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FLORISTIC ANALYSIS OF PLANT COMMUNITIES WITH THE PARTICIPATION OF A NARROW TIEN SHAN ENDEMIC, *TARAXACUM KOK-SAGHYZ* L.E.RODIN

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Abstract

Taraxacum kok-saghyz L.E.Rodin is a promising natural rubber source and an alternative to *Hevea brasiliensis* (Willd. ex A. Juss.) Müll.Arg. At the same time, *T. kok-saghyz* is a narrow endemic and a rare species with decreasing population size due to degradation of its natural habitat. Therefore, it is listed in the Red Data Book of Kazakhstan. Despite a large number of studies addressed various characteristics of this plant, the data on the floristic composition of plant communities it is part of are limited. The aim of our studies was to assess the floristic composition of plant communities with the participation of *T. kok-saghyz*. The article presents the most complete, up-to-date list of the flora comprising 169 species belonging to 110 genera and 35 families. We present the results of an analysis including taxonomic, chorological and ecological data, identified the basic spectrum consisting of 29 species which are the most characteristic indicators of the plant communities studied. For the first time, the 'core' of the flora was determined, consisting of 14 species. According to the habitat type, most of the basic spectrum was formed by mountain species (14) including one narrow endemic (Ketmentau), followed by Palaearctic species (8). According to ecological preferences, the following groups were distinguished: mesophytes (9 species), mesoxerophytes (7 species), and halophytes of various types (9 species). The share of species preferring saline habitats (halophytes) was 31.4 %. The most similar (Koch's index of biotal dispersity of 23.1 %) were communities at the western border of the surveyed area, and the value of the index gradually decreased towards the eastern border (from 22.7 % to 18.7 %). The results obtained can be important in the further studies on the populations of *T. kok-saghyz*, in searching for potential habitats and organizing population monitoring.

Key words: Asteraceae, ecotypes, floristic 'core', halophytes, rubber plant, Russian dandelion.

Introduction

There is a growing interest in *Taraxacum kok-saghyz* L.E.Rodin as a source of natural rubber (NR). The demand for this raw material is also growing, which is explained, first of all, by its superior elasticity, impact and abrasion resistance, in comparison with the synthetic analogue made from oil. Most globally produced NR (over 60 %) is used in the manufacture of car tires. The remaining approx. 40 % is used in the manufacture of high-strength conveyor belts, anti-corrosion coatings for boilers and pipes, glue, thin-walled high-strength small items, and medical equipment. The ever-growing demand for NR is also due to the replacement of petroleum products as sources of synthetic rubber with renewable natural resources (Kuluyev et al. 2015). Currently, the main source of NR is *Hevea brasiliensis* (Willd. ex A.Juss.) Müll. Arg. Plantations of this species in its native South America are in decline due to the spread of a dangerous disease caused by the fungus *Microcyclus ulei.* As a result, the cultivation *of H. brasiliensis* is currently concentrated in Southeast Asia and some African countries. The probability of loss of *H. brasiliensis* plantations in these regions due to the spread of the pathogenic fungus is quite high; therefore, there is a growing scientific interest in alternative natural sources of rubber, such as *T. kok-saghyz*, also called 'Russian dandelion'. It is worth mentioning that the roots of the species contain another valuable product, inulin. Moreover, the rubber obtained from the roots of *T. kok-saghyz* is hypoallergenic, while the one obtained from *H. brasiliensis* is not (van Beilen and Poirier 2007, Baitulin 2010, Baitulin and Baitulin 2010, Kuluyev et al. 2015, Kutuzova et al. 2015, Luo et al. 2017).

The search for an alternative to *H. brasiliensis* began in Europe and the USA before and during World War II (Whaley and Bowen 1947) and intensified in the 2000s. In the past 10–15 years, several authors addressed such issues as the history of the study of *T. kok-saghyz* as a source of NR and inulin, as well as the problems and prospects of its cultivation (Rakhmankulov et al. 2006; Baitulin 2010; Baitulin et al. 2012; Kuluyev et al. 2015; Kutuzova et al. 2015; Kreuzberger et al. 2016; Arias et al. 2016a, 2016b; Garshin et al. 2016). Additional studies addressed population genetics of the species and genome structure (Collins-Silva et al. 2012, Arias et al. 2016c, McAssey et al. 2016, Lin et al. 2017, Luo et al. 2017), the biochemical composition of roots (Ramirez-Cadavid et al. 2017), plant morphology in nature and in cultivation (Baitulin et al. 2011, Abidkulova et al. 2015), and the internal structure of vegetative organs (Akhmetova et al. 2015). Several publications on the current state of *T. kok-saghyz* populations in Kazakhstan have stressed the need to revive NR production in the Republic of Kazakhstan (Volis et al. 2009, Baitulin and Baitulin 2010, van Dijk et al. 2010, Ametov et al. 2015, Mukhitdinov et al. 2015, Magzieva et al. 2016). Despite the numerous recent studies on *T. kok-saghyz,* the floristic composition of its natural plant communities has received little attention. In addition to a short list of co-occurring species (Lipschitz 1934, Pavlov 1948, Golovkova 1959), comprehensive species lists are available only in the publication by Ametov et al. (2015) describing populations in the Tekes River Valley.

For further search and identification of new habitats of this local endemic listed in the Red Data Book of Kazakhstan (2014), it is important to have a detailed information of its plant communities, in-

cluding the constantly occurring and less frequent species. This information is also necessary for monitoring the state of populations, since a change in the floristic composition can be an indicator about the status of its populations.

The objective of our study was to reveal the basic species composition of plant communities with the participation of *T. kok-saghyz*, i.e. identification of species that are found almost universally co-occurring with *T. kok-saghyz* in all suitable habitats.

Fig. 1. *Taraxacum kok-saghyz* in the surroundings of Lake Tuzkol.

Materials and Methods

T. kok-saghyz (Fig. 1) is one of 62 species of the genus *Taraxacum* growing in Kazakhstan (Abdulina 1999). It is a perennial plant, up to 15 cm tall, with a thick root. Inflorescences (capitulae) contain bisexual ray florets with a yellow corolla; receptacles are 8–11 mm long; achenes are furrowed with a crest of white bristles. Flower arrows are usually numerous (up to 38), and sometimes are solitary. Leaves are up to 10 cm long and 3 cm wide, shallow toothed along the edge or entire. The species is characterized by a long growing season: the first rosettes of leaves appear in early May, and yellowing and drying usually happens in early August. It blooms throughout the summer. It is found in the Kegen, Saryzhaz and Tekes valleys of the Northern Tien Shan (Fig. 2) in salinized meadows, together with *Achnatherum spp*, on pebbles and in river valleys, floodplain and piedmont meadows, and on

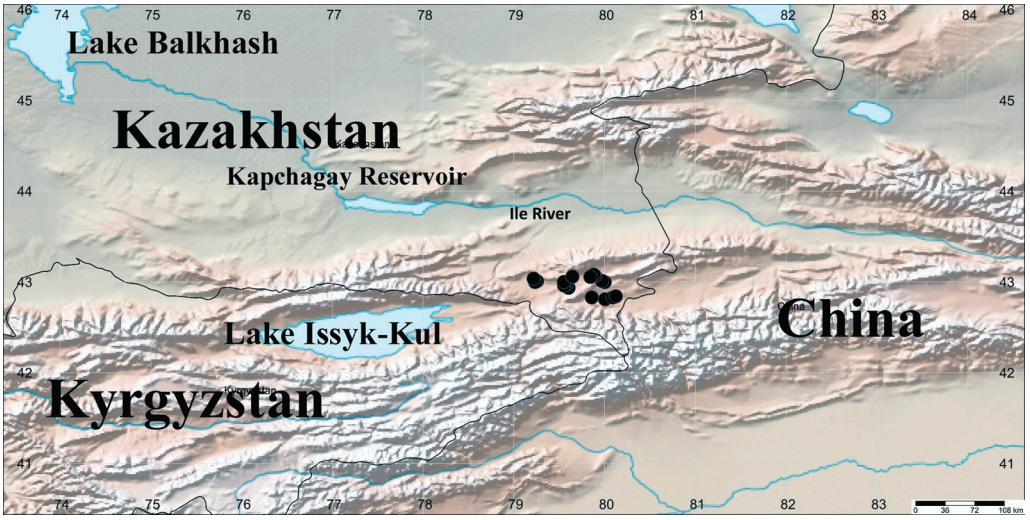

Fig. 2. The study area (marked by black dots).

northern mountain slopes at an altitude of almost 2000 m above sea level.

Its natural distribution range is a small area of up to 10,000 km^2 in three intermountain valleys in the southeast of the Almaty region at an altitude of 1800–2100 m a.s.l., the soils of which are characterized by different degrees of salinization (Volis et al. 2009, Baitulin and Baitulin 2010, Kutuzova et al. 2015, Garshin et al. 2016).

Our studies were conducted in 2009 and in 2014 in the Raiymbek district of the Almaty Region (Fig. 2). Over the course of the field trips, seven *T. kok-saghyz* habitats were examined; largest populations in the vicinity of Lake Tuzkol, in the Saryzhaz, Tekes, and Kegen valleys were examined in the most detail.

Sampling plots were established to study the vegetation cover, as well as 1×1 m census plots on which virgin and generative individuals of *T. kok-saghyz* were counted.

Geobotanical descriptions were carried out according to generally accepted methods (Korchagin and Lavrenko 1964), and species were identified according to botanical references (Komarov 1934–1964, Pavlov 1956–1966, Handbook for identification of plants of Central Asia 1968–1993). The habitat types were identified according to Goloskokov (1984), and the nomenclature of species according to Abdulina (1999) and POWO (2020). To determine the similarity coefficient of the floristic compositions at several locations of the distribution range studied we used the Koch's index (*IBD*) of biotal dispersity (Koch 1957) by formula (1).

$$IBD = \frac{T - S}{S(n-1)} \cdot 100\,, \qquad (1)$$

where: *S* is the total number of species in an area; *n* is the total number of sub-areas; *T* is the sum of species in all sub-areas, i.e. $T = S_1 + S_2 + \ldots + S_n$.

Results and Discussion

In 2009 and 2014, 37 detailed surveys were performed at 20 localities in the Kegen, Saryzhaz, and Tekes valleys and around Lake Tuzkol. Thus, the floristic composition of plant communities with the participation of *T. kok-saghyz* was described in detail (below).

List of co-occurring species of *T. kok-saghyz* is presented in supplementary material (Appendix).

Considering our previous studies (Ametov et al. 2015), the communities with the participation of *T. kok-saghyz* comprised 169 species from 110 genera and 35 families. The numbers were substantially higher than the numbers reported earlier: 73 species from 69 genera and 24 families (Ametov et al. 2015).

The first group, consisting of Asteraceae and Poaceae (23–22 species), were represented by the largest number of species, followed by second one of Fabaceae, Amaranthaceae, Brassicaceae and Cyperaceae (14–10 species). The third group of the most species-rich families included Ranunculaceae, Caryophylaceae, Orobanchaceae and Rosaceae (6–5 species). In total, the top 10 most species-rich families accounted for 70 % of the total species richness (Table 1). Of the remaining 25 families, five were represented by two to four species and ten, by one species each.

The generic coefficient (number of species per genus) was 1.54. The largest genus with eight species was *Carex*, followed by *Juncus, Trifolium, Galium, Artemisia* and *Saussurea* with four species each; seven genera had three species, 23 genera had two, and the rest had one

species each.

As a result of the analysis, we found that 14 species represented the 'core' of the plant communities (Table 2), and were found in 40 % or more revelés.

The group was followed by another 15 species, which were recorded in 25–39 % of the revelés (Table 3).

Table 1. Ten most species-rich families of plant communities with the participation of *T. kok-saghyz.*

Family	Number of species	Number of genera	Share of the total number of species, %
Asteraceae	23	13	13.6
Poaceae	22	15	13.0
Fabaceae	16	10	9.5
Amaranthaceae	14	11	8.3
Brassicaceae	11	9	6.5
Cyperaceae	10	2	5.3
Ranunculaceae	6	5	3.6
Caryophyllaceae	6	4	3.6
Orobanchaceae	6	5	3.6
Rosaceae	5	2	3.0
Total	118	76	70.0

Table 2. Species of the floristic 'core' of plant communities with the participation of *T. kok-saghyz*.

Species	Distribution area	Ecological group
1. Neotrinia splendens (Trin.) M.Nobis, P.D.Gudkova & A.Nowak	Mountain-Siberian-Iranian	hemihalomesoxerophyte
2. Hordeum brevisubulatum (Trin.) Link	Turan-Mongolian	halomesophyte
3. Leymus multicaulis (Kar. et Kir.) Tzvel.	Turanian	haloxeromesophyte
4. Puccinellia distans (Jacq.) Parl.	Palaearctic (PA)	halomesoxerophyte
5. Carex oederi Retz. (*Carex serotina* Merat)	Palaearctic (PA)	hydromezophyte
6. Iris halophila var. *sogdiana* (Bunge) Grubov	Mountain-Central Asian-Central Kazakhstan	mesophyte
7. Potentilla multifida L.	Mountains of Central Asia	mesoxerophyte
8. Oxytropis glabra (Lam.) DC.	Turan-Mongolian	mesophyte
9. Thermopsis turkestanica Gand.	Tarbagatae- Tien Shan	mesophyte
10. Plantago maritima L.	Holarctic (GA)	halomesophyte
11. Artemisia sublessingiana Krasch. ex Poljakov	Altai-Kazakhstan-Tien Shan	xerophyte
12. Cirsium esculentum (Sievers) C.A. Mey.	Gorno-Siberian-Tien Shan	hemigalomesophyte
13. Galatella tianschanica Novopokr.	Endemic (Ketmen)	halomesophyte
14. Inula rhizocephala Schrenk.	Altai-Iranian	mesophyte

Table 3. The most frequent co-occurring species of *T. kok-saghyz.*

Species	Distribution area	Ecological group
1. *Leymus angustus* (Trin.) Pilg.	Turan-Mongolian	haloxeromesophyte
2. *Phragmites australis* (Cav.) Trin. ex Steud.	Cosmopolitan	hydromezophyte
3. *Juncus triglumis* L.	Palaearctic (PA)	mesophyte
4. *Argentina anserina* (L.) Rydb.	Holarctic (GA)	hygromesophyte
5. *Potentilla virgata* Lehm.	Gorno-Siberian-Gorno-Central Asian	mesoxerophyte
6. *Caragana auruntiaca* Koehne	Dzhungar-Tien Shan	mesoxerophyte
7. *Trifolium repens* L.	Palaearctic (PA)	mesophyte
8. *Geranium collinum* Stephan ex Willd.	Palaearctic (PA)	mesophyte
9. *Lappula microcarpa* (Ledeb.) Gürke.	Mountains of Central Asia	mesoxerophyte
10. *Convolvulus lineatus* L.	Palaearctic (PA)	mesoxerophyte
11. *Plantago depressa* Willd.	Gorno-Siberian-Himalayan	mesoxerophyte
12. *Achillea millefolium* L.	Palaearctic (PA)	xerophyte
13. *Leontopodium campestre* (Ledeb.) Hand.-Mazz.	Gorno-Siberian-Gorno-Central Asian	mesophyte
14. *Ligularia alpigena* Pojark.	Dzungarian-Pamir-Alai	mesophyte
15. *Saussurea salsa* (Pall.) Spreng.	Palearctic (PA) (South Palearctic)	haloxerophyte

In total, 29 (17.2 %) of 169 species were most common in the communities with the participation of *T. kok-saghyz*. They were the characteristic indicators of these communities. Of these, the largest group comprised mountain species (14), followed by Palaearctic (8); endemic and cosmopolitan groups had one species each. According to ecological preferences, the largest group comprised mesophytes (9 species), followed by the species growing on saline soils (7) and mesoxerophytes (7).

Typical halophytes were represented by *Hordeum brevisubulatum, Leymus multicaulis, L. angustus, Puccinellia distans, Plantago maritima, Galatella tianschanica,* and *Saussurea salsa.*

In addition to the most common species above, there were less common, but quite abundant species, the presence of which was a characteristic feature of some plant communities. This group comprised 'relatively abundant' (sp-cop1) according to the Drude scale. There were 14 of those: *Agrostis gigantea*, *Poa bulbosa*, *P. pratensis*, *Carex stenophylla* subsp. *stenophylloides*, *Cerastium davuricum*, *Camphorosma monspeliaca*, *Atriplex verrucifera*, *Melilotus dentatus*, *Frankenia hirsuta*, *Astragalus tibetanus*, *Lomatocarpa albomarginata*, *Limonium gmelinii*, *Artemisia viridis*, *Artemisia schrenkiana.*

An analysis of the entire flora of communities studied revealed that the proportion of species preferring saline habitats was 31.4 %. Among those were typical halophytes (32 species), including representatives of the families Amaranthaceae (*Atriplex verrucifera*, *Bassia prostrata*, *Atriplex tatarica*, *Suaeda altissima*, *Salicornia europaea*, *Salsola rosacea*, *Climacoptera* spp.), Asteraceae (*Artemisia schrenkiana*, *Saussurea amara*, *S. robusta*, *S. prostrata*) and some other families (*Lysimachia maritima*, *Limonium gmelinii*, *L. myrianthum*, *Frankenia hirsuta*, *Nitraria*

sibirica, *Festuca arundinacea*, *Melilotus dentatus*).

Another 22 species were hemigalophytes and species that form, according to Bykov's (1962) terminology, galomesophilic ecotypes (*Elymus repens*, *Phragmites australis*), representatives of the family Fabaceae (*Lotus krylovii*, *Trifolium fragiferum*, *Vicia cracca*), *Primula longiscarpa*, *Galium amblyophylum*, *Artemisia austriaca*, *Aster altaicus*, *Scorzonera racemosa* and some others.

All these facts confirm the mesogalophytic nature of the co-occurring species of *T. kok-saghyz*. We were unable to find this species in the dry steppe communities. In Kyrgyzstan, by contrast, it is found in the steppes dominated by *Artemisia tianschanica* Krasch. ex Poljak., *Stipa capillata* L., and *Festuca valesiaca* Schleich. ex Gaudin (Golovkova 1959). Most likely, *T. kok-saghyz* was erroneously identified, because the author supplied the species name with the question mark.

Based on the analysis of the floristic composition according to the distribution area, we recorded a significant predominance of mountain species (about 50 %) and species with wide distribution range (mainly Palaearctic and Holarctic, with some cosmopolitans, about 40 %). The share of the lowland species was small. Apart from typical steppe species (*Festuca valesiaca*, *Cannabis sativa*), those were typical Turanian species (*Leymus multicaulis*, *Polygonum acetosum*, *Polygonum aviculare*, *Salsola rosacea*, *Limonium myrianthum*). The ranges of more than a dozen species (e.g. *Hordeum brevisubulatum*, *Poa bulbosa*, *Climacoptera lanata*, *Salsola orientalis*, *Ceratocarpus arenarius*, *Atriplex verrucifera*, *Oxytropis glabra*) were not typically Turanian, since they extend beyond the borders of the Turan plain itself to Mongolia, Iran, the Mediterranean.

Of the mountain species, the narrowest endemics were of significant interest, due to their limited distribution and conservation importance. Their range was limited to one ridge of the Eastern Tien Shan (Ketmen, *Galatella tianschanica*) or partly extended to the Northern Tien Shan (Zailiysky Alatau), somewhat to the west (into the Central Tien Shan) or east (into Western China): *Ligularia knorringiana, Lonicera alberti, Euphrasia bajankolica.*

It turned out that the most similar (similarity coefficient 23.1 %) were communities at the western border of the surveyed area, in the vicinity of the village of Kegen. The value of the indicator gradually decreased towards the eastern border: from 22.7 % in the Saryzhaz River Valley, to 19.7 % in the vicinity of the village of Karasaz, and 18.7 % in the Tekes River Valley. Future surveys should attempt to verify this pattern in other parts of the species distribution range.

Conclusions

In this article, we presented an extended list of species co-occuring with *T. kok-saghyz*, which was much longer than the lists produced by earlier studies (Lipschitz 1934, Pavlov 1948, Van Dijk et al. 2010, Ametov et al. 2015). We identified 14 species that make up the floristic 'core' and another 15 highly characteristic species were added. In our opinion, these 29 species are indicative of plant communities with the participation of *T. kok-saghyz,* i.e. their presence suggests a high probability of finding *T. kok-saghyz*. An analysis of the distribution range of these species indicates that most of them are mountainous or Palaearctic, which is not surprising, given that their habitat is in the inter-

mountain valleys at an altitude of about or slightly more than 2000 m. According to the results of the ecological analysis, most of the 29 species are mesogalophytic in nature. Of particular interest are four narrow mountain endemics that were found in communities with *T. kok-saghyz* and listed here. The results of the present study of the floristic composition of plant communities with the participation of *T. kok-saghyz* will help further study of this rare local endemic, which is also a very promising rubber-bearing plant. Specifically, our results will assist in searching for its potential habitats, as well as organizing population monitoring and assessing the stability of its state. This is because any changes in the diversity of typical plant community members will signal a change in the state of the species under study.

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Appendix

List of co-occurring species of *T. kok-saghyz*

No	Plant species name
	Equisetaceae Rich. ex DC
1.	*Equisetum arvense* L.
	Poaceae Barnhart
2.	*Agrostis gigantea* Roth
3.	*Alopecurus pratensis* L.
4.	*Brachypodium pinnatum* (L.) P.Beauv.
5.	*Bromus inermis* Leyss. (*Bromopsis inermis* (Leyss.) Holub)
6.	*Bromus oxyodon* Schrenk
7.	*Deschampsia cespitosa* (L.) P.Beauv.
8.	*Elymus repens* (L.) Gould (*Elytrigia repens* (L.) Nevski)
9.	*Elymus sibiricus* L.
10.	*Festuca rubra* L.
11.	*Festuca valesiaca* Schleich. ex Gaudin
12.	*Hordeum brevisubulatum* (Trin.) Link
13.	*Leymus angustus* (Trin.) Pilg.
14.	*Leymus multicaulis* (Kar. & Kir.) Tzvelev
15.	*Lolium arundinaceum* (Schreb.) Darbysh. (*Festuca regeliana* Pavl.)
16.	*Neotrinia splendens* (Trin.) M.Nobis, P.D.Gudkova & A.Nowak
17.	*Phleum alpinum* L.
18.	*Phragmites australis* (Cav.) Trin. ex Steud.
19.	*Poa annua* L.
20.	*Poa bulbosa* L.
21.	*Poa pratensis* L.
22.	*Puccinellia distans* (Jacq.) Parl.
23.	*Setaria viridis* (L.) P.Beauv.
	Cyperaceae Juss.
24.	*Carex capillaries* L.
25.	*Carex oederi* Retz. (*Carex serotina* Merat)
26.	*Carex orbicularis* Boott
27.	*Carex panicea* L.
28.	*Carex pycnostachya* Kar. et Kir.
29.	*Carex songorica* Kar. & Kir.
30.	*Carex stenophylla subsp. stenophylloides* (V.I.Krecz.) T.V.Egorova (*Carex stenophylloides* V. Krecz.)
31.	*Carex turkestanica* Regel
32.	*Schoenoplectus tabernaemontani* (C.C.Gmel.) Palla *(Scirpus tabernaemontani* C. C. Gmel.)
	Juncaceae Juss.
33.	*Juncus compressus* Jacq.
34.	*Juncus heptopotamicus* V.I.Krecz. & Gontsch.

35. *Juncus persicus* subsp. *libanoticus* (J.Thiébaut) Novikov & Snogerup (*Juncus vvedenskyii* V.Krecz.)
36. *Juncus triglumis* L.

Alliaceae J. Agardh

37. *Allium hymenorhizum* Ledeb.
38. *Allium korolkowii* Regel

Iridaceae Juss.

39. *Iris halophila* var. *sogdiana* (Bunge) Skeels (*Iris sogdiana* Bunge)

Orchidaceae Juss.

40. *Dactylorhiza umbrosa* (Kar. & Kir.) Nevski

Cannabaceae Endl.

41. *Cannabis sativa* L. (*Cannabis ruderalis* Janisch.)

Urticaceae Juss.

42. *Urtica cannabina* L.
43. *Urtica dioica* L.

Polygonaceae Juss.

44. *Polygonum aviculare* L. (*Polygonum heterophyllum* Lindm.)
45. *Polygonum acetosum* M.Bieb.
46. *Polygonum patulum* M.Bieb.

Amaranthaceae Juss.

47. *Anabasis salsa* (Ledeb.) Benth. ex Volkens
48. *Atriplex tatarica* L.
49. *Atriplex verrucifera* M.Bieb. (*Halimione verrucifera* (M. Bieb) Aellen)
50. *Bassia prostrata* (L.) Beck (*Kochia postrata* (L.) Schrad.)
51. *Camphorosma monspeliaca* L.
52. *Ceratocarpus arenarius* L.
53. *Chenopodium karoi* (Murr) Aellen (*Chenopodium prostratum* Bunge)
54. *Climacoptera lanata* (Pall.) Botsch.
55. *Climacoptera obtusifolia* (Schrenk) Botsch.
56. *Krascheninnikovia ceratoides* (L.) Gueldenst.
57. *Salicornia europaea* L.
58. *Salsola rosacea* L.
59. *Salsola orientalis* S.G. Gmel.
60. *Suaeda altissima* (L.) Pall.

Caryophyllaceae Juss.

61. *Cerastium davuricum* Fisch. ex Spreng.
62. *Cerastium dichotomum* L.
63. *Cerastium falcatum* (Gren.) Bunge ex Fenzl. (*Cerastium bungeanum* Vved.)
64. *Herniaria glabra* L.
65. *Holosteum umbellatum* L.
66. *Silene viscosa* (L.) Pers.

Ranunculaceae Juss.

67. *Delphinium iliense* Huth

68. *Halerpestes sarmentosa* (Adams) Kom. (*Halerpestes salsuginosa* (Pall. ex Georgi) Greene)
69. *Ranunculus pulchellus* C.A.Mey.
70. *Ranunculus testiculatus* Crantz (*Ceratocephala testiculatus* (Crantz) Besser)
71. *Thalictrum foetidum* L.
72. *Thalictrum simplex* L.

Brassicaceae Burnett

73. *Alyssum desertorum* Stapf
74. *Berteroa incana* (L.) DC.0
75. *Camelina microcarpa* Andrz. ex DC.
76. *Capsella bursa-pastoris* (L.) Medik.
77. *Descurainia sophia* (L.) Webb ex Prantl
78. *Draba nemorosa* L.
79. *Lepidium cartilagineum* (J.Mayer) Thell. (*Lepidium crassifolium* Waldst. et Kit.)
80. *Lepidium draba* L. (*Cardaria draba* (L.) Desv.)
81. *Meniocus linifolius* (Stephan ex Willd.) DC.
82. *Sisymbrium polymorphum* (Murray) Roth
83. *Thlaspi arvense* L.

Celastraceae R. Br. (Parnassiaceae S.F.Gray)

84. *Parnassia laxmannii* Pall.ex Schult.

Rosaceae Juss.

85. *Argentina anserina* (L.) Rydb. (*Potentilla anserina* L.)
86. *Potentilla multifida* L.
87. *Potentilla virgata* Lehm.
88. *Sanguisorba alpina* Bunge
89. *Sanguisorba officinalis* L.

Fabaceae Lindl.

90. *Astragalus peterae* H.T.Tsai & T.T.Yu (*Astragalus abramovii* Gontsch.)
91. *Astragalus tibetanus* Benth. ex Bunge
92. *Caragana aurantiaca* Koehne
93. *Lathyrus pratensis* L.
94. *Lotus krylovii* Schischkin & Serg. (*Lotus sergievskiae* R. Kam. et Kovalevsk.)
95. *Medicago falcata* L.
96. *Medicago lupulina* L.
97. *Medicago medicaginoides* (Retz.) E.Small (*Trigonella arcuata* C. A. Mey.)
98. *Melilotus dentatus* (Waldst. & Kit.) Desf.
99. *Oxytropis glabra* DC.
100. *Thermopsis turkestanica* Gand.
101. *Trifolium fragiferum* L.
102. *Trifolium lupinaster* L.
103. *Trifolium pratense* L.
104. *Trifolium repens* L.
105. *Vicia cracca* L.

Geraniaceae Juss

106. *Geranium collinum* Stephan ex Willd.
107. *Geranium sibiricum* L.

Nitrariaceae Lindl.

108. *Nitraria sibirica* Pall.

Zygophyllaceae R.BR.

109. *Tribulus terrestris* L.

Frankeniaceae Desv.

110. *Frankenia hirsuta* L.

Polygalaceae Hoffmanns. & Link

111. *Polygala comosa* Schkuhr (*Polygala hybrida* DC.)

Apiaceae Lindl.

112. *Bupleurum krylovianum* Schischk.
113. *Lomatocarpa albomarginata* (Schrenk) Pimenov & Lavrova (*Alposelinum albomarginatum* (Schrenk) M. Pimen.)
114. *Seseli valentinae* Popov

Primulaceae Batsch ex Borkh.

115. *Androsace ovczinnikovii* Schischk. & Bobrov
116. *Lysimachia maritima* (L.) Galasso, Banfi & Soldano (*Glaux maritima* L.)
117. *Primula knorringiana* Fed.
118. *Primula longiscapa* Ledeb.

Plumbaginaceae Juss.

119. *Goniolimon orthocladum* Rupr.
120. *Limonium gmelinii* (Willd.) Kuntze
121. *Limonium myrianthum* (Schrenk) Kuntze

Gentianaceae Juss.

122. *Gentiana aquatica* L.
123. *Gentiana leucomelaena* Maxim.

Convolvulaceae Juss.

124. *Convolvulus arvensis* L.
125. *Convolvulus lineatus* L.

Boraginaceae Juss.

126. *Arnebia guttata* Bunge
127. *Cynoglossum viridiflorum* Pall. ex Lehm.
128. *Lappula microcarpa* (Ledeb.) Gürke.

Lamiaceae Martinov

129. *Marrubium anisodon* K.Koch
130. *Ziziphora tenuior* L.

Orobanchaceae Vent. (Scrophulariaceae Juss.)

131. *Euphrasia bajankolica* Juz.
132. *Leptorhabdos parviflora* (Benth.) Benth.
133. *Odontites vulgaris* Moench
134. *Pedicularis dolichorrhiza* Schrenk
135. *Pedicularis rhinanthoides* Schrenk.

136. *Rhinanthus songaricus* (Sterneck) B. Fedtsch.

Plantaginaceae Juss.

137. *Plantago depressa* Willd.
138. *Plantago major* L.
139. *Plantago maritima* L.

Rubiaceae Juss.

140. *Galium amblyophyllum* Schrenk
141. *Galium saurense* Litv.
142. *Galium turkestanicum* Pobed.
143. *Galium verum* L.

Caprifoliaceae Juss.

144. *Lonicera alberti* Regel

Campanulaceae Juss.

145. *Adenophora liliifolia* (L.) A.DC.
146. *Codonopsis clematidea* (Schrenk) C.B.Clarke

Asteraceae Bercht. & J.Presl

147. *Achillea millefolium* L.
148. *Artemisia austriaca* Jacq.
149. *Artemisia heptapotamica* Poljak.
150. *Artemisia schrenkiana* Ledeb.
151. *Artemisia sublessingiana* Krasch. ex Poljakov
152. *Artemisia viridis* Willd.
153. *Aster altaicus* Willd.
154. *Cirsium esculentum* (Siev.) C.A.Mey.
155. *Cirsium sieversii* (Fisch. & C.A.Mey.) Petr. (*Cirsium polyacanthum* Kar. et Kir.)
156. *Galatella tianschanica* Novopokr.
157. *Inula rhizocephala* Schrenk
158. *Leontopodium campestre* (Ledeb.) Hand.-Mazz. (*Leontopodium fedtschenkoanum* Beauverd)
159. *Ligularia alpigena* Pojark.
160. *Ligularia knorringiana* Pojark.
161. *Saussurea amara* (L.) DC.
162. *Saussurea prostrata* C.Winkl.
163. *Saussurea robusta* Ledeb.
164. *Saussurea salsa* (Pall.) Spreng.
165. *Scorzonera parviflora* Jacq.
166. *Scorzonera racemosa* Franch.
167. *Taraxacum kok-saghyz* L.E.Rodin
168. *Taraxacum officinale* (L.) Weber ex F.H.Wigg.
169. *Tragopogon turkestanicus* S.A.Nikitin

Note: synonyms accepted in Kazakhstan are given in brackets.