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Systematic analysis of flora of Atyrau city

Abstract: Currently, a great deal of attention is attracted to the study of regional flora as part of the solution to the problem of the study and conservation of biodiversity. Complete information on the composition of the flora of a particular region is important; it allows to establish the structure and genesis of its components, identify individual characteristics, restore the history of formation and trends. Therefore, the study of the flora of any region will always be relevant. The most important qualitative indicator of the flora it is a systematic structure. This article presents the results of a study obtained during a systematic analysis of the flora of Atyrau. It was revealed that the flora of the study area includes 27 families, of which 10 leading families make up 73.4% of the total species composition. The leading families in this taxonomic composition are the following families: *Chenopodiaceae* (90 species, 26 genera), *Asteraceae* (70 species, 32 genera), *Poaceae* (55 species, 30 genera). Dominant genera are: *Artemisia*, *Astragalus*, *Salsola*. Endemic species in the city of Atyrau revealed – 8, rare species – 6. Flora was studied using geobotanical and floristic research methods, the main of which was route-reconnaissance. Based on the analysis of literature data, viewing the herbarium of KazNU, materials collected in the framework of the scientific and technical program 0200/PTF14 on the topic: “Risk assessment of the impact of anthropogenic impact on the population of the Kazakhstan part of the Caspian region”, as well as their own research on the study and collection of plants in Atyrau, a list of flora has been compiled, including 534 species belonging to 243 genera and 57 families.

Key words: flora, Atyrau city, systematic analysis, plant biodiversity, taxonomic composition, floristic spectrum.

Introduction

Under the conditions of a constantly growing anthropogenic impact on nature, one of the most pressing environmental problems is the conservation of biodiversity as an important factor in the stable functioning of the biosphere and the development of human society. At present, a lot of attention is paid to the problem of conservation of biological diversity; it is put forward as a priority. At the present stage of the development of society, when a person involves in production all new natural objects and territories, a comprehensive study of regional flora is of great importance. Full information about the composition of the flora of a particular region is important as it allows establishing the structure and genesis of its components, identification of individual characteristics, restoration

of the history of formation and trends of change. Therefore, the study of the flora of any region will always be relevant [1-5].

In this work, an analysis of the flora of the city of Atyrau is carried out, which is subject to increased anthropogenic impact on the environment, which leads to a deterioration in the quality of the natural environment, and in the long run is the reason for the reduction of biodiversity [6-9].

Atyrau is the administrative center of the Atyrau region. The city is better known to the general public as the “oil capital” of the Republic of Kazakhstan. The climate of Atyrau is sharply continental, arid. Summer is dry, long, hot; winter is not snowy, cold. The average temperature in January is 8-11 °C, in July +24 +25 °C. Annual snowfall is 100-200 mm. The major rivers flowing through the territory of the region are the Urals (total length 2534 km, within

Kazakhstan 1084 km), Emba (712 km), Sagyz (511 km), Oyyl (800 km). The large lake of the region is Inder (110.5 sq. Km). The soil cover of the territory is very diverse, due to the diverse conditions of soil formation and the history of formation. The desert zone is divided into subzones of the northern desert and brown soils into the subzone of the southern desert with gray-brown soils. The northeastern part belongs to the desert-steppe zone with light chestnut soils. A distinctive feature of the vegetation cover is its spatial heterogeneity. Among the leading factors determining the spatial distribution of vegetation are moistening conditions, salinity, soil composition and topography [9]. Currently, the city of Atyrau has been surrounded by industrial enterprises with a large number of harmful substances. Within the city are: Atyrau oil refinery, Atyrau Heat and Power Plant, washing station "PPS Oil Trade", oil depot LLP "Caspiypromstroy real estate" (KPSN), New oil depot, LLP "Akzhayyk-7" (repair and washing of railway rolling stock), oil depot in Shirina village, Asphalt plant, solid waste landfill, Atyrau oil pipeline department, Caspian pipeline consortium, Bolashak complex oil and gas treatment unit. Flora analysis plays a key role in solving the problems of biodiversity conservation in various regions. The work of both domestic and foreign authors is devoted to this problem: Mukhitdinov N.M. [10], Dimieva L.A. [11], Inelova Z.A. [12; 13], Ogar N.P. [14], Ivashchenko A.A. [15], Ganeshaiyah K.N. [16], Conti F. [17], Sivtceva-Maksimova P.S. [18], Ivanov A.L. [19].

A systematic analysis is necessary to identify the taxonomic structure of the flora. This analysis determines the hierarchical sequence of taxa of the rank of family and genus, which refers to the specific features of this flora, shows its difference from other flora, and also determines the affiliation of the flora to large phytochorions of the globe. From this point of view, the systematic structure of the flora. Thus, the aim of this work was to conduct a systematic analysis of Atyrau, one of the most developed industrial centers, to take measures to preserve the biological diversity of Kazakhstan.

Materials and methods

The material of the studies was the herbarium material of the Department of Biodiversity and

Bioresources of the Kazakh National University named after al-Farabi, materials collected during the period of 2014-2017 in the framework of the scientific and technical program 0200/PTF14 on the topic: "Risk assessment of the impact of anthropogenic impact on the population of the Kazakhstan part of the Caspian region", and own collection of species composition conducted during the period of 2018-2020.

In the field, a classical methods of floristic and geobotanical research are used [20]. The main method of investigation was route-reconnaissance, the essence of which was to identify the main patterns of distribution of species composition and vegetation in the study area.

Before starting work, a route was laid according to which studies were conducted. During the route, a geobotanical description of vegetation was carried out in separate, small areas, collection and herbarization of species, their entry in special forms. The route was planned in such a way that it passed through various phytocenoses, capturing a variety of habitats [21].

When determining the herbarium samples were used as sources of the "Flora of Kazakhstan volume 1-9" [22], "Illustrated determinant of plants of Kazakhstan volume 1-2" [23], the definition of families and genera was carried out with the help of "Flora of Kazakhstan" by M.S. Baitenov [24].

The location of species and supraspecific categories in the flora and floristic spectrum carried out according to the system of A. L. Takhtajan [25]. The spelling of Latin names, the nomenclatural changes of the taxa were verified in accordance with S. K. Cherepanov [26].

The rare and endemic species distribution was verified according to the Red Book of Kazakhstan [27].

Results and discussion

As a result of the analysis of the plant species composition, compiled on the basis of our own and published data [11; 14; 28], the flora of Atyrau includes 243 genera and 534 species from 57 families. The most important qualitative indicator of the flora is its systematic structure. Figure 1 presents the data on the systematic composition of families, genera, and species of flora in Atyrau.

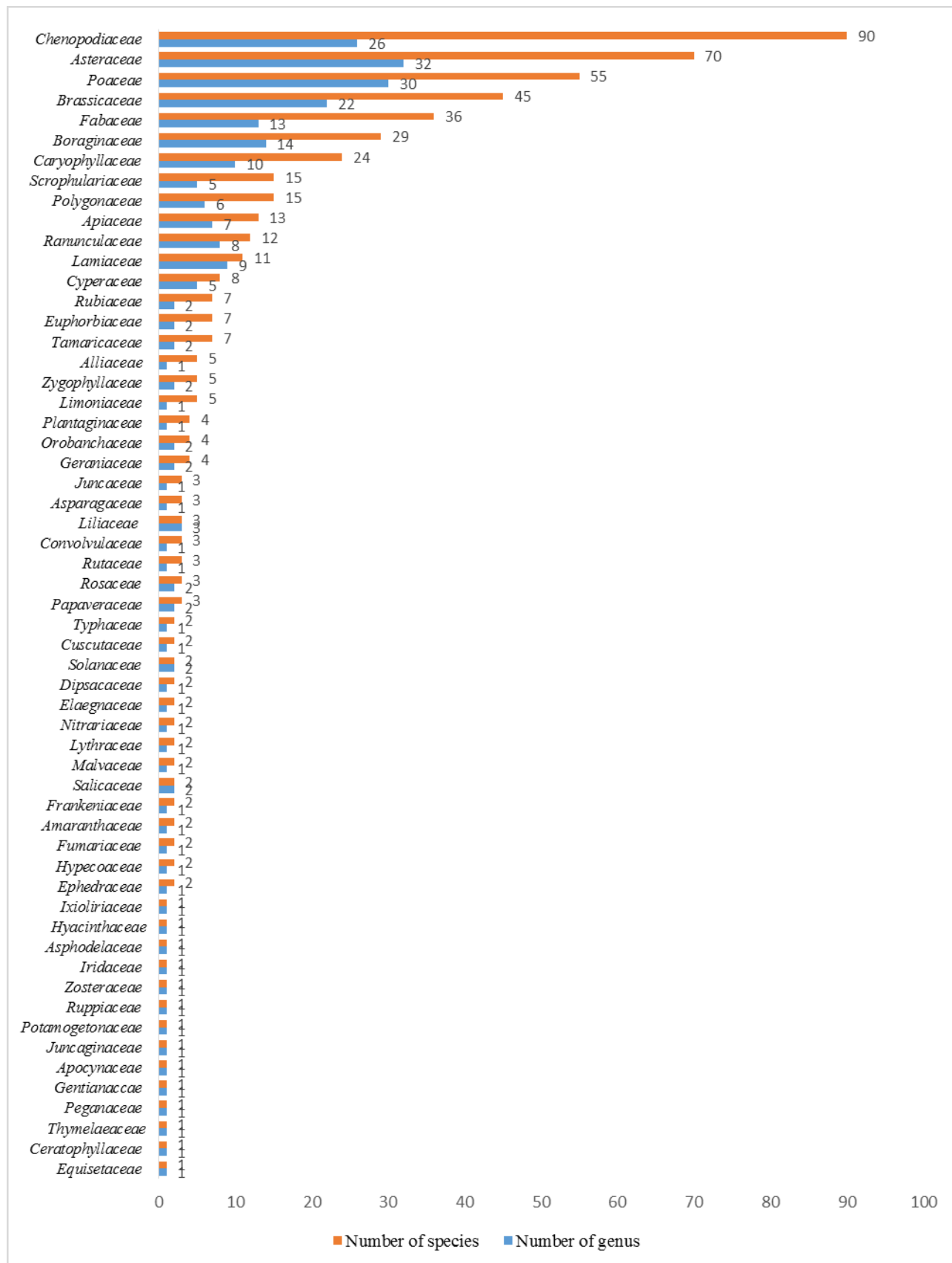


Figure 1 – Total taxonomic structure of flora of of Atyrau city

According to the Figure 1, a wealth of species families: *Asteraceae* Dumort. (32 genera: *Acantholepis*, *Acroptilon*, *Amberboa*, *Artemisia*, *Carthamus*, *Centaurea*, *Chondrilla*, *Cichorium*, *Cirsium*, *Cousinia*, *Echinops*, *Epilasia*, *Erigeron*, *Heteracia*, *Hyalea*, *Inula*, *Jurinea*, *Karelinia*, *Koelpinia*, *Lactuca*, *Mausolea*, *Microcephala*, *Onopordum*, *Rhaponticum*, *Scorzonera*, *Senecio*, *Serratula*, *Takhtajiantha*, *Tanacetum*, *Taraxacum*, *Tragopogon*, *Xanthium*), *Chenopodiaceae* Vent. (26 genera: *Agriophyllum*, *Anabasis*, *Atriplex*, *Bassia*, *Camphorosma*, *Ceratocarpus*, *Chenopodium*, *Climacoptera*, *Corispermum*, *Girgensohnia*, *Halimocnemis*, *Halocnemum*, *Halogeton*, *Halopeplis*, *Halostachys*, *Halothamnus*, *Haloxylon*, *Horaninovia*, *Kalidium*, *Kirilowia*, *Kochia*, *Nanophyton*, *Petrosimonia*, *Salicornia*, *Salsola*, *Suaeda*), *Poaceae* Barahart (30 genera: *Achnatherum*, *Aeluropus*, *Agropyron*, *Alopecurus*, *Anisantha*, *Bromus*, *Calamagrostis*, *Catabrosella*, *Crypsis*, *Cynodon*, *Echinochloa*, *Elymus*, *Elytrigia*, *Eragrostis*, *Eremopyrum*, *Festuca*, *Hordeum*, *Leymus*, *Lolium*, *Melica*, *Phragmites*, *Poa*, *Polypogon*, *Psathyrostachys*, *Puccinellia*, *Secale*, *Setaria*, *Stipa*, *Stipagrostis*, *Trisetaria*), *Brassicaceae* Burnett (22 genera: *Alyssum*, *Arabidopsis*, *Barbarea*, *Camelina*, *Cardaria*, *Clypeola*, *Crambe*, *Cryptospora*, *Descurainia*, *Erysimum*, *Goldbachia*, *Hymenolobus*, *Lepidium*, *Leptaleum*, *Matthiola*, *Megacarpaea*, *Meniococus*, *Pachypterygium*, *Sisymbrium*, *Strigosella*, *Tauscheria*, *Tetracme*), *Boraginaceae* Juss (*Argusia*, *Arnebia*, *Asperugo*, *Cynoglossum*, *Gastrocotyle*, *Heterocaryum*, *Lappula*, *Lycopsis*, *Myosotis*, *Nonea*, *Paracaryum*, *Rindera*, *Rochelia*, *Suchtelenia*), *Faba-*

ceae Vent. (13 genera: *Alhagi*, *Ammodendron*, *As-tragalus*, *Caragana*, *Eremosparton*, *Ewersmannia*, *Glycyrrhiza*, *Halimodendron*, *Lathyrus*, *Medicago*, *Melilotus*, *Onobrychis*, *Trigonella*) achieved through generic diversity. However, the systematic structure of the flora of Atyrau is also characterized by the significant participation of single-species families: *Equisetaceae* Rich. ex DC. (*Equisetum ramosissimum* Desf.), *Ceratophyllaceae* S.F. Gray (*Ceratophyllum demersum* L.), *Thymelaeaceae* Juss. (*Diarthron vesiculosum* (Fisch. and Mey. ex Kar. and Kir.) C.A. Mey.), *Peganaceae* (Engl.) Tiegh. ex Takht. (*Pegatum harmala* L.), *Gentianaceae* Juss (*Centaurium pulchellum* (Sw.) Druce), *Apocynaceae* Juss. (*Trachomitum scabrum* (Russan.) Pobed.), *Juncaginaceae* Rich. (*Triglochin palustre* L.), *Potamogetonaceae* Engl. (*Potamogeton pectinatus* L.), *Ruppiaceae* Hutch. (*Ruppia maritima* L.), *Zosteraceae* Dumort (*Zostera noltii* Hornem.), *Iridaceae* Juss. (*Iris tenuifolia* Pall.), *Asphodelaceae* Juss. (*Eremurus inderiensis* (Stev.) Regel), *Hyacinthaceae* Batsch (*Ornithogalum fischerianum* Krasch.), *Ixioliriaceae* Nakai (*Ixiolirion tataricum* (Pall.) Roem. and Schult.). The share of 15 single-species families accounts for only 2.62% of the total number of species. The presence in the flora of one – two-species families is always of great interest, because centers of their species diversity are found in other climatic regions.

The floristic spectrum of Atyrau city and the following systematic groups, presented in Table 1, shows that flowering plants were prevailing, while the horsetail and gymnosperms occupied the lowest share.

Table 1 – Distribution of plants of Atyrau city by the systematic groups

Systematic group	Number of families	Number of genus	Number of species	% of the total number of species
Horsetail	1	1	1	0.19
Gymnosperms	1	1	2	0.37
Angiosperms:				
- dicotyledonous	40	191	444	83.14
- monocotyledons	15	50	87	16.29
Total:	57	243	534	100

The species composition of the flora of Atyrau city is dominated by the divisions of *Magnoliophyta*, which accounts for 531 species (99.43%) and only a small number of species (3 or 0.56 %) belongs to *Pinophyta* and *Equisetophyta* (Figure 2).

The total number of dicotyledons in the flora of the study area includes 40 families (*Ceratophyllaceae* S.F. Gray., *Ranunculaceae* Juss., *Papaveraceae* Juss., *Hypocoaceae* (Dumort.) Willk., *Fumariaceae* D.C., *Caryophyllaceae* Juss., *Amaranthaceae* Juss.,

Chenopodiaceae Vent., *Polygonaceae* Juss., *Limoniaceae* Ser., *Tamaricaceae* Link, *Frankeniaceae* S.F. Gray, *Salicaceae* Mirbel, *Brassicaceae* Burnett, *Malvaceae* Juss., *Euphorbiaceae* Juss., *Thymelaeaceae* Juss., *Rosaceae* Juss., *Lythraceae* J. St.-Hil., *Fabaceae* Lindl., *Rutaceae* Juss., *Zygophyllaceae* Lindl., *Nitrariaceae* Bercht. et J. Presl., *Peganaceae* (Engl.) Tigh. ex Takht., *Geraniaceae* Juss., *Elaeagnaceae* Juss., *Apiaceae* Lindl., *Dipsacaceae* Juss., *Rubiaceae* Juss., *Gentianaceae* Juss., *Apocynaceae* Juss., *Solanaceae* Juss., *Convolvulaceae* Juss., *Cuscutaceae* Dumort., *Boraginaceae* Juss., *Scrophulariaceae* Lindl., *Orobanchaceae* Vent., *Plantaginaceae* Lindl., *Lamiaceae* Lindl., *Asteraceae* Dumort.), containing 191 genera and 444 species, which is 83.14% of the

total number of species. Monocotyledons includes 15 families (*Juncaginaceae* Rich., *Potamogetonaceae* Engl., *Ruppiaceae* Hutch., *Zosteraceae* Dumort., *Iridaceae* Juss., *Liliaceae* Juss., *Alliaceae* J. Agardh., *Asphodelaceae* Juss., *Hyacinthaceae* Batsch, *Ixioliriacae* Nakai, *Asparagaceae* Juss., *Juncaceae* Juss., *Cyperaceae* Juss., *Poaceae* Barahart, *Typhaceae* Juss.) containing 50 genera and 87 species or 16.29% of the total species, the spore plants (*Equisetaceae* Rich. ex DC.) and gymnosperms (*Ephedraceae* Dumort.) – 3 species (0.56%).

There is a clear tendency in the ratio of the number of monocotyledonous and dicotyledonous genera towards increasing role of dicotyledonous, which is even more evident on the level of the families.

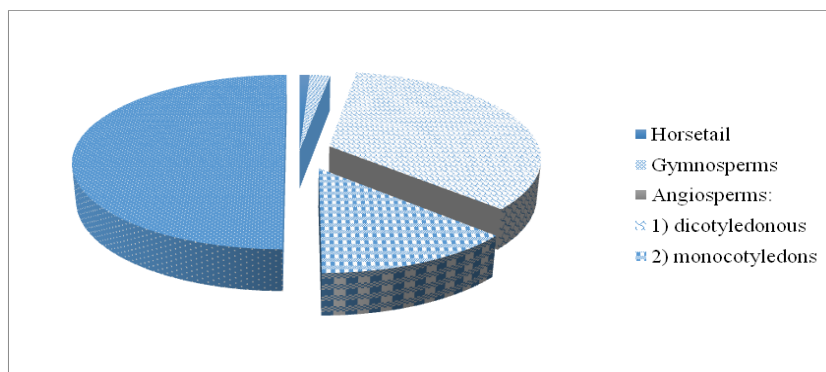


Figure 2 – Ratio of systematic groups of flora of Atyrau city

Accordingly, in the studied flora, most families, genera, and species are angiosperms, among which dicotyledons predominate.

On the territory of Atyrau city 57 families of plants were identified. Traditionally, in floristic works 10 large families of plants are considered in descending order of the number of species, which is called the family spectrum of flora. Analysis of the largest families of the flora of Atyrau city has allowed identifying the 10 largest families in the greatest number of species.

The first 10 families (*Chenopodiaceae*, *Asteraceae*, *Poaceae*, *Brassicaceae*, *Fabaceae*, *Boraginaceae*, *Caryophyllaceae*, *Polygonaceae*, *Scrophulariaceae*, *Apiaceae*) contain 392 species of plants, which is about 73.4% of the total number of species.

Figure 3 shows the spectrum of the 10 largest families in the flora of Atyrau city.

According to the data, the first place in the number of species and genera is occupied by the family

Chenopodiaceae (90 species, or 16.85 % of the total number of species, 26 genus), then the second place is occupied by the *Asteraceae* family (70 species or 13.11 %, 32 genus). The third place is occupied by the *Poaceae* family, which contains 30 genera, 55 species, or 10.3% of the total number of genera. This is followed by the family *Brassicaceae* – 45 species (8.43%), 22 genera. The family *Fabaceae* – 36 species (6.74 %), numbers of genus 13. *Boraginaceae* family contains 29 species (5.43%), 14 genera, *Caryophyllaceae* – 24 species (4.49%), 10 genera. This is followed by the families *Polygonaceae* and *Scrophulariaceae*, which contain the same number of species – 15 (2.81%), but a different number of genera – 6 and 5, respectively. In tenth place is the *Apiaceae* family with 13 species (2.43%) and 7 genera. The above 10 families include 73.4 % of the total species composition of the flora of the studied region. Other families are characterized by more low species and generic diversity.

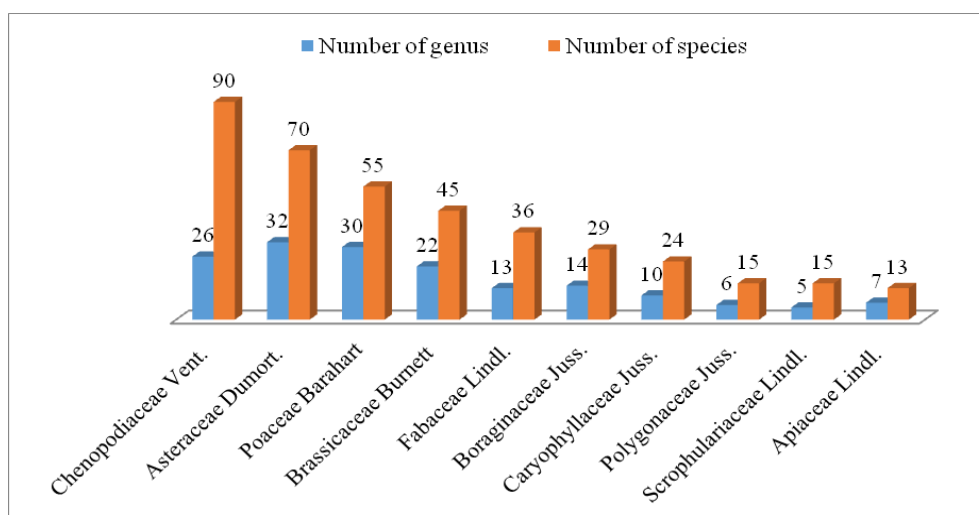


Figure 3 – Number of species and genera in 10 leading families of flora of Atyrau city

Table 2 provides information on the number of species for the largest genera of flora Atyrau city. The largest and largest genera mainly belong to the leading families of the studied flora (*Asteraceae*, *Fabaceae*, *Chenopodiaceae*). The species of these genera under appropriate environmental conditions create a common floral background.

Table 2 – Number of species in the largest genera of flora of Atyrau city

Genus	Number of species	% of the total number of species
<i>Artemisia</i>	16	3
<i>Astragalus</i>	14	2.62
<i>Salsola</i>	12	2.45
<i>Suaeda</i>	10	1.87
<i>Atriplex</i>	9	1.48
<i>Climacoptera</i>	8	1.5
<i>Anabasis</i>	7	1.31
<i>Tamarix</i>	6	1.12
<i>Gypsophila</i>	5	0.94
<i>Agropyron</i>	4	0.75
Total – 10	91	17.04

According to the data presented in the Table 2 the largest genera are *Artemisia* (16 species or 3%), *Astragalus* (14 species or 2.62 %), *Salsola* (12 species, 2.45 %), *Suaeda* (10 species or 1.87 %). Can also be noted by the number of species: *Atriplex* (9

species, 1.48 %), *Climacoptera* (8 species, 1.5 %), *Anabasis* (7 species, 1.31 %), *Tamarix* (6 species, 1.12 %), *Gypsophila* (5 species, 0.94 %), *Agropyron* (4 species, 0.75%).

Accordingly, for 10 genera (4.11 % of the total number of genera) 91 species of flora are present in Atyrau city. On the territory of Atyrau city 8 endemic and 6 rare species were identified. In the study area, the following plants are endemic species: *Atriplex pungens* Trautv., *Rubia cretaceae* Pojark., *Saponaria aspathulifolia* (Fenzl) Vved., *Gypsophila krascheninnikovii* Schischk., *Stemmacantha nitida* (Fisch.) M. Dittrich (= *Rhaponticum nitidum* Fisch., *Jurinea tenuiloba* Bunge, *Corispermum laxiflorum* Schrenk, *Suaeda kossinskyi* Iljin. The rare species: *Crambe tatarica* Sebeok, *Lepidium meyeri* Claus, *Rubia cretaceae* Pojark., *Linaria cretacea* Fisch. ex Spreng., *Tulipa biflora* Pall., *Ornithogalum fischeranum* Krasch.

Conclusion

Flora analysis plays a key role in solving the problems of biodiversity conservation in various regions. In accordance with the Convention on Biodiversity, the first step for conservation is an inventory of flora and natural plant resources, which is the foundation for the development of a scientifically based algorithm for the rational use of plant wealth.

On the basis of the literature review and analysis of the herbarium, collected within the framework of scientific and technical program 0200/PTF14 “Risk assessment of the impact of anthropogenic impact on the population of the Kazakhstan part of the Caspian region” and additional research on the study of

Atyrau flora, a list of plants has been compiled, including 534 species belonging to 243 genera and 57 families. The first ten leading families contain 392 species and make up 73.4% of the total species composition of the flora of the study area. The leading families in this taxonomic composition are *Chenopodiaceae* (90 species, or 16.85% of the total number of species, 26 genera), *Asteraceae* (70 species or 13.11%, 32 genera), *Poaceae* (55 species, which is 10.3% of the total, 30 genera). Dominant genera are *Artemisia* (16 species or 3%), *Astragalus* (14 species or 2.62%), *Salsola* (12 species or 2.25%). Endemic plants in the city of Atyrau revealed – 8 species, rare – 6 species.

The results of the research will serve as the basis for the rational use of flora and vegetation in Atyrau, as well as the conservation of biodiversity.

The data obtained as a result of the study can be used to compile a floristic summary of Atyrau, the analysis of which serves as the basis for recommendations on the protection of the plant gene pool, which under the conditions of increasing anthropogenic pressure will serve as material for long-term environmental monitoring of the ecosystems of the region.

The results of a systematic analysis of the flora of Atyrau allow us to identify centers of endemism and relictness, as well as to solve the issues of the place and role of this flora in a number of other adjacent flora.

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