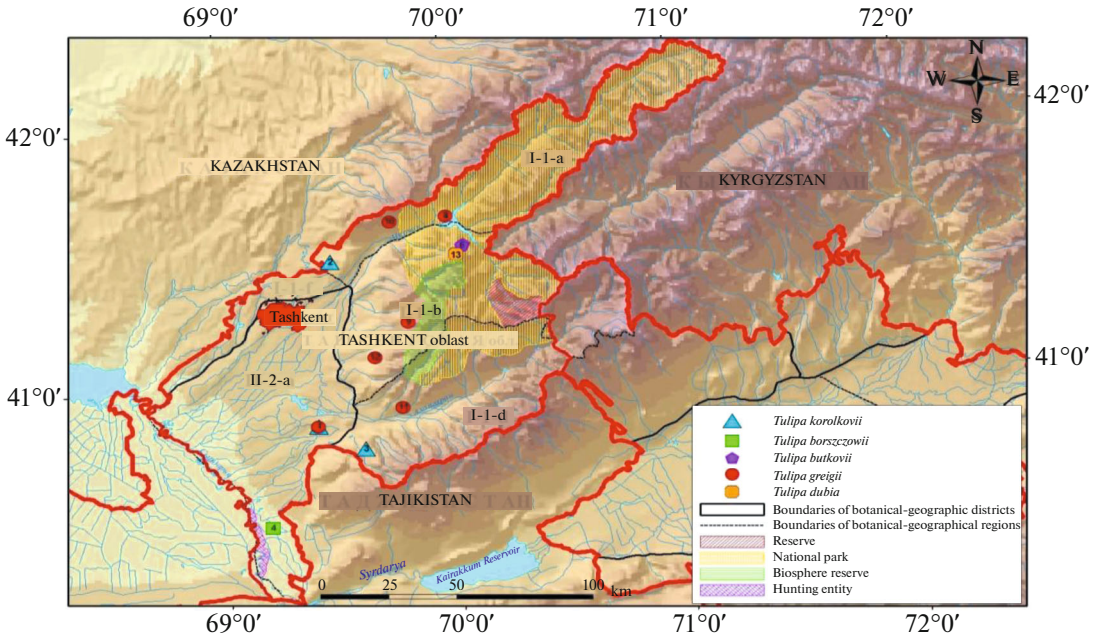


Fig. 1. The locations of the studied cenopopulations.

species was considered endemic to Kazakhstan (Ivashchenko, 2005) and listed in the Red Data Book of the Republic of Kazakhstan (2014). In recent years *T. borszczowii* were also found on the territory of Uzbekistan, in Central and Southeastern Kyzylkum, on the territory of Jizzakh and Navoi regions (Tojibaev, Beshko, 2015; Shomurodov, Abduraimov, 2017). In 2021 cenopopulation *T. borszczowii* was found in the Bekabad district of the Tashkent region, in the Dalverzin sands (CP 4) as part of the ephemeral-ephemeroid-dzhuzgun community (*Calligonum litwinowii* + *Calligonum microcarpum* + *Carex pachystylis* + *Poa bulbosa* + *Bromus tectorum* + *Draba verna*). This is a new previously unknown locality of the species; the nearest known populations grow in Southeastern Kyzylkum on the eastern coast of Lake Tuzkan. The state of the Kyzylkum populations of the species was previously studied by O.S. Abduraimov (2017). The studied *T. borszczowii* population is located in an unprotected area (Fig. 1); it is threatened by intensive grazing, the development of a sandy massif for farmland, and sand mining.

***Tulipa butkovii* Botschantz** is a local endemic of the western part of the Chatkal Range, a national endemic of Uzbekistan (Vvedensky, Kovalevskaya, 1971). Its range covers a section of the northern slope of the Chatkal Range between the city of Maly Chimgan and the Akbulak river (about 170–175 km^2), where it grows in scattered populations on fine-earth, rubbly, and rocky slopes in the middle mountain belt. Flowering in April–May, fruiting in May–June. *T. butkovii* was included in the first, second, and third editions of the Red Book of the Republic of Uzbekistan (1984, 1998, 2006), but was subsequently excluded due to the fact that its taxonomic position as an independent species was called into question (Van Raamsdonk, de Vries, 1995; Tozhibaev, 2010). According to preliminary estimates (Tojibaev and Beshko, 2015), this species meets the IUCN criteria for the Endangered (EN) category. The plant is protected in the Chatkal Reserve and the Ugam-Chatkal National Park. The ontogenetic structure of the cenopopulations of the species has not been previously studied. In 2021, two cenopopulations were studied with the participation *T. butkovii* (CPs 5 and 6) as part of a forb-shrub community (*Prunus erythrocarpa* + *Prunus mahaleb* + *Spiraea hypericifolia* + *Ferula tenuisecta* + *Prangos pabularia* + *Eremurus lactiflorus* + *Eremurus turkestanicus*), while both are located on the territory of the national park (Fig. 1) in a tract popular among tourists and vacationers. The recreational factor currently has a moderately negative impact on the population, collecting tulips for bouquets is suppressed by the inspectors of the national park. However, in recent years, the recreational pressure on the ecosystems of the national park has been steadily increasing and one can confidently predict an increase in anthropogenic pressure on the populations of the species.

***Tulipa greigii* Regel** is endemic of the Northern and Western Tien Shan (Uzbekistan, Kazakhstan, Kyrgyzstan, and Tajikistan). It is listed in the Red Book of the Republic of Uzbekistan (2019) with status 3 (vulnerable, declining species). The species is also listed in the Red Books of the Republic of Kazakhstan (2014), the Kyrgyz Republic (2006) and the Republic of Tajikistan (2015). On the territory of Uzbekistan it is found in

Table 1. The characteristics of the studied cenopopulations (CP)

CPU No.	Location	Geographical coordinates	Altitude m above sea level BS	CPU area, ha	Anthropogenic factors	Plant community	General PP herbage, %	PP type, %
1	2	3	4	5	6	7	8	9
Tulipa korolkowii								
1	Pskentsky district, lower reaches of the river. Angren, the vicinity of the village Gultepa and the cemetery "Bobo-Gozi"	40.86993° N, 69.40286° E	417	1	Livestock grazing, agricultural land development	Miscellaneous-herbal-ephemeral	60	2
2	Kibrai region, foothills of the ridge. Karzhantau, environs of the village. Maisky, White Sands tract	41.49887° N, 69.48399° E	675	3	Livestock grazing, dirt road use, sand pit mining, garbage dump	Forbs-ephemeraroid	40	1
3	Pskentsky district, foothills of the Kuraminsky ridge, south of the city of Almalyk, Karasai tract	40.77909° N, 69.60288° E	792	5	Grazing	Ephemeral-Eremurus-Grass	40	1
Tulipa borszczowii								
4	Bekabad district, valley of the middle course of the river Syrdarya, Dalverzin sands	40.48678° N, 69.18714° E	270	50	Livestock grazing, sand mining, agricultural land development	Ephemeral-ephemeral-dzhuzgunovoe	30	1
Tulipa butkovii								
5	Bostanlyk district, Chatkal ridge, Chimgan mountain range, Ugam-Chatkal National Park, Gulkam tract, right (northern) slope	41.55186° N, 70.07034° E	1176	30	Recreation	Forbs-shrubkovo	30	3
6	Left (southern) slope of the Gulkam tract	41.54476° N, 70.06546° E	1324	10	Recreation	Forbs-shrubkovo	40	4
Tulipa greigii								
7	Pskentsky district, lower reaches of the river Angren, vicinity of Gultepa village, holy place and cemetery "Bobo-Gozi"	40.86847° N, 69.4002° E	424	0.1	Virtually absent	Cereal-ephemera-roid	85–90	2

Table 1. (Contd.)

CPU No.	Location	Geographical coordinates	Altitude m above sea level BS	CPU area, ha	Anthropogenic factors	Plant community	General PP herbage, %	PP type, %
1	2	3	4	5	6	7	8	9
8	Bostanlyk district, Ugam-Chatkal national park, foothills of the Ugam ridge. between kishlaks Khumsan and Sidzhak	41.60137° N, 69.99819° E	1270	40	Recreation, haymaking	Forbs-couch grass	70	2
9	Parkent district, Chatkal ridge, outskirts of Sukok village	41.260391° N, 69.812325° E	1399	7	Recreation, grazing	Forbs-eremurus-almond	18–20	1
10	Bostanlyk district, Ugam-Chatkal national park, Mt. Karzhantau, southern slope of the Aktashsay tract	41.646496° N, 69.753532° E	1076	5	Recreation, haymaking	Forbs-rose hips	35	2
11	Akhangaran district, Chatkal ridge, Talbulaksay tract	40.932854° N, 69.771532° E	802	8	Recreation, agricultural land development	Forbs-Flemis-Eremurus	60	1
12	Parkent district, foothills of the Chatkal ridge, 3 km from the village Krasnogorsk	41.128615° N, 69.660791° E	719	15	Recreation, grazing	Forbs-sedge-eremurus-andiz	70	2
Tulipa dubia								
13	Bostanlyk district, Chatkal ridge, Chimgan mountain range, Ugam-Chatkal National Park, Aksai tract (central couloir of the Big Chimgan)	41.51366° N, 70.03878° E	1983	1.7	Recreation, grazing	Ligular-ram	60	5

Tashkent and Namangan regions, protected in the Chatkal Reserve, Ugam-Chatkal National Park and Ugam-Chatkal Biosphere Reserve. It grows in single specimens or scattered populations on clayey and rocky slopes of foothills, lower and middle mountain belts. Flowering in April–May, fruiting in June–July. The ontogenetic structure of the cenopopulations of the species in Uzbekistan has not been previously studied. In 2021, of six cenopopulations that contain *T. greigii,* one of them (CP 7) grows in the composition of the cereal-ephemeroid community (*Carex pachystylis* + *Poa bulbosa* + *Hordeum bulbosum* + *Hordeum spontaneum* + *Elaeosticta allioides*), in the fenced area of the holy place and cemetery and practically does not experience the negative impact of anthropogenic factors. CP 8 is located on the territory of the Ugam-Chatkal National Park as part of a forb-couch grass community (*Thinopyrum intermedium* subsp. *intermediate* + *Hordeum bulbosum* + *Centaurea virgata* subsp. *squarrosa* + *Hypericum perforatum* + *Origanum tythanthum* + *Ziziphora pedicellata*), among apricot plantations (*prunus armeniaca*), in an area used as grassland, which is also a popular place for spring picnics. In this area located near the highway, collection

of tulips for bouquets is often noted. The remaining cenopopulations (CP 9–12) grow in the unprotected area (Fig. 1); the main negative factors that affect them are listed in Table 1. CP 9 was noted in the forb–eremurus–almond community (*Prunus amygdalus* + *Eremurus robustus* + *Poa angustifolia* + *Capsella bursa pastoris*), CP 10 – as part of the forb-rose hip community (*Rosa webbiana* + *Rosa kokanica* + *crambe cordifolia* subsp. *kotschyana* + *Poa bulbosa*), CP 11 is part of the forb-flomis-eremurus community (*Eremurus regelii* + *Phlomis regelii* + *capparis spinosa* var. *herbacea* + *Phlomoides isochila*), and CP 12, is part of the forb-sedge-eremurus-andise (*Eremurus regelii* + *Inula grandis* + *Carex pachystylis*).

***Tulipa dubia* Vved** is endemic of the Western Tien Shan (Uzbekistan, Kazakhstan, Kyrgyzstan). Listed in the Red Book of the Republic of Uzbekistan (2019) with status 3 (vulnerable, declining species). On the territory of Uzbekistan it is found in Tashkent and Namangan regions, protected in the Chatkal Reserve, Ugam-Chatkal National Park and Ugam-Chatkal Biosphere Reserve. It grows in single specimens or scattered populations on rocky slopes and screes in the middle and upper mountain belts. It blossoms in April–June and bears fruit in May–August, depending on the altitude of the area. A cenopopulation that contains this species (CP 13) was described in the Bostanlyk district of the Tashkent region, in the Aksai tract (the central couloir of the Greater Chimgan), at an altitude of 1983 m a.s.l. BS in the ligular-ram community (*Koenigia coriaria* + *Ligularia alpigena*) with another endemic of the Western Tien Shan, *T. tschimganica* Botschantz. The species was included in the first, second, and third editions of the Red Book of the Republic of Uzbekistan (1998, 2006, and 2009) with status 2, but subsequently has been excluded due to the fact that this taxon was reduced to subspecies of Kaufmann's tulip: *T. kaufmanniana* subsp. *tschimganica* (Botschantz.) Tojibaev (Tojibaev, 2010). CP 13 grows on the territory of the Ugam-Chatkal National Park, near the tourist trail in one of the most visited tracts, where, moreover, cattle are intensively grazing in the summer.

All studied species are bulbous perennials and ephemeroids.

The structure of cenopopulations was studied by the generally accepted method (Uranov, 1975; *Tsenopopulyatsii rastenii*..., 1976). Transects were laid with a length of 10 m, divided into sites of 1 m^2 each. In each cenopopulation, from 30 to 50 registration sites of 1 m^2 were laid, on which all individuals of tulips were counted, as broken down by age groups. Since the studied species are vulnerable and most of them have conserved status, the ontogenetic state of individuals was determined by aboveground organs, and generative plants were not divided into young (g1), middle-aged (g2) and aging (g3). Using GPS, the area occupied by each population was determined.

Geobotanical descriptions of plant communities were carried out according to the standard methodology on sites of 100 m^2 (*Polevaya geobotanika*, 1964). All plant species were recorded, their abundance, height, vitality and phenophase, total projective cover of the herbage (TPC), projective cover of the species (PPC). The condition of the vegetation cover, the anthropogenic factors affecting it, and the degree of impact were also noted.

The ontogenetic structure of cenopopulations is defined as the ratio of individuals of different ontogenetic states in a cenopopulation. An individual is taken as a counting unit. When characterizing the population structure, they relied on the concept of a characteristic ontogenetic spectrum (Zaugolnova, 1994). According to the nature of the distribution of ontogenetic groups, four types of spectra are distinguished: left-sided, centered, right-sided, and bimodal. The characteristic spectrum depends on the biological characteristics of the species.

Cenopopulations were described according to the classification of A.A. Uranov and O.V. Smirnova (1969). The population density was determined as the number of individuals per unit area. In this case, the average density was determined, i.e., number per unit of the entire surveyed area, and ecological density, i.e., number per unit of area actually occupied by the population (Odum, 1986). When determining the values of the aging index and recovery index, the method of N.V. Glotova (1998), A.R. Ishbirdin, and M.M. Ishmuratova (2004) was used.

The accepted Latin names of the studied species are given according to the international Plants of the World Online database (2022).

RESULTS AND DISCUSSION

In the course of our research, the ontogenetic structures of 13 cenopopulations of five species of wild tulips was studied: *Tulipa korolkowii* (3) *Tulipa borszczowii* (1), *Tulipa butkovii* (2) *Tulipa greigii* (6) and *Tulipa dubia* (1). Based on the characteristics of the biology of tulips (high seed productivity and seed germination, a long pregenerative period, the ability to vegetative reproduction), the characteristic range of cenopopulations of the studied species should be considered left-sided (Smirnova, 1987).

It was found that according to the classification of A.A. Uranov and O.V. Smirnova (1969), the studied cenopopulations (CP) species of the genus *Tulipa* L. are normal, CP 1, 2, 5, 6, 8, 9, 12, and 13 are full members, and CP 3, 4, 7, 10, and 11 are incomplete. The left-sided type includes six cenopopulations (CP 1, 2, 4, 6, 9, and 10), four are centered (CP 3, 7, 11, and 12) and three are bimodal (CP 5, 8, and 13).

Cenopopulations with a left-sided type of spectrum. The ontogenetic structure of the majority of the studied cenopopulations is of the left-sided type (CP 1, 2,

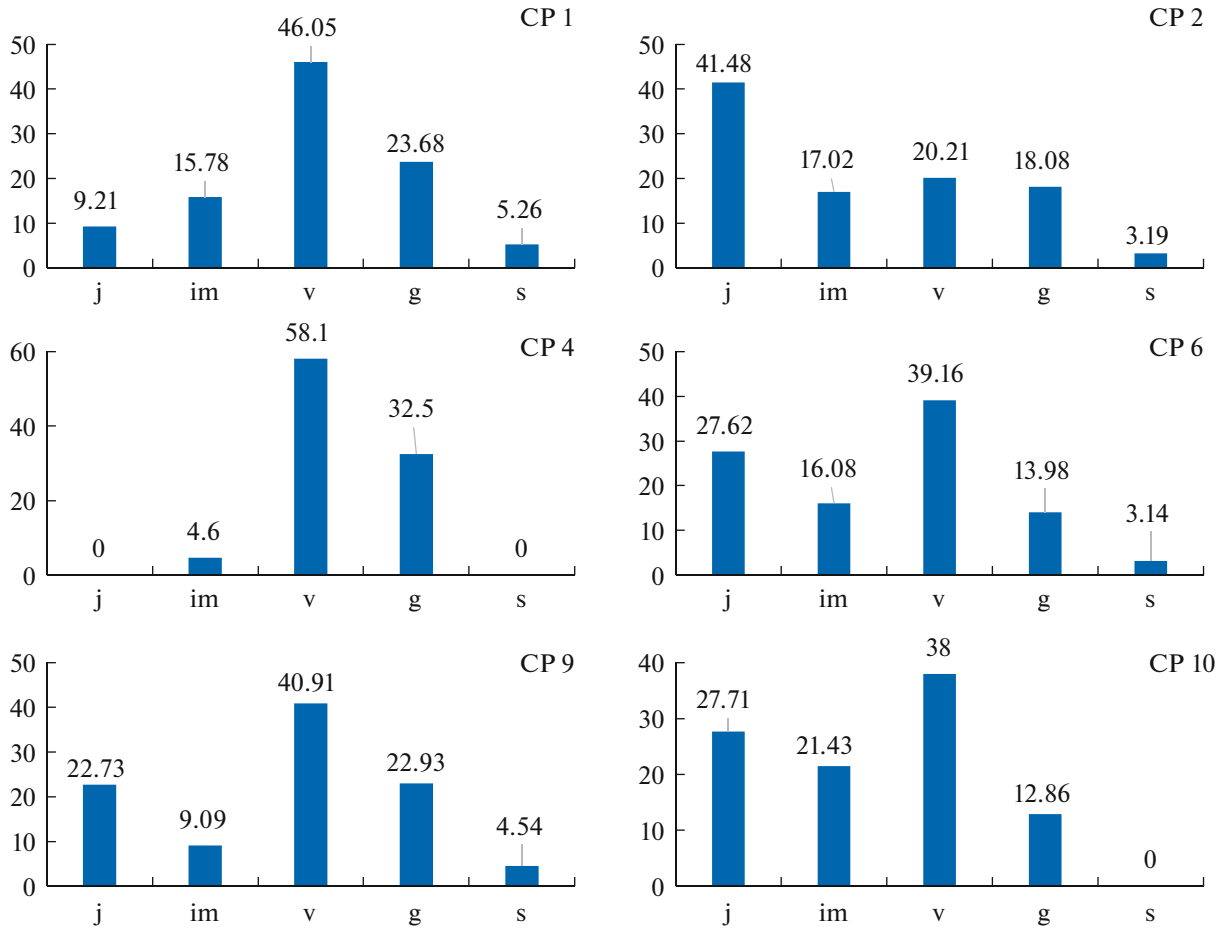


Fig. 2. Cenopopulations with a left-sided ontogenetic spectrum.

4, 6, 9, and 10). The left-sided spectra are single-vertex (Fig. 2). In CP 2, the absolute maximum occurs for juveniles: 41.48%. This variant of the spectrum in representatives of the genus *Tulipa* is formed with abundant fruiting and a sufficient amount of precipitation in the autumn–winter–spring period (Kashin et al., 2016, 2019). In other cenopopulations (CP 1, 4, 6, 9, and 10), virginal individuals predominate (from 39.6 to 58.1%, respectively), which is associated with both good seed reproduction and the longer duration of this ontogenetic state in representatives of the genus. A smaller proportion of immature individuals in most cases is explained by the elimination of young plants (water erosion, intensive use of pastures in spring during the growing season of tulips, or high competition with other species).

Cenopopulations with a centered type of spectrum. In cenopopulations with a centered type of spectrum, the absolute maximum is observed in generative plants (CP 3, 7, 11, and 12). In these cenopopulations, the proportion of generative individuals varies from 36.66 to 52.94%. The spectrum shows a gradual increase in the share of a certain ontogenetic group compared to the previous one, which is probably due to an increase in the duration of the individuals in subsequent states and a decrease in the death of individuals (Fig. 3). According to literature data, the duration of the pregenerative period in species of the genus *Tulipa* L. under natural conditions averages 4–5 years and the duration of the generative period is 10–25 years (Bochantseva, 1956; Kobozeva, 2010; Abduraimov, 2017). One of the noted populations (CP 7) grows in the fenced area of the holy place and cemetery, where, due to the lack of grazing, a dense and high herbage has formed with a projective cover of up to 90% and dominance of cereals (*Hordeum bulbosum* L., *H. spontaneum* K. Koch, and *Poa bulbosa* L.), the ephemeroid *Carex pachystylis* J. Gay, and bipartite ephemera. The low proportion of juvenile and immature individuals in this cenopopulation is explained by competition with other species in the phytocenosis.

Bimodal ontogenetic spectrum. Such a spectrum is usually formed in cenopopulations with moderate seed reproduction. They have a high proportion of juvenile and generative individuals (Fig. 4). If the successful transition of seedlings formed due to the mass germination of past years, on the one hand, leads to an increase in immature individuals (CP 13), then, on the

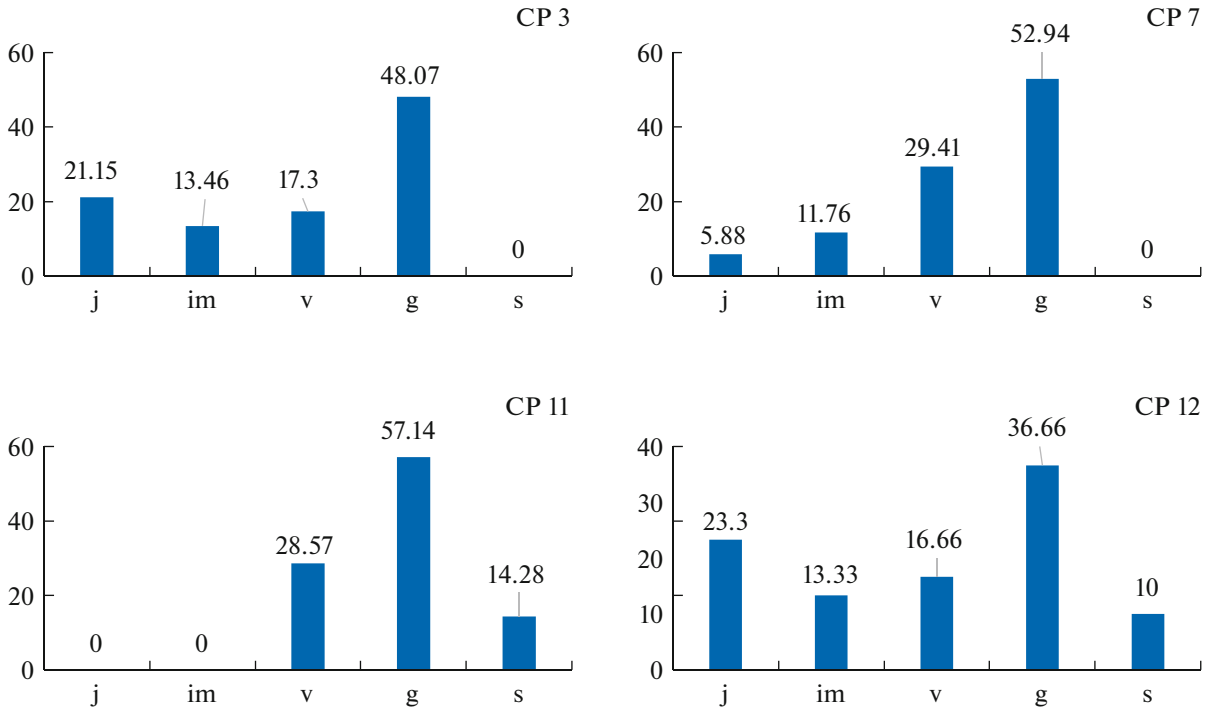


Fig. 3. Cenopopulations with a centered ontogenetic spectrum.

other hand, the lengthening of the duration of the generative period under favorable conditions contributes to an increase in the proportion of generative individuals. It should be especially noted that in one box of species of the genus *Tulipa* 150 to 450 potential seeds are formed.

The location of the bulbs of bulbous plants of different depths, depending on weather conditions and nutrients in the soil, is one of the strategies for their adaptation to the external environment. According to the literature data, the deeper location of the bulbs is explained by the need for moisture and the avoidance of high temperatures, while the formation of stolons in tulips is associated with the need for more nutrient-rich soil horizons (Bochantseva, 1962).

Tulipa butkovii And *Tulipa dubia* form stolons during the pregenerative period (*v*). With the weakening of the seed reproduction of the species under the influence of various factors, vegetative reproduction is one of the strategies for self-preservation in natural conditions.

Depending on the ecological and phytocenotic conditions of the habitat, the density of individuals in the surveyed communities varied from 0.85 (*T. greigii*) up to 16.25 ind./m^2 (*T. dubia*), and the ecological density is from 1.13 to 17.10 ind./m^2.

A comparison was also made of the recovery (Iv) and aging (Ist) indices, which reflect the dynamic processes in the cenopopulation. In most of the surveyed cenopopulations, the recovery index is above one, which indicates good seed reproduction of individuals.

In cenopopulations of CPs 7 and 11 that contain *T. greigii* recovery index below 1. In these cenopopulations, generative individuals make up 52.94–57.14%, and seed reproduction has a low rate. As mentioned above, the cenopopulation of CP 7, growing in the fenced area of the holy place and cemetery Bobo-Gozi has a low recovery index due to competition with other species in the phytocenosis. A high proportion of generative individuals in cenopopulations *T. greigii* is also explained by the fact that this species has a long generative period of 12–16 years (Table 2).

The aging index in the studied cenopopulations has a relatively low index, from 0 for CPs 3, 4, 7, and 10 to 0.11–0.16 for CPs 11 and 12. A low proportion of senile individuals in the ontogenetic spectrum is one of the biological features of tulips (Baranova, 1999; Kobozeva, 2010).

According to A.A. Uranov and O.V. Smirnova (1969), the studied coenopopulations of species of the genus *Tulipa* are normal, with the exception of CPs 4, 7, 9, 10, and 11, which have a smaller number in comparison with other cenopopulations. CPs 1, 2, 4, 6, 9, and 10 are young; CPs 3, 7, 11, and 12 are mature; and CPs 5, 8, and 13 are falsely mature.

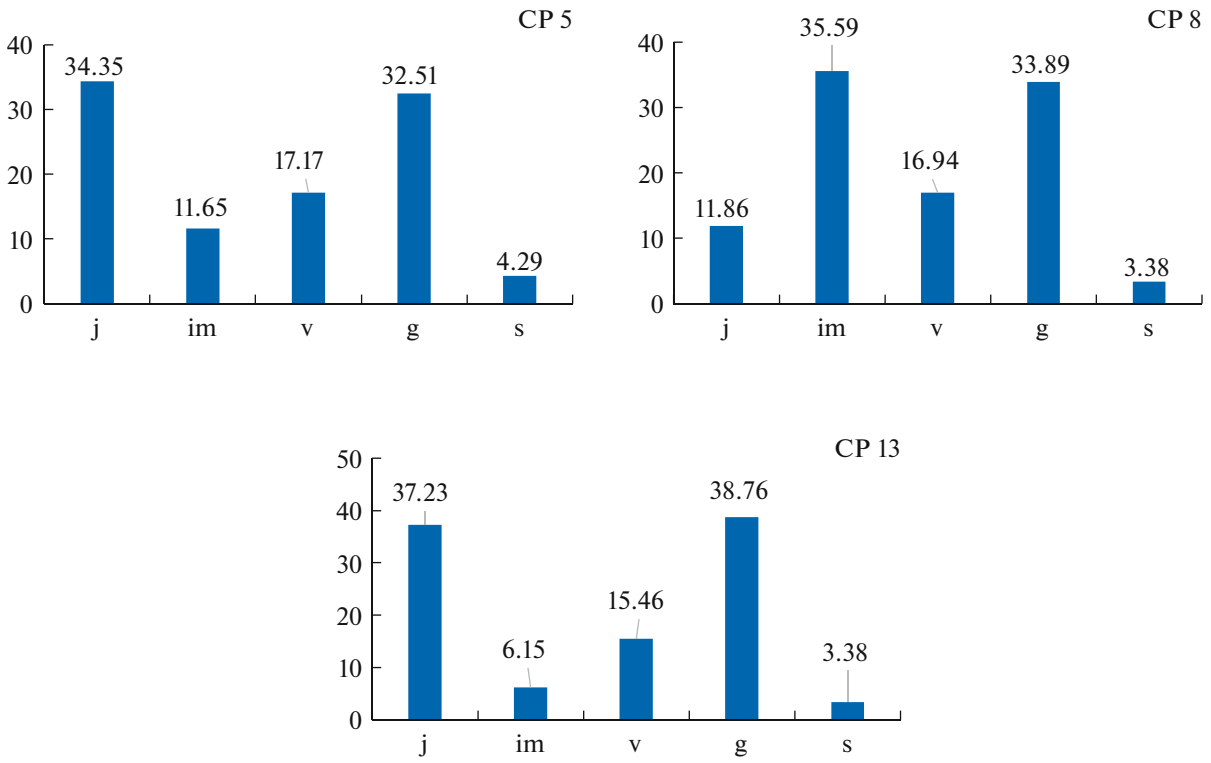


Fig. 4. Cenopopulations with a bimodal ontogenetic spectrum.

Table 2. The demographic characteristics of coenopopulations of species of the genus *Tulipa*

CPU No.	I_V	I_{st}	Density of individuals, pcs./m^2	R_{ecol}, 1 m^2	The total number of individuals in the CPU, pcs.	CPU types
T. korolkowii						
1	3	0.05	3.8	4.22	76	Young
2	4.35	0.03	4.7	5.52	94	Young
3	1.07	0	2.6	3.25	52	Mature
T. borszczowii						
4	1.92	0	2.05	2.73	41	Young
T. butkovii						
5	1.94	0.04	8.15	8.57	163	False mature
6	5.92	0.03	14.3	15.5	286	Young
T. greigii						
7	0.88	0	0.85	1.13	17	Mature
8	1.89	0.03	2.95	3.27	59	False mature
9	3.17	0.04	1.1	1.22	22	Young
10	6.77	0	3.5	3.88	70	Young
11	0.5	0.16	1.05	1.23	21	Mature
12	1.45	0.11	1.5	1.87	30	Mature
T. dubia						
13	1.51	0.03	16.25	17.10	325	False mature

I_V is the recovery index; I_{st} is the aging index; R_{ecol} is the ecological density.

CONCLUSIONS

Thus, the vast majority of the studied cenopopulations of species of the genus *Tulipa* L. that grow on the territory of the Tashkent region of the Republic of Uzbekistan in various ecological and phytocenotic conditions and in areas with different environmental regimes and levels of anthropogenic pressure, are classified as normal and full-membered. The influence of grazing leads to a significant decrease in the vitality of cenopopulations of species of the genus *Tulipa* L. In some cenopopulations, senile individuals are absent, which is a biological feature of the genus *Tulipa*. Individuals undergo complete ontogeny only in favorable habitat conditions with sufficient soil moisture and good mineral nutrition.

Given the limited distribution, low abundance, and significant threat to *Tulipa borszczowii* populations in Uzbekistan, it is recommended that this species be included in the next edition of the national Red Book with the creation of a protected area with the status of a reserve or natural monument in the Dalverzin Sands to preserve this relict sandy massif. Inclusion of *Tulipa butkovii* in the Red Data Book of Uzbekistan is also recommended, since the constantly increasing recreational load poses a threat to the populations of this species, which is a narrow local endemic of the Chatkal Range and a national endemic.

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COMPLIANCE WITH ETHICAL STANDARDS

Conflict of interests. The authors declare that they have no conflicts of interest.

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