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Brief Review of Kazakhstan Flora and Use of its Wild Species

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ABSTRACT

Approximately 15% of the 161 families of the Kazakhstan flora account for about 75% of the 1118 genera and more than 80% of the >6000 plant species. The sum of the species in the Tamaricaceae, Alliaceae, Polygonaceae, Chenopodiaceae, Caryophyllaceae, Brassicaceae, Zygophyllaceae and Ranunculaceae represent a marked part of their corresponding families' representatives of the world flora and comprise about 15% of the total Kazakhstan flora. A search of the scientific literature revealed uses associated with representatives from at least 120 families of Kazakhstan's flora and more than 50 different kinds of biological activity. Wild species are used in medicine, as food, fodder, essential oils, tanning or as a source of dying agents or in rubber production. In this review, we provided an analysis of the distribution of biological activity among different families and try to outline the representative Kazakhstan flora that should be the subject of more thorough investigations.

Keywords: biological activity, floristic representation, peculiarities, species use

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INTRODUCTION

Kazakhstan is situated in the center of the Euro-Asia continents with a total area fourth in line after Russia, China and India. This huge territory stretches for about 3,000 km from the Caspian Sea to the Altai Mountains and about 1,600 km from the western-Siberian lowland to the Tien-Shan Mountains. According to bio-geographical land area characteristics, most of the Kazakhstan territory together with territories of the former Soviet Asian (Uzbekistan, Kyrgyzstan, Tajikistan, and Turkmenistan referred to in Soviet publications as Middle Asia*) and Caucasus Republics, considerable parts of Iran, Syria, Turkey, the Gobi desert and so on are components of the Iran-Turan floristic region of the Mediterranean Subkingdom (Takhtadzhian 1978; Takhtadzhian *et al*. 1986). A vast territory of the republic, a large distance from the oceans and openness from the north and south and to the west all contribute to the climate. On Kazakhstan plains, natural zones spread along latitudes where we can find several ecoregions: forest and forest-steppes in the northern part, more than 25% as steppe, about 25% as semi-desert, about 40% as desert regions, with about 7% as mountains. The inner-continental location and the lack of water flow to oceans cause considerable temperature amplitudes and marked soil salinity of the Iran-Turanian deserts. Because of the wide ranges in elevation throughout the country, there are wide variations in the average annual temperature and rainfall. In the forest-steppe the average precipitation is 300-400 mm per year, whilst in the steppe this falls to 250 mm. In the Kazakh *small hills* this increases to 300-400 mm, and in the semi deserts and deserts this falls to 100-200 mm; in the South Turan deserts it is as little as 75-125 mm.

Kazakhstan' position between Siberia and the Central Asian deserts, and between the Caspian Sea and the high mountains of the Tien-Shan shows how the country possesses a great variety of natural landscapes (forest-steppes, steppes, arid foothills, small hills and high mountain ranges, deserts' plateaus, salt marshes and sand massives, primarily in lowland areas, lakes' cavities, rivers, and streams, wetlands), with a variety of ecosystems and rich biological diversity. The territory of Kazakhstan was divided into 29 main floristic provinces and a few subprovinces with characteristic flora (see Pavlov, Kazakhstan Flora, V.1, 1956, pp 30-32). For instance, even though the mountain ecosystems cover only 7% of the country, each mountain system (the Altai, Tarbagatai, Dzhungar Alatau, Northern and Western Tien-Shan, Chu-Ili mountains, Zailiyiski Alatau and

* In the Soviet scientific literature the geographical name "Middle Asia" is referred to as the Asian republics of the USSR, except for Kazakhstan. The territory of "Central Asia" includes "Middle Asia", Kazakhstan, Mongolia, a part of China (the Gobi Desert) (see Rachkovskaya *et al*. 2003, p 227). In our manuscript the description of plant species' distribution in "Kazakhstan" is meant by default.

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Karatau) represents a separate floristic province. This is caused by the location of each mountain system, its character of development, certain geo-botanical integrity and the number of natural zones due to the altitude, namely so-called "belt-forming" groups of various vegetation types, which are peculiar to certain altitudinal strips on mountain profiles. Thus, due to its location, the Altai is characterized by a typically Siberian flora found nowhere else in Central Asia. On the other hand Weber (2003) revealed the extraordinarily similarity of the Russian Altai (Kazakh Altai has many common floral species) and the American Southern Rocky Mountain Flora.

The biodiversity of the Kazakhstan mountains increases in richness from the northeast (Altai) to the southwest (West Tien-Shan and Karatau). For instance, in Karatau not less than 180 endemic species were enumerated (see Pavlov, Kazakhstan Flora 1956-1966). Later RV Kamelin (1990) included in the list more than 150 endemic "races" (species and sub species) characteristic only to Karatau. The plain deserts comprise the Caspian Lowland, the Manghyshlak Peninsula, the Usturt Plateau, the southern part of Turgai plateau and Kazakh Melkosopochnik (Eastern Betpak Dala and Nothern Balkhash region), the Turan Lowland (Aral region, The Kysyl Kum) (see Rachkovskaya *et al*. 2003). The various morphostructures are present within the desert zone: plains of different origin, sandy massifs, melkosopochniks and low mountains. In the plain part of the steppe and desert zones peculiarities of both diversity and flora are increased from west to east. However in the northern steppes, grain crops have largely replaced native vegetation.

Of the common prevailing plant species of Kazakhstan, most are perennial mesophylic, perennial meso-xerophytic herbaceous plants, meso-xerophylic and xerophylic shrubs and small shrubs, annual ephemerals and perennial ephemeroids. The relatively high level of species endemism, as high as 13%, and genera endemism, as much as 12%, in the Kazakhstan flora indicates the original character of the flora and its local development on the crossroads of northern and southern lowland and mountain landscapes during a complicated geological history (see Takhtadzhian 1978; Baitenov 2001).

The objective of this work was to scrutinize the Kazakhstan flora to outline the representatives of floristic families and genera, specific to Kazakhstan to further search for biological activities and their corresponding metabolites. Revealing the useful properties of plants would allow botanists, biotechnologists and biochemists to cooperate so as to define directions of research of plants with similar kinds of biological activity on a taxonomic (chemotaxonomic) basis.

PECULIARITIES OF KAZAKHSTAN FLORA

A certain number of plant families are typical for each region (see Kamelin 1990). Baitenov (2001) reported that 161 plant families, 1118 genera and 6040 species are represented in Kazakhstan. These numbers were somewhat different from those reported in the "Checklist of Vascular Plants of Kazakhstan" by Abdulina (1999); however, these differences are not so significant in their characterizations of floristic peculiarities. Moreover, the work of both authors was primarily based on two earlier studies: Pavlov, Kazakhstan Flora Vol 1-1X (1956-1966) and Goloskokov, Illustrated Key Book of Kazakhstan Plants Vol 1 (1969), Vol 2 (1972). Analysis of Kazakhstan flora showed that about 15% of all families accounted for about 75% of the genera and more than 80% of all plant species. In **Table 1**, the most representative plant families of Kazakhstan flora are shown. A total of 25 families are listed. Both in the world and in Kazakhstan flora, the maximum number of species are representatives of the Asteraceae, Fabaceae, and Poaceae. The representatives of these families account for a third of all vascular plants in Kazakhstan. Additionally, all genera of the Tamaricaceae, two-thirds of the Ranunculaceae, and about half of all the world genera of the Chenopodiaceae and Caryophyllaceae, and one third of the genera of the Limoniaceae, Rosaceae, and Boraginaceae are represented in Kazakhstan. The majority of species from the Tamaricaceae family are spread throughout the Mediterranean Sea basin and arid regions of Middle Asia, about one fourth of the Tamaricaceae species of the world flora are in Kazakh-

Table 1 Number of genera and species in several families of vascular plants in Kazakhstan (according to Baitenov 2001) and their percentages relative to worldwide totals.*

Family	Kazakhstan	Worldwide*	Kazakhstan	Endemic genera	Kazakhstan	Worldwide*	Percentage
	Genera		Percentage	I-T*/Kazakhstan	Species**		
Alliaceae J.Agardh	1	30	3.3	2	140/2.3	700	20.0
Apiaceae Lindl.	79	400	19.8	69/17	232/3.9	3000	7.7
Asphodelaceae Juss.	1	40	2.5		15	1500	1.0
Asteraceae Dumort.	146	1500	9.7	65/35	883/15	20000	4.4
Berberidaceae Juss.	4	15	26.7		13	650	2.0
Boraginaceae Juss.	44	130	33.8	15/9	161/2.7	2500	6.4
Brassicaceae Burnett	96	380	25.3	76/31	330/5.4	3000	11.0
Caryophyllaceae Juss.	42	90	46.7	11/3	282/5.0	2000	14.1
Chenopodiaceae Juss.	51	100	51.0	30/25	256/4.2	1500	17.1
Cyperaceae Juss.	19	100	19.0		182/3.0	4000	4.6
Dipsacaceae Juss. A.L. Jussiev	5	15	33.3		16	300	5.3
Euphorbiaceae Juss.	4	320	1.3		61	7500	0.8
Fabaceae Lindl.	45	700	6.4	12/5	671/11.0	17000	3.9
Iridaceae Juss.	5	80	6.3		36	1800	2.0
Lamiaceae Lindl.	49	200	24.5	19/11	247/4.0	3500	7.1
Liliaceae Juss.	8	45	17.8	2/2	83	1300	6.4
Limoniaceae Lincz.	7	20	35.0		52	600	8.7
Poaceae Barnhart	101	700	14.4	11/5	482/8.0	10000	5.0
Polygonaceae Juss.	11	45	24.4	1	141/2.3	800	17.6
Ranunculaceae Juss.	33	50	66.0	2/1	208/3.4	2000	10.4
Rosaceae Juss.	34	100	34.0	4/2	212/3.5	3000	7.1
Rubiaceae Juss.	8	600	1.3		61	6200	1.0
Scrophulariaceae Juss.	24	280	8.6	5/1	176/2.6	3000	5.9
Tamaricaceae Link	4	4	100		21	90	23
Zygophyllaceae R.Br.	2	30	6.7	3	31	240	12.9

* The number of genera and world species in the table were taken from "Life of Plants". Principal Ed. Takhtadzhian, see Reference list. According to the data being presented in internet databases the number of Liliaceae, Apiaceae, Cyperaceae, Fabaceae world genera are less, and the number of Poaceae, Rosaceae, Polygonaceae, Limoniaceae species are somewhat higher. The abundant diversity in the family Liliaceae (4000 species) causes it to be split into several smaller families.
I-T* The Iran-Turan floristic region
** Amount (% of total)

stan. In Kazakhstan, the genus *Allium* L. represents about one fifth of the world Alliaceae family. There are one sixth of the species from both the Polygonaceae and Chenopodiaceae, about one seventh from Caryophyllaceae, more than 10% each from Brassicaceae, Zygophyllaceae, and Ranunculaceae species, only 5% of the Poaceae, and lastly about 4.5% of the Asteraceae and about 4% of Fabaceae species of the world flora (see **Table 1**). On the Kazakhstan territory representatives of more than 150 endemic genera of the Iran-Turan floristic region grow (see Takhtadzhian 1978, pp 122-126). Among them there are 35 endemic genera of 65 the Asteraceae's endemic genera of the Iran-Turan region, 25 of 30 Chenopodiaceae, 31 of 76 Brassicaceae, 11 of 19 Lamiaceae, and 17 of 69 Apiaceae (**Table 1**). One can enumerate 10 *monotypic* endemic genera of plants found only in Kazakhstan: *Physandra*, *Rhaphidolophyton*, *Pseudoeremostachys*, *Pseudomarrubium*, *Botschanzevia*, *Cancriniella*, *Spiraeanthus*, *Pterygostemon*, *Pastinacopsis*, and *Niedzwedzkia* (Takhtadzhian 1978; Baitenov 2001).

Thus, Kazakhstan' biodiversity is globally and regionally important because of its bio-geographical location between northern European, Asian, and Middle Eastern regions, its large size and variety of ecosystems, and the presence of internationally important endemic, rare and threatened species of flora.

USEFUL WILD PLANTS OF KAZAKHSTAN FLORA

Past uses of plants by native population

In the early part of the 20th century, the branch of botany dealing with the practical use of plants, compounds, and products derived from them was described in Russia as "economic botany." Gradually in the Soviet Union, a practical experience in this field of botany became subjected to analysis, systematization, and determination of future research targets. During this early 30-50 year period of the last century, attempts at searching and identifying plants possessing useful characteristics were undertaken in Kazakhstan. N.V. Pavlov in the book "Plant Raw Material of Kazakhstan" (1947) presented extensive data on the number of floristic, ethnobotanical, biochemical, medicinal characteristics, plant resources, a traditional and possible use of more than 1100 representatives of 92 Kazakhstan plant families. A brief analysis of this information concerning the use of Kazakhstan floral representatives by population is presented below.

Indigenous inhabitants of the Kazakhstan territory before the Soviet time, as cattle-breeders, kept simple, nomadic lifestyles; therefore, the use of floral representatives described was relative to wild plant species as fodder sources or as those poisonous to livestock, especially for traditionally bred cattle, sheep, horses and camels. A considerable number of fodder plants of native ranges are in the families Poaceae and Fabaceae. *Stipa karataviensis* Roshev, *S. lessingiana* Trin. et Rupr., *Festuca* sp., *Bromus danthoniae* Trin. C.A. Mey, *Agropyrum ramosum* (Trin.) Richt, *Dactylis glomerata* L., *Koeleria glauca* (Spreng) DC. *Agrostis alba* L., *Poa angustifolia* L., *P. bulbosa* L. were best used as forage herbs in their respective habitats in corresponding phases of vegetation. In the southern regions of Kazakhstan, *Cynogon dactylon* (L.) Pers. remained green when all other plants dried up. *Crypsis aculeata* (L.) Ait., and *Aeluropus lithoralis* (Gouan) Parl., being salt tolerant, were edible for all kinds of cattle on sandy soils (especially after leaching). There were the important Fabaceae forage plants as well, such as *Medicago falcata* L., *M. lupulina* L., *M. platycarpos* Trautv. (*Melissitus platycarpos* (L.) Golosk., *M. sativa* L., *Trifolium pratense* L., *Oxytropis glabra* (Lam.) DC, and *Astragalus* species (many of them on sandy soil). Several representatives of the Asteraceae could be eaten, particularly by sheep, in early vegetative stages and/or in late autumn and winter. Several plant species of the Chenopodiaceae were good feed for sheep, horses, and camels. These included *Atriplex tatarica* L., *Eurotia ceratoides* (L.) C.A.Mey (at present *Krascheninnikovia ceratoides* (L.) Gueldenst (young shoots and leaves), *Ceratocarpus arenarius* L., and *Kochia prostrata* (L.) Schrad. particularly in autumn and winter after leaching, because many Chenopodiaceae representatives grow on salty soils. Other known forage plants are several species from the genera *Geranium* L. (Geraniaceae), *Kobresia* Willd. (Cyperaceae)] and *Ferula* L. (Apiaceae). At the same time, it should be noted that many representative species, for instance among the Fabaceae and Asteraceae, were described as poisonous for livestock.

Representatives from the Alliaceae and Rosaceae families included most food plant species used by native populations. Specifically, the Alliaceae species, *Allium altaicum* Pall., *A. altissimum* Regel., *A. angulosum* L., *A. atrosanguineum* Schrenk, *A. pskemense* B. Fedtsch., *A. longicuspis* Regel., and *A. victorialis* L. were mentioned as being edible. Among the Rosaceae species there are many fruit and berry wild species, namely *Malus sieversii* (Ledeb.) M. Roem., *Rubus caesius* L., *Rubus idaeus* L., *Rosa alberti* Regel., *Armeniaca vulgaris* Lam., *Prunus divaricata* Ledb., *Crataegus* L. spp., and *Sorbus* L. spp. Apples (*Malus sieversii*), apricots (*Armeniaca vulgaris*), hawthorns (*Crataegus* spp.), and barberry (*Berberis* spp.) are the most important wild food plants up to now. Of the Polygonaceae spp., leaves of *Oxyria digyna* (L.) Hill and *Rumex thyrsiflorus* Fingerh., stalks of *Rheum compactum* L. and *R. wittrockii* Lundstr., and immature fruits of *Calligonum aphyllum* (Pall.) Gurke were eaten by native people. Of the Chenopodiaceae representatives, leaves of *Spinacia turkestanica* Iljin, and seeds of *Agriophyllum arenarium* M.B.Fl. were mentioned as being edible. Thickened rhizomes of *Ferula karelinii* Bunge (Apiaceae) growing in sand deserts could be used to satisfy thirst; rhizomes of *Korolkowia severzowii* (Regel) Regel (Liliaceae) were edible; and rhizomes of *Stubendorffia orientalis* Schrenk (Brassicaceae) boiled before consumption. Among edible wild plants growing at the southeast of Kazakhstan representative genera included *Eremurus* M. Bieb., *Humulus* L., *Urtica* L., *Rheum* L., *Rumex* L., *Gentiana* L., *Chamaenerium* Adans, *Taraxacum* Wigg., *Aegopodium* L., *Heracleum* L., and *Cichorium* L. (Pavlov 1943).

For processing livestock leather Kazakhs used *Rumex* spp. and *Polygonum coriarium* Grig. as tanning agents and the roots of *Rumex confertus* Willd. (Polygonaceae) and *Limonium gmelinii* (Willd.) O. Kuntze (Limoniaceae), the blossom clusters of *Delphinium* spp. (Ranunculaceae), the roots of *Halimodendron halodendron* (Pall.) Voss (Fabaceae), and the seeds of *Peganum harmala* L. (Peganaceae), *Macrotomia* DC, *Onosma* L. and *Echium* L. spp. (Boraginaceae) as dying agents. Ensuing research revealed that more than 20 species are valuable tanning plants, including: *P. Bucharicum* G., *Rumex tianschanicus* A. Losinsk., *R. Paulseniacus* Rechiil, *Rheum tataricum* L., and *Rh. Maximowiozii* Losinsk.

Traditional use of medicinally important plants included *Anthoxanthum odoratum* L. (Poaceae), which was used against diseases of the respiratory system, including tuberculosis. *Eminium Regelii Vved* (Araceae), *Asyneuma argutum* (Rgl.) Bornm. (Campanulaceae), *Scabiosa songorica* (Dipsacaceae) and *Ranunculus grandifolius* C.A. Mey (Ranunculaceae) were used against tuberculosis, *Cyperus rotundus* L. (Cyperaceae) against fever, *Glycyrrhiza glabra* L. (Fabaceae) against cough, *Zygophyllum brachypterum* Kar. et Kir. (Zygophyllaceae) and *Polygonum bistorta* L. (Polygonaceae) against abscesses, *P. amphibium* L. against gout and rheumatism, and endemic *Ferula iliensis* (Apiaceae) against cold, headache, indisposition, skin diseases, ulcer and wounds. The herbs *Verbascum phlomoides* L. (Scrophulariaceae), *Echinops karatavicus* Rgl. et Schmalh (Asteraceae), *Bovista plumbea* Pers. (Lycoperdaceae) were used for healing wounds, *Rosularia turkestanica* (Rgl. et Winkl.) Berger for treating ulcerous skin, and a representative of monotypic genus *Korolkovia* Sewerzowii Rgl. against gastroenteric diseases. Mainly *Ammothamnus lehmannii* Bunge. (Fabaceae), *Chenopodium botrys* L. (Chenopodiaceae), *Cynanchum sibiricum* Willd. (Asclepiadaceae), and *Pyrethrum achilleifolium* M.B. (Asteraceae) were used as insecticides (see also Sinicin 1982; Koukenov 1994, 1996; Khalmatov *et al*. 1998).

In the Soviet era, 100 plant species representing 10 plant families were checked for their ability to produce rubber (Pavlov 1937). The availability of rubber was reported as a common property for the *Liguliflorae* from Asteraceae. In this plant group, a correlation between the availability of rubber and latex was shown. By analyzing dozens of plant species, some were determined to be suitable as dyes for natural fabrics, including species of the genera *Rheum* L., *Delphinium* L., *Berberis* L., *Padus* Mill., *Helianthemum* Hill., *Macrotomia* DC, *Onosma* L., and *Scutellaria* L. (Pavlov 1935). Pavlov's coworkers and followers continued to carry out detailed characterizations of useful properties of representatives of the Kazakhstan flora. For instance, *Polygonum coriarium* Grig. was introduced as a tanning agent; *Rheum tataricum* L. was used for leather treatment; *Salix* spp. were used as tanning agents and dyes; roots of *Acanthophyllum gypsophiloides* Regel (at present *Allochrusa gypsophiloides* (Regel.) Schischk. were purchased from inhabitants for saponin production (see Mikhaylova 1965).

Medicinal effects of some Kazakhstan flora species

According to "Kazakhstan flora" (1956-1966) (Pavlov) and "Illustrated Key Book of Kazakhstan Plants" (1969, 1972) (Goloskokov) in Kazakhstan flora there are more than 1000 plant species with medicinal properties. In the "Guidelines for work with medicinal plants" (Beklemishev 1999) there are: the list of medicinal plants of the "XI The State Pharmacopoeia of USSR" (pp 91-94), the list of 262 plant species officially recognized as medicinal, half of which grow in Kazakhstan as well; the list of 271 medicinal plants cultivated in the Almaty Botanic Garden (Grudsinskaja, pp 133-139) and a description of the distribution of 124 wild medicinal plant species throughout the Kazakhstan regions (Egeubaeva *et al*., pp 150-158). The last full list including about 2000 useful (medicinal, food, technical, ornamental and so on) plant species of Kazakhstan flora and their geographical distribution throughout the territory is being prepared by M Grudzinskaya, M Esimbekova and NG Gemedzhieva.

Many plant species common to the former Soviet Union territories were widely used in traditional medicine (Koukenov 1994; Budantsev, Lesiovskaja 2001; Chikov 2002). At the same time, one can enumerate a considerable number of useful medicinal plant species restricted to Middle Asia and the Kazakhstan area (see Mikhailova 1972; Sinitsin 1982; Baitenov 1985; Koukenov 1994, 1996; Khalmatov *et al*. 1998; Koukenov 1999; Chikov 2002). Related species from Kazakhstan and Middle Asia also had a medicinal effect, such as *Aconitum soongoricum* Stapf. (Ranunculaceae) possessing anaesthetic and antibacterial effects; endemic *Crataegus almaatensis* Pojark. (Rosaceae) as a cardiotonic; *Valeriana turkestanica* Sumn. (V. dubia Bunge) (Valerianaceae) as an antispasmatic and obtundent; *Rhaponticum carthamoides* (Willd.) Iljin (Asteraceae) possessing activities similar to those of *Panax ginseng* C.A. Mey (Araliaceae); *Parmelia vagans* Nyl. (Parmeliaceae) with antituberculosis, antibacterial, and antitumor activities. *Psoralea drupacea* Bunge (Fabaceae), endemic to Middle Asia and Iran, and included in the Red Data Book of Kazakh SSR (KRDB) (Bikov 1981) was used as decreasing photosensitivity; *Artemisia aschurbajewii* C. Winkl. (Asteraceae) used by local populations of Middle Asia against gastroenteric disorders; *A. cina* endemic of Kazakhstan as antiinflamatory, tuberculostatic and sedative; *A. gmelinii* Web. ex Stechm. as anti-inflammatory, haemostatic, wound-healing, and antitumor agent. *Leonurus turkestanicus* V. Krecz. et Kuprian (Lamiaceae Lindl) possessed sedative, hypotensive, and cardiotonic effects. The Tien-Shan species *Silene brahuica* Boiss (Caryophyllaceae) was used to treat stomach diseases. There are a great number of *Silene* L. species in Western and Middle Asia, 65 of them in Kazakhstan. Species of the Polygonaceae family are known since ancient times as medicinal plants in Asia. For example representatives of the *Calligonum* L. genus were useful against infection/invasion and immune system disorders. The center of origin and spread of many *Calligonum* species lies in the Iran-Turan region. Of 80 species in total, 30 were revealed to be from Kazakhstan. Roots of *Acanthophyllum* C.A. Mey species (Caryophyllaceae) were used in traditional medicine of Middle Asia as wound healing and expectoral agents. Plant components had a sedative, antisclerotic, and antimicrobial action. The center of origin of this genus is southwestern Asia and the bordering Iran and Afghanistan regions. Fifty species were revealed in Western Asia and the Iran-Turan regions, from which 10 were in Kazakhstan. *Rheum wittrockii* Lunstr (KRDB) (Polygonaceae) was used by Kazakhs against gastroenteric and skin diseases; *Rheum altaicum* Losinsk. (KRDB) was used as an anti-inflammatory and to treat skin diseases. *Ligularia* Cass. spp. (Asteraceae), which spread throughout Middle Asia, was used for wound healing, as an anti-inflammatory, and against infection/invasion, dermatitis, and articulation diseases. Representatives of the *Scorzonera* L. genus were useful against infection/invasion, as bactericides, wound healing, antitumor (mammary gland), against cardiovascular and nervous system disorders and as detoxicants. *Tragopogon* L. spp. spread mainly in the Mediterranean Sea basin, in Caucasus and in the Iran-Turan region (with 27 species in Kazakhstan) possessing immunostimulating, antitumor, genitourinary, and dermatosis activities, treating nervous systems disorders. *Caragana* Lam. species (Fabaceae) demonstrated activities for inflammation, wound healing, digestive system diseases, and dermatitis. Of 80 species spread over the Pamiro-Alai, Tien-Shan, and Altai-Sajani regions, 19 grow in Kazakhstan. *Tribulus terrestris* L. (Zygophylaceae) was used as an antislerotic remedy; *Silene brahuica* Boiss. (Caryophyllaceae) was employed against gastroenteric disorders. Representatives of the above mentioned genera could be the subject of detailed studies as probable sources of biologically active components with corresponding medicinal effects.

Biological activities and perspectives of floristic representatives for further investigations

According to Takhtadzhian (1978), Russia and the Northern region of Kazakhstan are in the Circumboreal region and contain similar plant species. Therefore, the following sources were used for obtaining information on biological activity for corresponding Kazakhstan flora representatives: 7 volumes of "Plant Resources of USSR" (Fedorov and Sokolov 1984-1993), 2 volumes "Plant Resources of Russia and The adjacent States" (Sokolov and Boudantsev 1994, 199) and "Wild Useful Plants of Russia" (Budantsev and Lesiovskaja 2001). They include accessible data from numerous experiments, carried out in the Soviet era, for identifying useful properties (biological activity and others) in particular plant species growing within the Soviet Union territory.

According to these sources representatives from at least 120 families of the Kazakhstan flora possessed more than 50 different kinds of biological activity. As an example, antibacterial activity was revealed in about 60% of families (95 of 161) and about 30% of genera (320 of 1118); fungicidal in about 50 and 23%, antiprotozoal in 9 and 33%, and insecticidal in 9 and 27% of the families and genera, respectively. In about 21% of the families and 5% of the genera there were species with antiviral activity and in about 16% and 5%, respectively with antitumor activities. Nevertheless many of the species in the above-mentioned books were common for different regions of the former Soviet Union, and not only for Kazakhstan.

Kazakhstan floral data allows us to concentrate on the following families: Asteraceae and Fabaceae as most Angiospermae representatives in Kazakhstan (15 and 11%,

Table 2 Biological activity in several plant families in Kazakhstan flora.

Reported activity	**Alliaceae**	**Apiaceae**	**Asteraceae**	**Boraginaceae**	**Brassicaceae**	**Caryophyllaceae**	**Chenopodiaceae**	**Fabaceae**	**Lamiaceae**	**Limoniaceae**	**Poaceae**	**Polygonaceae**	**Ranunculaceae**	**Rosaceae**	**Zygophyllaceae**
Acaricidal		*	*			*									
Algicidal			*	*											
Antiamebaeoidal		*		*					*					*	
Antibacterial	*	*	*	*	*	*	*	*	*	*	*	*	*	*	
Anticystic		*													
Antifeedant			*						*						
Antihelminthal			*												
Antihistamine								*							
Antimutagenic			*												
Antioxidant			*												
Antiprotozoal	*		*	*	*	*	*	*	*			*	*	*	*
Antithrombosis									*						
Antitrichomonadae		*		*				*	*					*	
Antitumor		*	*						*		*		*	*	
Antiviral		*	*	*		*		*	*					*	
Cytostatic								*					*		
Cytotoxic	*		*										*		
Estrogenic		*	*					*			*		*		
Fungicidal	*	*	*	*	*	*	*	*	*		*	*	*		
Growth Inhibitory			*						*		*				
Herbicidal			*												
Ichthyocidal					*			*							
Insecticidal		*	*	*	*	*	*	*	*			*	*	*	
Phytotoxic			*								*				
Raticidal				*				*	*				*	*	
Repellent			*		*				*				*		
Tuberculostatic			*												

correspondingly); the Tamaricaceae, Alliaceae, Polygonaceae, Chenopodiaceae and Brassicaceae, including respectively about 23, 20, 18, 17 and 11% of the species of the world family representatives (see **Table 1**); the Alliaceae, Limoniaceae, Liliaceae, Fabaceae, Boraginaceae and Lamiaceae, including about 32, 31, 29, 22, 17 and 16% of endemics, respectively (see Baitenov 2001). Also taken into consideration was the fact that half of the world species of Alliaceae were found in the Iran-Turan region and that Chenopodiaceae species were especially abundant in the Mediterranean Sea basin and the Iran-Turan region (Takhtadzhian 1978; Baitenov 2001). Because most of the Kazakhstan territory is semi-desert and desert, there are many interesting species of xeric environments. Among them about one third of Kazakhstan's Chenopodiaceae species inhabit sandy desert; 40% of Polygonaceae representatives live in the desert; *Zygophyllaceae* spp. are widespread in Kazakhstan and are frequently found in arid regions. Brassicaceae species are spread throughout the Mediterranean Sea basin as well as Western and Middle Asia; Apiaceae with numerous species in the Mediterranean Sea basin and the Iran-Turan region; and the Lamiaceae, which contains species spread throughout the Mediterranean Sea basin, the Western regions and Middle Asia. Also it is of importance that in Kazakhstan there are 35 (53%) endemic genera of 65 endemic Asteraceae genera of the Iran-Turan region, 25 (83%) of 30 Chenopodiaceae, 31 (41%) of 76 Brassicaceae, 11 (58%) of 19 Lamiaceae, and 17 (25%) of 69 Apiaceae, see **Table 1** (Takhtadzhian 1978, pp 122-126).

In **Table 2** data demonstrating activities revealed by investigators (cited in above-mentioned publications) in representatives of plant families, and reflecting the peculiarities of Kazakhstan floral representation, are presented. Antibacterial activity was found in all families presented except for the Zygophyllaceae. Fungicidal activity was present in all families except for Limoniaceae and Zygophyllaceae. Antiprotozoal activity was revealed in all families listed except for Apiaceae, Limoniaceae, and Poaceae. Insecticidal activity was not mentioned in the Alliaceae, Limoniaceae, Poaceae and Zygophyllaceae. Besides activities shown in **Table 2** there were also antiandrogenic, antigonadotrophic, antileukemia, antimetastatic, antimutagenic, antiestrogenic, neurotrophic, anti-inflammatory, antiproliferative, fibrinolytic and other activities. For example, in the Asteraceae family, representatives demonstrated immunostimulating, antiproliferative, antimutagenic, antiexudative, fibrinolytic, phytotoxic, antifeedant activities, among others; in the Fabaceae, antihistaminic and antiestrogenic activities; in Ranunculaceae, immunomodulating and antiandrogenic activities, in Rosaceae antibacteriophage action. Thus, according to **Table 2**, there were no data for species in the Tamaricaceae family, very scarce data for those in Limoniaceae and Zygophyllaceae, insufficient data for Chenopodiaceae, Polygonaceae and Brassicaceae, all of which are characteristic families of Kazakhstan flora. There was very little information concerning, for instance, antimutagenic, antituberculosis, antioxidant, cytotoxic, phytotoxic and herbicidal activities. Perhaps this does not reflect the principal absence of such activities, but most likely the absence of research directed by modern approaches and methods for typical representatives of the Kazakhstan flora.

In **Table 3** the amount and percentage of plant species in corresponding families with insecticidal and fungicidal activities are shown. In about 6% of the Scrophulariaceae and 5% of both Ranunculaceae and Apiaceae species, and 3% of Chenopodiaceae insecticidal activity was shown. About 10% of Kazakhstan's representatives of the Apiaceae, 8% of the Lamiaceae, about 7% of the Rosaceae and Asteraceae, and 6% of the Scrophulariaceae and Alliaceae possessed fungicidal activity. However, all genera with this type of activity were spread out very widely, frequently being representatives of the Holarctic Kingdom. For instance, *Prangos* and *Ferula* L. (Apiaceae) (the Mediterranean basin and Midlle Asia) are representative genera

Table 3 Kazakhstan floral families containing representatives having insecticidal and/or fungicidal activity.

Family	Total species in Kazakhstan	Species with insecticidal activity	% to the total family species in Kazakhstan	Species with fungicidal activity	% to the total family species in Kazakhstan
Alliaceae	140	-	-	8	5.7
Apiaceae	232	11	4.7	23	9.9
Asteraceae	883	29	3.3	61	6.9
Boraginaceae	161	1	0.6	6	3.7
Brassicaceae	330	2	0.6	10	3.0
Caryophyllaceae	282	3	1	4	1.4
Chenopodiaceae	256	8	3.1	2	0.8
Cyperaceae	182	1	0.5	2	0.5
Euphorbiaceae	61	1	1.6	1	1.6
Fabaceae	671	7	1	18	2.7
Iridaceae	36	-	-	1	2.8
Lamiaceae	247	10	4	20	8.1
Liliaceae	83	2	2.4	1	1.2
Poaceae	482	-	-	11	2.3
Polygonaceae	141	1	0.7	3	2.1
Ranunculaceae	208	10	4.8	12	5.8
Rosaceae	212	-	-	16	7.5
Scrophulariaceae	176	11	6.3	11	6.3

with fungicidal activity; representatives with insecticidal activity Chenopodiaceae: *Halocnemum strobilaceum* Pall.) M.B. (monotypic genus) spread throughout the Black Sea Coast and the Iran-Turan region, *Halostachys belangeriana* (Moq.) Botsch. (monotypic genus) in Iran-Turan, and representatives of the oligotypic genus *Kalidium caspicum* (L.) Ung in Central Asia; *Ammothamnus lehmannii* Bunge ex Boiss (Fabaceae), *Dodartia orientalis* L. (monotypic genus of Scrophulariaceae) both in Iran-Turan, and *Prangos* J. Lindley in the Mediterranean see basin and the western and Central Asia.

When looking at the types of activities reported for representatives from a particular family, the family Asteraceae contained the largest number, followed by the Lamiaceae, Fabaceae, Apiaceae, Boraginaceae, Ranunculaceae (see **Table 2**). The order of families with maximum number of activities overlaps to some degree with the summary by Medvedeva (1996). L. I. Medvedeva reviewed "Plant Resources of USSR" (the last, i.e. 9th volume was published in 1996) in which 7500 species were characterized of 21,770 species in the former Soviet Union territory. This "Reference Book" was the result of analysis of more than 31,000 scientific publications concerning the chemical composition and recourses of plants growing in the USSR territory. Of them, 3000 species had a description for chemical components and useful properties; others had only a chemical characterization, while only 400 species had useful properties listed. 25,000 individual substances were referenced. One of the possible reasons for the overlap in the lists of families with maximum activities is probably that numerous species are common for both Kazakhstan and USSR territories. On the other hand the order of Kazakhstan families mentioned above does not correspond to the descending order of percentage of species in particular families in Kazakhstan (compare **Tables 1** and **2**). In the families with a high representation of worldwide flora in Kazakhstan, namely Alliaceae (20%), Polygonaceae (about 18%), Chenopodiaceae (17%), Caryophyllaceae (14%), Zygophylaceae (13%) and Brassicaceae (11%) (see **Table 1**), not so many activities were cited.

More species from Kazakhstan floral families were determined to have antibacterial activity than for any other activity reported. This level of activity was followed by antiprotozoal, fungicidal and insecticidal activities with all of them being well represented. Although the maximum number of species in a particular family with fungicidal activity was in the family Asteraceae, the percentage of species within families containing this activity was maximum in the family Apiaceae (10%) followed by Lamiaceae (8%) and Rosaceae (7.5%) (see **Table 3**). For insecticidal activity, the percentage of species within families containing this activity was maximum in the family Scrophulariaceae (more then 6%) followed by Ranunculaceae and Apiaceae (about 5% each). Not many species with a narrow habitat can be enumerated, e.g. Asteraceae genus *Amberboa* (Pers.) Less., a representative with fungicidal and antibacterial activity spread over western Asia, in the Iran-Turan region; *Ancanthia* DC. with antitumor activity found in western Iran-Turan and Siberia; *Chartolepis* Boiss with antibacterial activity present in Caucasus, Iran-Turan; *Pseudohandelia* Tzvl. with antihelmintic activity, in Middle Asia; *Stizolophus* Cass. with antibacterial and antifungal activity, in western and Middle Asia; representative of genus *Trachelanthus* G. Kunze (Boraginaceae) with antitrichomanadae activity, in Pamirs-Alai, Tien-Shan; Cariophylaceae genus *Allochrusa* Bunge with insecticidal and antibacterial activity, in Iran-Turan; Chenopodiaceae genus *Anabasis* L. with insecticidal activity, mainly in Iran-Turan; *Kalidium* Mog. with insecticidal activity, in Middle Asia; Lamiaceae genus *Phlomis* L. with antibacterial, antiamebaeoidal, antiprotozoal, and growth inhibitory activity mainly in Iran-Turan; *Perovskia* Kar. with antibacterial, antiprotozoal activity, in Iran, Middle Asia and western Tibet.

An analysis of the scientific literature and inventory of the Kazakhstan flora for identifying biological activities resulted in a wealth of information regarding some individual chemical constituents for more than 1700 species. Representatives of the Kazakhstan flora were analyzed for availability of secondary metabolites, particularly alkaloids, glycosides, saponins, flavonoids, coumarins, and tanning agents (Mikhailova 1972; Mikhailova 1975; Demidovskaja 1976). Thus of 200 species analyzed 24 in that number *Juniperus sabina* L., *J. semiglobosa* Rgl., *J. serawschanica* Kom., *J. turkestanica* Kom., *Ferula dschaudshamyr* Eug. Kor., *F. akitschkeni* B. Fedtsch. ex K.-Pol., *Artemisia sublessingiana* (Kell.) Krasch. ex Poljak, *A. palisticha* Poljak, *A. halophila* Krasch, *A. leucodes* Schrenk, *A. terrae-albae* Krasch, and *A. transiliensis* Poljak had essential oil quantities ranging from 0.5 to 2.5 ml/100 g. In another investigation of about 70 species a high level of essential oils was found in *Scabiosa ochroleucosa* L. (Dipsacaceae), *Bupleurum* spp. (Apiaceae), *Hedisarum semenovii* Rgl. et Herd (Fabaceae), *Asparagus soongoricus* Iljin, *A. neglectus* Kar. et Kir (Liliaceae) and *Helichrysum maracanticum* M.Pop. The level of extracted essential oil depended not only on the species studied and the organs used, but also the conditions of plants' habitats (Egeubaeva 2002). This author noted that of about 300 analyzed species more essential oil species occurred in Apiaceae (79), Asteraceae (71), and Lamiaceae (41) families.

The greatest compositional variation of coumarins was found in representatives of the Apiaceae: *Tetrataenium ol-*

gae (Rgl. et Schmalh.) Manden, *Heracleum dissectum* Ledeb., *H. sibiricum* L., *Malabaila graveolens* (M.B.) Hoffm., *Zosima orientalis* Hoffm. A high level of flavonoids was noted in *Euphorbia lamprocarpa* Prokh., *E. jaxartica* Prokh., *E. alatavica* Boiss. (Euphorbiaceae), *Hymenolyma bupleoides* (Schrenk.) Korov. and *Bupleum* spp. (Apiaceae), *Lonicera karelii* Bge. (Caprifoliaceae).

Unfortunately, the scientific activity within Kazakhstan, during the 1980s and 1990s decreased for political and economic reasons. In the last decade the situation has been changing both due to the Government's financial support and international cooperation. Thus biological activities and corresponding compounds of essential oils, alkaloids have been revealed in endemic Kazakhstan species (Adekenov 2007). The composition of essential oils of the Asteraceae family representatives, namely *Artemisia glabella* Kar. et Kir., endemic *A. filatovae* A. Kupr, endemic *A. tomentella* Trautv., endemic *A. cina*, *A. Tournefortiana* Rchb, Middle Asian endemic *A. leucodes* Schrenk, endemic *A. albicerata* Krasch., endemic *A. quinqueloba* Trautv., endemic *Tanacetum ulutavicum* Tzvel., endemic *Tanacetum scopulorum* (Krasch.) Tzvel.; Middle Asian endemic *Lachnophyllum gossipinum* Bunge; *Ajania Poljak*, *Ajania fruticulosa* (Ledeb.) Poljak, *Rhaponticum serratuloides* Georgi) Bobr, *Achillea nobilis*, *Stizolophus balsamita* (Lam) Cass ex Takht, *Centaurea scabiosa* L., endemic *Hyssopus macranthus* Boriss, *Lagochilus diacanthophyllus* (Pall.) Benth. (Lamiaceae) were investigated to identify individual sesquiterpenes. Biological screening of individual sesquiterpenes and those derivatives (chemical modifications) for fungicidal, antibacterial, antituberculosis, antiinflammatory and immunomodulating activities was carried out. It was shown that essential oil from *Artemisia filatovae* inhibited tuberculosis strains tested; essential oil from *A. tomentella* possessed strong antimicrobial activity against Gram-positive and -negative bacteria and from *A. cina* antidermatomycotic activity. On the basis of the sesquiterpene lactones' activity *Achillea millefolium*, *A. nobilis*, *Ajania fruticulosa*, *Artemisia siversiana* Willd, *A. filatovae*, *Inula helenium* L., *I. caspica* Blume, *Pulicaria prostrata* (Gilib.) Aschers, and *Tanacetum vulgare* L. were selected (of 109 Asteraceae spp.) as perspective ones for antifeedant and repellent activities. Alkaloids from *Delphinium elatum* L. and *Aconitum anthoroideum* DC. (Ranunculaceae). possessed antibacterial activity, *A. leucostomum* Worosch., *A. villosum* Reichenb., *A. monticola* Steinb., *A. anthoroideum*, *D. elatum*, *D. ilinense* Huth cytotoxic activity.

Six species of *Rumex* L.genus, and 7 spp. of *Polygonum* L. (Polygonaceae), 16 species of *Sedum* L. and *Pseudosedum* (Boiss.) Berger (Crassulaceae), 2 spp. of *Marrubium* L. (Lamiaceae), 2 spp. of *Patrinia* Juss. (Valerianaceae), *Bryonia alba* L. (Cucurbitaceae), 3 spp. of *Suaeda* Forssk. ex Scop. (Chenopodiaceae) and 3 spp. of Tamaricaceae were studied for their chemical composition and chemical modifications. 25 of the chemical modifications have yet to be placed in clinical tests for antitumour, radiomodulating, fungicidal, insecticidal, growth regulating, anti-inflammatory activities (Musichkina *et al*. 2007).

As an example of international cooperation, we can single out the join Project of the Institute of Plant Biology and Biotechnology (with invited coworkers from the Institute of Botany and Phytointroduction, Kazakhstan) and USDA, USA, supported by the USA. Screening of crude extracts of the aerial parts of *Haplophyllum sieversii* against *Colletotrichum fragariae*, *C. gloeosporioides*, *C. acutatum*, *Botrytis cinerea*, *Fusarium oxysporum*, and *Phomopsis obscurans* indicated the presence of growth inhibitory components against *C. fragariae*, *C. gloeosporioides*, and *C. acutatum* (Cantrell *et al.* 2005). Fractionation was directed using bioautographical methods resulting in the isolation of the bioactive alkaloids flindersine, anhydroevoxine, haplamine, and a lignan eudesmin. These four compounds were evaluated for activity against *C. fragariae*, *C. gloeosporioides*, *C. acutatum*, *Botrytis cinerea*, *Fusarium oxysporum*, and *Phomopsis obscurans* in a dose-response growth-inhibitory bioassay. Of the four compounds tested, flindersine demonstrated the highest level of antifungal activity. Additionally, flindersine, eudesmin, and haplamine were screened against the freshwater phytoplanktons *Oscillatoria perornata*, *O. agardhii*, *Selenastrum capricornutum*, and *Pseudanabaena* sp. (strain LW397). Haplamine demonstrated selective inhibition against the odor-producing cyanobacterium *O. perornata* compared to activity against the green alga *S. capricornutum*, with lowest-observed-effect concentration values of 1.0 and 10.0 μM, respectively. Over 220 crude extracts from 45 plant species collected in various regions throughout both Greece and Kazakhstan were evaluated for termiticidal activity against *Coptotermes formosanus* Shiraki (Fokialakis *et al.* 2006). The objective of the study was to identify novel, natural chemotypes from biologically active crude plant extracts that may be useful as part of termite treatment regimens in their natural form or as synthons for structure-activity studies in the future. Extracts from two Greek species (*Echinops ritro* L., growing in Kazakhstan also and *E. spinosissimus* Turra subsp. *Spinosissimus*) and extracts from two Kazkhstan species (*Echinops albicaulis* Kar. et Kir. and *E. transiliensis* Golosk.) were active. Fractionation and isolation of constituents from the most active extracts from each of the four species has been completed resulting in the isolation of eight thiophenes possessing varying degrees of termiticidal activity. However, a comparison of the activity for isolated thiophenes to synthetic insecticides showed the need for a much higher (100-fold) concentration of the isolated thiophenes for 100% mortality of termites.

Ninety-two extracts of 23 species representing Kazakhstan flora have been investigated for their phytotoxic, antialgal, and antifungal activities (Kobaisy *et al.* 2006). *Verbascum songaricum* Schrenk ex Fisch. et C.A. Mey extracts had algicidal activity against *Oscillatoria perrornata* Sluja and *Selenastrurm capricornutum* Printz. Extracts from *Nepeta pannonica* L. (Lamiaceae) showed strong phytotoxic activity to bentgrass and lettuce, extracts from *Artemisia terae-albae* Krasch, *Geranium colinum* Steph. ex Willd., *Haplophyllum Sieversii* Fisch. et Mey., and *Tamarix arceuthoides* Bunge were phytotoxic to bentgrass. Extracts of *Aconitum leucostomum* Worosch., *Delphinium semibarbatum* Bienert ex Boiss., *Eremurus inderiensis* (Stev.) Regel and *E. fuscus*Vved. ex [E.Nikit.] (Asphodelaceae), *Ferula leiophylla* Korov., *Geranium collinum*, *Haplophyllum Sieversii* Fish et Mey Kar. et Kir., *Iris songarica* Schrenk, *Juniperus pseudosabina* Fisch. et C.A. Mey. (Cupressaceae), and *Verbascum songaricum* were found to have antifungal activity against one or more of pathogenic fungi *Colletotrichum accutatum*, *C. fragarie* and *C. gloesporioides*.

Screening over 70 crude plant extracts from 17 separate species primarily from Kazakhstan evaluated extracts from *Limonium myrianthum* (Schrenk) O. Kuntze and *Inula helenium* L. both demonstrating selective inhibition against the odor-producing cyanobacterium *O. perornata* compared to activity against the green alga *S. capricornutum* (Cantrell *et al.* 2007). Bioassay-guided fractionation of the *L. myrianthum* dichloromethane extract resulted in the identification of nepodin, torachrysone, chrysophanol, and physcion. Nepodin demonstrated the desired selective inhibition with lowest-complete-inhibition concentration values of 100 μg/mL and >100 μg/mL towards *O. perornata* and *S. Capricornutum*, respectively. Similarly, chrysophanol also demonstrated the desired selective inhibition with lowest-complete inhibition concentration values of 10 μg/mL and >100 μg/mL, respectively. Bioassay-guided fractionation of the *I. helenium* hexane extract resulted in the isolation of alantolactone, isoalantolactone, and 11αH,13-dihydroisoalantolactone. Activities of these three isolated constituents as well as those of synthetic isomers were evaluated.

CONCLUSION

One of the primary reasons for the collection and analysis of data concerning the use of Kazakhstan floral representtatives is to aid further studies of the Kazakhstan flora. Screening for biological activities and corresponding plant metabolite investigations (for example, antitumor, immuno-modulating, anti-inflammatory, antidiabetic, antituberculosis, antiallergic, allelochemic, antioxidant, etc.) have been hindered in Kazakhstan because of very poor financing after the collapse of the Soviet Union. As the education and knowledge around these new activities has increased in Kazakhstan, the profound investigations of flora for these activities will soon follow.

At present, it is necessary to urgently analyze Kazakhstan flora with a focus on those representatives characteristic of Kazakhstan that reveal useful biological activities and subsequently to isolate secondary metabolites causing these activities. Despite the previous success in conservation of Kazakhstan plant diversity by traditional ways (see Ivashenko *et al*. 2006) this analysis would also be useful for outlining the representatives to conserve the biological heritage of the region. Analyzing the above-mentioned data we tried to outline the families which should be the subject for more thorough investigations. In our opinion, certain circumstances should be carefully considered with the first being that the flora of Kazakhstan represents a certain portion of the worldwide flora. Based on a floristic comparative analysis of the "incomplete" flora of any natural region of the world (Kamelin 1990) representatives of some world floral families are absent in the Kazakhstan completely, as to others, a considerable part of the species of some families grow in this territory. This is why in the Kazakhstan territory, a considerable representation of world flora can be seen in the Tamaricaceae, Alliaceae, Polygonaceae, Chenopodiaceae Cariophylaceae, and Zygophylaceae families (see **Table 1**, % of total family species worldwide). According to Kazakhstan's scientific issues just in these families there were only a few types of biological activities revealed. On the other hand, taking into account that Kazakhstan is the part of the Iran-Turan floristic region, it is even more important to start a work in the future with the representatives of endemic genera of families, including high numbers of those, for instance Chenopodiaceae (more than 80% endemic genera of the Iran-Turan region), Boraginaceae (about 60%), Lamiaceae (about 60%), Asteraceae (about 55%), Brassicaceae (more 40%), Cariophylaceae (about 30%), and Appiaceae (about 25%) (see **Table 1**). All the more that, for instance in Asteraceae, Lamiaceae, Boraginaceae more types of biological activities has yet been reported.

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REFERENCES

* In Russian

Abdulina SA (1999) *Checklist of Vascular Plants of Kazakhstan*, Almaty, 187 pp*

Adekenov SM (2007) New biological active compounds in endemic plants of Kazakhstan. In: *Materials of II International Conference on Natural Products: Chemistry, Technology and Medicinal Perspectives*, Almaty, pp 30-41*

Baitenov MS (1985) *In the World of Rare Plants*, "Kainar", Alma-Ata, 176 pp*

Baitenov MS (2001) *Flora of Kazakhstan. Genus Complex of Flora* (Vol 2) "Gylym", Almaty, 279 pp*

Beklemishev ND (Ed) (1999) *Guidelines for Work with Medicinal Plants*, "Dary-Darmek", Almaty, 232 pp*

Bikov BK (Ed) (1981) *Red Data Book of Kazakh SSR. Rare and Endangered Species of Animals and Plants. Part 2. Plants*, "Nauka", Alma-Ata, 260 pp*

Budantsev AL, Lesiovskaja EE (Eds) (2001) *Wild Useful Plants of Russia* "St-PChPhA" St-Petersburg, 663 pp*

Cantrell CL, Schrader K, Mamonov L, Sitpaeva G, Kustova T, Dunbar C, Wedge D (2005) Isolation and identification of antifungal and antialgal alkaloids from *Haplophyllum sieversii. Journal of Agricultural and Food Chemistry* **53**, 7741-7748

Cantrell CL, Mamonov LK, Ryabushkina NA, Kustova TS, Fischer NH, Schrader KK (2007) Bioassay-guided isolation of anti-algal constituents from *Inula helenium* and *Limonium myrianthum. ARKIVOC* (vii), 65-75

Chikov PS (2002) *Medicinal Plants*, "Medicina", Moscow, 496 pp*

Demidovskaja LF (Ed) (1976) *New Medicinal and Essential Oil Plants of Kazakhstan* "Nauka", Alma-Ata, 212 pp*

Egeubaeva RA (2002) *Wild Essential Oil Plants of South-East Kazakhstan*, "Gylym", Almaty, 241 pp*

Fedorov AA, Sokolov PD (Eds) *Plant Resources of USSR* (1984/1985, 1986, 1987, 1988, 1990, 1991, 1993) 7 Volumes, "Nauka", Leningrad, 460, 460, 326, 357, 326, 198, 350 pp*

Fokialakis N, Osbrink W, Mamonov L, Gemejieva N, Mims A, Skaltsounis A, Lax A, Cantrell CL (2006) Antifeedant and toxicity effect of thiophenes from four echinops species against the formosan subterranean termite, *Coptotermes formosanus*. *Pest Management Science* **62**, 832-838

Goloskokov VP (Ed) (1969, 1972) *Illustrated Key Book of Kazakhstan Plants* V **1**, V **2**, "Nauka" Alma-Ata, 644, 572 pp*

Ivashenko AA, Grudzinskaya LM, Gemedzhieva NG, Teixeira da Silva JA, Ryabushkina NA (2006) Genetic resources of Kazakhstan flora: Experience, basic targets and methods for conservation of flowering plants. In: Teixeira da Silva JA (Ed) *Floriculture, Ornamental and Plant Biotechnology: Advances and Topical Issues* (Vol I), Global Science Books, Isleworth, UK, pp 583-588

Kamelin RV (1990) *Flora of Syrdariinsky Karatau*, "Nauka", Leningrad, 144 pp*

Khalmatov KhKh, Kharlamov IA, Mavlankulova ZI (1998) *Medicinal Plants of the Soviet Middle Asia*, Tashkent, 196 pp

Kobaisy M, Tellez MR, Schrader KK, Wedege DE, Sitpaeva GT, Gemedjieva NG, Mukanova GS, and Mamonov LK (2006) Phytotoxic, antialgal, and antifungal activity of constituents from selected plants of Kazakhstan. In: Rimando AM, Duke SO (Eds) *Natural Products for Pest Management*, American Chemical Society, Oxford University Press, 142-151 pp

Koukenov MK (Ed) (1994) *Atlas of Natural Habitat and Resources of Medicinal Plants of Kazakhstan*, "Gylym", Almaty, 166 pp*

Koukenov MK (Ed) (1996) *Medicinal Plants of Kazakhstan and their Use*, "Gylym", Almaty, 343 pp*

Koukenov MK (1999) *Botanical Resources History of Kazakhstan*, "Gylym", Almaty, 199 pp*

Medvedeva LI (1996) Condition of a Level Scrutiny of Flora of Russia and The adjacent States (According to the Directory "Plant Resources of USSR V. 1-7, Plant Resources of Russia and The adjacent States. Vols 8-9, 1984-1996). In: *Materials of Scientific Conference for Botanical Resources Study*, St. Petersburg, pp 6-11*

Mikhaylova VP (Ed) (1965) *Technical Plants of Kazakhstan and their use* "Nauka", Alma-Ata, 285 pp*

Mikhailova VP (Ed) (1972) *Medicinal Plants of Kazakhstan* "Nauka" Alma-Ata, 118 pp*

Mikhaylova VP (Ed) (1975) *Wild technical and Medicinal Plants of Kazakhstan* "Nauka"Alma-Ata, 212 pp*

Musichkina RA, Korulkin DJu, Abilov JA (2007) Kazakhstan' plants are perspective source for biological active substances and preparations. In: *Materials of II International Conference on Natural Products: Chemistry, Technology and Medicinal Perspectives*, Almaty, pp 64-73*

Pavlov NV (1935) *Dying Plants of Karatau*, Proceedings of Middle Asia Statement University. S. VIII-b. Tashkent, Issue 19, 44 pp*

Pavlov NV (1937) Rubber-containing Plants of west Tien-Shan. *Proceedings of Applied Genetics and Selection. Systematics, Ecology and Geography of Plants*, Leningrad, issue 1, pp 255-302*

Pavlov NV (1943) *Wild Adible Plants in Neighbourhood of Alma-Ata*, "Kaz. Brabch of AS of USSR" Alma-Ata, 28 pp*

Pavlov NV (1947) *Plant Raw Material of Kazakhstan*, "Academy of Science USSR", Moscow-Leningrad, 552 pp*

Pavlov NV (Ed) *Kazakhstan Flora* (1956, 1958, 1960, 1961, 1961, 1963, 1964, 1965, 1966). 9 Volumes, "Nauka", Alma-Ata, pp 354, 292, 460, 548, 515, 465, 497, 447, 640*

Rachkovskaya EI, Volkova EA, Khramtsov VN (Eds) (2003) *Botanical Geography of Kazakhstan and Middle Asia (Desert region)*, Saint Petersburg, 423 pp (in Russian and in English)

Sinitsin GS (1982) *New Medicinal Plants of Kazakhstan*, "Nauka" Alma-Ata, 127 pp*

Sokolov PD, Boudantsev AL (Eds) *Plant Resources of Russia and the Adjacent States* (1994, 1996). V 8, V 9, "Nauka", S-Petersburg, 271, 571 pp*

Takhtadzhian AL (1978) *The Floristic Regions of the World*, "Nauka", Leningrad, 247 pp*

Takhtadzhian AL, Crovello ThJ, Cronquist A (1986) *Floristic Regions of the World*, University of California Press, Berkeley, 522 pp

Weber WA (2003) The Middle Asian Element in the Southern Rocky Mountain Flora of the western United States: a critical biogeographical review. *Journal of Biogeography* **30**, 649-685