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PLANT COMMUNITIES WITH THE PARTICIPATION OF *TULIPA TARDA* STAPF IN KAZAKHSTAN: FLORISTIC COMPOSITION AND ANALYSIS

The article presents the results of studies on distribution, ecological preferences and floristic composition of communities with the participation of the rare northern Tian-Shan endemic *Tulipa tarda* Stapf. As a result of the analysis of our own materials, data from herbaria, literature and some Internet sources, a point map of the distribution of the species in Kazakhstan was compiled. Based on the descriptions of 13 geobotanical plots, the altitudinal distribution range of the species (1100-1900 m above sea level) was determined, and relative indifference of the species to the steepness and exposure of slopes, as well as its confinement to multicomponent plant communities, mainly of the steppe and semi-steppe type, were established. According to our results combined with two descriptions from the adjacent territory of Kyrgyzstan, the flora of communities with the participation of *T. tarda* comprises 199 species of higher plants from 140 genera and 45 families. The 16 most species rich families (from Asteraceae to Crassulaceae) comprise 78% of the entire flora of the surveyed communities. The floristic core of the communities consists of only 13 species, most of which are steppe and petro-lithophilic ecological elements. The communities with the participation of *Tulipa tarda* include eight species listed in the Red Book of Kazakhstan, which stresses the need for special protection of not only of the species under study, but also of all plant communities with its participation.

Key words: *Tulipa tarda* Stapf, plant community, floristic composition, endemic, Red Book, ecological element.

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Қазақстандағы *Tulipa tarda* Stapf қатысатын өсімдіктер қауымдастығы: флоралық құрамы және талдау

Мақалада сирек кездесетін солтүстік Тянь-шань эндемигі *Tulipa tarda* Stapf қауымдастығының флоралық құрамы, экологиялық сәйкестігі және таралуы бойынша нәтижелер келтіріледі. Жеке материалдарымызды, гербарий мәліметтерін, әдебиет және интернет көздерін өңдеу нәтижесінде түрдің таралуының нүктелік картасы жасалды. 13 геоботаникалық сынақ алаңдарының сипаттамаларының мәліметтері бойынша түрдің өсуінің биіктік интервалы (1100-1900 м теңіз деңгейінен жоғары) анықталды, оның беткейлердің көлбеуіне және экспозициясына салыстырмалы түрде бейімсіздігі, сондай-ақ көбінесе дала және дала типіндегі көп компонентті өсімдіктер қауымдастықтарына жататындығы анықталды. Авторлардың зерттеу нәтижелері бойынша Қырғызстанның іргелес аумағынан екі сипаттаманы толықтыра отырып, *T. tarda* қатысуымен қауымдастықтардың жалпы флоралық құрамы 140 туыс және 45 тұқымдастан жоғары өсімдіктердің 199 түрі құрайды. 16 жетекші тұқымдас құрамына (Asteraceae-ден Crassulaceae-ге дейін) зерттелген қауымдастықтардың барлық флоралық құрамының 78% кіреді. Қауымдастықтардың флоралық ядросы небәрі 13 түрді құрайды, олардың көпшілігі дала және петро-литофильді экологиялық элементтер болып табылады. *Tulipa tarda* қатысатын қауымдастықтардың құрамында Қазақстанның Қызыл кітабына (2014) енгізілген тағы 8 түрі бар. Бұл зерттелетін түрді ғана емес, сонымен бірге оның қатысуымен барлық өсімдік қауымдастықтарын ерекше қорғау қажеттілігін растайды.

Түйін сөздер: *Tulipa tarda* Stapf, өсімдік қауымдастығы, флоралық құрам, эндемик, Қызыл кітап, экологиялық элемент.

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Растительные сообщества с участием *Tulipa tarda* Stapf в Казахстане: флористический состав и анализ

В статье приводятся результаты исследований по распространению, экологической приуроченности и флористическому составу сообществ с участием редкого, северотяньшанского эндемика *Tulipa tarda* Stapf. В результате обработки собственных материалов, данных гербариев, литературных и некоторых интернет-источников, составлена точечная карта распространения вида в Казахстане. По данным описаний 13 пробных геоботанических площадок определен высотный интервал произрастания вида (1100–1900 м над уровнем моря), установлена относительная индифферентность его к крутизне и экспозиции склонов, а также приуроченность к многокомпонентным растительным сообществам преимущественно степного и остепненного типа. Общий флористический состав сообществ с участием *T. tarda*, по результатам исследований авторов, с дополнениями двух описаний с прилегающей территории Кыргызстана, включает 199 видов высших растений из 140 родов и 45 семейств. В состав 16 ведущих семейств (от Asteraceae до Crassulaceae) входит 78% от всего флористического состава обследованных сообществ. Флористическое ядро сообществ составляет всего 13 видов, большинство из которых являются степными и петро-литофильными экологическими элементами. В составе сообществ с участием *Tulipa tarda* имеется еще 8 видов, занесенных в Красную книгу Казахстана (2014), что подтверждает необходимость особой охраны не только исследуемого вида, но и всех растительных сообществ с его участием.

Ключевые слова: *Tulipa tarda* Stapf, растительное сообщество, флористический состав, эндемик, Красная книга, экологический элемент.

Introduction

The vast territory of Kazakhstan and a wide variety of natural conditions including three natural plains and several elevation belts of mountain ranges create the wealth and in many respects the uniqueness of the vegetation cover of this country. A significant proportion of floristic elements represented by almost six thousand species has various useful properties and has long been used by humans as food, fodder, medicinal, technical and ornamental plants [1-3]. The latter are not only a valuable feature of natural landscapes which makes them particularly attractive; it is also an object of ecological tourism which has become especially popular in our country in recent decades [4, 5]. Ornamental plants also have practical importance, because they are used in landscape architecture and also as a source of valuable genetic material for the development of new cultivars and races. Among such plants, one of the leading places is occupied by representatives of bulbous ephemeroïds. They are especially valued because of early flowering, frost resistance, ease of reproduction and wide possibilities of use, from flower beds, borders and rock gardens to landscape installation projects, etc.

Within this group of plants, representatives of the genus *Tulipa* L. are most popular and famous

[6]. South Kazakhstan and the adjoining regions of the mountainous Central Asia are the center of origin of tulips, from where they distributed throughout the territory of the Ancient Mediterranean [7]. Both wild species of this genus and man-made cultivars, which have been in cultivation for more than five hundred years [8] and still are a focus of gardening activities in Western Europe, the CIS, Turkey, and Japan, have been a focus of research by scientists from various countries [9-18]. Still, there are many white spots in the taxonomy, distribution, and biology of wild tulips.

Even the species diversity of the genus within Kazakhstan turned out to have been insufficiently studied. Recently the number of species has increased from 32 [19, 1] to 42 due to new discoveries of the already known and descriptions of new species for science: *Tulipa lemmersi* Peterse et J. Groot, *T. berkariensis* Ruksans, *T. ivasczenkoae* Epiktetov et Belyalov, *T. auliecolica* Perezhogin, *T. turgaica* Perezhogin, and *T. kolbintsevii* Zonn [20-24].

Being highly decorative early flowering species, wild tulips and their populations are under strong anthropogenic pressure, especially in the vicinity of large cities. Therefore, most of Kazakh wild species need special protection. The Red Book of Kazakhstan [25] lists 18 species for the conservation of which the development of special measures

is required. The latter should be based on the results of a detailed study of the species distribution, abundance, density and age spectrum of its populations, as well as the identification of the most vulnerable populations in areas of habitat disturbance and increased anthropogenic pressure.

However, to date most of these 18 species have been insufficiently studied. In the literature, there are data mostly on several large-flowered species [26-28]. It is of interest that even such a narrow endemic as *Tulipa tarda*, the natural distribution range of which is limited to a small area in the Northern Tien-Shan within Kazakhstan and Kyrgyzstan [29], has been studied mainly in cultivation [30, 9, 7, 31-33].

It should be emphasized that this species is popular in cultivation almost all over the world. Thus, in the reference book on the introduction of rare and endangered plants of the USSR [34], of 59 species of wild tulips it ranks along with one of the most popular *Tulipa greigii* Regel (cultivated in 21 cities) and is second only to *Tulipa schrenkii* Regel (grown in 26 cities). The latter has a vast distribution range from the Black Sea region to Western Siberia and has been cultivated in Europe since 1554, and in Turkey, since earlier times [8]. *T. tarda*, by contrast, has been cultivated only since 1905 [35]. At the same time, the rate of reproduction (including vegetative reproduction), and early and abundant flowering brought popularity and worldwide recognition to *T. tarda*; it is now an indispensable element of most botanical gardens of the CIS countries, Europe, North America and private collections [36-40].

In this regard, it was *T. tarda* that was chosen by us as a study object. Our research addressed the distribution of the species within Kazakhstan, its ecological and phytocenotic preferences, floristic composition of communities with its participation, as well as the numbers and state of its natural populations in Kazakhstan.

In this article, we present the results of the first stage of our research, taking into account the analysis of the available herbarium and literature data.

Materials and methods

To verify the natural distribution range of *T. tarda*, in addition to the review of the available literature, we used data from herbariums of the Institute of Botany and Phytointroduction (Almaty), the Botanical Institute named after I. V.L. Komarov RAS (St. Petersburg), the Moscow State University, some digital European repositories available on the

Internet, as well as Plantarium.ru reports [38-40]. In total, 29 herbarium sheets (about 50 samples) and 21 photographs were studied, mainly of cultivars from various locations in Russia (from St. Petersburg to Vladivostok), Ukraine (Kiev), Kyrgyzstan (Bishkek) and Germany (Dusseldorf). Only two images from natural populations were available: those taken in the valley of the river Kastek (Kazakhstan) and the basin of the river Kichi-Kemin (Kyrgyzstan). We recorded the *Tulipa tarda* populations at 17 locations on the northern slope of the Zailiyskiy Alatau, from the valley of the river Karakastek to Karakunuz valley (near the border with Kyrgyzstan). All these data became the basis for a point map of the species distribution range in Kazakhstan (Figure 1). In four gorges (Kastek, Karakastek, Zhamanty and Chubarbaytal), we examined the populations of this species and described 13 geobotanical sites. The descriptions were carried out according to generally accepted methods [41].

For each species, the height and phenophase were recorded. Species abundance was recorded according to the Drude scale [42], in which the following grades were adopted:

- soc (socialis) – “abundant”, the above-ground parts of plants are close together; other species are very rare, with only single individuals observed;
- cop₃ (copiosus) – “numerous”, plants form the background;
- cop₁ – “quite numerous”, plants are found occasionally, they are scattered;
- sp (sparsus) – “sparse”, plants are very rare.
- sol (solitarius) – “solitary”, only a few specimens can be observed in the surveyed area;
- un (unicum) – “single plant”.

To clarify taxonomic affiliation of certain species, a herbarium was collected. Species identification was carried out according to relevant summaries and keys [19, 43]. The nomenclature of species and families is given according to the summary by S.A. Abdulina [1].

Results

Tulipa tarda Stapf, of the family Liliaceae, belongs to the section Biflores AD Hall ex Zonn. et Veldk., subgenus *Eriostemones* (Boiss.) Ramsd., according to the latest classification of the genus [21, 44] This species was described by O. Stapf in 1935. The place of growth of type specimens was indicated vaguely: “probably Turkestan”. Perhaps Stapf described cultivated plants. In Western Europe, the species was known since 1905 under the name *T. dasystemon* hort., that is, the hairy-stalked “garden”

tulip. *T. tarda* is a herbaceous perennial with a bulb enveloped in black-brown, leathery, completely non-pubescent outer covering (tunic). The stem is very short, glabrous, with 3-7 very close, almost whorled, lanceolate, bright green leaves with purple edging along the margin. Usually the flower is solitary, but sometimes there are 2 – 3 – 5 flowers, and in cultivation the number can be up to 10-18. Sepals are up to 3-4 cm long, white, with a large yellow spot, sharp at the base; the outer sepals are greenish-violet along the back. In sunny weather, the flowers open wide in the form of a flat star up to 6 cm in diameter. Filaments are yellow at the base with dense hairy rings; anthers are yellow, with gray edging. The fruit is a rounded capsule up to 3.8 cm long and 1-1.8 cm wide, with a tip elongated into a spout; the number of viable seeds is 120. Seed reproduction, as well as intensive vegetative reproduction are due to stolons and axillary bulbs. Plants bloom from mid-April to mid-May, and bear fruit in June [19, 45].

Some authors [44, 46] do not recognize the independence of *T. tarda* describing it as a synonym of the Iranian endemic *T. urumiensis* Stapf. However, in the latest nomenclature summary [47] both are recognised as distinct species; moreover, due to a disjunction of ranges and certain morphologi-

cal differences, we also consider them to be distinct species. According to the results of studies of introduction of both species in Russia, Belarus and Switzerland [9-11], *T. urumiensis* differs from *T. tarda* not only in the exclusively yellow color of the flowers, but also in its smaller size (up to 8 cm, not 15-26 cm), the length of the lower leaf (up to 10-12.8 cm, not 20-26 cm), and flower height (up to 5 cm, not 3-4); it also has fewer leaves (2-4, not 3-7) and flowers (1-2 and not 1-6 (13)) and a lower coefficient of vegetative propagation (2.1 versus 2.9). In addition, these descriptions indicate that the anthers in *T. urumiensis* are yellow, while in *T. tarda* they are bordered along their entire length by a clear dark gray stripe. The latter trait is characteristic of all the individuals we have examined, both in natural populations and in cultivation.

According to the habitat type, *T. tarda* is a northern Tien-Shan endemic that grows in the western part of the Zailiyskiy Alatau ridge and adjacent regions of northern Kyrgyzstan (the valley of the Chu and Chon-Kemin rivers with the adjacent northern slopes of the Kyrgyz ridge and Kungey Alatau) [19, 48].

Thus, the main part of its distribution range is located in Kazakhstan (Figure 1).

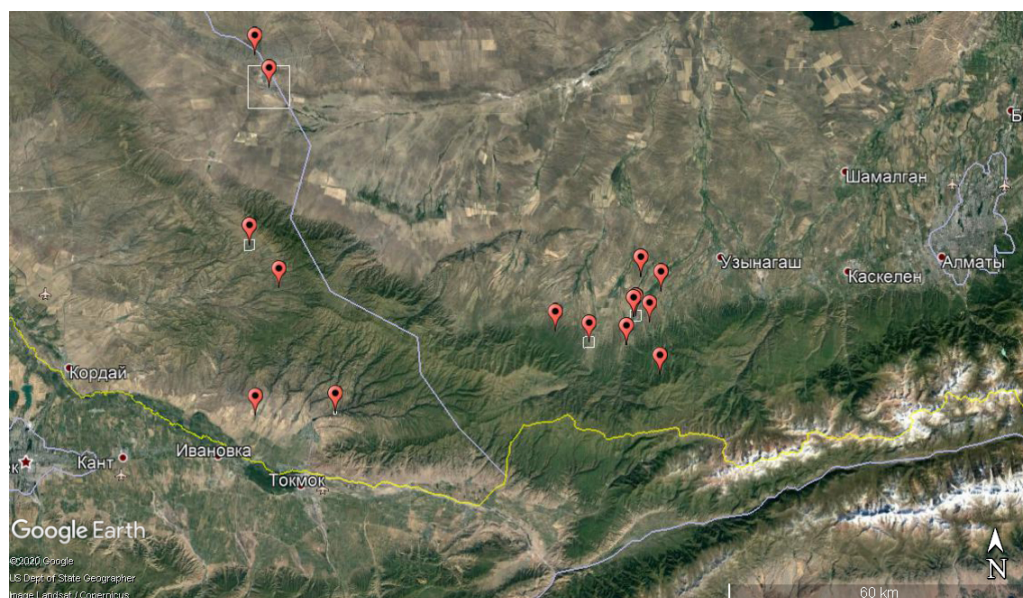


Figure 1 – Distribution area of *Tulipa tarda* Stapf in Kazakhstan

In relation to the ecological preferences of *T. tarda*, according to our descriptions, the following has been established. This species grows in the lower and middle mountain belts, that is in the steppe and shrub and forest-meadow belts according

to Baitulin *et al.* [49], in the range of 1100-1900 m above sea level. It is found mainly on gravelly and rocky slopes, often on rocks. The steepness of the plots varies substantially; from gentle, almost level sections of the foothills to steep, 60-70°. In relation

to the exposure of the slopes, *T. tarda* does not show any particular preferences. It can be found on the southern and northern, eastern and western, as well as on the slopes of intermediate exposure, mostly on north-western and south-eastern slopes.

On the sites studied by us, the plant communities with the participation of *T. tarda* were predominantly multicomponent, of the steppe, semi-steppe, or meadow-steppe type, often with shrubs. They can be classified as grass and herb or herb and grass, sometimes with the dominance of sedges (*Carex praecox*, *C. turkestanica*), herbaceous plants (*Iris alberti*, *Sedum hybrida*, *S. ewersii*), and in rare cases, of *Andropogon ischaemum*.

Using the data from 13 descriptions made by us in the western part of the Zailiyskiy Alatau ridge and in the valleys of four rivers (Karakastek, eight sites; Kastek, two sites; Zhamanty, one site; and Chubarbaital, two sites), as well as the data of Isakov [50] from the valley of the river Chon-Kemin on the territory of Kyrgyzstan, we compiled a list of plants recorded in plant communities with the participation of *T. tarda*. The list is presented in Table 1, in which the five listed sites are indicated under the following numbers: 1) the valley of the river Karakastek; 2) the valley of the river Kastek; 3) the valley of the river Zhamanty; 4) the valley of the river Chubarbaital; 5) the valley of the river Chon – Kemin.

Table 1 – Floristic composition of plant communities with the participation of *T. tarda*

Family, species	Number of descriptions and abundance of species				
	1	2	3	4	5
Aceraceae					
<i>Acer semenovii</i> Regel et Herd.	-	-	-	1 sol	-
Berberidaceae					
<i>Berberis sphaerocarpa</i> Kar. et Kir.	-	-	-	-	2 sol
Celastraceae					
<i>Euonymus semenovii</i> Regel et Herd.	3 sol	1 sol	1 sol	-	-
Caprifoliaceae					
<i>Lonicera altmannii</i> Regel et Schmalh.	1 un	-	-	-	-
<i>L. microphylla</i> Willd. ex Roem. et. Schult.	1 un	2 sol	-	-	-
Cupressaceae					
<i>Juniperus sabina</i> L.	-	-	-	-	1 sol
Ephedraceae					
<i>Ephedra equisetina</i> Bunge	2 un	2 un	-	1 un	-
<i>E. intermedia</i> Schrenk et C. A. Mey.	-	1 sol	-	-	2 sol
Fabaceae					
<i>Caragana kirghisorum</i> Pojark.	-	-	-	-	2 sol
Polygonaceae					
<i>Atraphaxis pyrifolia</i> Bunge	1 sol	1 un	-	2 un	-
<i>A. spinosa</i> L.	-	-	-	-	1 sol
<i>A. virgata</i> (Regel) Krasn.	-	1 sol	-	2 sol	-
Ranunculaceae					
<i>Atragene sibirica</i> L.	1 un	-	-	-	-
<i>Clematis songarica</i> Bunge	-	-	-	-	2 un – sol
Rhamnaceae					
<i>Rhamnus cathartica</i> L.	1 un	-	-	1 un	-
Rosaceae					
<i>Cerasus tianshanica</i> Pojark.	-	2 sol	-	2 sol	-

Continuation of table 1

Family, species	Number of descriptions and abundance of species				
	1	2	3	4	5
<i>Cotoneaster multiflora</i> Bunge	3 un	-	1 un	-	-
<i>C. suavis</i> Pojark.	-	-	-	-	2 un – sol
<i>Rosa platyacantha</i> Schrenk	3 sol-sp	1 sp	1 sp	2 sp	2 sol
<i>Spiraea hypericifolia</i> L.	2 sol	1 sol	-	2 sp	2 cop ₂
<i>S. lasiocarpa</i> Kar. et Kir.	2 un	-	-	-	-
Herbs					
Aspleniaceae					
<i>Ceterach officinarum</i> DC.	1 un	-	-	-	-
Athyriaceae					
<i>Cystopteris fragilis</i> (L.) Bernh.	4 sol	-	-	1 sol	-
Poaceae					
<i>Agropyron cristatum</i> (L.) Beauv.	-	-	-	-	1 cop ₂
<i>Anisantha tectorum</i> (L.) Nevski	1 sol	1 cop ₁	-	-	2 sol
<i>Botriochloa ischaemum</i> (L.) Keng	1 cop ₂	1 sp	-	-	1 sol
<i>Bromus oxyodon</i> Schrenk	1 sp	1 sol	-	-	2 sp
<i>Dactylis glomerata</i> L.	2 un-sol	-	-	-	-
<i>Elytrigia geniculata</i> (Trip.) Nevski	-	1 sp	-	-	2 sol
<i>Festuca arundinacea</i> Schreb.	1 un	-	-	-	-
<i>F. valesiaca</i> Gaud.	5 sol	1 sp	-	-	1 sp
<i>Helictotrichon hookeri</i> (Scribn.) Hern.	1 sol	-	-	-	-
<i>Koeleria cristata</i> (L.) Pers.	-	-	-	-	2 sol
<i>Leymus flexilis</i> (Nevski) Tzvel.	-	-	-	-	2 sol
<i>Milium effusum</i> L.	1 un	-	-	-	-
<i>Phleum phleoides</i> (L.) Karst.	1 un	-	-	-	-
<i>Piptatherum songaricum</i> (Trin. et Rupr.) Roshev. ex E. Nikit.	-	-	-	1 sol	2 sol
<i>Poa angustifolia</i> L.	3 sp-cop ₁	-	-	-	-
<i>P. bulbosa</i> L.	-	1 sp	-	-	1 sol
<i>P. nemoralis</i> L.	2 sol-sp	-	-	-	-
<i>P. relaxa</i> Ovcz.	4 sol-sp	-	-	-	1 sol
<i>Stipa caucasica</i> Schmalh.	-	-	-	-	1 sol
<i>S. capillata</i> L.	-	-	-	-	2 sol
Cyperaceae					
<i>Carex praecox</i> Schreb.	2 sp	-	-	-	-
<i>C. turkestanica</i> Regel.	1 sp	1 sp	1 sp	2 sp-cop ₁	2 sol
Asphodeliaceae					
<i>Eremurus cristatus</i> Vved.	-	1sp-sol	1 sol	1 sol	2 sol
Liliaceae					
<i>Gagea bulbifera</i> (Pall.) Roem. et Schult.	-	1 sol	-	-	-
<i>G. filiformis</i> (Ledeb.) Kunth	3 sol	1 sol	1 sol	-	-
<i>G. tenera</i> Pascher	-	1 sol	-	1 sol	-
<i>G. turkestanica</i> Pascher	1 sol	-	-	-	-

Family, species	Number of descriptions and abundance of species				
	1	2	3	4	5
<i>Tulipa alberti</i> Regel	-	-	-	1 cop ₁	-
<i>T. greigii</i> Regel	-	-	-	1 sp-cop ₁	-
<i>T. kolpakovouskiana</i> Regel	-	-	-	-	1 sol
<i>T. ostrouskiana</i> Regel	1 sol	1 sol	-	2 sol	-
<i>T. tarda</i> Stapf	sol-cop ₁	sp-cop ₁	sp	sp-cop ₁	sol-sp
Alliaceae					
<i>Allium caesium</i> Schrenk	1 sol	-	-	-	1 sol
<i>A. galanthum</i> Kar. et Kir.	-	-	-	-	1 sol
<i>A. pallasii</i> Murr.	-	1 sol	-	-	-
<i>A. petraeum</i> Kar. et Kir.	1 un	-	-	-	-
<i>A. setifolium</i> Schrenk	1 cop ₁	-	-	-	-
Ixioliriaceae					
<i>Ixiolirion tataricum</i> (Pall.) Herb.	- 2	2 sp	1 sp	-	-
Iridaceae					
<i>Crocus alatavicus</i> Regel et Semen.	-	1 sol	-	-	-
<i>Iris alberti</i> Regel	3 sol-cop ₂	1 sp	-	-	-
Urticaceae					
<i>Urtica dioica</i> L.	1 un	-	-	-	-
Polygonaceae					
<i>Polygonum alpinum</i> All.	2 un-sol	-	-	-	-
<i>P. nitens</i> (Fisch. et C.A. Mey.) V.Petrov ex Kom.	1 un	-	-	-	-
<i>Rheum cordatum</i> Losinsk.	-	-	-	-	1 sp
<i>R. wittrockii</i> Lundstr.	2 sol	-	-	-	-
<i>Rumex tianshanicus</i> Losinsk.	-	1 sol	-	-	-
Chenopodiaceae					
<i>Kochia prostrata</i> (L.) Schrad.	-	-	-	2 sol	1 sol
Caryophyllaceae					
<i>Arenaria leptoclada</i> Guss.	1 sp	-	-	-	-
<i>Cerastium bungeanum</i> Vved.	1 sol	-	-	-	-
<i>C. davuricum</i> Fisch. ex Spreng.	1 sol	-	-	-	-
<i>C. tianschanicum</i> Schischk.	1 sol	-	-	-	-
<i>Dianthus kuschakewiczii</i> Regel et Schmalh.	2 sol	-	-	-	1 sol
<i>Silene brahuica</i> Boiss.	-	1 sol	-	-	-
<i>S. venosa</i> (Gilib.) Aschers.	1 un	-	-	-	-
<i>S. kuschakewiczii</i> Regel et Schmalh.	1 sp	-	-	1 sol	-
<i>Stellaria graminea</i> L.	1 sp	-	-	-	-
Paeoniaceae					
<i>Paeonia intermedia</i> C.A. Mey.	1 sp	-	-	-	-
Ranunculaceae					
<i>Aconitum leucostomum</i> Worosch.	1 sol	-	-	-	-
<i>Aquilegia atrovinosa</i> M.Pop.ex Gamajun.	1 un	-	-	-	-

Continuation of table 1

Family, species	Number of descriptions and abundance of species				
	1	2	3	4	5
<i>Ceratocephalus testiculatus</i> (Crantz) Bess.	-	1 sp	-	-	-
<i>Delphinium iliense</i> Huth	3 sol	-	-	-	-
<i>Ranunculus polyanthemus</i> L.	1 sol	-	-	-	-
<i>Thalictrum isopyroides</i> C.A. Mey.	-	1 sol	-	-	-
<i>Th. minus</i> L.	3 sol	-	1 sol	1 sol	-
Papaveraceae					
<i>Glaucium fimbriigerum</i> Boiss.	-	-	-	-	2 sol
<i>Papaver litwinowii</i> Fedde ex Boiss.	-	1 sol	-	-	2 sol
Fumariceae					
<i>Corydalis glaucescens</i> Regel	1 sol	-	-	1 sol	-
<i>Fumaria vaillantii</i> Loisel.	-	-	-	-	2 sol
Brassicaceae					
<i>Alyssum desertorum</i> Stapf	1 sol	-	-	-	2 sol
<i>Crambe kotschyana</i> Boiss.	-	-	-	-	2 cop ₁₋₂
<i>Draba subamplexicaulis</i> C.A.Mey.	2 sol	-	-	-	-
<i>Erysimum diffusum</i> Ehrh.	1 sol	2 sol	1 sol	-	-
<i>Neuroloma subsiliquosum</i> (M.Pop.) Botsch.	1 sol	-	-	1 sol	1 sol
<i>Sisymbrium brassiciforme</i> C. A. Mey.	1 un	-	-	1 sol	2 sol
<i>Thlaspi perfoliatum</i> L.	2 sol	-	-	-	-
Crassulaceae					
<i>Pseudosedum longidentatum</i> Boriss.	1 sol	-	-	1 sol	-
<i>Rosularia turkestanica</i> (Regel et C.Winkl.) Berger	1 sol	2 sol	-	-	-
<i>Sedum alberti</i> L.	-	-	-	1 sp	-
<i>S. ewersii</i> Ledeb.	4 sp	-	1 sp	-	-
<i>S.hybridum</i> L.	5 sol -cop ₁	-	1 sp	-	-
Saxifragaceae					
<i>Saxifraga sibirica</i> L.	1 sol	-	-	-	-
Rosaceae					
<i>Alchemilla tianschanica</i> Juz.	2 sol	-	-	-	-
<i>Geum urbanum</i> L.	2 un	-	-	-	-
<i>Potentilla multifida</i> L.	-	-	-	-	1 sol
<i>P.orientalis</i> L.	1 sp	-	-	1 sol	1 sol
<i>P.transcaspia</i> Th.Wolf.	2 un	1 un	-	-	-
<i>P.virgata</i> Lehm.	2 sol	1 sol	-	-	-
Fabaceae					
<i>Astragalus alpinus</i> L.	1 sol	-	-	-	-
<i>A. fedtschenkoanus</i> Lipsky	-	-	-	1 sol	-
<i>A. keminensis</i> Isakov	-	-	-	-	1 sol
<i>A.schmalhauseni</i> Bunge	-	-	-	-	1 sol
<i>Cicer songaricum</i> Steph.ex DC.	-	-	-	-	1 sol
<i>Medicago falcata</i> L.	1 un	-	-	-	2 sol

Family, species	Number of descriptions and abundance of species				
	1	2	3	4	5
<i>M. lupulina</i> L.	1 sol	-	-	-	-
<i>Melilotus officinalis</i> (L.) Pall.	1 sol	-	-	-	-
<i>Oxytropis macrocarpa</i> Kar. et Kir.	-	-	-	-	2 sol
<i>Trifolium repens</i> L.	1 sol	-	-	-	-
<i>Vicia cracca</i> L.	2 sol	-	-	-	-
<i>V. subvillosa</i> (Ledeb.) Boiss.	-	-	-	1 sp	-
Geraniaceae					
<i>Geranium collinum</i> Steph. ex Willd.	4sp	-	-	-	-
<i>G. transversale</i> (Kar. et Kir.) Vved.	-	-	1 sol	1 sol	-
Polygalaceae					
<i>Polygala hybrida</i> DC.	2 sol	-	-	-	-
Euphorbiaceae					
<i>Euphorbia jaxartica</i> Prokh.	-	-	-	-	1 sol
<i>E. pachyrrhiza</i> Kar. et Kir.	1 sol	2 sol	-	-	-
Balsaminaceae					
<i>Impatiens parviflora</i> DC.	1 sol	-	-	-	-
Malvaceae					
<i>Alcea nudiflora</i> (Lindl.) Boiss.	-	1 un	-	-	-
Hypericaceae					
<i>Hypericum hirsutum</i> L.	1 un	-	-	-	-
<i>H. perforatum</i> L.	1 sol	1 sol	1 sol	-	-
<i>H. scabrum</i> L.	-	-	-	-	1 sol
Violaceae					
<i>Viola acutifolia</i> (Kar. et Kir.) W. Beck.	3 sol -sp	-	-	-	-
<i>V. occulta</i> Lehm.	-	1 sol	-	-	-
<i>V. rupestris</i> F.W. Schmidt	1 un	-	-	-	-
<i>V. suavis</i> M. Bieb.	1 sol	-	-	-	-
<i>Viola</i> sp.	2 sol	-	-	-	-
Apiaceae					
<i>Aegopodium tadschikorum</i> Schischk.	3 sol	-	-	-	-
<i>Bupleurum aureum</i> Fisch.	1 sol	-	-	-	-
<i>B. tianschanicum</i> Freyn	-	1 sol	-	-	-
<i>Ferula akitschkensis</i> B. Fedtsch. ex K.- Pol.	3 un	-	-	-	-
<i>F. ovina</i> (Boiss.) Boiss.	1 un	2 sol	-	1 sol	-
<i>F. samarkandica</i> Korov.	-	1 sol	-	-	1 sol
<i>Heracleum dissectum</i> Ledeb.	1 un	-	-	-	-
<i>Hymenolyma trichophyllum</i> (Schrenk) Korov.	-	1 sol	-	-	1 sol
<i>Bunium setaceum</i> (Schrenk) H. Wolff	3 sol	-	-	-	-
<i>Seseli schrenkianum</i> (C. A. Mey. ex Schischk. M. Pimen. et Sdobnina	5 sp-sol	-	-	-	-

Continuation of table 1

Family, species	Number of descriptions and abundance of species				
	1	2	3	4	5
<i>Vicatia atosanguinea</i> (Kar.et Kir.) P. K. Mukher- ee et M. Pimen.	3 sp -sol	-	-	-	-
Primulaceae					
<i>Primula kaufmanniana</i> Regel	3 sp -sol	-	-	-	-
Gentianaceae					
<i>Gentiana tianschanica</i> Rupr.	1 sol	-	-	-	-
Boraginaceae					
<i>Lappula sinaica</i> (DC.) Aschers ex Schweinf.	-	-	-	-	2 sol
<i>Lithospermum arvense</i> L.	1 sp	-	-	-	-
<i>L. officinalis</i> L.	1 un	-	-	-	-
<i>L. tenuiflorum</i> L.fil.	1 sp	-	-	-	-
<i>Myosotis caespitosa</i> K.F.Schultz	1 un	-	-	-	-
<i>Onosma irritans</i> M. Pop. ex Pavl.	-	1 sol	-	-	-
Lamiaceae					
<i>Betonica foliosa</i> Rupr.	3 sol -sp	-	-	-	-
<i>Dracocephalum integrifolium</i> Bunge	1 sol	-	-	-	-
<i>Lagocholus platycalyx</i> Schrenk ex Fisch.et C.A.Mey.	-	-	-	-	2 sol
<i>Lallemantia royleana</i> (Benth.) Benth.	-	-	-	-	2 sol
<i>Leonurus turkestanicus</i> V. Krecz. et Kuprian.	1 un	-	-	-	2 sol
<i>Nepeta pannonica</i> L.	-	-	-	-	1 sol
<i>Origanum vulgare</i> L.	3 sol-sp	-	-	-	-
<i>Phomoides pratensis</i> (Kar.et Kir.) Adyl., R. Kam. et Machmedov	2 un	-	-	-	-
<i>Ph. speciosa</i> (Rupr.) Adyl., R. Kam. et Machmedov	1 sol	1 sol	1 sol	1 sol	1 sol
<i>Ziziphora bungeana</i> Juz.	-	1 sp	-	-	-
Scrophulariaceae					
<i>Dodartia orientalis</i> L.	1 sp	-	-	1 sol	-
<i>Euphrasia pectinata</i> Ten.	-	-	-	-	1 sol
<i>Linaria transiliensis</i> Kuprian.	-	-	-	-	1 sol
<i>Pedicularis alberti</i> Regel	2 sol	-	-	-	-
<i>Scrophularia heicheriiflora</i> Schrenk	-	-	-	1 sol	-
<i>Verbascum songoricum</i> Schrenk ex Fisch. et C. A. Mey.	-	1 un	-	-	2 sol
<i>Veronica cardiocarpa</i> (Kar. et Kir.) Valpers	-	-	1 sp	-	-
<i>V. spuria</i> L.	2 sol	-	-	-	-
Rubiaceae					
<i>Galium aparine</i> L.	-	1 cop ₁	1 sp	-	-
<i>G. turkestanicum</i> Pobed.	2 sol	-	-	-	-
<i>Galium</i> sp.	1 sol	-	-	-	-

Family, species	Number of descriptions and abundance of species				
	1	2	3	4	5
Valerianaceae					
<i>Patrinia intermedia</i> (Horn.) Roem. et Schult.	1 sol	1 un	1 sol	1 sol	-
<i>Valeriana chionophila</i> M. Pop. et Kult.	-	-	-	1 sol	-
<i>Valerianella plagiostephana</i> Fisch. et C. A. Mey.	-	-	-	-	1 sol
Campanulaceae					
<i>Campanula glomerata</i> L.	3 sol -sp	-	-	-	-
Asteraceae					
<i>Achillea millefolium</i> L.	3sp-cop ₁	1 sp	-	-	-
<i>Allredia acantholepis</i> Kar. et Kir.	1 sol	-	-	-	-
<i>Artemisia absinthium</i> L.	3 un-sol	-	-	-	-
<i>A. dracunculus</i> L.	3 sol -sp	1 sol	-	2 sol	-
<i>A. santolinifolia</i> (Turcz. ex Pamp.) Krasch.	3 sol	1 sol	-	-	-
<i>A. sublessingiana</i> Krasch. ex Poljak.	-	2 sol	-	-	-
<i>A. tianschanica</i> Krasch. ex Poljak.	-	-	-	-	2 sp
<i>A. vulgaris</i> L.	2 sol	-	-	1 sol	-
<i>Aster canescens</i> (Nees) Fisjun	1 sol	-	-	-	-
<i>Centaurea ruthenica</i> Lam.	-	-	-	-	2 sol-sp
<i>Cichorium intybus</i> L.	-	1 sol	-	-	-
<i>Cirsium semenovii</i> Regel	1 un	-	-	-	-
<i>Galatella coriacea</i> Novopokr.	1 sol	-	-	-	-
<i>Ligularia alpigena</i> Pojark.	1 sol	-	-	-	-
<i>L. thomsonii</i> (Clarke) Pojark.	2 sol	-	-	-	-
<i>Picris nuristanica</i> Bornm.	1 un	-	-	-	-
<i>Rhinactinidia limoniifolia</i> (Less.) Novopokr. et Pojark.	1 sol	-	-	-	-
<i>Serratula alata</i> C. A. Mey.	-	1 sol	-	-	-
<i>Steptorhamphus crassicaulis</i> (Trautv.) Kirp.	1 sol	1 un	-	-	-
<i>Taraxacum officinale</i> L.	4 un-sol	-	-	-	-
<i>Tragopogon dubius</i> Scop.	-	-	-	-	1 sol

Note: Abbreviations in the table indicate the degree of abundance of species according to Drude, deciphered in the section Materials and methods of research, and the numbers before the abbreviation indicate the number of descriptions.

Thus, the flora of plant communities with the participation of *T. tarda* comprises 199 species from 140 genera and 45 families, 17 of which are represented by only one species (Table 1). There is almost the same number (16) of the most species rich families (with 5 to 21 species). In total, the latter comprise 157 species, i.e. 78% of the flora of the surveyed communities with the participation of *T. tarda*. In descending order of the number of species,

these families are: Asteraceae, Poaceae, Fabaceae, Rosaceae, Apiaceae, Lamiaceae, Ranunculaceae, Caryophyllaceae, Liliaceae, Scrophulariaceae, Polygonaceae, Brassicaceae, Boraginaceae, Alliaceae, Violaceae, and Crassae. This arrangement is in many ways similar to that of the top ten species rich families of the entire flora of the Zailiyskiy Alatau [49], with the exception of Brassicaceae and Chenopodiaceae. On our list, the former occupies the

12th place instead of the fourth on the list of flora of the entire ridge. The family Chenopodiaceae is represented by only one species, while in the entire flora of the ridge there are 68 species of Chenopodiaceae. In the communities with the participation of *T. tarda*, the top ten families were Apiaceae and Liliaceae (11 and nine species, respectively). This can be explained by the greater dryness and rockiness of the habitats of the species studied.

Among the life forms represented in the described communities, herbaceous plants, in particular perennials, predominate (about 90%); the share of annuals and biennials is only 13%. Shrubs are represented by 20 species (about 10%); of the trees, only *Acer semenovii* was recorded. We presented the general floristic composition of communities with the participation of *T. tarda* within the entire natural distribution range of the species, taking into account data from Kyrgyzstan [50]. It should be emphasized that 34 species recorded by K. Isakov were not present in our descriptions. However, almost all of them, with the exception of the endemic of Kyrgyzstan *Astragalus kemenensis*, are known to grow in Kazakhstan; therefore, they can be found in other locations that have not yet been examined by us.

Comparing the obtained data with the results of our studies on other species, it should be emphasized that in terms of floristic richness (199 species), communities with the participation of *T. tarda* occupy an intermediate position in comparison with other species of Kazakh tulips; that is between the rich communities (with the participation of *T. greigii* and *T. altaica*, and 320 and 246 accompanying species, respectively) and poor communities (with the participation of local endemics *T. ivaschenkoae* and *T. lemmersii*, and 46 and 59 accompanying species, respectively) [51].

The floristic core of the plant communities with the participation of *T. tarda* consists of 13 species recorded in 40% or more descriptions: *Rosa platyacantha*, *Spiraea hypericifolia*, *Ephedra equisetina*, *Festuca valesiaca*, *Sedum hybridum*, *S. ewersii*, *Artemisia dracuncululus*, *Euonymus semenovii*, *Atraphaxis pyrifolia*, *Cystopteris fragilis*, *Tulipa ostromskiana*, *Thalictrum minus*, and *Taraxacum officinale*. According to their ecological preferences, most of the species listed above are steppe or petro-lithophytic elements.

The importance of preserving communities with the participation of the Red Book listed species *T.*

tarda is enhanced by the fact that they include eight more species of the same category: *T. alberti*, *T. greigii*, *T. koplakovskiana*, *T. ostromskiana*, *Crocus altavicus*, *Iris alberti*, *Rheum wittrockii*, *Valeriana chinophila*.

Conclusion

T. tarda is a narrow endemic of the Northern Tien-Shan listed in the Red Book of Kazakhstan [25]; it occurs sporadically and forms isolated populations in the western part of the Zailiyskiy Alatau ridge, from the Uzun-Kargaly gorge to Karakunuz valley. As a result of the analysis of the descriptions of 13 geobotanical sites, ecological and phytocenotic preferences of *T. tarda* and the floristic composition of communities with its participation have been established. The altitudinal distribution range of this species comprises two mountain zones, steppe and shrub – forest-meadow, within the range of 1100-1900 m above sea level. The preferred habitats of the species are confined to slopes of various exposures and steepness, from gentle to almost steep, on gravel and rocky slopes. The vegetation cover ranges from sparse, with a total projective cover of 30% or more on rocks, to dense (85-95%). The plant communities with the participation of *T. tarda* are predominantly multicomponent, of the steppe, semi-steppe, or meadow-steppe type, most often with the presence of shrubs. In total, these communities comprise 199 species from 140 genera and 45 families. The most species rich (from 5 to 21 species) are 16 families, which comprise 78% of the entire flora.

In terms of life forms, herbaceous plants predominate (about 90%); there are 20 species of shrubs and only one tree species (*Acer semenovii*). The floristic core of the communities with the participation of *T. tarda* is represented by five shrubs and eight herbaceous perennials, most of which, like the species studied, belong to the steppe and petro-lithophilic ecological elements. *T. tarda* is a rare species listed in the Red Book of Kazakhstan. Therefore it deserves special protection, alongside with the communities with its participation. The importance of conservation and protection of these communities is enhanced by the presence of eight other Red Book listed species: *T. alberti*, *T. greigii*, *T. kolpakowskiana*, *T. ostromskiana*, *Iris alberti*, *Crocus alatavicus*, *Rheum wittrockii*, and *Valeriana chinophila*.

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