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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

**STUDY AND EFFECTIVE USE OF FLORA OF
QAKH DISTRICT**

Specialty: 2417.01 – “Botany”

Field of science: Biology

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GENERAL DESCRIPTION OF WORK

Relevance and degree of development of the topic:

Preservation and sustainable use of biodiversity in modern period is one of the most pressing issues for mankind¹. In 2010, the United Nations Convention on Biological Diversity's Global Strategy for Plant Protection: 2011-2020 set Target 1 as "the development of electronic floristic lists of all known plant species in the world"². In addition, in 2016, the "National Strategy for the Protection and Sustainable Use of Biological Diversity in the Republic of Azerbaijan for 2017-2020"³ was approved in the country.

Various physical-geographical and natural-climatic conditions of the Qakh district, which is located in the north-west of Azerbaijan, as well as the fertile soil cover of the area, dense river network and etc. factors affect to the formation of a rich and diverse vegetation of the area. Despite all of this, the vegetation of the region has not been studied in detail to date. In this regard, it is considered very important to study in detailed of the flora of the region in the modern period.

Object and subject of research. The object of research is the flora of Qakh district. The subject of the research includes the determination of the species composition of the flora of the region, comparative analysis of the flora, the study of endemic, rare, relict and economically important species and the study of changes in vegetation.

¹ Ibadullayeva, S.J., Huseynova, I.M. Overview of the plant diversity of Azerbaijan // - Switzerland: Biodiversity, Conservation and Sustainability in Asia, Springer – 2021, – p. 431-478.

² Convention on Biological diversity, 2012. Global Strategy for Plant Conservation: 2011-2010 // Richmond: Botanic Gardens Conservation International, 35 p.

³ Azərbaycan Respublikasında bioloji müxtəlifliyin qorunması və davamlı istifadəsinə dair 2017-2020-ci illər üçün Milli Strategiyanın təsdiq edilməsi haqqında: [Elektorn resurs] / Azərbaycan Respublikası Prezidentinin sərəncamı. – Bakı, 3 oktyabr 2016. URL: <http://www.e-qanun.az/framework/33817>.

Aims and objectives of the research. The main purpose of the research is to study the current state of the flora of Qakh district, to study the characteristics and changes in the vegetation in terms of protection of plant diversity of flora, to study economically important species for efficient and sustainable use of flora.

In order to achieve the goal of the research, the following tasks were set:

- Determination of species composition of flora of Qakh district and compilation of flora synopsis;
- Analysis of the flora of the region on the basis of various indicators;
- Study of vegetation characteristics of the study area;
- Investigation of changes in the vegetation cover of the region in order to protect plant diversity;
- Study of economically important plant species in terms of efficient and sustainable use of flora;
- Study of the natural resources of some widespread medicinal plant species.

Research methods. For the implementation of the dissertation work, route and semi-stationary geobotanical methods, classical and modern systematic determinants for the determination of the plants, mathematical-computer programs in statistical analysis, as well as modern methods and approaches were used.

The main provisions submitted for defense.

- Different physical-geographical and natural-climatic conditions of Qakh district affected the formation of rich and diverse vegetation here;
- The impact of anthropogenic, climatic and natural factors on natural ecosystems in the region, as well as the rapid spread and migration of invasive species in the area pose a number of threats to the flora of the region;
- The flora of the region is rich in medicinal plants, which are important for the medical industry, and there are opportunities to supply their raw materials.

Scientific novelty of the work. For the first time, the species composition of the flora of the Qakh district was determined and a synopsis of the flora was compiled. Four species new to the flora of the region (*Adiantum capillus-veneris* L., *Erigeron annuus* (L.) Pers., *Papaver macrostomum* Boiss. & Huet., *Lathraea squamaria* L.), as well as new distribution area for 10 species were recorded. The flora of the area was comparatively analyzed on the basis of various indicators.

Endemic, rare and relict plants in the flora of the region have been identified. For the first time, relicts were analyzed according to the age of the geological period in which they developed. Maps of distribution areas of rare plant species have been compiled.

The main features and changes of the current condition of the vegetation cover of the research area were studied and 8 vegetation types were identified for the first time in the area. In terms of flora conservation, it was carried out the assessment and prediction of suitable distribution geographical areas for the current and future period of 4 rare and 4 invasive species.

For the first time, a complete list of the species composition of the economically important plants was given in terms of efficient use of flora, and raw material reserves of 7 widespread medicinal plants were determined in the area.

The theoretical and practical significance of the work. Information on the flora of Qakh district can be used in the future in the new compilation of "Flora of Azerbaijan". Information on the current state of rare plants in the flora of the region can be used in the compilation of the "Red Book of the Republic of Azerbaijan", and information on invasive plants in the next edition of the "Black Book of Azerbaijan". Information on the current climate and anthropogenic impacts on the vegetation of the area can help in the development of research in the field of biodiversity conservation in the future and the development of measures to expand conservation measures. Information on the study of raw material reserves of medicinal plants in the area can be used in the pharmaceutical and medical industries.

Approbation and application. The results of the dissertation were discussed at international conferences entitled "Environmental changes and conservation of plant diversity" (Baku, 2013), "Principles and methods of biodiversity conservation" (Yoshkar-Ola, 2013), "Principles and methods of biodiversity conservation" (Yoshkar-Ola, 2015), "Modern problems of medicine and natural sciences" (Yoshkar-Ola, 2016), "Multidisciplinary approaches in solving modern problems of fundamental and applied sciences" (Baku, 2020) and local conferences entitled "New challenges in botanical research" (Baku, 2018), "Innovation and traditions in modern botany" (Baku, 2019).

The following 20 scientific works were published on the topic and content of the dissertation: 12 articles, 4 conference proceedings, 3 theses, 1 book. Out of them, 4 were published in the journals in the international databases (Web of Science, Russian Science Citation Index).

The organization where the dissertation work is carried out. The dissertation work was carried out at the Department of Phytosociology of ecosystems of the Institute of Botany of the Azerbaijan National Academy of Sciences.

Structure and scope of work. The dissertation is written in the Azerbaijani language and consists of an introduction, 6 chapters, results, practical recommendations and a list of references with 234 titles, 212 pages. In general, the dissertation consists of 215460 characters (Introduction — 9127 characters, Chapter I — 11736 characters, Chapter II — 23362 characters, Chapter III — 19610 characters, Chapter IV — 52811 characters, Chapter V — 50407 characters, Chapter VI — 44100 characters, Results — 2608 characters, Practical recommendations - 1699 characters). In the main part of the dissertation 2 maps, 23 tables, 74 figures (16 diagrams, 2 schemes, 56 photos) are given. The dissertation is completed with 95 page Appendices (Appendix 1 — 80 pages, Appendix 2 — 15 pages).

CHAPTER I. PHYSICAL AND GEOGRAPHICAL CONDITIONS OF QAKH DISTRICT

This chapter of the dissertation provides information about the geographical position, area, relief, geomorphological structure, soil cover, climatic conditions and hydrographic network of the research area.

CHAPTER II. HISTORY OF STUDY OF FLORA OF QAKH DISTRICT

This chapter provides a chronological analysis of research papers on the history of the dissertation theme, based on the sources of literature. A small number of scientists provide information about the flora of the research area, as well as individual plant species. Thus, as a result of the analysis of the literature, it was determined that the flora of Qakh district has not been studied in detail so far.

CHAPTER III. OBJECT AND METHODOLOGY OF STUDY

3.1. Object of research. The object of research on the dissertation is the flora of the Qakh administrative region, located in the northwestern part of Azerbaijan. Endemic, relict, rare, invasive and economically important plants distributed in the area have also been studied for comprehensive study, conservation and sustainable use of biodiversity. According to the division on the botanical-geographical region of Azerbaijan, the northern and north-eastern part of the region belongs to the Western part of the Greater Caucasus botanical-geographical region, the central part to the Alazan-Ayrichay valley botanical-geographical region, and the southern part to the Bozgir plateau botanical-geographical region.

3.2. Research methodology. Research work was carried out on the topic of the dissertation in the field and laboratory in 2012-2020. Field work was carried out in the research area to determine the species composition of the flora of the region, as well as it was investigated literature data and herbarium materials stored in the Herbarium Fund (BAK) of the Institute of Botany of the Azerbaijan National Academy of Sciences (ANAS). Geobotanical methods of

route, semi-stationary observations and accounting sites were used during field works⁴. Classical⁵ and modern literature were used to determine the collected herbarium materials. The scientific name of the plant was first determined based on the work "Flora of Azerbaijan", then it was studied the modern literature⁶, and taking into account the nomenclature changes and synonyms, the final status and scientific name of the plant was given based on the "World Flora Online" database⁷.

Biomorphological analysis of the flora of the area was carried out according to I.G. Serebyakov (1964) and C. Raunkiaer (1934) systems. It was used A.P. Shennikov's method (1964) according to the water regime during the bioecological analysis of the flora of the area.

The study and description of the phytocenotic properties of cenoses in the study area was carried out on the basis of generally accepted methods in geobotany⁸. The abundance of species in the phytocenosis was determined according to the Braun-Blanke system.

Endemic plants of the flora was determined based on the research works of A.M. Askerov (2016) and "Red list of endemic plants of the Caucasus" (2014). The relictity of plants has been determined on the basis of a number of literature, and relicts have been analyzed in three groups according to the age of the geological period in which they developed (A.L. Ivanov, 1998): I. Third period - plants preserved until the Neogene period of the Cenozoic era; II.

⁴ Novruzov, V. Fitosenologiyanın əsasları (Geobotanika). Dərslik / V. Novruzov. – Bakı: Elm, – 2010. – 308 s.

⁵ Флора Азербайджана: [в 8 томах]. – Баку: Изд-во АН Азерб. ССР, – т. 1. – 1950. – 370 с.; т. 2. – 1951. – 318 с.; т. 3. – 1952. – 407 с.; т. 4. – 1953. – 402 с.; т. 5. – 1954. – 580 с.; т. 6. – 1955. – 540 с.; т. 7. – 1957. – 648 с.; т. 8. – 1961. – 690 с.

⁶ Əsgərov, A.M. Azərbaycanın bitki aləmi (Ali bitkilər – Embryophyta) / – Bakı: TEAS Press, – 2016, 444 s.

⁷ World Flora Online (2020) WFO [Elektron resurs] URL: <http://www.worldfloraonline.org>.

⁸ Миркин Б.М., Наумова Л.Г. Современная наука о растительности. Москва. Изд-во Логос, 2001.264 с.

Glacial - plants of very cold climate in the glacial epoch of the Fourth Cenozoic Era and the period of formation of large glaciers; III. Xerothermal - plants of the fourth glacial epoch of the Cenozoic era¹⁵.

Biogeographic analysis of the flora was identified based on "Flora of the Caucasus", in addition *Asteraceae* Dumort. family has been analyzed based on the works of a number of scientists.

The economic importance of plants was determined on the basis of literature data^{9, 10, 11, 12} and observations and conversations conducted in the research area.

The names and characteristics of the vegetation types of the vegetation are given according to V.J. Hajiyevev (2017) and S.J. İbadullayeva¹³.

To determine the similarity of the flora composition of all three botanical-geographical regions of the Qakh district it was used the floristic similarity coefficient (K_J) of P. Jakkar. Then, dendrogram trees were constructed based on the results obtained.

Canonical Correspondence Analysis (CCA)¹⁴ has been used to analyze the relationship between environmental factors and rare plants. Depending on the frequency of occurrence, 19 rare plants and 6 environmental factors (2 geographical - altitude, slope, 4 climate - annual average precipitation (mm), annual average temperature (T_{mean}), annual average minimum temperature (T_{min}) and annual

⁹ İbadullayeva, S.C. Azərbaycan florasının Kərəvüzkimiləri / S.C. İbadullayeva. –Bakı: Elm – 2004. – 347 s.

¹⁰ İbadullayeva, S., Ələkbərov, R. Dərman bitkiləri (Etnobotanika və Fitoterapiya) / S. İbadullayeva, R. Ələkbərov. – Bakı: Elm, – 2013. – 331 s.

¹¹ Mehdiyeva, N.P. Azərbaycanın dərman florasının biomüxtəlifliyi / N.P. Mehdiyeva. – Bakı: Letterpress, – 2011. – 88 s.

¹² Qasımov M., Muradov V. Boyaqçılıq / M. Qasımov, V. Muradov. – Bakı: Elm, – 2017. – 292 s.

¹³ İbadullayeva, S.C., Mustafayev, A.B., Şirəliyeva, G.Ş. Böyük Qafqazın yüksək dağlıq ərazilərinin bitkiliyinin təsnifatı // - Bakı: AMEA-nın Xəbərləri, Biologiya və tibb elmləri seriyası, - 2014. Cild. 69, N3. – s. 58-64.

¹⁴ Palmer M.W. Putting things in even better order: the advantages of canonical correspondence analysis // Ecology, – 1993. 74(8), – p. 2215-2230.

average maximum temperature (T_m)) were selected. Data processing and statistical analysis were performed in PAST computer program.

To study the current and future potential geographical distribution areas of rare and invasive plants in the study area it was used the Ensemble Modeling (AM) method of the Species Distribution Model (NYM)¹⁵, and "Maxent", "Random forest" and "Gradient boosting" algorithms were applied. The distribution of plant species in the geographical area and 19 bioclimatic data¹⁶ were used in the construction of the model. The forecast for the current period covers 1970-2018, and the average for the future period covers 2040-2080. The MRI-CGCM3 (MG) (CMIP5) future climate scenario was used¹⁷. In this case, 4 climate scenarios (RCP 2.6, RCP 4.5, RCP 6.0, RCP 8.5) were analyzed, depending on the amount of Gases that create a Thermal Effect (GHG). The model was built using of the mathematical and statistical computer program "R" (version 3.6.2). Interpretation of the compiled maps: 0.00-0.10- areas not suitable for species distribution, 0.10-0.40 - low suitable areas, 0.40-0.70 - medium suitable areas, 0.70-1.00 - highly suitable areas.

Indicators of the coenopopulation of rare plants and the number of individuals were used based the approaches and methodology adopted by the International Union for Conservation of Nature (IUCN) (2019).

Raw material resources of 7 widespread medicinal plants (*Achillea nobilis* L., *Ajuga genevensis* L., *Lepidium draba* L., *Origanum vulgare* L., *Peganum harmala* L., *Pojarkovia pojarkovae* (Schischk.) Greuter, *Scilla siberica* Haw.) were studied in Qakh

¹⁵ Grenouillet, G. Ensemble modelling of species distribution: The effects of geographical and environmental ranges / G. Grenouillet, L. Buisson, N. Casajus [et al.] // *Ecography*, – 2011, 34, – p. 9 -17.

¹⁶ WorldClim, Historical monthly weather data [Elektron resurs] URL: <https://www.worldclim.org/data/monthlywth.html>

¹⁷ Yukimoto, S. A New Global Climate Model of the Meteorological Research Institute: MRI-CGCM3 / S.Yukimoto, Y. Adachi, M. Hosaka // *Journal of the Meteorological Society of Japan*, – 2012, v. 90A, – p. 23-64.

district¹⁸. The volume of operational raw material reserves and possible annual supply capacity was calculated taking into account the recovery period of each species senopopulation.

CHAPTER IV. ANALYSIS OF FLORA OF QAKH DISTRICT

During study of the flora of the world, as well as the flora of any area, it is very important to study it comparatively on the basis of various indicators.

4.1. Taxonomic analysis. As a result of field research conducted during 2012-2020, it was determined that 1298 taxa (1218 species, 77 subspecies and 3 variations) belonging to 112 families and 543 genera were distributed in the flora of Qakh district^{19, 20, 21}. Based on the collected information, a synopsis of the flora of the region was compiled and given in the appendix to the dissertation (Appendix 1). The synopsis provides information on latin and azerbaijani names, synonyms, life forms, distribution area, endemicity, relict, rarity, ecological group, geographical area and economical importance of the plant.

As a result of the analysis of the total flora of the area by taxonomic groups, it was determined that the main part of the flora consists of representatives of *Magnoliophyta* with 1181 species, 75 subspecies and 2 variations belonging to 94 families and 520 genera.

¹⁸ Ресурсоведение и стандартизация лекарственного растительного сырья: учеб. пособие / Сост.: К.А. Пупыкина, С.Р. Хасанова, Н.В. Кудашкина, Э.Х. Галиахметова, Р.Р. Шакирова. — Уфа: ФГБОУ ВО БГМУ Минздрава России, 2019. — 116 с.

¹⁹ Dadaşova, A.Q. Qax rayonunun bitki örtüyünün floristik tədqiqi // –Bakı: Azərbaycan Milli Elmlər Akademiyasının Botanika İnstitutunun Elmi Əsərləri, – 2013. c. 33, – s. 42-45.

²⁰ Dadaşova, A.Q. Qax rayonunun Alazan-Əyriçay botaniki-coğrafi rayonuna aid mərkəzi hissəsinin florasının taksonomik, bioekoloji və biomorfoloji təhlili // – Bakı: Azərbaycan Milli Elmlər Akademiyasının Botanika İnstitutunun Elmi Əsərləri, – 2014. cild 34, – s. 95-99.

²¹ Alizade, V., Mehdiyeva, N., Karimov, V., Ibrahimova, A. Plants of the Greater Caucasus (Azerbaijan) / V. Alizade, N. Mehdiyeva, V. Karimov, A. Ibrahimova. – Baku: Red N Line, – 2019. – 352 p.

This is 96.91% of the total flora of the region. The second place in the flora of the region is occupied by *Polypodiophyta* with 27 species, 1 subspecies belonging to 12 families and 17 genera, which is 2.16% of the total flora. Minority divisions in the study area are *Pynophyta* with 7 species, 1 subspecies belonging to 4 families and 4 genera (0,69%), *Equisetophyta* with 2 species belonging to 1 family and 1 genera (0,15%) və *Lycopodiophyta* with 1 species belonging to 1 family and 1 genus (0,08%) (Table 1).

Table 1
Analysis of the flora of Qakh district by taxonomic groups

№	Taxonomic group	Order	Family	Genus	Species	Subspecies	Variation
1	Division: Lycopodiophyta	1	1	1	1	-	-
1.1	Class: Isoetopsida	1	1	1	1	-	-
2	Division: Equisetophyta	1	1	1	2	-	-
2.1	Class: Equisetopsida	1	1	1	2	-	-
3	Division: Polypodiophyta	7	12	17	27	1	-
3.1	Class: Polypodiopsida	7	12	17	27	1	-
4	Division: Pynophyta	4	4	4	7	1	1
4.1	Class: Pinopsida	3	3	3	6	-	1
4.2	Class: Gnetopsida	1	1	1	1	1	-
5	Division: Magnoliophyta	49	94	520	1181	75	2
5.1	Class: Liliopsida	14	16	102	215	9	-
5.2	Class: Magnoliopsida	37	78	418	966	66	2
Total by divisions:		64	112	543	1218	77	3

There are 15 leading families in the flora of the study area, among which the representatives of the *Asteraceae* Giseke family (137 species, 15 subspecies) are more widespread (Table 2). In addition, *Poaceae* Barnhart (104 species, 2 subspecies) and *Fabaceae* Juss. (87 species, 6 subspecies) are the leading families of the flora, and the representatives of these three families make up 27.04% of the total flora of the territory. The remaining 12 families contain 11-20 plants, 50 families - 1-9 plants, and 35 families - 1 plant.

Table 2**Leading families of the flora of Qakh district**

№	Family	Species		Subspecies		Variation	
		num ber	in % of total flora	num ber	in % of total flora	num ber	in % of total flora
1.	Apiaceae	51	4.19	3	3.9	-	-
2.	Asteraceae	137	11.25	15	19.48	-	-
3.	Boraginaceae	34	2.79	3	3.9	-	-
4.	Brassicaceae	50	4.11	1	1.3	-	-
5.	Caprifoliaceae	29	2.38	-	-	-	-
6.	Caryophyllaceae	50	4.11	4	5.19	1	33.33
7.	Cyperaceae	30	2.46	3	3.9	-	-
8.	Fabaceae	87	7.14	6	7.79	-	-
9.	Lamiaceae	48	3.94	4	5.19	-	-
10.	Orchidaceae	26	2.13	1	1.3	-	-
11.	Orobanchaceae	29	2.38	2	2.6	-	-
12.	Plantaginaceae	25	2.05	-	-	-	-
13.	Poaceae	104	8.54	2	2.6	-	-
14.	Ranunculaceae	36	2.96	2	2.6	-	-
15.	Rosaceae	64	5.25	1	1.3	-	-
Total:		800	65.68	47	61.05	1	33.33

The flora of the region consists of 17 leading genera (Table 3). There are also 5-9 plants in 41 genera and 2-4 plants in 179 genera. Species containing only 1 plant predominate in the flora of the region, as 305 species are monotypes.

Table 3**Leading genera of the flora of Qakh district**

№	Genus	Species		Subspecies		Variation	
		num- ber	in % of total flora	num- ber	in % of total flora	number	in % of total flora
1.	Alchemilla	12	0.98	-	-	-	-
2.	Bromus	12	0.98	-	-	-	-
3.	Campanula	11	0.90	7	9.09	-	-
4.	Carex	16	1.31	3	3.9	-	-
5.	Cerastium	11	0.90	1	1.3	1	33.33
6.	Epilobium	9	0.74	2	2.6	-	-
7.	Euphorbia	13	1.07	-	-	-	-

Followed by Table 3

8.	Galium	16	1.31	-	-	-	-
9.	Geranium	13	1.07	-	-	-	-
10.	Lathyrus	12	0.98	-	-	-	-
11.	Minuartia	10	0.82	1	1.3	-	-
12.	Orobanche	13	1.07	1	1.3	-	-
13.	Poa	11	0.90	-	-	-	-
14.	Ranunculus	13	1.07	1	1.3	-	-
15.	Trifolium	20	1.64	-	-	-	-
16.	Veronica	16	1.31	-	-	-	-
17.	Vicia	18	1.48	2	2.6	-	-
Total:		245	226	18,53	18	23.39	1

The distribution of the taxonomic composition of the flora of the region was studied on all three botanical-geographical regions, which the research area belongs (Figure 1). As a result of the analysis, it was determined that the vegetation of the Western part of the Greater Caucasus botanical-geographical region is richer than other botanical-geographical regions and makes up 80.89% of the total flora of the region. The flora of the botanical-geographical regions of the Alazan-Ayrichay valley and the Bozgir plateau are close in terms of taxon numbers.

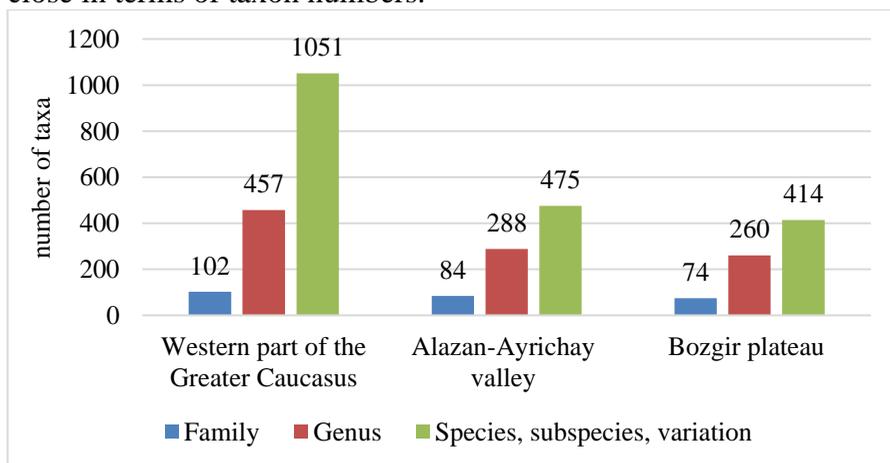


Figure 1. Distribution of taxonomic composition of flora of Qakh district by botanical-geographical regions

Comparative analyzes were conducted to determine the number of families, genera, species, subspecies and variations that are identical between the flora of all three botanical-geographical regions (Figure 2). As a result, it was determined that 12 families, 81 genera, 185 species, 7 subspecies for the Western part of the Greater Caucasus and Alazan-Ayrichay valley; 3 families, 38 genera, 69 species, 7 subspecies the Western part of the Greater Caucasus and Bozgir plateau; 7 families, 25 genera, 55 species, 7 subspecies, and 1 variation for Alazan-Ayrichay valley and Bozgir plateau botanical-geographical regions are the same for the botanical-geographical regions. In addition, 62 families, 159 genera and 149 species, and 7 subspecies are found in all three botanical and geographical regions of the area.

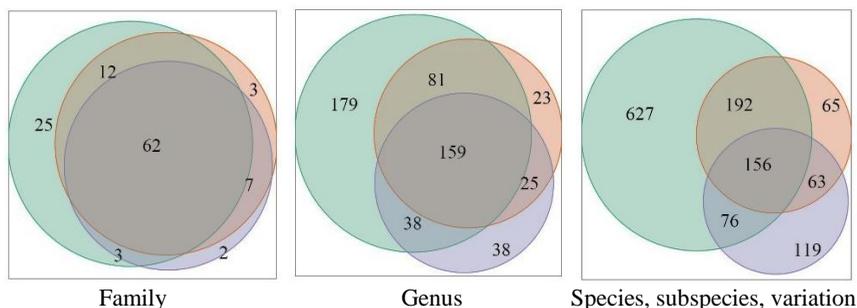


Figure 2. Determination of the similarity of families, genera, species, subspecies, variations in the flora of botanical-geographical regions. □ Qakh district; ● the Western part of the Greater Caucasus; ● Alazan-Ayrichay valley; ● Bozgir plateau

The floristic similarity coefficient of the vegetation of Bozgir plateau and Alazan-Ayrichay valley botanical-geographical regions is high: $K_J=0.58$ (family), $K_J=0.29$ (genus) və $K_J=0.25$ (species, subspecies, variation). Floristic similarity coefficient of other botanical-geographical regions: the Western part of the Greater Caucasus and Alazan-Ayrichay valley — $K_J=0.30$ (family), $K_J=0.29$ (genus) və $K_J=0.22$ (species, subspecies, variation); the Western part

of the Greater Caucasus and Bozgir plateau — $K_J=0.10$ (family), $K_J=0.15$ (genus) və $K_J=0.09$ (species, subspecies, variation).

Based on the results of the floristic similarity coefficient analysis, the dendrograms of hierarchical clusters were constructed (Figure 3).

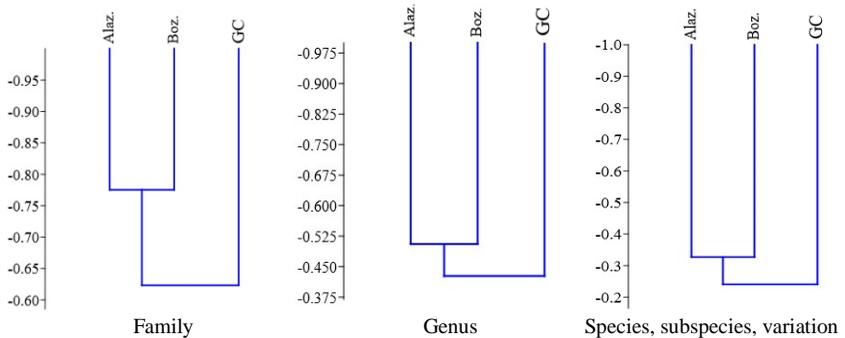


Figure 3. Hierarchical cluster analysis of floristic similarity of botanical-geographical regions: Boz. - Bozgir plateau; Alaz. - Alazan-Ayrichay valley; GC - Western part of the Greater Caucasus

During field works, 4 new species were found for the flora of Qakh district: *Adiantum capillus-veneris* L., *Erigeron annuus* (L.) Pers.²², *Lathraea squamaria* L., *Papaver macrostomum* Boiss. & Huet.²³ (Figure 4). Of these, *Erigeron annuus* is a new species for the flora of Azerbaijan⁴³. Also, the migration of some plant species within the study area was observed in botanical-geographical regions. Thus, new habitats have been identified for a total of 10 species: *Astragalus cicer* L., *Anacamptis laxiflora* (Lam.) R. M.

²² Мехтиева Н.П., Дадашова А.Г., Али-заде В.М. Новый для флоры Азербайджана вид *Phalacrologium annuum* (Asteraceae) // Санкт-Петербург: Ботанический журнал, – 2017. т. 104, №5, – с. 689-692.

²³ Dadaşova, A.Q., Əlizadə, V.M. Azərbaycan florasının bəzi növləri üçün yeni yayılma arealları, bioekoloji və fitosenotik xüsusiyyətləri // – Bakı: Azərbaycan Milli Elmlər Akademiyasının Xəbərləri, Biologiya və tibb elmləri, – 2015. c. 70, №1, – s. 11-15.

Bateman, *Anacamptis coriophora* (L.) R.M. Bateman, *Ficaria ledebourii* Grossh. & Schischk., *Crataegus pseudoheterophylla* Pojark., *Juniperus foetidissima* Willd., *Pistacia atlantica* Desf., *Rhus coriaria* L., *Vinca herbacea* Waldst. & Kit. for Alazan-Ayrichay valley.; *Convolvulus lineatus* L. for the Western part of the Greater Caucasus.

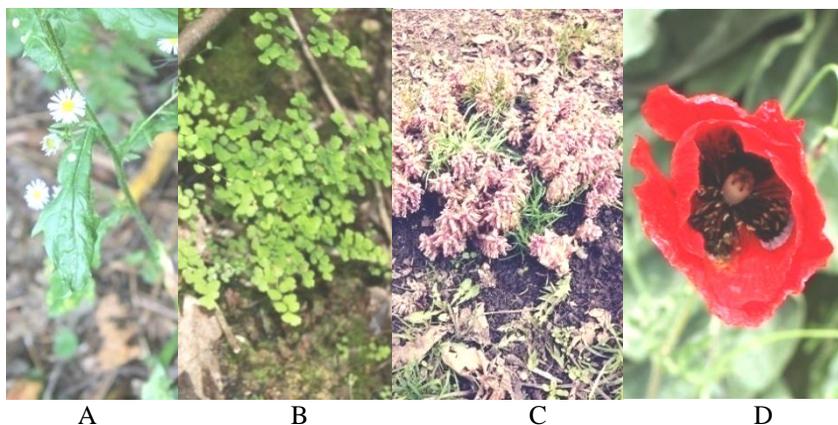


Figure 4. New species for the flora of Qakh district: A - *Erigeron annuus*, B - *Adiantum capillus*, C - *Lathraea squamaria*, D - *Papaver macrostomum*

As a result of comparative analysis of the flora of the area by altitude, it was determined that the flora of the lower and middle mountain zones is richer than other altitude zones.

A database called "Electronic flora of the Qakh district" based on the information collected on the flora of the district was created. In the database following information were given on 21 indicators - the name of the plant, synonym, distribution, life form, endemism, relict, economic importance, etc. other information.

4.2. Biomorphological analysis. Biomorphological analysis of the flora of the region was carried out based on the I.G. Serebyakov system. As a result of the analysis, 9 main and 3 transient biomorphological groups were identified for the general flora. As a result of biomorphological analysis it was found that the flora of the

area is significantly dominated by grasses with 88.37%. The other 11.63% consists of woody plants²⁴ (Table 4). Out of the total 151 woody plants found in the area, 126 are distributed in the northern and north-eastern part of the study area. The richness of woody plants here depends on the relief, climate and ecological conditions of the area. Thus, in the northern and north-eastern part of the region, forest vegetation is more widespread than in other parts of the region. In particular, the slopes covered with mountain forests occupy large areas. Depending on the ecological conditions in different habitats, some plants can spread in several life forms. For example, *Carpinus orientalis* Mill. species can be found in the form of both trees and shrubs in the study area.

Table 4

Biomorphological analysis of flora of Qakh district (I.Q. Serebryakov)

№	Life form	Number of taxon (species, subspecies, variation)	Percentage of total taxon (%)
1.	Tree	53	4.08
2.	Tree or shrub	23	1.77
3.	Shrub	56	4.31
4.	Subshrub	4	0.31
5.	Semishrub	9	0.69
6.	Semi-subshrub	2	0.16
7.	Liana	4	0.31
8.	Annual	285	21.96
9.	Biennial	54	4.16
10.	Perennial	757	58.32
11.	Annual or biennial	36	2.77
12.	Biennial or perennial	15	1.16
TOTAL		1298	100

As a result of biomorphological analysis of the flora of the district based on the C. Raunkier system, it was determined that 134 phanerophytes (10.32%), 17 chamephytes (1.31%), 678

²⁴ Ibrahimova A.G. Diversity and Distribution of Woody Plants in Qakh district (Azerbaijan) // – Москва: Естественные и технические науки, – 2020. №4 (142), – с. 39-41.

hemicryptophytes (52.23%), 149 cryptophytes (11.48%) and 320 therophytes (24.65%) were distributed in the flora of the area. In general, the flora of the area is dominated by hemicryptophytes. Although hemicryptophytes predominate in the Western part of the Greater Caucasus and Alazan-Ayrichay valley, but the number of therophytes is higher in the Bozgir plateau.

4.3. Biogeographic analysis. As a result of biogeographic analysis of the flora of the region, it became clear that the plants belonging to the geographical area types of boreal, xerophilous and Caucasian are more widespread in the area. In general, all three geographical area types make up 84.36% of the region's flora (Table 5). The presence of an ancient geographical area type in the territory indicates that the flora of the region has an ancient history. This geographical area type is dominated by members of the colchidal area class. The advantage of the boreal geographical area type means that the flora of the area is more closely related to the flora of the Northern Hemisphere.

4.4. Bioecological analysis. As a result of bioecological analysis of the flora of Qakh district according to the water regime, it was found that the flora of the area contains 726 mesophytes, 167 xerophytes, 59 hygrophytes and 5 hydrophytes from the main ecological groups. Mesophytes dominate in the study area with 55.93%. In addition, 171 xeromesophytes, 129 mesoxerophytes, 25 hygromezophytes and 16 mesohygrophytes from transient ecological groups are spread in the flora of the region.

4.5. Endemism analysis. The flora of Qakh district has a large number of endemic plants. As a result of the analysis, 181 (171 species, 10 subspecies) Caucasian endemics of 48 families, 104 genera and 3 species Azerbaijani endemics of 2 families and 3 genera were distributed in the region. In general, most of the endemics (168) are distributed in the Western part of the Greater Caucasus botanical-geographical region. Thus, this area is very distinguished from other botanical-geographical regions with high endemism. In addition, there are 26 endemics in the Bozgir plateau and 14 in the Alazan-Ayrichay valley botanical-geographical regions.

Table 5

Biogeographic analysis of the flora of Qakh district

№	Type of geographical area	Class of geographical area	Taxon	As a percentage of the total number of taxa
I.	Ancient	Ancient	16	1.23
		Minor Asia -Ancient Mediterranean	7	0.54
		Kolchid	20	1.54
		Hirkan	12	0.92
		Total:	55	4.23
II.	Boreal	Holarctic	83	6.39
		Palaearctic	168	12.94
		Europe	219	16.87
		Atlantic	7	0.54
		Front Asia	1	0.08
		Total:	478	36.82
III.	Steppe	Pannon	8	0.62
		Pontic	15	1.15
		Sarmat	8	0.62
		Total:	31	2.39
IV.	Xerophil	Mediterranean sea	199	15.33
		Front Asia	154	11.86
		Central Asia	10	0.77
		Total:	363	27.96
V.	Desert	Turan	19	1.47
		Sahara-Iran	1	0.08
		Total:	20	1.55
VI.	Caucasus	Caucasus	254	19.57
		Total:	254	19.57
VII.	Adventive	-	25	1.93
		Total:	25	1.93
VIII.	Unknown	-	72	5.55
		Total:	72	5.55
TOTAL:			1298	100

4.6. Analysis of relict plants. In the study area, 178 (166 species, 11 subspecies, 1 variation) relict plants belonging to 68

families and 131 genera are spread in the study area, which is 13.71% of the total flora. Analysis of relict plants according to the age of the geological period in which they developed revealed that 138 tertiary (Rt), 26 glacial (Rg) and 17 xerothermal (Rx) relicts were distributed in the region. Out of total relicts, 77.53% are date back to tertiary. Relics are more widespread in the northern and northeastern parts of the study area, especially in the lower and middle mountain ranges.

4.7. Analysis of rare plants. Decreased plant diversity or the disappearance of certain plant species from nature leads to a direct degradation of vegetation. In the territory of Qakh district, 56 species, 4 subspecies, 1 variation belonging to 34 families and 53 genera are spread. The number of rare plants in *Orchidaceae* Juss. (7) and *Iridaceae* Juss. (6) families are higher than in other families. Rare plants were analyzed for their life forms (according to Serebryakov) and it was found that out of the total rare plants, 43 are grasses (annual - 1, perennial - 42), and 18 are woody plants (tree - 13, shrub - 3, subshrub - 1, liana - 1). The maps on the distribution of rare plants in Qakh district were compiled, as well as, the current state of coenopopulations was assessed and environmental factors affecting them were recorded.

The study analyzed the relationship of 19 rare plants to environmental factors in their habitat. As a result, it was found that the distribution of rare plants depends more on the height factor and less on the minimum air temperature.

4.8. Analysis of invasive plants. There are 14 invasive species of 7 families and 11 genera in the flora of Qakh district. The number of invasive species belonging to the family Asteraceae (7 taxa) is higher than other families. As a result of our observations in the Qakh district, some invasive species were more aggressive than others, and noted their rapid migration to new areas was observed. These are *Acalypha australis* L., *Ailanthus altissima* (Mill.) Swingle., *Erigeron annuus* (L.) Desf., *Phytolacca americana* L. və *Xanthium spinosum* L. növləridir.

CHAPTER V. FEATURES, PROTECTION AND CHANGES OF VEGETATION COVER IN THE QAKH DISTRICT

In Qakh district, 8 vegetation types have been identified: 1) forest, 2) shrub, 3) meadow, 4) rock and talus, 5) water-wetland, 6) steppe, 7) semi-desert, 8) areas developed for agricultural crops (Figure 5).

For the northern and north-eastern part of the region, which belongs to the Western part of the Greater Caucasus botanical-geographical region 6 plant vegetation types have been identified: 1) forest, 2) shrub, 3) meadow, 4) rock-talus, 5) water-wetland and 6) areas developed for agricultural crops. There are mainly broad-leaved forests with the predominance of *Fagus* L., *Quercus* L. and *Carpinus* L. species in this area of the region, as well as it is distributed in the mixed forests with the participation of coniferous species. In the lower part of the forest, on the mountain slopes, mainly distributed mixed shrub vegetation type predominance of *Rosa* L., *Rubus* L., *Juniperus* L. genera. As the height increases, the shrub vegetation type is replaced by forest area. Mountain meadows are dominated by *Asteraceae*, *Fabaceae*, *Apiaceae*, *Lamiaceae* and *Poaceae* families.

For the central part of the region, which belongs to Alazan-Ayrichay valley botanical-geographical region, 5 vegetation types have been identified: 1) forest, 2) shrub, 3) meadow, 4) water-wetland, 5) areas developed for agricultural crops. Here main distributed plain forests with dominated by *Quercus robur subsp. pedunculiflora* (K.Koch), as as well as tugai forests in the areas around Ayrichay. *Rubus sanctus* species predominates in mixed shrubs in the area. The representatives of *Asteraceae*, *Fabaceae*, *Lamiaceae*, *Poaceae* families predominate in meadow plants, *Rapistrum rugosum* (L.) All., *Lepidium draba* L. species are predominates in areas developed for agricultural crops, *Phragmites australis* (Cav.) Trin. ex Steud. predominate in water-wetland vegetation types.

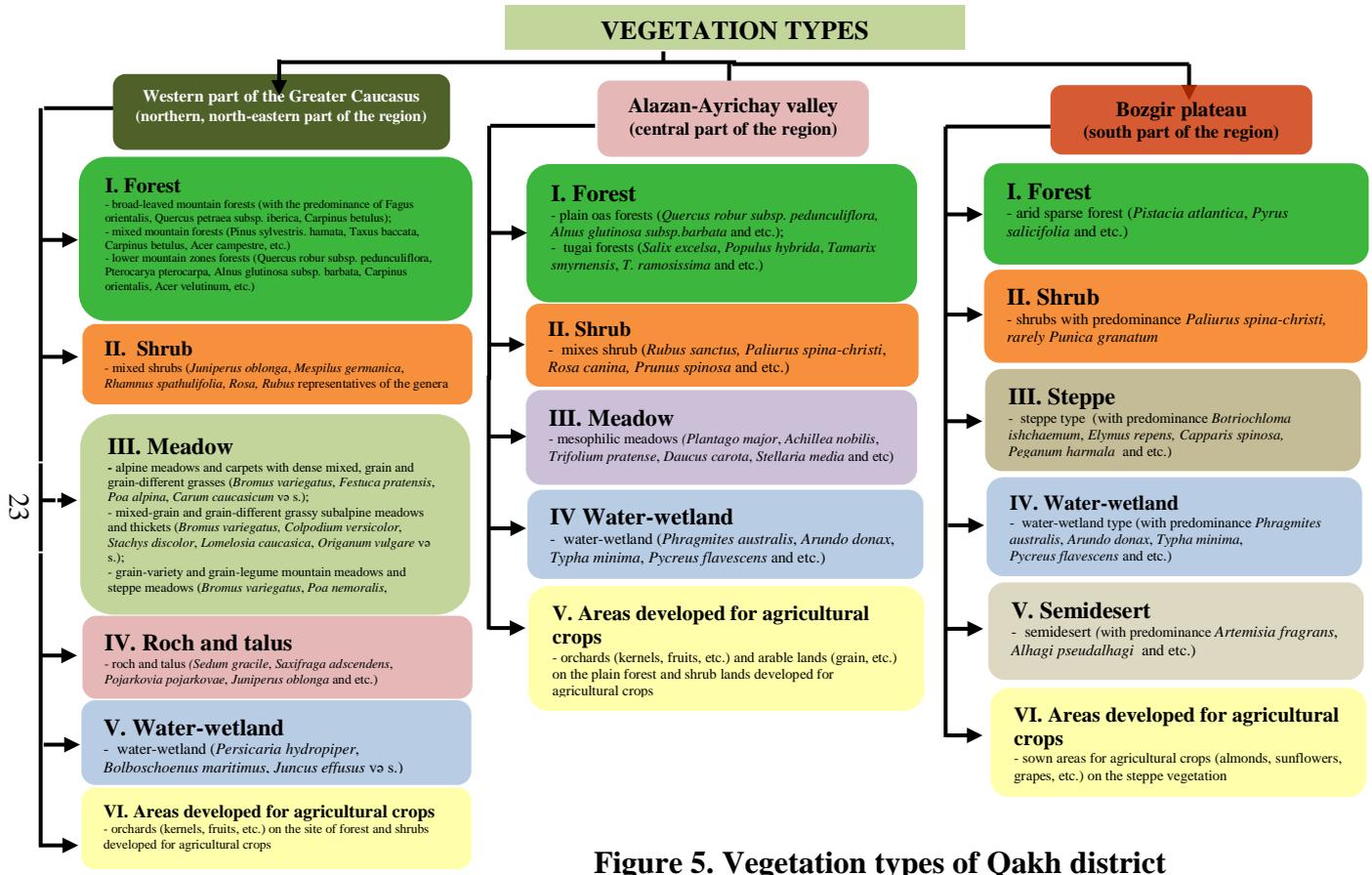


Figure 5. Vegetation types of Qakh district

For the southern part of the region, which belongs to the Bozgir plateau botanical-geographical region, 6 vegetation types have been identified: 1) forest, 2) shrub, 3) steppe, 4) water-wetland, 5) semi-desert, 6) areas developed for agricultural crops. In arid sparse forests *Pyrus salicifolia* Pall., *Pistacia atlantica* Desf. and etc. tree species were recorded. The shrub vegetation type is composed mainly of *Paliurus spina-christi*, as well as *Punica granatum* with several individual. Mainly *Bothriochloa* və *Artemiseta* formation are distributed in the steppe vegetation type. The semi-deserts are partially distributed in the southern part of the region.

It have been noted that climatic anthropogenic and natural processes affect the vegetation in the Qakh district and cause changes. In particular, intensive landslides, soil erosion and other natural processes were noted in the northern and north-eastern parts (around Ilisu, Saribash, Agchay, Qakhbash villages, around Kurmukchay and Agchay). In the northern, north-eastern and central parts of the region, as a result of excessive and unplanned grazing and trampling, desertification centers have appeared in the vegetation. In the central part, as a result of anthropogenic factors, forest vegetation is replaced by shrub vegetation type. In the southern part, it was noted the development of natural ecosystems for agricultural crops. All these processes have a significant impact on the degradation of vegetation.

In order to assess the impact of climate change on biodiversity, which is considered a global problem, it was studied the potential distribution areas for present and future periods on 4 rare species (*Taxus baccata* L., *Rhus coriaria* L., *Orchis purpurea* Huds., *Limodorum abortivum* (L.) Sw.)²⁵, as well as the maps were compiled and potential distribution areas were calculated (Figure 6).

²⁵ Ibrahimova A.G. Distribution pattern of threatened plants in Qakh district (Azerbaijan): environmental factors affecting and prediction of the potential distribution // – Минск: Журнал Белорусского государственного университета. Экология, – 2020. №2, – с. 9-17.

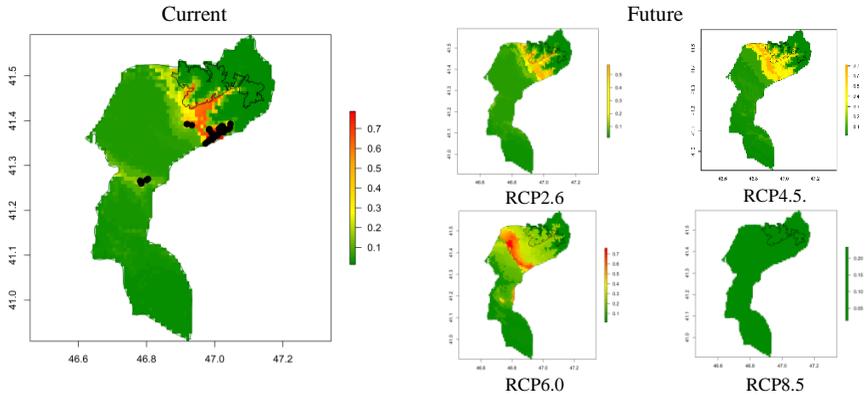


Figure 6. Assessment of areas suitable for the current and future distribution of the rare species *Rhus coriaria*

In order to study the migration of foreign species in the local flora, it was studied the potential distribution areas of 4 invasive species (*Acalypha australis*, *Ailanthus altissima*, *Erigeron annuus* and *Phytolacca americana*) for the present and future periods, created precting maps and were calculated the potential distribution areas (Figure 7).

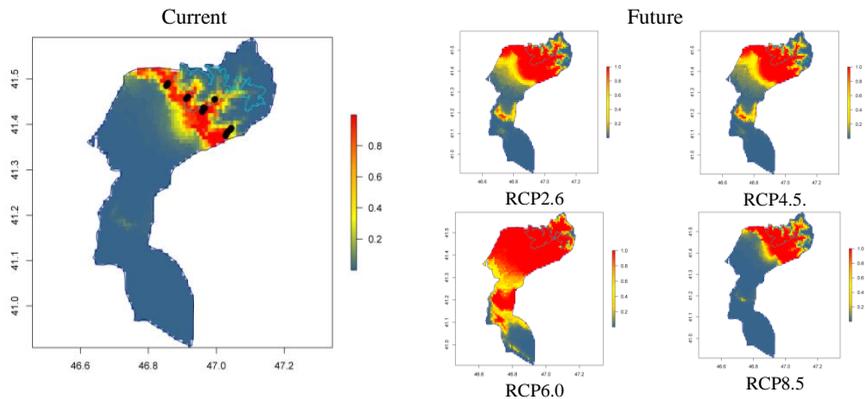


Figure 7. Assessment of areas suitable for the current and future distribution of the rare species *Acalypha australis*

CHAPTER VI. EFFECTIVE USE OF FLORA OF QAKH DISTRICT

6.1. Economically important plant species. Qakh district has a rich source of wild plants that have not been fully studied and evaluated so far. As a result of our studies, 1018 (965 species, 51 subspecies, 2 variations) economically important plants belonging to 106 families and 467 genera were distributed in the general flora of the research area. Of these, 571 species are medicinal, 485 species are dyes, 412 species are ornamental, 373 species are food, 367 species are feed, 336 species are melliferous, 223 species are aromatic and 130 species are plants with different technical characteristics.

Out of the total economically plants distributed in the study area, 825 taxa are distributed in the northern and north-eastern part of the region, 399 taxa in the center part of the region, 341 taxa in the southern part, and 133 throughout the study area. In general, a number of economically important plants predominate from the lowlands to the middle mountain zone in the study area²⁶.

6.1.1. Medicinal plants. 546 species, 23 subspecies, 2 variation medicinal plants belonging to 100 families and 361 genera are spread in the territory of Qakh district. Out of these, 257 (47.07%) are used in folk medicine and 157 (28.75%) are official medicinal plants. In terms of its use in medicine, the flora of the region is rich in a number of biologically active substances: essential oils - 184, ash - 110, flavanoids - 148, alkaloids - 90, coumarins - 49, essential oils - 74. In addition, 147 medicinal plants are rich in various vitamins. As a result of our observations, it became clear that many of medicinal plants are widely used by humans in the treatment of various diseases. For example, trees - *Juglans regia*, *Crataegus pentagyna*, *Cydonia oblonga*, from bushes - *Cornus mas*, *Viburnum opulus*,

²⁶ Ibrahimova A.G. Distribution pattern of useful plants along an elevational gradient in Qakh district (Azerbaijan) // Multidisciplinary approaches in solving modern problems of fundamental and applied sciences. Second International Scientific Conference of Young Scientists and Specialists, – Baku: – 3 march – 6 march, – 2020, – p. 100-101.

Berberis vulgaris, *Punica granatum*, from grasses - *Achillea nobilis*, *Carum carvi*, *Hypericum perforatum*, *Plantago major*, *Urtica dioica* and etc.

6.1.2. Food plants. In the flora of Qakh district 243 species and 14 subspecies of food plants belonging to 70 families and 359 genera are spread. Some plants are traditionally used by the local population - *Allium ursinum* L., *Asparagus officinalis* L., *Stellaria media* (L.) Vill., *Malva sylvestris* L., *Urtica dioica* L. and other species²⁷.

6.1.3. Feed plants. 359 species and 21 subspecies of 61 genera and 219 genera of feed plants were spread in the study area. The green and dry masses of the feed plants with high nutritional value (*Bromus riparius* Rehmman, *Cynodon dactylon* (L.) Pers., *Elytrigia repens* (L.) Gould, *Festuca pratensis* Huds., *Lolium perenne* L., *Medicago lupulina* L., *Trifolium medium* L., *Vicia sativa subsp. nigra* (L.) Ehrh.) are considered important in terms of feed for animals and are highly nutritious.

6.1.4. Dye plants. 462 species, 22 subspecies and 1 variation of dye plants belonging to 82 families and 234 genera are spread in Qakh district. This is 37.37% of the total flora of the study area. It is possible to obtain different colors and shades of color from the dye plants spread in the area, for example, yellow - *Carthamus lanatus* L., *Diospyros lotus* L.; black color - *Potentilla recta* L., *Juglans regia* L.; red color - *Punica granatum* L., *Galium verum* L.; brown color - *Acer platanoides* L., *Rhamnus spathulifolia* Fisch. & C.A.Mey., *Sorbus aucuparia* L., green color - *Morus alba* L., *M. nigra* L., blue color - *Rumex alpinus* L., *Plantago major* L., orange color - *Mespilus germanica* L., *Urtica dioica* L. and other colors.

6.1.5. Ornamental plants. Ornamental plants distinguished by their charming appearance are distributed in the flora of the research area within 389 species, 22 subspecies, 1 variation belonging to 90

²⁷ Ibrahimova, A.G. Wild food plants of Qakh district of Azerbaijan, the Southeastern Caucasus: diversity and distribution pattern along an elevation gradient // – Baku: Plant & Fungal Research, – 2019. v. 2, №2, p. 49-56.

families and 250 genera ²⁸. For example, from evergreen trees and shrubs - *Taxus baccata*, *Juniperus foetidissima*, *Hedera pastuchovii*, plants with highly decorative leaves - *Asplenium trichomanes*, *Dryopteris filix-mas*, *Polypodium vulgare*, *Polystichum lonchitis*, grasses - *Galanthus alpinus*, *Orchis purpurea*, *Consolida orientalis* and other plants are spread.

6.1.6. Melliferous plants. In the flora of Qakh district 323 species, 12 subspecies, 1 variation of melliferous plant belonging to 77 families and 214 genera are spread. 86 of the total melliferous plants are first-class melliferous plants (*Lonicera iberica* Bieb., *Lathyrus pratensis* L., *Mentha longifolia* (L.) L., and etc.).

6.1.7. Aromatic plants. 215 species, 7 subspecies, 1 variation of aromatic plants belonging to 58 families and 162 genera are spread in the research area. Some aromatic plants are also used as food additives and spices. The flora of the region includes spicy food plants such as *Asperugo procumbens* L., *Artemisia absinthium* L., *Artemisia vulgaris* L., *Daucus carota* L. and etc.

6.1.8. Technical plants. In the flora of Qakh district, 124 species, 5 subspecies, 1 variation of technical plants belonging to 50 families and 94 genera are spread. Some technical plants are widely used by the locals. For example, *Paliurus spina-christi*, *Phragmites australis*, *Corylus avellana* and others. In the study area, a rare species of *Rhus coriaria* was cut down for use as firewood in some areas of the region.

6.2. A stock of some widespread medicinal plants. Medicinal plants are of special importance for the health of human life. The vegetation of the region is rich in useful species of wild plants, which are important for the medical industry, and there are opportunities to use them. Some medicinal plants in the study area are widely distributed in the wild nature. For this purpose, the raw material

²⁸ Ibrahimova A.G. Ornamental plant species richness along elevation gradient of Qakh district, Azerbaijan // AMEA Botanika İnstitutunun akademik Aleksandr Alfonsoviç Qrossheymin 130 illiyinə həsr olunmuş gənc alim və tədqiqatçıların "Müasir botanikada innovasiya və ənənələr" mövzusunda konfrans, – Bakı, – 20 dekabr, – 2019, – s. 34.

reserves of 7 widespread medicinal plants (*Achillea nobilis*, *Ajuga genevensis*, *Lepidium draba*, *Origanum vulgare*, *Peganum harmala*, *Pojarkovia pojarkovae* and *Scilla sibirica*²⁹) were studied. As a result of research and analysis, their distribution in the area, dry raw material productivity (kg/ha), biological and operational raw material reserves and possible annual supply capacity were identified.

The raw material for the following medicinal plants were studied and calculated: *Achillea nobilis* - the total possible annual supply capacity has been identified with 2.11 t in 13.5 ha studied area (aboveground part); *Ajuga genevensis* – the total possible annual supply capacity has been identified with 1.53 t in 22.5 ha studied area (aboveground part); *Lepidium draba* – the total possible annual supply capacity has been identified with 9.41 t in 161 ha studied area (aboveground part); *Origanum vulgare* – the total possible annual supply capacity has been identified with 7.94 t in 25 ha studied area (aboveground part); *Peganum harmala* – the total possible annual supply capacity has been identified with 74.27 t in 55 ha studied area (aboveground part); *Pojarkovia pojarkovae* – the total possible annual supply capacity has been identified with 303.36 ha in 540 t studied area (aboveground part); *Scilla sibirica* – the total possible annual supply capacity has been identified with 16.01 t (aboveground part) and 7.23 t (aboveground part) in 24 ha studied area.

RESULTS

1. In the flora of Qakh district, 1218 species, 77 subspecies and 3 variations belonging to 112 families and 543 genera were identified and a flora abstract of the area was prepared. The predominate families in the flora of the study area are (137 species, 15 subspecies; 11.71%), *Poaceae* Barnhart (104 species, 2 subspecies; 8.17%) və *Fabaceae* Juss. (87 species, 6 subspecies; 7.16%). Four new species

²⁹ Ibrahimova, A.G., Mehdiyeva N.P., Alizade, V.M. Phytocenotic characteristics and natural resources of *Scilla sibirica* (Hyacinthaceae) in the northwestern Azerbaijan // AMEA Botanika İnstitutu və Azərbaycan Botaniklər Cəmiyyətinin akademik Valeri Ulyanişşevin 120 illiyinə həsr edilmiş simpozium, – Bakı, – 25 dekabr, – 2018, – s. 65.

for the flora of the region (*Adiantum capillus-veneris*, *Erigeron annuus*, *Lathraea squamaria*, *Papaver macrostomum*) and new distribution areas for 10 species were identified. *E. annuus* is new to the flora of Azerbaijan.

2. The grasses are dominated by 88.37% of the flora in the region (annual - 285, annual or biennial - 36, biennial - 54, biennial or perennial - 15, perennial - 757). 11.63% of the total flora consists of woody plants (tree - 53, tree or shrub - 23, shrub - 56, subshrub - 4, semishrub - 9, semi-subshrub - 2, liana - 4). Following this analysis, phanerophytes are represented in the flora of the area by 134 taxa (10.32%), chamephytes by 17 taxa (1.31%), hemicryptophytes by 678 taxa (52.23%), cryptophytes by 149 taxa (11.48%) and terophytes by 320 taxa (24.65%).

3. The flora of the study area is dominated by 478 (36.82%) boreal, 363 (27.96%) xerophilous and 254 (19.57%) Caucasian geographical area types. In addition, there are 55 (4.23%) ancient, 31 (2.39%) steppe, 20 (1.55%) desert and 25 (1.93%) adventive geographical area types. The geographical area type of 72 plants (5.55%) is unknown.

4. According to the analysis by ecological groups, 726 (56%) mesophytes, 167 (13%) xerophytes, 59 hygrophytes (5%) and 5 (0.39%) hydrophytes are in the flora of the region. Xeromesophytes belonging to transitional ecological groups were represented in the study area by 171 (13%), mesoxerophytes by 129 (10%), hygromezophytes by 25 taxa (2%) and mesohygrophytes by 16 taxa (1%).

5. In the general flora of the region 171 species, 10 subspecies (13.94%) are endemic to the Caucasus, 3 species (0.23%) are endemic to Azerbaijan; 166 species, 11 subspecies, 1 variation (13.71%) relict plants; 56 species, 4 subspecies, 1 variation (4.7%) were recorded as rare plants. There are 14 (1.08%) invasive species in the flora of the region.

6. 8 types of vegetation have been identified for the vegetation of the region: 1) forest, 2) shrub, 3) meadow, 4) rock and talus, 5) water-wetland, 6) steppe, 7) semi-desert, 8) areas developed for

agricultural crops. Various changes in the vegetation types of the region under the influence of climate, anthropogenic and natural factors were noted.

7. According to the effective use of the flora of the region, 965 species, 51 subspecies, 2 variations (78.43%) of economically important plants belonging to 106 families and 467 genera were spread in the area. Out of these, 571 medicinal, 485 dyes, 412 decorative, 373 foods, 367 feeds, 336 melliferous, 223 aromatic and 130 have different technical properties. Possible annual supply capacity for widespread medicinal plants in the area *Achillea nobilis* - 2.11 t, *Ajuga genevensis* - 1.53 t, *Lepidium draba* - 9.41 t, *Origanum vulgare* - 7.94 t, *Peganum harmala* - 74.27 t, *Pojarkovia pojarkovae* - 303.36 t, *Scilla siberica* - 16.01 t (underground part) and *Scilla siberica* - 7.23 t (aboveground part).

PRACTICAL RECOMMENDATIONS

1. From the point of view of conservation of vegetation of Gakh region, especially in the central, northern and north-eastern part of the region it is recommended to carry out organizational work on pasture management, application of grazing norms and strict observance of grazing periods with certain shifts and planned grazing of cattle. Thus, in this regard, special pastures and hayfields should be allocated in the area, and the issues of proper organization of the time of land rest in these areas should be planned.

2. In order to prevent intensive natural processes (soil erosion, landslides, floods, etc.) in the mountainous areas (northern and north-eastern part) of the region, it is recommended to increase the number of soil and irrigated plant species in terms of strengthening mountain slopes. In this regard, *Cotinus coggygia*, *Rhus coriaria*, *Rhamnus pallasii*, *Lonicera caprifolium*, etc. plant species can be used to strengthen slopes such as on the mountain slopes.

3. In terms of protection of rare plant species in the flora of the study area, it is recommended to carry out following works: the development of information boards, regular monitoring of the distribution of very endangered plants (*Atropa caucasica*,

Cephalanthera rubra, *Ophrys apifera*, *Limodorum abortivum* and etc.), as well as the organization of collection of seeds of rare plant species in nature without harming the gene pool.

4. In terms of protection of plant diversity of the local flora of the region, it is necessary to carry out monitoring and mechanical control measures (removal of plants from the soil) in areas where invasive plant species are widespread, as well as to carry out future research on the bioecology of invasive plant species.

List of published scientific works on the topic of the dissertation:

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