

Checklist

Revised checklist of endemic vascular plants of Kazakhstan

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Abstract

We compiled a checklist of endemic vascular plants occurring in Kazakhstan, employing an exhaustive examination of literature sources, herbarium collections, databases and field observations. Our study reveals that 451 taxa can be considered endemic to Kazakhstan, constituting 7.97% of the total vascular plant diversity in the country. These endemic taxa, originating from 139 genera and 34 families, predominantly thrive in the southern regions of Kazakhstan, specifically in the mountain ridges of the Kazakh part of the Tian Shan, including Karatau (123 taxa), Dzungarian Alatau (80 taxa) and Trans-Ili and Kungey Alatau (50 taxa). Notably, 107 endemic species are granted legal protection. Detailed information regarding life form, life cycle, conservation status and geographical distribution across floristic regions was meticulously compiled for each endemic taxon. Of the six groups of life forms, herbs include the highest part of endemic taxa (367 taxa), followed by dwarf semishrubs (25 taxa), shrubs (23 taxa), subshrubs (20 taxa), undershrubs (13 taxa) and trees (3 taxa). The observed life cycles are perennials (408 taxa), annuals (33 taxa) and biennials (10 taxa). This paper serves as a fundamental groundwork for prospective investigations aimed at assessing population sizes and hotspots of plant endemism throughout Kazakhstan, crucial for determining conservation status of endemic plants.

Key words: Biodiversity hotspots, Central Asia, conservation, endemism, floristic division

Introduction

Endemic plants hold particular importance in studying the history of flora and vegetation of diverse geographical regions, since they represent an important element of biodiversity and serve as vital benchmarks for identifying areas of high biodiversity value. In recent years, much attention has been paid to the study of endemic plants, as evidenced by a large number of scientific



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publications (Tojibaev et al. 2020a; Baasanmunkh et al. 2022; Erst et al. 2022; Chung et al. 2023; Villaseñor et al. 2023).

Kazakhstan occupies a central position within Eurasia and holds a notable distinction of being the ninth largest country globally, with 2,724,900 km² of land area. The territory of Kazakhstan is characterised by a remarkable ecological heterogeneity (Abdulina 1999; Akzhigitova et al. 2003), marked by prominent zonal boundaries, notably the demarcation between the cold-temperate and temperate regions of Northern Eurasia and the Irano-Turanian warm region with the Mediterranean-like type of climate, the latter encompassing the southern part of Kazakhstan.

The remarkable diversity of natural conditions in Kazakhstan contributes to the exceptional richness of its flora, its notable originality and a significant number of endemic plant species in Kazakhstan. According to the latest inventory, 5,658 vascular plant species, representing 159 families and 1,067 genera, occur in the country (Abdulina 1999).

The investigation of endemic plant species, which represent a vital and highly vulnerable component of biodiversity, has garnered significant attention in numerous countries. The number of endemic plants in the countries neighbouring Kazakhstan varies, with China exhibiting the highest number of endemic species at 14,939 (Huang et al. 2011). There are over 2,700 endemic taxa in Russia (Kamelin and Budantsev 2019), Mongolia has 102 taxa (Baasanmunkh et al. 2022), Kyrgyzstan has 393 taxa (Lazkov and Sultanova 2014) and Uzbekistan has 378 taxa (Sennikov et al. 2016). Based on a comprehensive review of the “Flora of Kazakhstan” (Pavlov 1956–1966), Goloskokov (1969) counted 760 endemic species from 199 genera and 47 families in Kazakhstan. Otherwise, various sources estimated the presence of 709 to 823 species of endemic plants in Kazakhstan (Pavlov 1956–1966; Bykov 1966; Goloskokov 1969; Baitenov 2001; Gemedjieva et al. 2010).

The scientific literature contains a substantial body of work focused on the investigation of endemic taxa in Kazakhstan. However, these publications predominantly revolve around limited geographical areas, such as specific mountain ranges, floristic regions or administrative divisions (Pavlov 1970; Goloskokov 1979; Baitenov 1982; Anapiev 1996; Bakeev and Atikeeva 2015; Ishmuratova et al. 2015, 2016a, 2016b; Sadyrova et al. 2017; Mukhtubaeva et al. 2017; Kupriyanov 2022). Reports focusing on endemic plant species within certain families and genera have also been published, including studies on Poaceae (Kupriyanov et al. 2018), Apiaceae (Klyuykov and Ukrainskaya 2018), Asteraceae (Kupriyanov 2018), Ranunculaceae (Shchegoleva 2019a), Chenopodiaceae (Osmanali et al. 2019) and *Oxytropis* (Perezhogin et al. 2020).

The available information regarding the composition of endemic plant species in Kazakhstan, as documented in the “Flora of Kazakhstan” (Pavlov 1956–1966) and other related sources (Bykov 1966; Goloskokov 1969), is largely outdated. Since then, numerous species previously classified as endemic have been discovered beyond the borders of Kazakhstan or reduced to synonyms. In addition, in the last 10 years alone, more than 25 species of endemic plants have been described as new to science from the territory of Kazakhstan, for example: six species of *Tulipa* (*T. annae* J.de Groot & Zonn, *T. auliekolica* Perezhogin, *T. dianaeverettiae* J.de Groot & Zonn., *T. turgaica* Perezhogin, *T. salsola* Rukšāns & Zubov, *T. ivasczenkoae* Epiktetov & Belyalov) (Epiktetov and Belyalov 2013; Perezhogin 2013; de Groot and Zonneveld 2020; Rukšāns and Zubov 2022); five

apomictic species of *Taraxacum* (*T. atrochlorinum* Kirschner & Štěpánek, *T. corvinum* Kirschner & Štěpánek, *T. dzhungaricola* Kirschner & Štěpánek, *T. subulacinum* Kirschner & Štěpánek) (Kirschner and Štěpánek 2017); three species of *Allium*: *A. koksense* R.M.Fritsch, N.Friesen & S.V.Smirn., *A. lepicum* R.M.Fritsch, N.Friesen & S.V.Smirn. and *A. toksanbaicum* N.Friesen & Veselova (Friesen et al. 2021a, 2021b); two species of *Hedysarum* (*H. tarbagataicum* Knjaz. and *H. ulutavicum* Knjaz.) (Knyazev 2019); *Myosotis kazakhstanica* O.D.Nikif. (Nikiforova 2018); *Gagea almaatensis* Levichev, A.Peterson & J.Peterson (Peterson et al. 2016); *Galatella bectauatensis* Kupr. & Koroljuk (Kupriyanov and Korolyuk 2013); *Rhapon-ticoides zaissanica* Kupr., A.L.Ebel & Khrustaleva (Kupriyanov 2020); *Astragalus saphronovae* Kulikov (Kulikov 2014); *Phlomis mindshelkensis* Lazkov (Lazkov 2014); *Phlomoides boroldaica* A.L.Ebel (Ebel et al. 2019); *Fritillaria kolbintsevii* Rukšāns & Zubov (Rukšāns and Zubov 2021); *Galium zaisanicum* Pinzhenina & Kupr. (Pinzhenina and Kupriyanov 2023); *Prangos multicostata* Kljuykov & Lyskov (Lyskov et al. 2016), *Sphaenolobium korovinii* Pimenov & Kljuykov (Pimenov and Kljuykov 2014) and *Nitraria iliensis* Banaev & Tomoshevich (Banaev et al. 2023).

Consequently, the current knowledge regarding the species diversity of endemic plants in Kazakhstan remains poorly available. In order to address this knowledge gap, our research endeavour aimed to compile the checklist of endemic vascular plants in Kazakhstan, based on an extensive analysis of literary sources, comprehensive revision of herbarium collections and data from field observations.

Materials and methods

For the compilation of an endemic plant checklist in Kazakhstan, extensive literature sources were consulted. Initially, nine volumes of the “Flora of Kazakhstan” (Pavlov 1956, 1958, 1960, 1961a, 1961b, 1963, 1964, 1965, 1966) were utilised, alongside the complete list of the country’s flora (Abdulina 1999). The broad-scale inventory of Central Asian plants, “Conspectus Florae Asiae Mediae”, spanning 11 volumes (Kovalevskaya 1968, 1971; Bondarenko and Nabiev 1972; Pakhomova 1974, 1976; Kamelin et al. 1981; Adylov 1983, 1987; Nabiev 1986; Adylov and Zuckerwanik 1993; Khassanov 2015), was also referenced. Additionally, the “Plants of Central Asia” series, consisting of 16 volumes (Grubov 1963–2008), was incorporated. Reports detailing endemic plants within specific geographical and administrative regions of Kazakhstan were used (Pavlov 1970; Goloskokov 1979; Baitenov 1982; Anapiev 1996; Bakeev and Atikeeva 2015; Ishmuratova et al. 2015, 2016a, 2016b; Mukhtubaeva et al. 2017; Sadyrova et al. 2017; Kupriyanov 2022). Furthermore, lists highlighting endemic plants within particular species-rich families and genera were considered, such as Ranunculaceae (Shchegoleva 2019a), Apiaceae (Klyuykov and Ukrainskaya 2018), Asteraceae (Kupriyanov 2018), *Achillea* (Kupriyanov and Kulemin 2023), *Oxytropis* (Perezhogin et al. 2020) and Chenopodiaceae (Suchorukow 2007; Osmanali et al. 2019). Lists encompassing endemic plants within broader geographical regions, which include parts of Kazakhstan, were also reviewed (Tolmachev 1974; Pyak et al. 2008; Tojibaev et al. 2020a; Erst et al. 2022). Additionally, we paid attention to the species described from Kazakhstan and new combinations published from 2013 to 2023, subsequent to the publication of the latest flora list by Abdulina (1999).

Following the compilation of a list of endemic taxa, we conducted a comprehensive re-assessment of the distribution of each species by cross-referencing

published floristic records encompassing the administrative and geographical regions of Kazakhstan (Goloskokov 1949; Stepanova 1962; Karmysheva 1973, 1982; Pavlov 1980; Baitenov 1985; Pugachev 1994; Safronova 1996; Kotukhov 2005; Aralbay et al. 2006; Kadenova et al. 2008; Aipeisova 2012, 2013; Ishmuratova et al. 2016a; Kokoreva et al. 2018; Ivashchenko 2020; Kupriyanov 2020; Sitpayeva et al. 2020; Kubentayev et al. 2021; Orazov et al. 2022, 2024; Khasanov et al. 2023; Kulymbet et al. 2023; Osmonali et al. 2023; Sumbembayev et al. 2023). Furthermore, in order to clarify the presence of presumably endemic plants of Kazakhstan in neighbouring countries, we consulted floristic records of those territories (Kamelin 1990; Yakovlev 2003; Kulikov 2005; Wu et al. 2008; Ryabina and Knyazev 2009; Lazkov and Sultanova 2014; Knyazev 2016; Nowak et al. 2020; Vaganov and Shmakov 2020; Sennikov and Tojibaev 2021; Baasanmunkh et al. 2022), as well as publications documenting the discovery of former Kazakhstan endemics outside their native range (Ho and Fu 1993; Yakovlev 2003; Kurtto et al. 2004; German 2005; Mavrodiev et al. 2005; German 2006a, 2006b; German et al. 2006; Belkin 2009; Sennikov et al. 2011; Soskov 2011; German et al. 2012; German et al. 2013; Byalt and Bubyreva 2014; German 2014; Nobis et al. 2014; Pimenov and Kljuykov 2014; Vesselova 2016; German and Al-Shehbaz 2017; Lazkov and Sennikov 2017a, 2017b; Nobis et al. 2017; Pimenov 2017; Golovanov et al. 2018; Golovanov and Knyazev 2019; Ma and Xu 2019; Shchegoleva et al. 2019b; Zolotukhin and Chkalov 2019; Ovchinnikova 2021; Tojibaev et al. 2022; Sennikov and Lazkov 2023; Vaganov 2023; Juramurodov et al. 2024).

To verify endemic taxa distributions, we employed systematic reports detailing the flora of Kazakhstan and its neighbouring regions (Baitenov 1977; German and Chen 2009; Kljuykov et al. 2018; Smirnov et al. 2018; Nobis et al. 2020; Pimenov 2020; German and Veselova 2022; Sennikov et al. 2023). Additionally, we conducted a thorough examination of specimens housed in various herbaria, including LE, MW, TK, TASH, MHA, SVER, KUZ, ALTB, NS, NSK and MOSP (herbarium acronyms according to Thiers (2023)), as well as the data sourced from the Global Biodiversity Information Facility (GBIF 2023), the International Legume Database and Information Service (ILDIS) (Roskov et al. 2009), BrassiBase: Introduction to a novel database on Brassicaceae evolution. Plant & Cell Physiology (Kiefer et al. 2014), World Plants. Synonymic Checklist and Distribution of the World Flora (Hassler 1994–2024) and the Compositae Working Group (CWG) (2023).

Within the scope of this investigation, we provide a list and an analysis of national endemic vascular plants growing strictly within Kazakhstan (see Appendix 1). This study considers two taxonomic levels of endemic plants: species and subspecies; taxa with a rank lower than subspecies were not considered. Additionally, we present a separate list encompassing sub-endemic taxa (see Suppl. material 1). In this paper, sub-endemics refer to taxa that were formerly considered endemics, but subsequently found in a neighbouring country or countries, based on published literature or herbarium material. In addition, we present a list of former endemics of Kazakhstan reclassified as synonyms of taxa with broader geographical distributions (see Suppl. material 2).

The distribution of each endemic taxon in Kazakhstan is given according to the floristic division of the country (Pavlov 1956). This division partitions Kazakhstan's territory into 29 distinct floristic regions and seven subregions (Fig. 1).

The systematic order and taxonomic position of the families are based on the classification of angiosperms by APG IV (2016). The names of the accept-

ed genera and species are mostly in accordance with Plants of the World On-line (POWO 2023), with corrections according to recently-published taxonomic revisions. The authorship of species, genera and families has been critically cross-checked against the information provided in the International Plant Names Index (IPNI 2023).

Results

Based on a rigorous revision of endemic vascular plants in Kazakhstan, a total of 451 taxa have been identified as endemic to the country (Appendix 1), which account for 7.97% of the total number (5,658 species) of vascular plants in Kazakhstan (Abdulina 1999). The endemic taxa recognised in this study belong to 139 genera and 34 families. Notably, Kazakhstan is home to five monotypic endemic genera, i.e. *Karatavia* Pimenov & Lavrova, *Botschantzevia* Nabiev, *Tschulaktavia* Bajtenov ex Pimenov & Kljuykov, *Cancriniella* Tzvelev and *Sauria* Bajtenov. No endemic families are present in the country.

The greatest number of endemic taxa is registered in the following families: Asteraceae Bercht. & J.Presl (111 taxa from 29 genera), Fabaceae Lindl. (81 taxa from 6 genera), Apiaceae Lindl. (27 taxa from 13 genera), Lamiaceae Martinov (27 taxa from 8 genera), Boraginaceae Juss. (23 taxa from 10 genera), Brassicaceae Burnett (23 taxa from 8 genera), Amaryllidaceae J.St.-Hil. (22 taxa from 1 genus), Liliaceae Juss. (18 taxa from 3 genera), Rosaceae Juss. (17 taxa from 7 genera), Poaceae Barnhart (15 taxa from 8 genera) and Amaranthaceae Juss. (14 taxa from 10 genera) (Fig. 2A). The remaining 23 families are represented by one to 10 species each.

Genera with the greatest number of endemic taxa are as follows: *Astragalus* L. with 46 taxa, *Oxytropis* DC. with 22 taxa, *Allium* L. with 21 taxa, *Taraxacum* F.H.Wigg. with 20 taxa, *Jurinea* Cass. with 20 taxa, *Tulipa* L. with 13 taxa, *Lappula* Moench with 11 taxa, *Artemisia* L. with nine taxa, *Zygophyllum* L. with nine taxa and *Phlomoides* Moench with nine taxa. The remaining genera are represented by one to seven taxa (Fig. 2B).

The highest concentration of endemic plants was documented in two floristic regions: Karatau, with 123 taxa and Dzungarian Alatau, with 80 taxa. Additionally, a noteworthy range of 30 to 52 endemic taxa were observed in eight other floristic regions, namely Trans-Ili Kungey Alatau (50 taxa), Betpak-Dala (46 taxa), Western Tian Shan (46 taxa), Balkhash-Alakol (46 taxa), Chu-Ili Range (36 taxa), Eastern Upland (35 taxa), Western Upland (31 taxa) and Altai (27 taxa). On the other hand, a comparatively smaller number of endemic plants (not exceeding 5 taxa) were identified in six floristic regions: Caspian Region (4 taxa), Syrt (4 taxa), Kyzylkum (3 taxa), Mangyshlak (2 taxa), Kokchetav (2 taxa) and Buzachi (1 taxon). In the other two floristic regions (Bukeev, Southern Ustyrt), no endemic plants were found (Fig. 3A, B).

Amongst all endemic plants in Kazakhstan, 107 species, constituting 23.7% of the overall number of endemic taxa, are presently under the state-level legal protection (Baitulin 2014).

Amongst the six groups of life forms accepted by the Flora of Kazakhstan (Pavlov 1956), herbs include the greatest part of endemic taxa (367), followed by dwarf semishrubs (25 taxa), subshrubs (20 taxa), shrubs (23 taxa), undershrubs (13 taxa) and trees (3 taxa). The dominant life cycles are perennials (408 taxa), followed by annuals (33 taxa) and biennials (10 taxa).

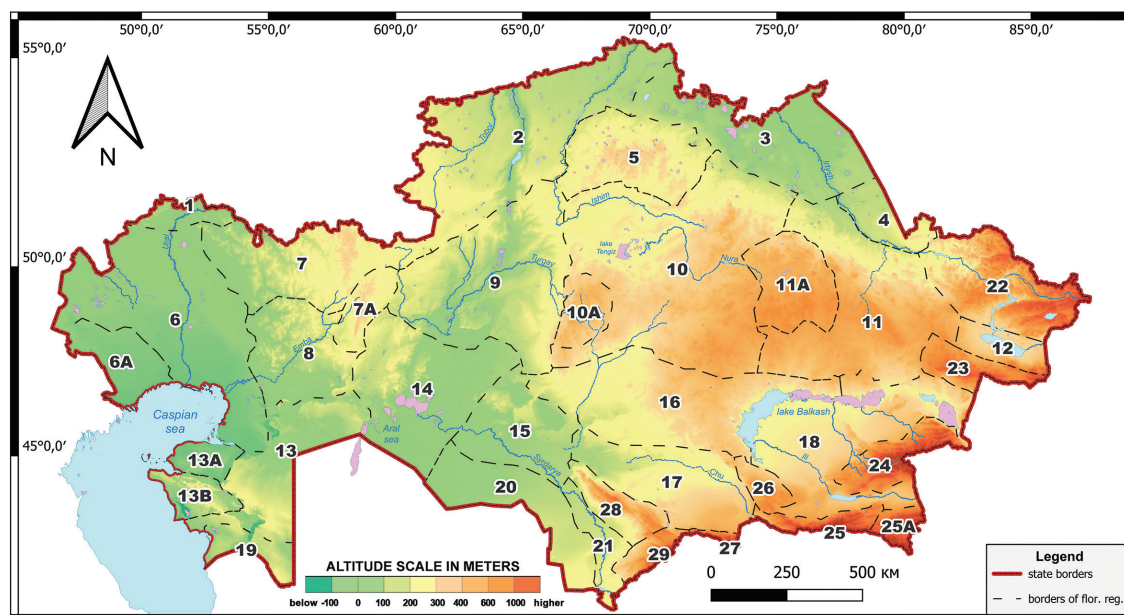


Figure 1. Map of the floristic division of Kazakhstan (Pavlov 1956): 1 – Syrt, 2 – Tobol-Ishim, 3 – Irtysh, 4 – Semipalatinsk pine forest, 5 – Kokchetav, 6 – Caspian Region, 6a – Bukeyev, 7 – Aktobe, 7a – Mugojar, 8 – Emba, 9 – Turgay, 10 – Western Upland, 10a – Ulutau, 11 – Eastern Upland, 11a – Karkaraly, 12 – Zaysan, 13 – Northern Ustyrt, 13a – Buzachi, 13b – Mangyshlak, 14 – Aral Region, 15 – Kyzylorda, 16 – Betpak-Dala, 17 – Moiynkum, 18 – Balkhash-Alakol, 19 – Southern Ustyrt, 20 – Kyzylkum, 21 – Turkestan, 22 – Altai, 23 – Tarbagatai, 24 – Dzungarian Alatau, 25 – Trans-Ili Kungey Alatau, 25a – Ketmen-Terskey Alatau, 26 – Chu-Ili Range, 27 – Kyrgyz Alatau, 28 – Karatau, 29 – Western Tian Shan.

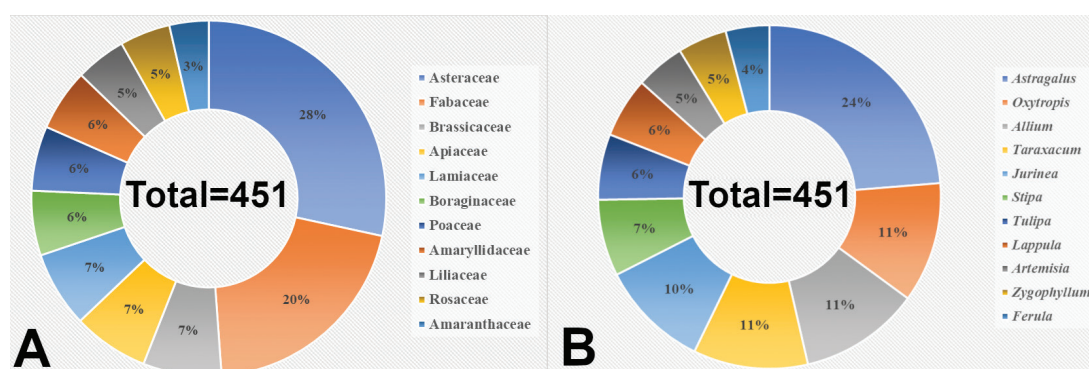


Figure 2. The largest families by the number of endemic taxa (A). The largest genera by the number of endemic taxa (B).

According to the results of our research, 341 taxa previously considered endemics are recognised as sub-endemics of Kazakhstan (see Suppl. material 1) because they were found in the neighbouring countries. The largest number of plants previously considered endemic to Kazakhstan was found in China – 152 taxa, Kyrgyzstan – 138 taxa, Uzbekistan – 71 taxa, Russia – 59 taxa, Mongolia – 59 taxa, Tajikistan – 31 taxa, Turkmenistan – 19 taxa. The total of 169 former endemic taxa of Kazakhstan were synonymised to taxa with wider distribution ranges (see Suppl. material 2).

Discussion

Based on our critical evaluation of vascular plants of Kazakhstan, 451 taxa are identified as endemic to the country (Appendix 1). This figure corresponds to

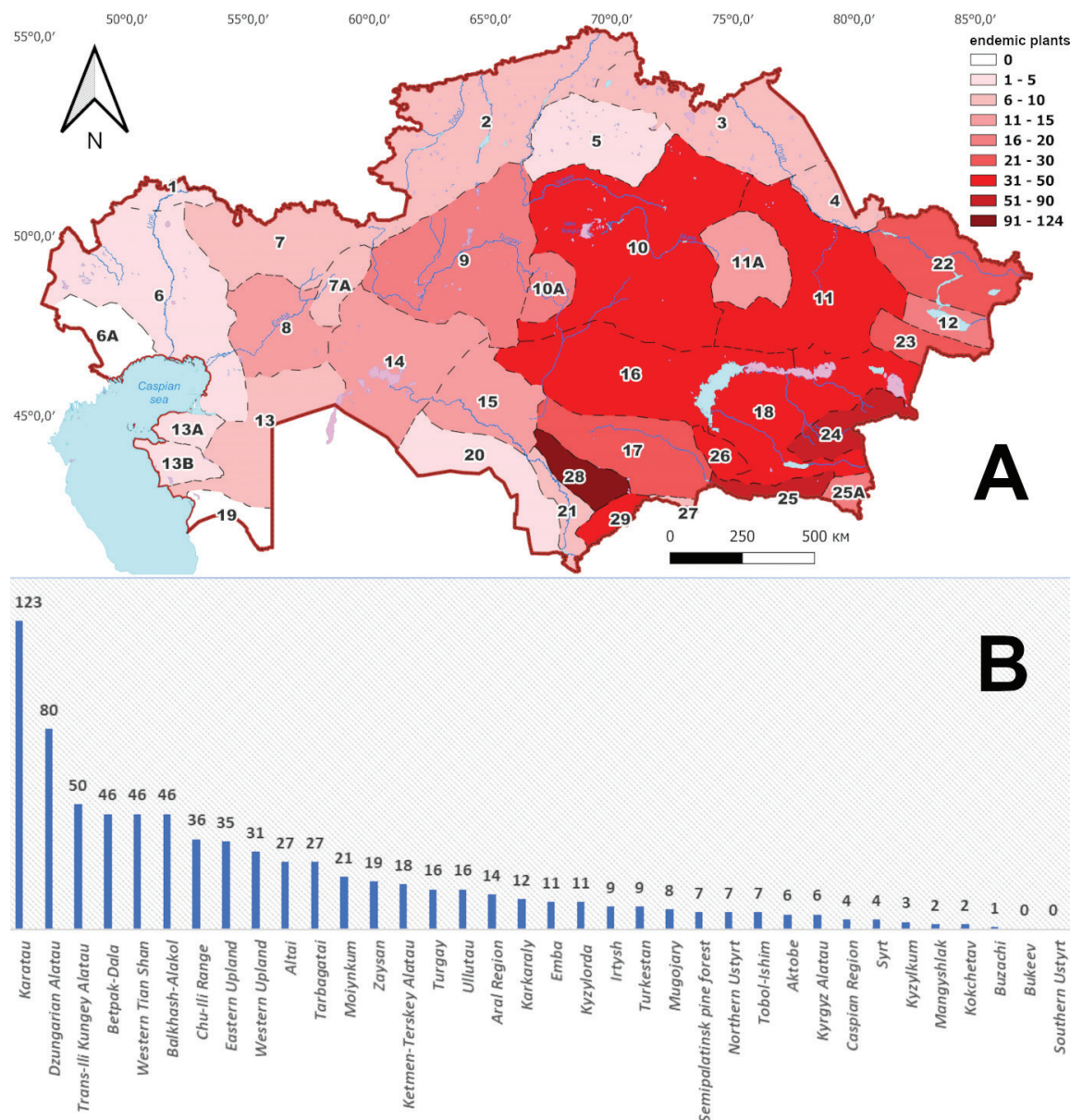


Figure 3. Endemic taxa richness in the floristic regions of Kazakhstan (A). The number of endemic taxa in the floristic regions of Kazakhstan (B).

55–63% of the previously-reported numbers, i.e. 709–823 species (Pavlov 1956–1966; Bykov 1966; Goloskokov 1969; Baitenov 2001; Gemedjeva et al. 2010). The substantial difference in the number of endemic taxa compared to earlier publications is due to their reliance on outdated information solely derived from the nine-volume edition of the Flora of Kazakhstan (Pavlov 1956–1966). Our review reveals that 341 taxa previously considered endemics are to be treated as sub-endemics of Kazakhstan (see Suppl. material 1), whereas 169 former endemic taxa were synonymised to taxa with wider distribution ranges (see Suppl. material 2). For example, two most recent publications removed two endemic taxa from Kazakhstan: *Allium valentinae* Pavlov was found in Kyrgyzstan (Sennikov and Lazkov 2023), whereas the generic status of *Pseudomarrubium* was rejected (Zhao et al. 2023). Such examples provide evidence of ongoing taxonomic and floristic studies that are constantly shaping the list of endemic plants of Kazakhstan.

Despite the extensive territory and diverse natural conditions of Kazakhstan, the occurrence of endemic taxa appears highly uneven in the country. The largest number of endemic plants is concentrated in mountainous areas, specifically in the southern and south-eastern parts of Kazakhstan, within the following floristic regions: Karatau (123 taxa), followed by the Dzungarian Alatau (80 taxa) and Trans-Ili Kungey Alatau (50 taxa). These results fully align with the analysis presented by Gemedjieva et al. (2010), who examined the distributions of endemic plants in Kazakhstan, despite their use of outdated taxonomic and distributional data. The distribution pattern of endemic taxa across the territory of Kazakhstan supports the assertion made by Körner (2002) that mountain systems serve as biodiversity and endemism hotspots due to the compression of distinct climatic zones over varying altitudes. According to the latest global analysis of seed plant endemism, the territory of Kazakhstan is assigned to the centre of neo-endemism (Cai et al. 2023). The mountainous regions of Tian Shan in the south and the Altai Mountains in eastern Kazakhstan appear to have favoured this, because the mountainous regions exhibit a great diversity in their plant lineages and, therefore, contribute to high levels of neo-endemism.

The distribution of endemic plants in Kazakhstan is presumably influenced by the geological and climatic history of the territory. Past climate change and geological history help to explain how diversification and relictualisation shape the distribution of neo- and paleoendemism and simultaneously phylogenetic endemism worldwide (Cai et al. 2023). The influence of geological history on speciation, differentiation, migration and extinction of species has been highlighted by many scientists (Takhtajan 1969; Raven and Axelrod 1974; Latham and Ricklefs 1993; Axelrod et al. 1996; Huang et al. 2011). A prime example illustrating this phenomenon is the endemic taxa richness in the ancient Karatau Mountains (123 taxa), located at the westernmost limit of the Tian Shan. The Karatau Mountains possess a complex geological composition, characterised by the presence of the oldest Precambrian shale formations in Central Asia, as well as the Lower Paleozoic formations consisting of metamorphosed limestones and shales, overlain by a quartzite stratum (Kamelin 1990). An important factor in the distribution of endemic plants is long-term climatic stability. Central Asia is known for the presence of ancient plant lineages which survived there due to the continuous history of suitable climatic conditions (e.g. in *Lactuca* s.l.: Kilian et al. (2017)). The influence of geological and climatic history on the distribution of endemic plants in Kazakhstan requires additional research, given the poorly-studied bedrock types in Central Asia.

In the flora of Kazakhstan, herbs include most of the endemic taxa. The life forms of plants reflect their adaptability to environmental conditions and form the units of ecological classification, grouping plants with similar adaptive structures (Aipeisova 2009). According to Yurtsev (1976) and Rabotnov (1978), studies of life forms contribute to the understanding of species biology and their roles within ecosystems. The diversity of life forms represents a cumulative effect of long-term evolutionary processes responding to gradual changes in regional ecological conditions (Keller 1938; Shennikov 1950; Serebryakov 1964).

Amongst endemic plants of Kazakhstan, perennials (408 taxa) are most numerous. A global analysis of the distribution of plant life cycles around the world has shown that annual plants predominate in hot and arid conditions, especially during the long dry season (Poppenwimer et al. 2022). The number of annuals and biennials in Kazakhstan is 43 taxa or 9% of the total number

of endemic plants of Kazakhstan. The distribution of endemic annuals over the territory of Kazakhstan is relatively uniform. The greatest number of annuals is noted in Western Upland (7 taxa), Zaysan (6 taxa) and Karatau (6 taxa). Amongst the families, the greatest number of annual endemic taxa is registered in Boraginaceae Juss. (17 taxa), Brassicaceae Burnett (8 taxa) and Amaranthaceae Juss. (6 taxa); in other families, 1–3 taxa are registered.

Given that numerous endemic plant species have restricted distributions, which makes them more prone to extinction (Myers et al. 2000; Pitman and Jørgensen 2002), it is crucial to emphasise the assessment and protection of such species (Baasanmunkh et al. 2022). Amongst 451 endemic taxa of Kazakhstan, 107 species are currently under state protection. We consider it necessary to further re-assess the status of protection of endemic plants of Kazakhstan using IUCN criteria.

During the critical examination of endemic plants in Kazakhstan, we found that some endemic plants were inaccurately attributed to other countries in the Plants of the World Online (POWO 2023). For instance, *Arthropytum subulifolium* Schrenk and *Atriplex iljinii* Aellen, according to POWO, are supposedly present in Turkmenistan. However, *Arthropytum subulifolium* Schrenk exclusively grows in a narrow region of the Chu-Ili Range in Kazakhstan (Osmanali et al. 2019), while *Atriplex iljinii* is solely found in the Mangistau, Aktobe and Kyzylorda Regions of Kazakhstan (Suchorukow 2007). *Stipa argillosa* Kotukhov and *Thalictrum bykovii* Kotukhov, along with *Gagea azutavica* Kotukhov, are incorrectly recorded in POWO as species native to the Altai Republic in the Russian Federation, whereas these species were described from East Kazakhstan (Kotukhov 1989, 1990, 1998).

At the same time, in the POWO database, certain species were erroneously assigned to Kazakhstan. For instance, the distributions of *Kamelinia tianschanica* F.O.Khass. & I.I. Malzev, *Cousinia xanthiocephala* Tscherneva, *Vicoa krascheninnikovii* Kamelin, *Phlomoides tschimganica* (Vved.) Adylov, Kamelin & Makhm. and *Erysimum aksaricum* Pavlov are limited to Uzbekistan (Kamelin 1976; Kupriyanov 2018; Tojibaev et al. 2020b). *Cousinia balchanica* Tscherneva and *Minuartia palyzanica* Proskur. were described from Turkmenistan (Proskuryakov 1987; Cherneva 1996), while *Taraxacum darschajense* Orazova and *Hedysarum ovczinnikovii* Karimova ex Kovalevsk. were reported to occur in Tajikistan (Orazova 1982; Adylov 1983) and *Crucianella schischkinii* Lincz. was found in both Uzbekistan and Tajikistan (Kamelin 2017). These errors are associated with the difficulty of matching administrative boundaries with plant distribution areas in complicated mountainous territories.

Conclusions

This checklist includes all strictly endemic plants of Kazakhstan, consisting of 451 taxa (species or subspecies) belonging to 139 genera and 34 families. The largest number of endemic taxa is concentrated in mountainous areas, specifically in the southern and south-eastern parts of Kazakhstan.

This paper serves as a fundamental groundwork for prospective investigations aimed at assessing population sizes and numbers of endemic taxa throughout Kazakhstan, crucial for determining their conservation status. Of course, this checklist of plant endemics of Kazakhstan is not final and will be revised in the future as a result of ongoing taxonomic and floristic studies.

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Additional information

Conflict of interest

All authors declare that they have no competing interests and personal relationships and agree on the contents of the paper.

Ethical statement

No ethical statement was reported.

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Author contributions

Conceptualisation – SAK; methodology – SAK, YVP, DTA; formal analysis – OVB, BBK; writing – preparation of the initial draft – SAK, DTA, VPY, BBK; editing, SAK, DTA, GAL, ALE, ANK; author's supervision – SAK; project administration – SAK, KSI; acquisition of funding – IKS. All authors have read and agreed with the published version of the manuscript.

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Data availability

All of the data that support the findings of this study are available in the main text or Supplementary Information.

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Appendix 1. Annotated checklist of endemic taxa of Kazakhstan

In the checklist, families are listed in alphabetical order; lower-level taxa (genera, species and subspecies) within a family are also listed in alphabetical order.

The following information is given after the name of each taxon:

Life form (Lf) and life cycle (Lc) according to the Flora of Kazakhstan (Pavlov 1956); conservation status (Cs) according to the Red Book of Kazakhstan (Baitulin 2014). The species included in the Red Book of Kazakhstan are denoted by RB.

The distribution (D) of each taxon in Kazakhstan is given according to the floristic division of Kazakhstan (Pavlov 1956), where the territory of the country is divided into 29 floristic regions and seven subregions: 1 – Syrt, 2 – Tobol-Ishim,

3 – Irtysh, 4 – Semipalatinsk pine forest, 5 – Kokchetav, 6 – Caspian Region, 6a – Bukeev, 7 – Aktobe, 7a – Mugojary, 8 – Emba, 9 – Turgay, 10 – Western Upland, 10a – Ulutau, 11 – Eastern Upland, 11a – Karkaraly, 12 – Zaysan, 13 – Northern Ustyrt, 13a – Buzachi, 13b – Mangyshlak, 14 – Aral Region, 15 – Kyzylorda, 16 – Betpak-Dala, 17 – Moiynkum, 18 – Balkhash-Alakol, 19 – Southern Ustyrt, 20 – Kyzylkum, 21 – Turkestan, 22 – Altai, 23 – Tarbagatai, 24 – Hungarian Alatau, 25 – Trans-Ili Kungey Alatau, 25a – Ketmen-Terskey Alatau, 26 – Chu-Ili Range, 27 – Kyrgyz Alatau, 28 – Karatau, 29 – Western Tian Shan. Asterisks refer to annotations placed after the checklist.

Fam. 1. Amaranthaceae Juss.

Gen. 1. *Anabasis* L.

1. *Anabasis gypsicola* Iljin [Lf: Shrub. Lc: Per. D: 13, 16, 28]
2. *Anabasis turgaica* Iljin & Krasch. [Lf: Herb. Lc: Per. Cs: RB. D: 10a]

Gen. 2. *Arthrophytum* Schrenk

3. *Arthrophytum balchaschense* (Iljin) Botsch. [Lf: Subshrub. Lc: Per. D: 16, 17, 18, 25]
4. *Arthrophytum betpakdalense* Korovin & Mironov [Lf: Dwarf semishrub. Lc: Per. D: 16]
5. *Arthrophytum pulvinatum* Litv. [Lf: Dwarf semishrub. Lc: Per. D: 14]
6. *Arthrophytum subulifolium* Schrenk * [Lf: Subshrub. Lc: Per. D: 26]

Gen. 3. *Atriplex* L.

7. *Atriplex iljinii* Aellen * [Lf: Herb. Lc: An. D: 8, 13, 14]

Gen. 4. *Climacoptera* Botsch.

8. *Climacoptera turgaica* (Iljin) Botsch. [Lf: Herb. Lc: An. D: 2, 6, 9, 14]

Gen. 5. *Halimocnemis* C.A.Mey.

9. *Halimocnemis mironovii* Botsch. [Lf: Herb. Lc: An. D: 16, 26]

Gen. 6. *Horaninovia* Fisch. & C.A.Mey.

10. *Horaninovia capitata* Sukhor. [Lf: Herb. Lc: An. D: 18]

Gen. 7. *Nanophyton* Less.

11. *Nanophyton erinaceum* subsp. *karataviense* U.P.Pratov [Lf: Subshrub. Lc: Per. D: 28]

Gen. 8. *Petrosimonia* Bunge

12. *Petrosimonia hirsutissima* (Bunge) Iljin ex Pavlov [Lf: Herb. Lc: An. D: 9, 13, 15, 16, 17, 18]

Gen. 9. *Salsola* L.

13. *Salsola euryphylla* Botsch. [Lf: Undershrub. Lc: Per.Cs: RB. D: 14]

Gen. 10. *Suaeda* Forssk. ex J.F.Gmel.

14. *Suaeda scabra* Lomon. [Lf: Herb. Lc: An. D: 14]

Fam. 2. Amaryllidaceae J.St.-Hil.

Gen. 11. *Allium* L.

15. *Allium azutavicum* Kotukhov [Lf: Herb. Lc: Per. D: 22]
16. *Allium bajtulinii* Bajtenov & I.I.Kamenetskaya [Lf: Herb. Lc: Per. D: 25]
17. *Allium goloskokovii* Vved. [Lf: Herb. Lc: Per. D: 23, 24]
18. *Allium ivasczenkoae* Kotukhov [Lf: Herb. Lc: Per. D: 22]
19. *Allium iliense* Regel [Lf: Herb. Lc: Per. D: 26]
20. *Allium jaxarticum* Vved. [Lf: Herb. Lc: Per. D: 29]
21. *Allium kasteki* Popov. [Lf: Herb. Lc: Per. Cs: RB. D: 25]

22. *Allium kokuense* R.M. Fritsch, N. Friesen & S.V. Smirn. [Lf: Herb. Lc: Per. D: 24]
23. *Allium kujukense* Vved. [Lf: Herb. Lc: Per. D: 28, 29]
24. *Allium lasiophyllum* Vved. [Lf: Herb. Lc: Per. D: 25, 25a]
25. *Allium lehmannianum* Merckl. ex Bunge [Lf: Herb. Lc: Per. D: 9, 10, 15, 16, 20]
26. *Allium lepticum* R.M.Fritsch, N.Friesen & S.V.Smirn. [Lf: Herb. Lc: Per. D: 24]
27. *Allium oreoprasoides* Vved. [Lf: Herb. Lc: Per. D: 28]
28. *Allium sergii* Vved. [Lf: Herb. Lc: Per. Cs: RB. D: 28]
29. *Allium scrobiculatum* Vved. [Lf: Herb. Lc: Per. D: 16, 17, 26]
30. *Allium subscabrum* (Regel) R.M.Fritsch [Lf: Herb. Lc: Per. D: 18, 26]
31. *Allium toksanbaicum* N.Friesen & Veselova [Lf: Herb. Lc: Per. D: 24]
32. *Allium turtschicum* Regel [Lf: Herb. Lc: Per. Cs: RB. D: 28]
33. *Allium victoris* Vved. [Lf: Herb. Lc: Per. D: 29]
34. *Allium viridulum* Ledeb. [Lf: Herb. Lc: Per. D: 11, 18, 23]
35. *Allium zaissanicum* Kotukhov [Lf: Herb. Lc: Per. D: 12]

Fam. 3. Apiaceae Lindl.

Gen. 12. *Autumnalia* Pimenov

36. *Autumnalia botschantzevii* Pimenov [Lf: Herb. Lc: Per. D: 28, 29]

Gen. 13. *Eryngium* L.

37. *Eryngium karatavicum* Iljin [Lf: Herb. Lc: Per. Cs: RB. D: 28]

Gen. 14. *Ferula* L.

38. *Ferula glaberrima* Korovin [Lf: Herb. Lc: Per. Cs: RB. D: 17]
39. *Ferula gypsacea* Korovin [Lf: Herb. Lc: Per. Cs: RB. D: 21]
40. *Ferula leucographa* Korovin * [Lf: Herb. Lc: Per. Cs: RB. D: 28]
41. *Ferula malacophylla* Pimenov & J.V.Baranova [Lf: Herb. Lc: Per. Cs: RB. D: 28]
42. *Ferula pachyphylla* Korovin [Lf: Herb. Lc: Per. D: 28]
43. *Ferula sugatensis* Bajtenov [Lf: Herb. Lc: Per. Cs: RB. D: 25]
44. *Ferula taucumica* Baitenov [Lf: Herb. Lc: Per. Cs: RB. D: 18]
45. *Ferula xeromorpha* Korovin [Lf: Herb. Lc: Per. Cs: RB. D: 21]

Gen. 15. *Hyalolaena* Bunge

46. *Hyalolaena tschuliensis* (Pavlov) Pimenov & Kljuykov [Lf: Herb. Lc: Per. Cs: RB. D: 26]

Gen. 16. *Karatavia* Pimenov & Lavrova

47. *Karatavia kultiasovii* (Korovin) Pimenov & Lavrova [Lf: Herb. Lc: Per. Cs: RB. D: 28, 29]

Gen. 17. *Pachypleurum* Ledeb.

48. *Pachypleurum altaicum* Revuschkin [Lf: Herb. Lc: Per. D: 22]

Gen. 18. *Pilopleura* Schischk.

49. *Pilopleura goloskokovii* (Korovin) Pimenov [Lf: Herb. Lc: Per. Cs: RB. D: 24]

Gen. 19. *Prangos* Lindl.

50. *Prangos dzhungarica* Pimenov [Lf: Herb. Lc: Per. D: 24]
51. *Prangos equisetoides* Kuzjmina [Lf: Herb. Lc: Per. Cs: RB. D: 28]
52. *Prangos lachnantha* (Korovin) Pimenov & Kljuykov [Lf: Herb. Lc: Per. Cs: RB. D: 17]
53. *Prangos multicostata* Kljuykov & Lyskov * [Lf: Herb. Lc: Per. D: 23]

Gen. 20. *Schrenkia* Fisch. & C.A.Mey.

54. *Schrenkia congesta* Korovin [Lf: Herb. Lc: Per. D: 28, 29]

55. *Schrenkia involucrata* Regel & Schmalh. [Lf: Herb. Lc: Per. D: 16, 17, 26, 28, 29]

56. *Schrenkia kultiassovii* Korovin [Lf: Herb. Lc: Per. Cs: RB. D: 29]

57. *Schrenkia papillaris* Regel & Schmalh. [Lf: Herb. Lc: Per. D: 28]

Gen. 21. *Schtschurowskia* Regel & Schmalh.

58. *Schtschurowskia margaritae* Korovin [Lf: Herb. Lc: Per. Cs: RB. D: 28]

Gen. 22. *Seseli* L.

59. *Seseli betpakdalense* Bajtenov [Lf: Herb. Lc: Per. D: 16]

60. *Seseli mironovii* (Korovin) Pimenov & Sdobnina [Lf: Herb. Lc: Per. D: 16]

Gen. 23. *Sphaenolobium* Pimenov

61. *Sphaenolobium korovinii* Pimenov & Kljuykov [Lf: Herb. Lc: Per. D: 28, 29]

Gen. 24. *Tschulaktavia* Bajtenov ex Pimenov & Kljuykov

62. *Tschulaktavia saxatilis* (Bajtenov) Bajtenov ex Pimenov & Kljuykov [Lf: Herb. Lc: Per. Cs: RB. D: 24]

Fam. 4. Asparagaceae Juss.

Gen. 25. *Asparagus* Tourn. ex L.

63. *Asparagus vvedenskyi* Botsch. [Lf: Herb. Lc: Per. Cs: RB. D: 21]

Fam. 5. Asteraceae Bercht. & J.Presl

Gen. 26. *Alfredia* Cass.

64. *Alfredia integrifolia* (Iljin) Tulyag. [Lf: Herb. Lc: Per. D: 24]

Gen. 27. *Amberboa* (Pers.) Less.

65. *Amberboa takhtajanii* Gabrieljan [Lf: Herb. Lc: An. D: 12]

Gen. 28. *Arctium* L.

66. *Arctium alberti* (Regel & Schmalh.) S.López, Romasch., Susanna & N.Garcia [Lf: Herb. Lc: Per. D: 28, 29]

67. *Arctium arctiodes* (Schrenk) Kuntze [Lf: Herb. Lc: Per. D: 9, 10, 15, 16]

68. *Arctium grandifolium* (Kult.) S.López, Romasch., Susanna & N.Garcia RB. [Lf: Herb. Lc: Per. Cs: RB. D: 28, 29]

69. *Arctium ugamense* (Karmysch.) S.López, Romasch., Susanna & N.Garcia [Lf: Herb. Lc: Per. D: 29]

Gen. 29. *Artemisia* L.

70. *Artemisia aralensis* Krasch. [Lf: Dwarf semishrub. Lc: Per. D: 7, 9, 10, 14]

71. *Artemisia camelorum* Krasch. [Lf: Dwarf semishrub. Lc: Per. D: 7, 7a, 8, 9, 10, 14, 15]

72. *Artemisia filatovae* Kupr. [Lf: Dwarf semishrub. Lc: Per. D: 10]

73. *Artemisia hippolyti* A.Butkov [Lf: Dwarf semishrub. Lc: Per. D: 16]

74. *Artemisia kasakorum* (Krasch.) Pavlov [Lf: Herb. Lc: Per. D: 8, 11]

75. *Artemisia kotuchovii* Kupr. [Lf: Herb. Lc: Per. D: 22]

76. *Artemisia quinqueloba* Trautv. [Lf: Subshrub. Lc: Per. D: 7, 8, 14, 15, 16]

77. *Artemisia saurensis* Kupr. [Lf: Dwarf semishrub. Lc: Per. D: 23]

78. *Artemisia valida* Krasch. ex Poljakov [Lf: Dwarf semishrub. Lc: Per. D: 21, 28]

Gen. 30. *Brachanthemum* DC.

79. *Brachanthemum kasakorum* Krasch. [Lf: Dwarf semishrub. Lc: Per. D: 2, 10, 16, 18]

Gen. 31. *Cancriniella* Tzvelev

80. *Cancriniella krascheninnikovii* (Rubtzov) Tzvelev [Lf: Herb. Lc: Per. Cs: RB. D: 16, 26]

Gen. 32. *Centaurea* L.

81. *Centaurea kryloviana* Serg. * [Lf: Herb. Lc: Per. D: 11, 12, 22]

Gen. 33. *Chondrilla* L.

82. *Chondrilla bosseana* Iljin [Lf: Herb. Lc: Per. D: 17, 18]
 83. *Chondrilla macra* Iljin [Lf: Herb. Lc: Per. D: 16, 17]
 84. *Chondrilla mujunkumensis* Iljin & Igolkin [Lf: Herb. Lc: Per. D: 17, 18]

Gen. 34. *Cousinia* Cass.

85. *Cousinia aspera* (Kult.) Karmysch. [Lf: Herb. Lc: Per. D: 29]
 86. *Cousinia gomolitzkii* Juz. ex Tscherneva [Lf: Herb. Lc: Per. D: 28]
 87. *Cousinia kasachstanica* Sennikov [Lf: Herb. Lc: Per. D: 27]
 88. *Cousinia mindshelkensis* B.Fedtsch. [Lf: Herb. Lc: Per. Cs: RB. D: 28]
 89. *Cousinia perovskiensis* (Bornm.) Juz. ex Tschern. [Lf: Herb. Lc: Per. D: 14, 15, 16, 17, 18, 20, 24]
 90. *Cousinia schepsaica* Karmysch. [Lf: Herb. Lc: Per. D: 29]
 91. *Cousinia turkestanica* (Regel) Juz. [Lf: Herb. Lc: Per. D: 29]
 92. *Cousinia xanthiocephala* Tscherneva [Lf: Herb. Lc: Per. D: 21]

Gen. 35. *Echinops* L.

93. *Echinops kasakorum* Pavlov [Lf: Herb. Lc: Per. Cs: RB. D: 28]
 94. *Echinops pubisquameus* Iljin [Lf: Herb. Lc: Per. D: 28]
 95. *Echinops subglaber* Schrenk [Lf: Herb. Lc: Per. D: 15, 16, 28]
 96. *Echinops transiliensis* Golosk. [Lf: Herb. Lc: Per. D: 25, 26]

Gen. 36. *Galatella* Cass.

97. *Galatella bectauatensis* Kupr. & Koroljuk [Lf: Herb. Lc: Per. D: 11]
 98. *Galatella polygaloides* Novopokr. [Lf: Herb. Lc: Per. D: 25a]
 99. *Galatella saxatilis* Novopokr. [Lf: Herb. Lc: Per. Cs: RB. D: 25]

Gen. 37. *Hieracium* L.

100. *Hieracium bectauatense* Kupr. [Lf: Herb. Lc: Per. D: 11]

Gen. 38. *Jurinea* Cass.

101. *Jurinea almaatensis* Iljin [Lf: Herb. Lc: Per. Cs: RB. D: 25]
 102. *Jurinea bracteata* Regel & Schmalh. [Lf: Herb. Lc: Per. D: 24]
 103. *Jurinea cephalopoda* Iljin [Lf: Herb. Lc: Per. Cs: RB. D: 15, 21, 28]
 104. *Jurinea czilikinoana* Iljin [Lf: Herb. Lc: Per. D: 28]
 105. *Jurinea eximia* Tekutj. [Lf: Herb. Lc: Per. Cs: RB. D: 28]
 106. *Jurinea fedtschenkoana* Iljin [Lf: Herb. Lc: Per. Cs: RB. D: 1, 7, 7a, 10]
 107. *Jurinea hamulosa* Rubtzov [Lf: Herb. Lc: Per. D: 23, 24]
 108. *Jurinea karatavica* Iljin [Lf: Herb. Lc: Per. D: 17, 18]
 109. *Jurinea kazachstanica* Iljin [Lf: Herb. Lc: Per. D: 6, 7, 8, 14]
 110. *Jurinea knorringiana* Iljin [Lf: Herb. Lc: Per. D: 28]
 111. *Jurinea krascheninnikovii* Iljin [Lf: Herb. Lc: Per. D: 9, 11a, 15, 16, 17, 26]
 112. *Jurinea lithophila* Rubtzov [Lf: Herb. Lc: Per. D: 24]
 113. *Jurinea monticola* Iljin [Lf: Herb. Lc: Per. D: 28]
 114. *Jurinea multiceps* Iljin [Lf: Herb. Lc: Per. D: 28]
 115. *Jurinea pineticola* Iljin [Lf: Herb. Lc: Per. D: 3, 4]
 116. *Jurinea rhizomatoidea* Iljin [Lf: Herb. Lc: Per. D: 28]
 117. *Jurinea robusta* Schrenk [Lf: Herb. Lc: Per. Cs: RB. D: 16, 25, 26]
 118. *Jurinea serratuloides* Iljin [Lf: Herb. Lc: Per. D: 12, 23]
 119. *Jurinea suidunensis* Korsh. [Lf: Herb. Lc: Per. D: 12, 18, 24]
 120. *Jurinea xerophytica* Iljin [Lf: Herb. Lc: Per. D: 4, 9, 11, 12, 14]

Gen. 39. *Lamyropsis* (Kharadze) Dittrich

121. *Lamyropsis macracantha* (Schrenk) Dittrich [Lf: Herb. Lc: Per. D:23, 24]
- Gen. 40. *Lepidolopha* C.Winkl.**
122. *Lepidolopha gomolitzkii* Kovalevsk. & Safral. [Lf: Herb. Lc: Per. D: 28]
123. *Lepidolopha karatavica* Pavlov [Lf: Herb. Lc: Per. Cs: RB. D: 28]
124. *Lepidolopha krascheninnikovii* Czil. ex Kovalevsk. & Safral. [Lf: Herb. Lc: Per. D: 28]
125. *Lepidolopha talassica* Kovalevsk. & Safral. [Lf: Herb. Lc: Per. RB. D: 29]
- Gen. 41. *Rhaponticum* Vaill.**
126. *Rhaponticum karatavicum* Regel & Schmalh. [Lf: Herb. Lc: Per. Cs: RB. D: 28]
- Gen. 42. *Ligularia* Cass.**
127. *Ligularia pavlovii* (Lipsch.) Cretz. [Lf: Herb. Lc: Per. Cs: RB. D: 28]
- Gen. 43. *Pseudoglossanthis* Poljakov**
128. *Pseudoglossanthis arctodshungarica* (Golosc.) Kamelin [Lf: Subshrub. Lc: Per. Cs: RB. D: 24]
129. *Pseudoglossanthis simulans* (Pavlov) Kamelin [Lf: Herb. Lc: Per. D: 29]
- Gen. 44. *Pseudopodospermum* (Lipsch. & Krasch.) Kuth.**
130. *Pseudopodospermum chantavicum* (Pavlov) Zaika, Sukhor. & N.Kilian [Lf: Herb. Lc: Per. Cs: RB. D: 26]
- Gen. 45. *Rhaponticoides* Vaill.**
131. *Rhaponticoides kultiassovii* (Iljin) Negaresh [Lf: Herb. Lc: Per. Cs: RB. D: 28]
132. *Rhaponticoides phyllopoda* (Iljin) Negaresh [Lf: Herb. Lc: Per. D: 28, 29]
133. *Rhaponticoides zaissanica* Kupr., A.L. Ebel et Khrustaleva [Lf: Herb. Lc: Per. D: 12]
- Gen. 46. *Saussurea* DC.**
134. *Saussurea mikeschinii* Iljin [Lf: Subshrub. Lc: Per. Cs: RB. D: 28]
135. *Saussurea ninae* Iljin [Lf: Herb. Lc: Per. D: 24]
136. *Saussurea pseudoblada* Lipsch. ex Filat. [Lf: Herb. Lc: Per. D: 24]
- Gen. 47. *Scorzonera* L.**
137. *Scorzonera dianthoides* (Lipsch. & Krasch.) Lipsch. [Lf: Herb. Lc: Per. D: 11]
138. *Scorzonera franchetii* Lipsch. [Lf: Herb. Lc: Per. D: 29]
139. *Scorzonera vavilovii* Kult. [Lf: Dwarf semishrub. Lc: Per. D: 28, 29]
- Gen. 48. *Senecio* L.**
140. *Senecio iljinii* Schischk. [Lf: Herb. Lc: Per. D: 24]
141. *Senecio nuraniae* Roldugin [Lf: Herb. Lc: An. D: 29]
- Gen. 49. *Takhtajaniantha* Nazarova**
142. *Takhtajaniantha veresczaginii* (Kamelin & S.V.Smirn.) Zaika, Sukhor. & N.Kilian [Lf: Herb. Lc: Per. D: 22]
- Gen. 50. *Tanacetopsis* (Tzvelev) Kovalevsk.**
143. *Tanacetopsis goloskokovii* (Poljakov) Karmysch. [Lf: Herb. Lc: Per. Cs: RB. D: 24, 25]
144. *Tanacetopsis pjataevae* (Kovalevsk.) Karmysch. [Lf: Herb. Lc: Per. Cs: RB. D: 28]
145. *Tanacetopsis popovii* Kamelin & Kovalevsk. [Lf: Herb. Lc: Per. D: 28]
- Gen. 51. *Tanacetum* L.**
146. *Tanacetum corymbiforme* (Tzvelev) K.Bremer & Humphries [Lf: Herb. Lc: Per. D: 23, 24]
147. *Tanacetum kelleri* (Krylov & Plotn.) Takht. [Lf: Herb. Lc: Per. Cs: RB. D: 22]
148. *Tanacetum mindshelkense* Kovalevsk. [Lf: Herb. Lc: Per. D: 28]

149. *Tanacetum saryarkense* Kamelin [Lf: Herb. Lc: Per. D: 16, 26]
 150. *Tanacetum saxicola* (Krasch.) Tzvelev [Lf: Herb. Lc: Per. Cs: RB. D: 7a, 8]
 151. *Tanacetum ulutavicum* Tzvelev [Lf: Herb. Lc: Per. Cs: RB. D: 10a]

Gen. 52. *Taraxacum* F.H.Wigg.

152. *Taraxacum almaatense* Schischk. [Lf: Herb. Lc: Per. D: 25]
 153. *Taraxacum arasanum* R.Doll [Lf: Herb. Lc: Per. D: 25]
 154. *Taraxacum atrochlorinum* Kirschner & Štěpánek [Lf: Herb. Lc: Per. D: 25]
 155. *Taraxacum botschantzevii* Schischk. [Lf: Herb. Lc: Per. D: 28]
 156. *Taraxacum cornucopiae* Kirschner & Štěpánek [Lf: Herb. Lc: Per. D: 25]
 157. *Taraxacum corvinum* Kirschner & Štěpánek [Lf: Herb. Lc: Per. D: 25]
 158. *Taraxacum dzhungaricola* Kirschner & Štěpánek [Lf: Herb. Lc: Per. D: 24]
 159. *Taraxacum glabellum* Schischk. [Lf: Herb. Lc: Per. D: 28]
 160. *Taraxacum karatavicum* Pavlov [Lf: Herb. Lc: Per. D: 28]
 161. *Taraxacum kasachiforme* R.Doll [Lf: Herb. Lc: Per. D: 25]
 162. *Taraxacum kasachum* R.Doll [Lf: Herb. Lc: Per. D: 25]
 163. *Taraxacum magnum* Korol. [Lf: Herb. Lc: Per. D: 25a]
 164. *Taraxacum medeense* R.Doll [Lf: Herb. Lc: Per. D: 24, 25]
 165. *Taraxacum perpusillum* Schischk. [Lf: Herb. Lc: Per. D: 24]
 166. *Taraxacum pseudolugubre* R.Doll [Lf: Herb. Lc: Per. D: 25]
 167. *Taraxacum pseudotianschanicum* R.Doll [Lf: Herb. Lc: Per. D: 8]
 168. *Taraxacum saposhnikovii* Schischk. [Lf: Herb. Lc: Per. D: 23, 24]
 169. *Taraxacum sublilacinum* Kirschner & Štěpánek [Lf: Herb. Lc: Per. D: 25]
 170. *Taraxacum urdzharensense* Orazova [Lf: Herb. Lc: Per. D: 23]
 171. *Taraxacum violaceum* R.Doll [Lf: Herb. Lc: Per. D: 25]

Gen. 53. *Tragopogon* L.

172. *Tragopogon karelinii* S.A.Nikitin [Lf: Herb. Lc: Bi. D: 10, 16, 18, 23, 24]

Gen. 54. *Vickifunkia* C.Ren, L.Wang, I.D.Illar. & Q.E.Yang

173. *Vickifunkia kareliniana* (Stschegl.) C.Ren, L.Wang, I.D.Illar. & Q.E.Yang
 [Lf: Herb. Lc: Per. D: 23]

Fam. 6. Berberidaceae Juss.

Gen. 55. *Berberis* L.

174. *Berberis karkaralensis* Kornil. & Potapov [Lf: Shrub. Lc: Per. Cs: RB. D: 11a]

Fam. 7. Betulaceae Gray

Gen. 56. *Betula* L.

175. *Betula karagandensis* V.N.Vassil. [Lf: Tree. Lc: Per. D: 11a]
 176. *Betula saviczii* V.N.Vassil. [Lf: Tree. Lc: Per. D: 10]

Fam. 8. Bignoniaceae Juss.

Gen. 57. *Incarvillea* Juss.

177. *Incarvillea semiretschenskia* (B.Fedtsch.) Grierson [Lf: Herb. Lc: Per. Cs: RB. D: 26]

Fam. 9. Boraginaceae Juss.

Gen. 58. *Eritrichium* Schrad. ex Gaudin

178. *Eritrichium relictum* Kudab. [Lf: Herb. Lc: Per. D: 24]

Gen. 59. *Heliotropium* Tourn. ex L.

179. *Heliotropium parvulum* Popov [Lf: Herb. Lc: An. Cs: RB. D: 16, 18, 25]

Gen. 60. *Lappula* Moench

- 180. *Lappula baitenovii* Kudab. [Lf: Herb. Lc: Bi. D: 25]
- 181. *Lappula coronifera* Popov [Lf: Herb. Lc: An. D: 11]
- 182. *Lappula cristata* (Bunge) B.Fedtsch. *[Lf: Herb. Lc: An. D: 10, 11, 12]
- 183. *Lappula diploloma* (Fisch. & C.A.Mey.) Gürke [Lf: Herb. Lc: An. D: 9, 11]
- 184. *Lappula glabrata* Popov [Lf: Herb. Lc: Bi. Cs: RB. D: 16]
- 185. *Lappula ketmenica* Kudab. [Lf: Herb. Lc: An. D: 25a]
- 186. *Lappula kuprijanovii* Ovczinnikova [Lf: Herb. Lc: Bi. RB. D: 28]
- 187. *Lappula lipschitzii* Popov [Lf: Herb. Lc: An. D: 21]
- 188. *Lappula pavlovii* Golosk. [Lf: Herb. Lc: An. D: 24]
- 189. *Lappula saphronovae* Kamelin [Lf: Herb. Lc: Bi. D: 13b]
- 190. *Lappula zaissanica* (Aralbaev) Aralbaev [Lf: Herb. Lc: An. D: 12]

Gen. 61. *Lepechiniella* Popov

- 191. *Lepechiniella austrodshungarica* Golosk. [Lf: Herb. Lc: An.-Bi. D: 10, 24]
- 192. *Lepechiniella michaelis* Golosk. [Lf: Herb. Lc: Per. Cs: RB. D: 24]
- 193. *Lepechiniella omphaloides* (Schrenk) Popov [Lf: Herb. Lc: Bi. D: 10]
- 194. *Lepechiniella saurica* (Bajtenov & Kudab.) Ovczinnikova [Lf: Herb. Lc: An. D: 23]

Gen. 62. *Mattiastrum* (Boiss.) Brand

- 195. *Mattiastrum karataviense* (Pavlov ex Popov) Czerep. [Lf: Herb. Lc: Per. Cs: RB. D: 28]

Gen. 63. *Myosotis* L.

- 196. *Myosotis kazakhstanica* O.D.Nikif. [Lf: Herb. Lc: An. D: 10, 10a, 11, 11a]

Gen. 64. *Paracaryum* Boiss.

- 197. *Paracaryum integerrimum* Myrz. [Lf: Herb. Lc: Per. Cs: RB. D: 28]

Gen. 65. *Rindera* Pall.

- 198. *Rindera ochroleuca* Kar. & Kir. * [Lf: Herb. Lc: Per. Cs: RB. D: 18]

Gen. 66. *Rochelia* Rchb.

- 199. *Rochelia leiosperma* (Popov) Golosk. [Lf: Herb. Lc: An. D: 24]

Gen. 67. *Sauria* Bajtenov

- 200. *Sauria akkolia* Bajtenov [Lf: Herb. Lc: Per. D: 17]

Fam. 10. Brassicaceae Burnett

Gen. 68. *Botschantzevia* Nabiev

- 201. *Botschantzevia karatavica* (Lipsch. & Pavlov) Nabiev [Lf: Dwarf semishrub. Lc: Per. Cs: RB. D: 28]

Gen. 69. *Clausia* Korn-Trotzky.

- 202. *Clausia kasakorum* Pavlov [Lf: Herb. Lc: Per. D: 10a]
- 203. *Clausia robusta* Pachom. [Lf: Herb. Lc: Per. D: 5]

Gen. 70. *Erysimum* Tourn. ex L.

- 204. *Erysimum kazakhstanicum* Botsch. [Lf: Herb. Lc: Bi. D: 10, 10a, 11, 23]

Gen. 71. *Eutrema* R.Br.

- 205. *Eutrema halophilum* (C.A.Mey.) Al-Shehbaz & Warwick* [Lf: Herb. Lc: An. D: 2, 3, 4, 11, 12]
- 206. *Eutrema platypetalum* (Schrenk) Al-Shehbaz & Warwick [Lf: Herb. Lc: Per. D: 24]

Gen. 72. *Isatis* Tourn. ex L.

- 207. *Isatis canaliculata* (Vassilcz.) V.V.Botschantz. [Lf: Herb. Lc: Bi. D: 9, 10]
- 208. *Isatis deserti* (N.Busch) V.V.Botschantz. [Lf: Herb. Lc: An. D: 16]

Gen. 73. *Lepidium* L.

- 209. *Lepidium jarmolenkoi* V.M.Vinogr. [Lf: Herb. Lc: Per. D: 16]
- 210. *Lepidium karataviense* Regel & Schmalh. [Lf: Herb. Lc: Per. D: 28]
- 211. *Lepidium mummenhoffianum* Al-Shehbaz [Lf: Herb. Lc: Per. D: 24]
- 212. *Lepidium pavlovii* Al-Shehbaz & Mummenhoff [Lf: Herb. Lc: Per. Cs: RB. D: 28, 29]
- 213. *Lepidium robustum* (Pavlov) Al-Shehbaz [Lf: Herb. Lc: Per. Cs: RB. D: 28]
- 214. *Lepidium sagittatum* (Kar. & Kir.) Al-Shehbaz [Lf: Herb. Lc: Per. Cs: RB. D: 23, 24]
- 215. *Lepidium trautvetteri* (Botsch.) Al-Shehbaz [Lf: Herb. Lc: Per. Cs: RB. D: 16, 18]

Gen. 74. *Parrya* R.Br.

- 216. *Parrya longicarpa* Krasn. [Lf: Herb. Lc: Per. D: 26]
- 217. *Parrya papillosa* (Vassilcz.) D.A.German & Al-Shehbaz [Lf: Herb. Lc: An. D: 28, 29]
- 218. *Parrya pavlovii* A.N.Vassiljeva [Lf: Herb. Lc: Per. D: 28]
- 219. *Parrya pazijae* (Pachom.) D.A.German & Al-Shehbaz [Lf: Undershrub. Lc: Per. D: 28, 29]
- 220. *Parrya saurica* (Pachom.) D.A.German & Al-Shehbaz [Lf: Herb. Lc: Per. D: 23]
- 221. *Parrya vvedenskyi* (Pachom.) D.A.German & Al-Shehbaz [Lf: Herb. Lc: Bi. D: 28, 29]

Gen. 75. *Rhammatophyllum* O.E.Schulz

- 222. *Rhammatophyllum pachyrrhizum* (Kar. & Kir.) O.E.Schulz [Lf: Dwarf semishrub. Lc: Per. D: 7a, 8, 9, 10, 10a, 11, 13, 14, 16, 22, 24]

Gen. 76. *Strigosella* Boiss.

- 223. *Strigosella myrzakulovii* Bajtenov [Lf: Herb. Lc: An. D: 28, 29]

Fam. 11. Campanulaceae Juss.

Gen. 77. *Sergia* Fed.

- 224. *Sergia sewerzowii* (Regel) Fed. [Lf: Herb. Lc: Per. D: 28, 29]

Fam. 12. Caryophyllaceae Juss.

Gen. 78. *Eremogone* Fenzl

- 225. *Eremogone turlanica* (Bajtenov) Czerep. [Lf: Herb. Lc: Per. Cs: RB. D: 28]

Gen. 79. *Dianthus* L.

- 226. *Dianthus karataviensis* Pavlov [Lf: Herb. Lc: Per. RB. D: 28, 29]
- 227. *Dianthus multisquameus* Bondarenko & R.M.Vinogr. [Lf: Herb. Lc: Per. D: 28, 29]

Gen. 80. *Gypsophila* L.

- 228. *Gypsophila aulieatensis* B.Fedtsch. [Lf: Herb. Lc: Per. Cs: RB. D: 28]

Gen. 81. *Silene* L.

- 229. *Silene anisoloba* Schrenk [Lf: Herb. Lc: Per. D: 10, 10a]
- 230. *Silene betpakdalensis* Bajtenov [Lf: Herb. Lc: Per. Cs: RB. D: 13, 16, 26]
- 231. *Silene jaxartica* Pavlov [Lf: Herb. Lc: Per. Cs: RB. D: 28]
- 232. *Silene muslimii* Pavlov [Lf: Herb. Lc: Per. Cs: RB. D: 24, 26]

Fam. 13. Convolvulaceae Juss.

Gen. 82. *Cuscuta* L.

- 233. *Cuscuta camelorum* Pavlov [Lf: Herb. Lc: An. D: 28]

234. *Cuscuta elpassiana* Pavlov [Lf: Herb. Lc: An. D: 26]

235. *Cuscuta karatavica* Pavlov [Lf: Herb. Lc: An. D: 28]

Fam. 14. Crassulaceae J.St.-Hil.

Gen. 83. *Pseudosedum* (Boiss.) A.Berger

236. *Pseudosedum karatavicum* Boriss. [Lf: Herb. Lc: Per. Cs: RB. D: 28]

Fam. 15. Cyperaceae Juss.

Gen. 84. *Cyperus* L.

237. *Cyperus soongoricus* Kar. & Kir. [Lf: Herb. Lc: An. D: 12]

Fam. 16. Euphorbiaceae Juss.

Gen. 85. *Euphorbia* L.

238. *Euphorbia heptapotamica* Golosk. [Lf: Herb. Lc: An. D: 24]

239. *Euphorbia kalbaensis* Baikov & I.V.Khan [Lf: Herb. Lc: Per. D: 22]

240. *Euphorbia saurica* Baikov [Lf: Herb. Lc: Per. D: 23]

241. *Euphorbia yaroslavii* Poljakov [Lf: Herb. Lc: Per. Cs: RB. D: 25]

Fam. 17. Fabaceae Lindl.

Gen. 86. *Astragalus* L.

242. *Astragalus abbreviatus* Kar. & Kir. [Lf: Herb. Lc: Per. D: 24, 25, 25a, 26, 27]

243. *Astragalus arganaticus* Bunge [Lf: Herb. Lc: Per. D: 18, 24]

244. *Astragalus balchaschensis* Sumnev. [Lf: Herb. Lc: Per. D: 18]

245. *Astragalus brotherusii* Podlech [Lf: Herb. Lc: Per. D: 25]

246. *Astragalus chaetolobus* Bunge [Lf: Subshrub. Lc: Per. D: 4, 11, 22]

247. *Astragalus citoinflatus* Bondarenko [Lf: Herb. Lc: Per. D: 17]

248. *Astragalus clausii* C.A.Mey. [Lf: Herb. Lc: Per. D: 6]

249. *Astragalus cytisoides* Bunge [Lf: Dwarf semishrub. Lc: Per. D: 18]

250. *Astragalus fragiformis* Willd. [Lf: Undershrub. Lc: Per. D: 22]

251. *Astragalus georgii* Gontsch. [Lf: Dwarf semishrub. Lc: Per. D: 28]

252. *Astragalus inflatus* DC. [Lf: Undershrub. Lc: Per. D: 22]

253. *Astragalus jaxarticus* Pavlov [Lf: Herb. Lc: Per. D: 26, 28]

254. *Astragalus juvenalis* Delile [Lf: Herb. Lc: An. D: 10, 18]

255. *Astragalus karataviensis* Pavlov [Lf: Dwarf semishrub. Lc: Per. Cs: RB. D: 21, 28]

256. *Astragalus karatjubeki* Golosk. [Lf: Subshrub. Lc: Per. D: 16, 18]

257. *Astragalus kasachstanicus* subsp. *coloratus* Knjaz. [Lf: Herb. Lc: Per. D: 10, 11a]

258. *Astragalus kazymbeticus* Saposhn. ex Sumnev. [Lf: Herb. Lc: Per. D: 24]

259. *Astragalus kopalensis* Lipsky [Lf: Shrub. Lc: Per. Cs: RB. D: 24]

260. *Astragalus krascheninnikovii* Kamelin [Lf: Shrub. Lc: Per. Cs: RB. D: 16]

261. *Astragalus krasnovii* Popov [Lf: Herb. Lc: Per. D: 26]

262. *Astragalus leucocalyx* Popov * [Lf: Shrub. Lc: Per. D: 28]

263. *Astragalus lipschitzii* Pavlov [Lf: Undershrub. Lc: Per. D: 28, 29]

264. *Astragalus mokeevae* Popov [Lf: Subshrub. Lc: Per. D: 28]

265. *Astragalus neopopovii* Golosk. [Lf: Herb. Lc: Per. D: 24]

266. *Astragalus psammophilus* Golosk. [Lf: Subshrub. Lc: Per. D: 18]

267. *Astragalus pseudocytisoides* Popov Lf: Dwarf semishrub. Lc: Per. Cs: RB. D: 25, 26]

268. *Astragalus psilopus* Schrenk [Lf: Herb. Lc: Per. D: 18, 24]
269. *Astragalus pulposus* Popov [Lf: Herb. Lc: Per. D: 25]
270. *Astragalus pycnolobus* Bunge [Lf: Subshrub. Lc: Per. D: 12, 22]
271. *Astragalus rariflorus* Ledeb. * [Lf: Herb. Lc: Per. D: 11]
272. *Astragalus rubtzovii* Boriss. [Lf: Herb. Lc: Per. Cs: RB. D: 25a]
273. *Astragalus saphronovae* Kulikov [Lf: Dwarf semishrub. Lc: Per. D: 7, 13, 13b]
274. *Astragalus sarchanensis* Gontsch. [Lf: Herb. Lc: Per. D: 24]
275. *Astragalus semenovii* Bunge [Lf: Herb. Lc: Per. D: 18, 24, 25a]
276. *Astragalus sisyrodytes* Bunge [Lf: Herb. Lc: Per. D: 28]
277. *Astragalus spartioides* Kar. & Kir. [Lf: Subshrub. Lc: Per. D: 18]
278. *Astragalus speciosissimus* Pavlov [Lf: Subshrub. Lc: Per. D: 28]
279. *Astragalus subcaracugensis* Sitpaeva [Lf: Subshrub. Lc: Per. D: 9]
280. *Astragalus subternatus* Pavlov [Lf: Herb. Lc: Per. Cs: RB. D: 28]
281. *Astragalus sumneviczii* Pavlov [Lf: Herb. Lc: Per. Cs: RB. D: 16]
282. *Astragalus terekensis* Fisjun [Lf: Herb. Lc: Per. D: 24]
283. *Astragalus transnominatus* M.N.Abdull. [Lf: Herb. Lc: Per. D: 26, 28]
284. *Astragalus tscharynensis* Popov [Lf: Undershrub. Lc: Per. Cs: RB. D: 24, 25]
285. *Astragalus turajgyricus* Golosk. [Lf: Herb. Lc: Per. D: 25]
286. *Astragalus unilateralis* Kar. & Kir. [Lf: Herb. Lc: Per. D: 4, 7, 8, 11, 12, 22]
287. *Astragalus virens* Pavlov [Lf: Herb. Lc: Per. D: 28]

Gen. 87. Caragana Lam.

288. *Caragana media* Sanchir [Lf: Shrub. Lc: Per. D: 10, 11]

Gen. 88. Chesneya Lindl. ex Endl.

289. *Chesneya karatavica* Kamelin [Lf: Herb. Lc: Per. D: 28]

Gen. 89. Hedysarum L.

290. *Hedysarum bectauatavicum* Bajtenov [Lf: Herb. Lc: Per. Cs: RB. D: 11]
291. *Hedysarum chantavicum* Popov ex Bajtenov [Lf: Herb. Lc: Per. D: 26]
292. *Hedysarum karataviense* B.Fedtsch. [Lf: Herb. Lc: Per. Cs: RB. D: 28]
293. *Hedysarum nikolai* Kovalevsk. [Lf: Herb. Lc: Per. D: 28]
294. *Hedysarum mindshilkense* Bajtenov [Lf: Herb. Lc: Per. Cs: RB. D: 28]
295. *Hedysarum pallidiflorum* Pavlov [Lf: Herb. Lc: Per. D: 28]
296. *Hedysarum pavlovii* Bajtenov [Lf: Herb. Lc: Per. D: 28]
297. *Hedysarum tarbagataicum* Knjaz. [Lf: Herb. Lc: Per. D: 3, 11, 12, 22, 23]
298. *Hedysarum ulutavicum* Knjaz. [Lf: Herb. Lc: Per. D: 10a]
299. *Hedysarum villosissimum* Knjaz. [Lf: Herb. Lc: Per. D: 10, 11]

Gen. 90. Onobrychis Mill.

300. *Onobrychis alatavica* Bajtenov * [Lf: Herb. Lc: Per. Cs: RB. D: 25]

Gen. 91. Oxytropis DC.

301. *Oxytropis alberti-regelii* Vassilcz. [Lf: Herb. Lc: Per. D: 29]
302. *Oxytropis almaatensis* Bajtenov [Lf: Herb. Lc: Per. Cs: RB. D: 25, 25a]
303. *Oxytropis bajtulinii* Kotukhov [Lf: Herb. Lc: Per. D: 22]
304. *Oxytropis biloba* Saposhn. [Lf: Herb. Lc: Per. Cs: RB. D: 23]
305. *Oxytropis bosculensis* Golosk. [Lf: Herb. Lc: Per. D: 25]
306. *Oxytropis brevicaulis* Ledeb. [Lf: Herb. Lc: Per. D: 2, 3, 9, 10, 11, 18]
307. *Oxytropis canopatula* Vassilcz. [Lf: Herb. Lc: Per. D: 28]
308. *Oxytropis cretacea* Basil. [Lf: Herb. Lc: Per. D: 1]
309. *Oxytropis echidna* Vved. [Lf: Undershrub. Lc: Per. Cs: RB. D: 28]
310. *Oxytropis fruticulosa* Bunge [Lf: Undershrub. Lc: Per. D: 24]

311. *Oxytropis gebleriana* Schrenk [Lf: Herb. Lc: Per. D: 1, 2, 3, 7a, 9, 10, 11, 16, 18]
312. *Oxytropis heteropoda* Bunge [Lf: Herb. Lc: Per. D: 24, 25]
313. *Oxytropis karataviensis* Pavlov [Lf: Herb. Lc: Per. Cs: RB. D: 28]
314. *Oxytropis kyziltalensis* Vassilcz. [Lf: Herb. Lc: Per. D: 24]
315. *Oxytropis niedzweckiana* Popov [Lf: Herb. Lc: Per. Cs: RB. D: 25]
316. *Oxytropis pulvinoides* Vassilcz. [Lf: Herb. Lc: Per. D: 24]
317. *Oxytropis satpaevii* Bajtenov [Lf: Herb. Lc: Per. D: 11]
318. *Oxytropis subcapitata* Gontsch [Lf: Herb. Lc: Per. D: 28]
319. *Oxytropis subverticillaris* C.A.Mey. [Lf: Herb. Lc: Per. Cs: RB. D: 3, 10, 10a, 11]
320. *Oxytropis sumnevicii* Krylov [Lf: Herb. Lc: Per. D: 22]
321. *Oxytropis talgarica* Popov [Lf: Herb. Lc: Per. D: 25]
322. *Oxytropis tomentosa* Gontsch. [Lf: Herb. Lc: Per. D: 28]

Fam. 18. Frankeniaceae Desv.

Gen. 92. *Frankenia* L.

323. *Frankenia bucharica* subsp. *mironovii* (Botsch.) Chrtek [Lf: Subshrub. Lc: Per. D: 16, 25, 26]
324. *Frankenia bucharica* subsp. *transkaratavica* (Botsch.) Chrtek [Lf: Subshrub. Lc: Per. D: 17]

Fam. 19. Gentianaceae Juss.

Gen. 93. *Comastoma* Toyok.

325. *Comastoma irinae* (Pachom.) Czerep. [Lf: Herb. Lc: An. D: 25]

Fam. 20. Lamiaceae Martinov

Gen. 94. *Dracocephalum* L.

326. *Dracocephalum pavlovii* Roldugin [Lf: Dwarf semishrub. Lc: Per. D: 29]

Gen. 95. *Phlomoides* Moench.

327. *Phlomoides affinis* (Schrenk) Salmaki [Lf: Herb. Lc: Per. D: 10, 10a, 11, 16, 17, 18, 28]
328. *Phlomoides boraldaica* A.L.Ebel [Lf: Herb. Lc: Per. D: 28, 29]
329. *Phlomoides czuiliensis* (Golosc.) Adylov, Kamelin & Makhm. [Lf: Herb. Lc: Per. D: 26]
330. *Phlomoides eremostachydioides* (Popov) Y.Zhao & C.L.Xiang [Lf: Herb. Lc: Cs: RB. Per. D: 28]
331. *Phlomoides gymnocalyx* (Schrenk) Adylov, Kamelin & Makhm. [Lf: Herb. Lc: Per. D: 18, 24, 26]
332. *Phlomoides iliensis* (Regel) Adylov, Kamelin & Makhm [Lf: Herb. Lc: Per. D: 18, 24]
333. *Phlomoides pectinata* (Popov) Adylov, Kamelin & Makhm. [Lf: Herb. Lc: Per. D: 28]
334. *Phlomoides rotala* (Schrenk ex Fisch., C.A.Mey. & Avé-Lall.) Salmaki [Lf: Herb. Lc: Per. D: 18]
335. *Phlomoides septentrionalis* (Popov) Adylov, Kamelin & Makhm. [Lf: Herb. Lc: Per. D: 27, 28, 29]

Gen. 96. *Phlomis* L.

336. *Phlomis mindshelkensis* Lazkov [Lf: Herb. Lc: Per. D: 28]

Gen. 97. *Lagochilus* Bunge ex Benth.

- 337. *Lagochilus androssowii* Knorring [Lf: Dwarf semishrub. Lc: Per. D: 15, 28]
- 338. *Lagochilus longidentatus* Knorring [Lf: Dwarf semishrub. Lc: Per. D: 16, 28]
- 339. *Lagochilus taukumensis* Tzukerv. [Lf: Dwarf semishrub. Lc: Per. D: 18]

Gen. 98. *Leonurus* L.

- 340. *Leonurus incanus* V.I.Krecz. & Kuprian. [Lf: Herb. Lc: Per. D: 24]

Gen. 99. *Salvia* L.

- 341. *Salvia trautvetteri* Regel [Lf: Herb. Lc: Per. D: 28, 29]

Gen. 100. *Scutellaria* L.

- 342. *Scutellaria androssovii* Juz. [Lf: Herb. Lc: Per. D: 15, 28]
- 343. *Scutellaria karatavica* Juz. [Lf: Herb. Lc: Per. Cs: RB. D: 28]
- 344. *Scutellaria kurssanovii* Pavlov [Lf: Herb. Lc: Per. D: 28]
- 345. *Scutellaria navicularis* Juz. [Lf: Subshrub. Lc: Per. Cs: RB. D: 18, 24]
- 346. *Scutellaria subcaespitosa* Pavlov [Lf: Herb. Lc: Per. Cs: RB. D: 27, 28, 29]
- 347. *Scutellaria titovii* Juz. [Lf: Herb. Lc: Per. D: 26]
- 348. *Scutellaria turgaica* Juz. [Lf: Herb. Lc: Per. D: 9, 10, 10a, 11, 11a, 16]

Gen. 101. *Thymus* L.

- 349. *Thymus crebrifolius* Klokov [Lf: Dwarf semishrub. Lc: Per. D: 10, 10a, 11a]
- 350. *Thymus eremita* Klokov [Lf: Dwarf semishrub. Lc: Per. D: 10a, 11]
- 351. *Thymus karatavicus* Dmitrieva [Lf: Dwarf semishrub. Lc: Per. D: 28, 29]
- 352. *Thymus magnificus* Klokov [Lf: Dwarf semishrub. Lc: Per. D: 25]

Fam. 21. Liliaceae Juss.

Gen. 102. *Fritillaria* L.

- 353. *Fritillaria kolbintsevii* Rukšāns & Zubov [Lf: Herb. Lc: Per. D: 24]

Gen. 103. *Gagea* Salisb.

- 354. *Gagea almaatensis* Levichev, A.Peterson & J.Peterson [Lf: Herb. Lc: Per. D: 25]
- 355. *Gagea iliensis* Popov [Lf: Herb. Lc: Per. D: 16, 18]
- 356. *Gagea sarysuensis* Murz. [Lf: Herb. Lc: Per. D: 10, 11]
- 357. *Gagea ularsaica* I.G.Levichev [Lf: Herb. Lc: Per. D: 28, 29]

Gen. 104. *Tulipa* L.

- 358. *Tulipa alberti* Regel [Lf: Herb. Lc: Per. Cs: RB. D: 10, 16, 18, 24, 26, 28, 29]
- 359. *Tulipa annae* J.de Groot & Zonn. [Lf: Herb. Lc: Per. D: 22, 24]
- 360. *Tulipa auliekolica* Perezhogin [Lf: Herb. Lc: Per. D: 2]
- 361. *Tulipa berkariensis* Rukšāns * [Lf: Herb. Lc: Per. D: 27, 28, 29]
- 362. *Tulipa brachystemon* Regel * [Lf: Herb. Lc: Per. Cs: RB. D: 24]
- 363. *Tulipa diana-verettiae* J.de Groot & Zonn. [Lf: Herb. Lc: Per. D: 22]
- 364. *Tulipa ivasczenkoae* Epiktetov & Belyalov [Lf: Herb. Lc: Per. D: 24]
- 365. *Tulipa kolbintsevii* Zonn. [Lf: Herb. Lc: Per. D: 24]
- 366. *Tulipa lemmersii* Zonn., Peterse & J.de Groot [Lf: Herb. Lc: Per. D: 29]
- 367. *Tulipa orthopoda* Vved. * [Lf: Herb. Lc: Per. D: 28, 29]
- 368. *Tulipa regelii* Krasn. [Lf: Herb. Lc: Per. Cs: RB. D: 26]
- 369. *Tulipa turgaica* Perezhogin [Lf: Herb. Lc: Per. D: 9]
- 370. *Tulipa salsola* Rukšāns & Zubov [Lf: Herb. Lc: Per. D: 24]

Fam. 22. Nitrariaceae Lindl.

Gen. 105. *Nitraria* L.

- 371. *Nitraria iliensis* Banaev & Tomoshevich [Lf: Shrub. Lc: Per. D: 18, 24]

Gen. 106. *Tetradiclis* Steven ex M.Bieb.

372. *Tetradiclis corniculata* Khalk. [Lf: Herb. Lc: An. D: 12]

Fam. 23. Orobanchaceae Vent.

Gen. 107. *Euphrasia* L.

373. *Euphrasia integriloba* J.J.Dmitriev & N.I.Rubtzov [Lf: Herb. Lc: An. D: 24]
374. *Euphrasia karataviensis* Govor. [Lf: Herb. Lc: An. D: 28, 29]

Gen. 108. *Pedicularis* L.

375. *Pedicularis czuiliensis* Semiotr. [Lf: Herb. Lc: Per. Cs: RB. D: 26]
376. *Pedicularis interrupta* subsp. *tarbagataica* (Semiotr.) Kamelin [Lf: Herb. Lc: Per. Cs: RB. D: 23]
377. *Pedicularis kokpakensis* Semiotr. [Lf: Herb. Lc: Per. D: 25a]
378. *Pedicularis masalskyi* Semiotr. [Lf: Herb. Lc: Per. D: 29]
379. *Pedicularis transversa* Baimukhambetova [Lf: Herb. Lc: Per. D: 25a]

Fam. 24. Plantaginaceae Juss.

Gen. 109. *Linaria* Mill.

380. *Linaria macrophylla* Kuprian. [Lf: Herb. Lc: Per. D: 8]

Fam. 25. Plumbaginaceae Juss.

Gen. 110. *Acantholimon* Boiss.

380. *Acantholimon karatavicum* Pavlov [Lf: Undershrub. Lc: Per. D: 17, 28]
382. *Acantholimon linczevskii* Pavlov [Lf: Undershrub. Lc: Per. Cs: RB. D: 28]
383. *Acantholimon mikeschii* Lincz. [Lf: Undershrub. Lc: Per. D: 28]
384. *Acantholimon minshelkense* Pavlov [Lf: Subshrub. Lc: Per. D: 28]
385. *Acantholimon pavlovii* Lincz. [Lf: Undershrub. Lc: Per. D: 29]
386. *Acantholimon squarrosus* Pavlov [Lf: Undershrub. Lc: Per. D: 28]

Gen. 111. *Limonium* Mill.

387. *Limonium botschantzevii* (Lincz.) M.Malekm., Akhani & Borsch [Lf: Herb. Lc: Per. D: 21]
388. *Limonium michelsonii* Lincz. [Lf: Herb. Lc: Per. Cs: RB. D: 24, 25, 25a]

Fam. 26. Poaceae Barnhart

Gen. 112. *Agropyron* Gaertn,

389. *Agropyron cristatum* subsp. *tarbagataicum* (Plotn.) Tzvelev [Lf: Herb. Lc: Per. D: 22, 23]

Gen. 113. *Elymus* L.

390. *Elymus arcuatus* (Golosc.) Tzvelev [Lf: Herb. Lc: Per. D: 25]
391. *Elymus glaucissimus* (Popov) Tzvelev [Lf: Herb. Lc: Per. D: 25]
392. *Elymus sibiricus* Kotukhov [Lf: Herb. Lc: Per. D: 22]

Gen. 114. *Festuca* Tourn. ex L.

393. *Festuca irtyschensis* E.B.Alexeev [Lf: Herb. Lc: Per. D: 3]
394. *Festuca saurica* E.B.Alexeev [Lf: Herb. Lc: Per. D: 23]

Gen. 115. *Leymus* Hochst.

395. *Leymus divaricatus* (Drobow) Tzvelev [Lf: Herb. Lc: Per. D: 25, 28]

Gen. 116. *Limnas* Trin.

396. *Limnas vereschaginii* Krylov & Schischk. [Lf: Herb. Lc: Per. Cs: RB. D: 22]

Gen. 117. *Poa* L.

397. *Poa koksensis* Golosc. [Lf: Herb. Lc: Per. D: 24]

Gen. 118. *Puccinellia* Parl.

398. *Puccinellia macropus* V.I.Krecz. [Lf: Herb. Lc: Per. D: 26]

Gen. 119. *Stipa* L.

399. *Stipa argillosa* Kotukhov * [Lf: Herb. Lc: Per. D: 22]
400. *Stipa austroaltaica* Kotukhov [Lf: Herb. Lc: Per. Cs: RB. D: 22]
401. *Stipa karakabinica* Kotukhov [Lf: Herb. Lc: Per. D: 23]
402. *Stipa kempirica* Kotukhov [Lf: Herb. Lc: Per. D: 23]
403. *Stipa kotuchovii* M.Nobis [Lf: Herb. Lc: Per. D: 23]

Fam. 27. Polygonaceae Juss.

Gen. 120. *Atraphaxis* L.

404. *Atraphaxis muschketowii* Krasn. [Lf: Shrub. Lc: Per. Cs: RB. D: 25]
405. *Atraphaxis teretifolia* (Popov) Kom. [Lf: Shrub. Lc: Per. Cs: RB. D: 10, 11, 18]

Gen. 121. *Calligonum* L.

406. *Calligonum turbineum* Pavlov [Lf: Shrub. Lc: Per. D: 17, 18, 20]

Gen. 122. *Rumex* L.

407. *Rumex fischeri* Rchb. [Lf: Herb. Lc: Per. D: 24]
408. *Rumex komarovii* Schischk. & Serg. [Lf: Herb. Lc: Per. D: 11]

Fam. 28. Ranunculaceae Juss.

Gen. 123. *Aquilegia* L.

409. *Aquilegia karatavica* Mikeschin [Lf: Herb. Lc: Per. Cs: RB. D: 28]
410. *Aquilegia vitalii* Gamajun. [Lf: Herb. Lc: Per. Cs: RB. D: 24]

Gen. 124. *Delphinium* L.

411. *Delphinium austroaltaicum* A.L.Ebel [Lf: Herb. Lc: Per. D: 22]
412. *Delphinium connectens* Pachom. [Lf: Herb. Lc: Per. D: 25a]
413. *Delphinium pavlovii* Kamelin [Lf: Herb. Lc: Per. D: 28]

Gen. 125. *Ranunculus* L.

414. *Ranunculus karkaralensis* Schegol. [Lf: Herb. Lc: Per. D: 11a]

Gen. 126. *Thalictrum* Tourn. ex L.

415. *Thalictrum bykovii* Kotukhov * [Lf: Herb. Lc: Per. D: 22]

Fam. 29. Rosaceae Juss.

Gen. 127. *Alchemilla* L.

416. *Alchemilla goloskokovii* Juz. [Lf: Herb. Lc: Per. D: 24]

Gen. 128. *Amelanchier* Medik.

417. *Amelanchier turkestanica* Litv. [Lf: Shrub. Lc: Per. D: 11]

Gen. 129. *Cotoneaster* Medik.

418. *Cotoneaster alatavicus* Popov [Lf: Shrub. Lc: Per. D: 24, 25, 27, 29]
419. *Cotoneaster altaicus* G.Klotz ex J.Fryer & B.Hylmö [Lf: Shrub. Lc: Per. D: 25]
420. *Cotoneaster krasnovii* Pojark. [Lf: Shrub. Lc: Per. D: 18, 24, 25, 26]
421. *Cotoneaster neoantoninae* A.N.Vassiljeva [Lf: Shrub. Lc: Per. D: 24, 25]
422. *Cotoneaster polyanthemus* E.L.Wolf [Lf: Shrub. Lc: Per. D: 24, 25]
423. *Cotoneaster talgaricus* Popov [Lf: Shrub. Lc: Per. D: 24, 25, 25a]

Gen. 130. *Crataegus* L.

424. *Crataegus ambigua* subsp. *transcaspica* (Pojark.) K.I.Chr. [Lf: Tree. Lc: Per. D: 13b]

Gen. 131. *Potentilla* L.

425. *Potentilla karatavica* Juz. [Lf: Herb. Lc: Per. D: 28]

426. *Potentilla salsa* Yu.A.Kotukhov [Lf: Herb. Lc: Per. D: 22]

427. *Potentilla schrenkiana* Regel [Lf: Herb. Lc: Per. D: 23, 24]

Gen. 132. *Rosa* L.

428. *Rosa dsharkenti* Chrshan. [Lf: Shrub. Lc: Per. D: 18]

429. *Rosa iliensis* Chrshan. [Lf: Shrub. Lc: Per. D: 17, 18]

430. *Rosa potentilliflora* Chrshan. & Popov [Lf: Shrub. Lc: Per. D: 25]

431. *Rosa schrenkiana* Crép. [Lf: Shrub. Lc: Per. D: 24]

Gen. 133. *Spiraeanthus* (Fisch. & C.A.Mey.) Maxim.

432. *Spiraeanthus schrenkianus* (Fisch. & C.A.Mey.) Maxim. [Lf: Shrub. Lc: Per. Cs: RB. D: 16, 21, 26, 28]

Fam. 30. Rubiaceae Juss.

Gen. 134. *Galium* L.

433. *Galium kasachstanicum* Pachom. [Lf: Herb. Lc: Per. D: 25a]

434. *Galium turgaicum* Knjaz. [Lf: Herb. Lc: Per. D: 7a]

435. *Galium zaisanicum* Pinzhenina & Kupr. * [Lf: Herb. Lc: Per. D: 12]

Gen. 135. *Rubia* L.

436. *Rubia cretacea* Pojark. [Lf: Herb. Lc: Per. Cs: RB. D: 1, 6, 7a, 8, 13]

437. *Rubia pavlovii* Bajtenov & Myrz. [Lf: Herb. Lc: Per. Cs: RB. D: 28]

Fam. 31. Rutaceae Juss.

Gen. 136. *Haplophyllum* A.Juss.

438. *Haplophyllum eugenii-korovinii* Pavlov [Lf: Subshrub. Lc: Per. Cs: RB. D: 28]

439. *Haplophyllum multicaule* Vved. [Lf: Subshrub. Lc: Per. D: 5, 10, 14, 16, 18, 24, 26]

Fam. 32. Scrophulariaceae Juss.

Gen. 137. *Scrophularia* Tourn. ex L.

440. *Scrophularia dshungarica* Golosk. & Tzag. [Lf: Herb. Lc: Per. Cs: RB. D: 24]

441. *Scrophularia nuraniae* Tzag. [Lf: Herb. Lc: Per. Cs: RB. D: 29]

Fam. 33. Thymelaeaceae Juss.

Gen. 138. *Diarthron* Turcz.

442. *Dendrostellera ammodendron* (Kar. & Kir.) Botsch. [Lf: Shrub. Lc: Per. D: 17, 18, 24, 25]

Fam. 34. Zygophyllaceae R.Br.

Gen. 139. *Zygophyllum* L.

443. *Zygophyllum balchaschense* Boriss. [Lf: Herb. Lc: Per. D: 11, 16]

444. *Zygophyllum betpakdalense* Golosk. & Semiotr. [Lf: Herb. Lc: Per. D: 16]

445. *Zygophyllum borissovae* Beier & Thulin [Lf: Herb. Lc: Per. D: 10, 11, 11a, 16]

446. *Zygophyllum furcatum* C.A.Mey. [Lf: Herb. Lc: Per. D: 10, 11, 11a, 23, 24]

447. *Zygophyllum karatavicum* Boriss. [Lf: Herb. Lc: Per. Cs: RB. D: 28]

448. *Zygophyllum kopalense* Boriss. [Lf: Herb. Lc: Per. Cs: RB. D: 16, 18, 25, 26]

449. *Zygophyllum steropterum* Schrenk [Lf: Herb. Lc: Per. D: 16, 17, 18, 26]

450. *Zygophyllum subtrijugum* C.A.Mey. [Lf: Herb. Lc: Per. D: 3. 4. 10, 10a, 11, 16]

451. *Zygophyllum taldykurganicum* Boriss. [Lf: Herb. Lc: Per. D: 18, 24]

Notes*:

- **Arthropytum subulifolium* Schrenk, according to POWO, is noted in Turkmenistan; however, according to our data and the scientific paper by Osmanali et al. (2019), this indication is incorrect. This species is a narrow-local endemic of the Chu-Ili Range in the south of Kazakhstan (Osmanali et al. 2019).
- **Atriplex iljinii* Aellen, similar to *Arthropytum subulifolium* Schrenk, is erroneously reported in Turkmenistan, as per the POWO database. The distribution of *A. iljinii* is poorly studied, known mainly from type specimens. This species is observed in the northwest of the Mangistau Region, as well as in the Aktobe and Kyzylorda (Aralkum Desert) Regions of Kazakhstan (Suchorukow 2007).
- **Ferula leucographa* Korovin, according to POWO, is recorded in Uzbekistan; yet, according to the updated synopsis of *Apiaceae* of Kazakhstan and Central Asia (Pimenov 2020), the species grows only in Kazakhstan.
- **Rindera ochroleuca* Kar. & Kir., as suggested by POWO, is observed in Altai in the Russian Federation; yet, our investigation did not find credible evidence supporting this information.
- **Eutrema halophilum* (C.A.Mey.) Al-Shehbaz & Warwick was previously reported in China (Wu et al. 2008); however, German DA and Chen WL (2009) in their scientific paper did not confirm the presence of this species in China.
- **Astragalus leucocalyx* Popov is recorded in POWO for Uzbekistan; nevertheless, Tojibaev et al. (2020b) in their scientific paper exclusively listed this species as occurring in Kazakhstan.
- **Prangos multicostata* Kljuykov & Lyskov., according to the scientific paper by Pimenov (2020), is a synonym for *Prangos dzhungarica* Pimenov. Further study is required to investigate whether species status of *Prangos multicostata* is warranted.
- **Centaurea kryloviana* Serg. is not recognised in POWO and GBIF, probably due to nomenclature errors. However, according to the scientific paper by Kupriyanov (2018), this species is endemic to eastern Kazakhstan.
- **Astragalus rariflorus* Ledeb., previously noted for Western Siberia (Krylov 1933), yet we did not find herbarium materials of this species from this territory. This species is also not recorded in the Flora of Siberia (Malyshev 1994).
- **Lappula cristata* (Bunge) B. Fedtsch. in JBIF is recorded for Western Siberia, on the territory of the Russian Federation (Bochkov and Seregin 2022); however, the presence of this species lacks substantial verification. Notably, the Flora of Siberia (Malyshev 1997) does not include any records of this species. Therefore, further investigation is necessary to elucidate the occurrence of *Lappula cristata* within the territory of the Russian Federation.
- **Onobrychis alata* Bajtenov was omitted from the list of flora of Kazakhstan (Abdulina 1999). Conspectus Florae Asiae Mediae (Kamelin et al. 1981) noted that this species needs to be re-collected to confirm species status.
- **Tulipa berkariensis* Rukšāns in POWO is recognised as a synonym of *Tulipa kaufmanniana* Regel., based on data from Everett (2013). Nevertheless, *T. berkariensis* from the Berkara Valley and other places in Kazakhstan has a lower amount of nuclear 2C DNA (based on the data flow cytometric measurement of nuclear DNA content) than authentic *T. kaufmanniana* from Uzbekistan (Zonneveld 2009). This discrepancy implies that *Tulipa berkariensis* should be recognised as a distinct taxonomic entity.

- **Tulipa orthopoda* Vved. listed in POWO is recognised as a synonym for *Tulipa bifloriformis* Vved., based on Christenhusz et al. (2013) and Everett (2013). This scientific paper also notes that the species status of *Tulipa orthopoda* should be warranted, based on differences in morphological characters and flowering period, but further fieldwork is required to establish the variability of *T. bifloriformis* in the wild.
- **Tulipa brachystemon* Regel in POWO is recognised as a synonym for *Tulipa tetraphylla* Regel, also according to Christenhusz et al. (2013) and Everett (2013). However, Zonneveld (2009) distinguishes *Tulipa brachystemon* Regel as an independent taxon, based on the nuclear DNA content (DNA value 2C).
- **Galium zaisanicum* Pinzhennina & Kupr. was described quite recently (Pinzhennina and Kupriyanov 2023), presumably due to its recent identification it is absent in the GBIF and POWO systems.
- **Stipa argillosa* Kotukhov in POWO is erroneously listed for the Altai Republic of the Russian Federation. This species is described from the territory of East Kazakhstan. Type: Southern Altai, south-eastern foothills of the Azutau Ridge, Bulgartabat tract, foothill desert, outcrops of tertiary clays, clay-rub-bly areas, 05/22/1991, Yu. Kotukhov (LE) (Kotukhov 1998). The Azutau Ridge borders the basin of Lake Markakol from the south and is entirely situated within the territory of Kazakhstan (Yegorina et al. 2003).
- **Thalictrum bykovii* Kotukhov, as well as the previous species in POWO, is erroneously listed for the Altai Republic of the Russian Federation. This species was also described from the territory of East Kazakhstan. Type: Southern Altai, eastern spurs of Azutau Ridge, Mramornaya Mount, Middle belt, 900–1100 m above sea level, south-eastern slope, steppe shrub meadows, 14/06/1984, Yu. Kotukhov (LE).

Supplementary material 1

Checklist of subendemic taxa previously considered endemic in Kazakhstan

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Data type: docx

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Supplementary material 2

Former endemics of Kazakhstan that are now reclassified as synonyms for species exhibiting broader geographical distributions

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