

UDC 581.9  
AGRIS F40

<https://doi.org/10.33619/2414-2948/84/11>

## SYSTEMATIC STRUCTURE, BIOMORPHOLOGY AND GEOGRAPHICAL ANALYSIS OF THE FLORA OF GANJA CITY AND ITS SURROUNDINGS

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## СИСТЕМАТИЧЕСКАЯ СТРУКТУРА, БИОМОРФОЛОГИЯ И ГЕОГРАФИЧЕСКИЙ АНАЛИЗ ФЛОРЫ ГОРОДА ГЯНДЖА И ЕГО ОКРЕСТНОСТЕЙ

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*Abstract.* In the given article, the flora of Ganja city and its surrounding areas was studied, the plants were systematically, biomorphologically, geographically, ecologically, and endemically analyzed. The article also analyzed rare and endangered plants on scientific basis. In the researched region, 68 families, 244 genera, and 441 species of plants were identified. It is reported that the basis of the flora composition of the territories is angiosperms, the leading families of which are Poaceae with 38 genera (15.6%), 63 species (14.3%), Fabaceae 23 genera (9.4%), 48 species (10.9%); Asteraceae is represented by 15 genera (6.6%), 35 species (7.9%). It was determined that the composition of the flora of the study area is dominated by perennial grasses with 194 species (44%).

*Аннотация.* Изучена флора г. Гянджа и его окрестностей, проведен систематический, биоморфологический, географический, экологический и эндемический анализ растений. Также на научной основе проанализированы редкие и исчезающие растения. В районе исследований выявлено 68 семейств, 244 рода и 441 вид растений. Сообщается, что основу состава флоры составляют покрытосеменные растения, ведущими семействами которых являются Poaceae с 38 родами (15,6%), 63 видами (14,3%), Fabaceae 23 рода (9,4%), 48 видов (10,9%); Asteraceae представлен 15 родами (6,6%), 35 видами (7,9%). Установлено, что в составе флоры исследуемой территории преобладают многолетние травы, насчитывающие 194 вида (44%).

*Keywords:* flora, ecogeographical analysis, biological analysis, endemism.

*Ключевые слова:* флора, эколого-географический анализ, биологический анализ, эндемизм.

### *Introduction*

The city of Ganja and its surroundings belong to the semi-desert, dry steppe climate type with mild winters and hot summers. Soils belonging to this climate have been formed within the geographical boundaries of the area. Soils are irrigated, salty, ordinary gray-brown. In the areas around Ganja, the soil belongs to the chestnut soil type, and the amount of humus in the decay layer is not higher than 3% in these soils, and all layers are low in nitrogen and phosphorus, and rich in potassium and calcium. The research conducted on the vegetation cover of the ecologically polluted

areas of Ganja city showed that the zoning type of vegetation in the area is desert, semi-desert, meadow, steppe [1, p. 35].

In the study given to investigate the flora of the city of Ganja and its surroundings exposed to anthropogenic pressures, flora was monitored in the polluted areas around Ganja (within a radius of 10 km), its systematic structure, biomorphological analysis, geographical analysis, ecological analysis and endemism were determined.

#### *Material and Methods*

The object and materials of the research were the plants, bushes, trees, and the representatives of the cultural plants grown in these areas, such as wheat and corn. Characteristic plants were monitored on the basis of nearly 500 different herbarium materials collected from these areas. Generally accepted geobotanical methods [2-4] were used in the study of the modern vegetation of the area.

During the geobotanical investigations of the vegetation types of Ganja city and its surroundings, the biomorphological analysis of the life forms of the species was determined by referring to the scientific works of a number of botanical scientists [5, p. 146-202]. Biomorphological analysis of the research area by I. G. Serebryakova [6, p. 53-55; 5, p. 146-202] and Ch. Raunkiaer's [5, p. 148-154] classification was considered as the main criterion.

During the study, geographical types, areal classes and types of plants related to the flora of the area were determined by A. A. Grossheim [7, p. 234], Portenier [8, p. 76-84; 9, p. 26-33] and determined according to the last system [10, p. 71-73; 11, p. 23-25].

#### *Experiments and Their Results*

The flora and vegetation of Ganja city and surrounding areas (10 km) were investigated and monitored. The physical and chemical properties of the soils in these areas were studied. The climate of the research areas belongs to the temperate, hot, semi-desert, dry steppe climate type. This climate type is very poorly supplied with humidity, summer is very hot, the lowest temperature (+10 °C) occurs in January. Land belonging to the dry (subtropical) steppe bioclimatic zone was formed within the geographical boundary of the territory. Soils are irrigated, salty, ordinary gray-brown. Here there is a mixed terrain broken by shallow ravines. The basis of the water network in the area is the Goshgar river, Ganja River, Kurek river and their tributaries, which take their sources from separate peaks and slopes on the northeastern side of the Small Caucasus. Although these rivers have a constant flow of water in the high and medium mountainous area, they dry up when they enter the lowland zone. The terrain, climate, and humidity of the studied areas, as well as exposure to intense anthropogenic pressures, made it impossible for a rich plant flora to form in these areas.

Aluminum plant in Ganja city, iron ore metallurgical plant of Dashkasan, Bullur and car factories of Ganja, chemical industry are the main polluters of these areas. Environmental stress in these areas is also related to the intensity of agriculture. Too many pesticides, herbicides, fungicides and various fertilizers are applied to the soil every year. In addition, pastures have been completely destroyed and the structure of the soil has been destroyed in areas engaged in cattle breeding (Shamkir, Samukh cattle breeding). Ganja has a meat and dairy plant, confectionary and candy shops, flour milling and baking enterprises, and the population density is high. Due to the large population and the close connection of the surrounding cities and regions, the environmental pressure of the transport sector in the area is also high. Considering such a high environmental pressure in the surrounding areas of Ganja, we can say that the vegetation in the area is in danger of

disappearing. Taking these into account, the condition of flora and vegetation in these areas was first clarified in the experiments.

441 plant species belonging to 68 families and 244 genera were identified on the basis of the herbarium specimens collected during the research conducted in 2011-2018 in the city of Ganja and its surrounding areas based on the determinants and based on literature data [12, p. 35-39]. This is 8.8% of the flora of Azerbaijan (out of 5000 plant species), and 6.3% of the Caucasian flora (out of 7000 plant species).

Table 1

SYSTEMATIC STRUCTURE OF THE FLORA OF GANJA CITY AND ITS SURROUNDING AREAS

<i>Plant Groups</i>	<i>Families</i>		<i>Genera</i>		<i>Species</i>	
	<i>Number</i>	<i>According to the total number, in %</i>	<i>Number</i>	<i>According to the total number, in %</i>	<i>Number</i>	<i>According to the total number, in %</i>
Highspores	4	5.9	5	2	8	1.8
Gymnosperms (Gymnospermae)	3	4.4	4	1.6	8	1.8
Angiosperms (Angiospermae):	61	89.7	235	96.3	425	96.4
a) monocots	9	13.2	51	20.9	82	18.6
b) dicots	52	76.5	184	75.4	343	77.8
Total:	68	100	244	99.9	441	100

As can be seen from the Table 1, angiosperms (425 species 96.4%) form the basis of the flora composition of the city of Ganja and its surrounding areas.

Table 2

INDICATORS ACCORDING TO THE NUMBER OF MAIN FAMILIES, GENERA AND SPECIES IN THE FLORA OF GANJA CITY AND ITS SURROUNDING AREAS

<i>№</i>	<i>Families</i>	<i>Genera</i>		<i>Species</i>	
		<i>Number</i>	<i>According to the total number, in %</i>	<i>Number</i>	<i>According to the total number, in %</i>
1.	Polypodiaceae	1	0.41	1	0.22
2.	Athyriaceae	1	0.41	1	0.22
3.	Aspleniaceae	2	0.82	5	1.13
4.	Equisetaceae	1	0.41	1	0.22
5.	Pinaceae	1	0.41	3	0.67
6.	Cupressaceae	2	0.82	3	0.68
7.	Ephedraceae	1	0.41	2	0.45
8.	Typhaceae	1	0.41	2	0.45
9.	Potamogetonaceae	1	0.41	1	0.22
10.	Alismataceae	1	0.41	1	0.22
11.	Butomaceae	1	0.41	1	0.22
12.	Poaceae	38	15.6	63	14.3

№	Families	Genera		Species	
		Number	According to the total number, in %	Number	According to the total number, in %
13.	Cyperaceae	5	2.0	10	2.3
14.	Araceae	1	0.41	1	0.22
15.	Juncaceae	1	0.41	1	0.22
16.	Alliaceae	1	0.41	2	0.45
17.	Salicaceae	2	0.82	4	0.91
18.	Juglandaceae	1	0.41	1	0.22
19.	Celtidaceae	1	0.41	2	0.45
20.	Moraceae	2	0.82	3	0.68
21.	Polygonaceae	4	1.6	8	1.8
22.	Chenopodiaceae	7	2.9	14	3.2
23.	Amaranthaceae	1	0.41	1	0.22
24.	Caryophyllaceae	10	4.1	23	5.2
25.	Ceratophyllaceae	1	0.41	1	0.22
26.	Ranunculaceae	11	4.5	16	3.6
27.	Papaveraceae	4	1.6	9	2.0
28.	Brassicaceae	13	5.3	18	4.1
29.	Crassulaceae	2	0.82	4	0.91
30.	Saxifragaceae	1	0.41	2	0.45
31.	Parnassiaceae	1	0.41	1	0.22
32.	Grossulariaceae	2	0.82	3	0.68
33.	Plantanaceae	1	0.41	1	0.22
34.	Rosaceae	14	5.7	27	6.1
35.	Fabaceae	23	9.4	48	10.9
36.	Geraniaceae	1	0.41	2	0.45
37.	Peganaceae	1	0.41	1	0.22
38.	Euphorbiaceae	1	0.41	5	1.13
39.	Celastraceae	1	0.41	3	0.68
40.	Aceraceae	1	0.41	2	0.45
41.	Rhamnaceae	1	0.41	2	0.45
42.	Vitaceae	1	0.41	1	0.22
43.	Tiliaceae	1	0.41	2	0.45
44.	Malvaceae	4	1.6	7	1.6
45.	Hypericaceae	1	0.41	1	0.22
46.	Tamaricaceae	2	0.82	4	0.91
47.	Cistaceae	1	0.41	2	0.45
48.	Elaeagnaceae	1	0.41	1	0.22
49.	Apiaceae	4	1.6	8	1.8
50.	Cornaceae	2	0.82	2	0.45
51.	Plumbaginaceae	1	0.41	1	0.22
52.	Ebenaceae	1	0.41	2	0.45
53.	Gentianaceae	1	0.41	3	0.68
54.	Apocynaceae	1	0.41	1	0.22
55.	Convolvulaceae	1	0.41	4	0.91
56.	Cuscutaceae	1	0.41	2	0.45

№	Families	Genera		Species	
		Number	According to the total number, in %	Number	According to the total number, in %
57.	Boraginaceae	4	1.6	6	1.4
58.	Verbenaceae	1	0.41	2	0.45
59.	Lamiaceae	11	4.5	21	4.8
60.	Solanaceae	6	2.5	9	2.0
61.	Scrophulariaceae	4	1.6	9	2.0
62.	Plantaginaceae	1	0.41	4	0.91
63.	Sambucaceae	1	0.41	2	0.45
64.	Caprifoliaceae	1	0.41	3	0.67
65.	Valerianaceae	1	0.41	5	1.12
66.	Dipsacaceae	3	1.2	4	0.91
67.	Cucurbitaceae	1	0.41	1	0.22
68.	Asteraceae	15	6.6	35	7.9
<i>Total:</i>		<i>244</i>	<i>100</i>	<i>441</i>	<i>100</i>

The leading families of the flora of Ganja city and its surroundings (Table 2) Poaceae 38 genera (15.6%), 63 species (14.3%), Fabaceae 23 genera (9.4%), 48 species (10.9%); Asteraceae 15 genera (6.6%), 35 species (7.9%) Brassicaceae 13 genera (5.3%), 18 species (4.1%); Rosaceae 14 genera (5.7%), 27 species (6.1%); Lamiaceae 11 genera (4.5%), with 21 species (4.8%); Caryophyllaceae 10 genera (4.1%), with 23 species (5.1%); are represented. Other families consist of 1-5 genera and 1-9 species. Genera with a small number (*Juniperus* L., *Ephedra* Tourn. ex L., *Cynodon* Rich., *Bromus* L., *Hordeum* L., *Salsola* L., *Polygonum* L., *Salsola* L., *Cydonia* Tourn. ex Mill, *Peganum* L., *Tamarix* L.) are of great importance in the formation of vegetation type and aspect in the area where they are spread.

As can be seen from Table 3, the number of genera represented by the most species in the study area is 21, and the number of species is 95. This is 21.5% of the flora of Ganja city and its surrounding areas. Other species are united in 220 genera and make up 78.5% of the flora (346 species). Including *Astragalus* L. (6; 1.4%), *Artemisia* L. (6; 1.4%), *Poa* L. (5; 1.12%), *Cerastium* L., (5; 1.12%), *Papaver* L. (5; 1.12%), *Medicago* L. (5; 1.12%), *Vicia* L. (5; 1.12%), etc. which are the most species in terms of the number of species in the floristic composition and they are outnumbered.

Table 3

THE GENERA WHICH REPRESENTED BY MORE SPECIES  
 IN THE FLORA OF GANJA CITY AND ITS SURROUNDINGS

№	Genera	Number of species	In % by number of species
1	<i>Avena</i> L.	4	0.91
2	<i>Poa</i> L.	5	1.12
3	<i>Hordeum</i> L.	4	0.91
4	<i>Cerastium</i> L.	5	1.12
5	<i>Dianthus</i> L.	4	0.91
6	<i>Papaver</i> L.	5	1.12
7	<i>Medicago</i> L.	5	1.12
8	<i>Melilotus</i> Mill.	4	0.91

№	Genera	Number of species	In % by number of species
9	<i>Astragalus</i> L.	6	1.4
10	<i>Vicia</i> L.	5	1.12
11	<i>Euphorbia</i> L.	5	1.12
12	<i>Convolvulus</i> L.	4	0.91
13	<i>Teucrium</i> L.	4	0.91
14	<i>Salvia</i> L.	4	0.91
15	<i>Solanum</i> L.	4	0.91
16	<i>Verbascum</i> L.	4	0.91
17	<i>Plantago</i> L.	4	0.91
18	<i>Valerianella</i> Mill.	5	1.12
19	<i>Artemisia</i> L.	6	1.4
20	<i>Cirsium</i> Mill.	4	0.91
21	<i>Taraxacum</i> F. H. Wigg.	4	0.91
<i>Total:</i>		95	21.5 (of the 441 species)

*Biomorphological analysis.* Contamination of the research area with various pollutants, as a result, had certain effects on the development and life forms of plants.

From the analysis of the flora of the study area, it was determined that perennial grasses dominate its composition with 194 species (44%) (Table 4). According to the number of species, annual-biennial grasses take the next place with 164 species (36.5%), of which 137 species (31%) are annuals, 21 species (4.8%) are biennials, and 6 species (1.4%) are annual and biennial. In the flora of Ganja city and its surrounding areas, there are trees with 24 species (5.4%), trees and shrubs with 3 species (0.7%), shrubs with 43 species (9.8%), shrubs and trees with 1 species (0.2%), semi-shrubs 11 species (2.5%) and shrubs are represented by 1 species (0.2%).

Table 4

LIFE FORMS OF PLANTS IN THE FLORA OF THE CITY OF GANJA  
 AND ITS SURROUNDINGS ACCORDING TO I. G. Serebryakov (1964)

Life forms	Number of species	Total number of species, in %
Trees	24	5.4
Trees and shrubs	3	0.7
Shrubs	43	9.8
Shrubs and trees	1	0.2
Semishrubs	11	2.5
Bushes	1	0.2
Perennial herbs	194	44
Annual-biennial herbs	6	1.4
Biennial	21	4.8
Annual	137	31
Total:	441	100

A biomorphological analysis of higher plants spreading in the study area was carried out (Table 5).

As can be seen from the Table 5, when the types of flora are analyzed by life forms, 215 (48.7%) hemicryptophytes make up more species; therophytes are represented by 137 species (31.1%) and cryptophytes by 10 species (2.3%), phanerophytes by 64 species (14.5%) and chamaephytes by 15 species (3.4%).

Table 5

BIOMORPHOLOGICAL (LIFE FORMS) ANALYSIS OF PLANTS  
 IN THE FLORA OF GANJA CITY AND ITS SURROUNDINGS  
 (According to Raunkiaer)

<i>Life forms</i>	<i>Number of species</i>	<i>Total number of species, in %</i>
Phanerophytes	64	14,5
Chamaephytes	15	3,4
Hemicryptophytes	215	48,7
Cryptophytes	10	2,3
Therophytes	137	31,1
Total:	441	100.0

*Geographical analysis.* The flora of Azerbaijan stands out from other regions due to its species diversity in the flora of the Caucasus. During the research, the geographical types of plants, areal classes and were determined [11, p. 71-73].

Table 6 as can be seen, in the formation of species in the flora of the city of Ganja and its surroundings, the ancient Mediterranean (35.8% with 158 species), the boreal (33.1% with 146 species) and the Caucasus (16.3% with 72 species) areal types. species are dominant. Other areal types with fewer species: adventive 11 species with 2.5%, Ancient (III period forest) areal type with 13 species with 3%, steppe with 26 species with 5.9%, desert with 7 species with 1.6% are represented. The areal type of 7 species (1.6%) has not been determined. It should also be noted that from the analysis of the species distributed in the research area according to geographical elements, it became clear that the species included in the Ancient Mediterranean areal type have a special role in the formation of the flora.

Table 6

ANALYSIS OF SPECIES IN THE FLORA OF GANJA CITY  
 AND ITS SURROUNDING AREAS BY AREAL TYPES

<i>Areal types</i>	<i>Number of species</i>	<i>Total number, in %</i>
Ancient (III period forest)	13	3
Boreal	146	33,1
Steppe	26	5,9
Xerophyte (Ancient Mediterranean)	158	35,8
The Caucasus	72	16,3
Adventive	11	2,5
Desert	7	1,6
Cosmopolitan	1	0,2
Undefined	7	1,6
Total:	441	100

*Conclusion*

1. 441 species including 68 families and 244 genera have been identified for Ganja city and its surroundings. Poaceae (63), Fabaceae (48), Asteraceae (35), Rosaceae (27), Caryophyllaceae (23), Lamiaceae (21), Brassicaceae (18) families dominate the flora of the areas which are under the effects of anthropogenic pollution.

2. In the flora of the study area, there are 194 types of perennial grasses (44%), annual and biennial grasses with 164 species (36.5%), trees with 24 species (5.4%), trees and shrubs with

3 species (0.7%), shrubs with 43 species (9.7%), shrubs and trees with 1 species (0.2%), semi-shrubs with 11 species (2.5%), shrubs with 1 species (0.2%) represented, and respectively 229 types (51.9%) of hemicryptophytes, 123 types (27.9%) of therophytes, 10 species (2.3%) cryptophytes, 64 species (14.5%) phanerophytes and 15 species (3.4%) are chamaephytes. Chamaephytes and Cryptophytes are exposed to strong pollution around the city.

3. Classification of the flora of the polluted area of Ganja city by areal type Mediterranean Sea (158 species 35.8%), Boreal (146 species 33.1%), Caucasus (72 species 16.3%), Adventive (11 species 2.5%), Ancient (III period forest) (13 species 2.9%), steppe (26 species 5.9%), desert (7 species 1, 6%) was analyzed according to the area type. 7 types (1.6%) have not been determined. The specific role of species included in the ancient Mediterranean areal type in the formation of the flora is a property.

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*Работа поступила  
в редакцию 02.10.2022 г.*

*Принята к публикации  
12.10.2022 г.*

*Ссылка для цитирования:*

Mahmudova U. Systematic Structure, Biomorphology and Geographical Analysis of the Flora of Ganja City and Its Surroundings // Бюллетень науки и практики. 2022. Т. 8. №11. С. 83-91. <https://doi.org/10.33619/2414-2948/84/11>

*Cite as (APA):*

Mahmudova, U. (2022). Systematic Structure, Biomorphology and Geographical Analysis of the Flora of Ganja City and Its Surroundings. *Bulletin of Science and Practice*, 8(11), 83-91. <https://doi.org/10.33619/2414-2948/84/11>