

REPUBLIC OF AZERBAIJAN

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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

**THE SPURGE FAMILY (*EUPHORBIACEAE* JUSS.) SPREAD
IN THE FLORA OF THE NAKHCHIVAN AUTONOMOUS
REPUBLIC: BIOECOLOGICAL FEATURES, RESERVES
AND PHYTOCHEMICAL COMPOSITION**

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GENERAL DESCRIPTION OF WORK

Relevance and development of the topic. Determining the adaptation of plants to changing environmental conditions, distribution patterns, raw material resources, bioecological and phytocenological characteristics of promising species is one of the issues of special importance in the last century within the biodiversity protection^{1,2}. The Nakhchivan Autonomous Republic is a typical mountainous territory with many different soil-climatic and landscape features, which in turn has allowed the formation of rich biodiversity in the area. Rocks, rocky-gravelly dry slopes, meadows, steppes, deserts and semi-deserts, forest cover, bushes, and pastures includes in the landscape of the area. Although each of these areas has own flora and vegetation, the presence of phytocenoses with similar composition is noteworthy. One of the most important and economically important issues is the study of phytocenoses formed by species of the family Euphorbiaceae, the determination of beneficial properties and ways of their use, protection and sustainable use of rare species. In general, phytochemical studies have not been carried out in the flora of the Autonomous Republic to assess the current state of vegetation and to select as a source of raw medicine, which were selected as a separate research object of the *Euphorbiaceae* family. Some information about the family can be found in the works of individual researchers in recent years^{3, 4}. Therefore, the species composition of the family in the flora of the area, the role of plant species, the study of rare and useful species is urgent.

¹ National Strategy for the Protection and Sustainable Use of Biological Diversity in the Republic of Azerbaijan for 2017-2020 [Electronic resource] // - Baku: Ganun, - 2016. <http://www.e-qanun.az/framework/33817>

²Buckland, S.T. Monitoring the biodiversity of regions: key principles and possible pitfalls / S.T.Buckland, A.Johnston // Biol. Conserv. – 2017. –V. 214, –P. 23–34.

³Talibov, T.H. Taxonomic spectrum of the flora of the Nakhchivan Autonomous Republic. (Higher spore, bare-seeded and covered-seeded plants) /T.H.Talibov, A.Sh.Ibrahimov, - Nakhchivan: Ajami, -2008. –364 p.

⁴Talibov, T. Poisonous plants of the flora of the Nakhchivan Autonomous Republic / T.Talibov, F. Safarova, –Nakhchivan: Ajami, –2017. –232p.

Drugs that are already used in the treatment of many diseases are synthesized from isolated bioactive molecules of some species belonging to the *Euphorbiaceae* family in most countries of the world^{5, 6}. Phytochemical research of such medicinal plants has not been studied to date. On the other hand, if we take into account that many species of this family are rare and endangered meet in the Azerbaijan Republic only in the territory of Nakhchivan AR, then it becomes clearer how important it is to assess these species within the range.

All of the above, the role and habitats of species included in the less studied family Euphorbiaceae in the flora of Nakhchivan AR in existing natural ecosystems and agrophytocenoses, detection of succession processes in different species of the family, their abundance, productivity and changed new habitats provides a basis for the selection and development of a number of other problematic issues that need to be addressed in Azerbaijan as an assessment of species that are unique to the flora of the autonomous republic as a research object

The purpose and tasks of the research. To clarify the taxonomic composition of family, to classify the species by studying the biomorphological and phytocenological features, to distinguish the types of cenosis (dominant, subdominant, edificator), to study the conservation and rational use of some species of *Euphorbiaceae* Juss. in the territory of the Nakhchivan Autonomous Republic.

To clarify the taxonomic composition of the family Euphorbiaceae Juss. in the territory of Nakhchivan Autonomous Republic, to study and classify the biomorphological, phytocenological features of species, to differentiate the coenosis-forming species (dominant,

⁵Fernanda, W.F. Bezerra. Bioactive Compounds and Biological Activity of Croton Species (Euphorbiaceae): An Overview /W.F.B.Fernanda, N.B.Priscila, S.O.Mozaniel [et al]//Current Bioactive Compounds, –2020, –Volume 16 , –Issue 4, –pp.383-393.

⁶Maryam, J. Pharmacological activities of selected plant species and their phytochemical analysis / J.Maryam, M.Bushra, Y.Abida [et al] // Journal of Medi. Plants Research. –2012. –Vol. 6 (37), –pp.5013-5022. DOI: 10.5897/JMPR09.259

subdominant, edificator), to study the reserve and phytochemical composition of some species, to prepare relevant recommendations and proposals on the protection and efficient use of rare species.

The following tasks are planned to be performed in order to achieve the goal of the research:

- Compiling taxonomic spectrum and conducting systematic analysis of plants belonging to the family spurge in the flora of Nakhchivan AR

- Biological, phytographical and ecological analysis of species belonging to the family spurge

- Identification of endemic, rare and endangered species, study of ways of their effective use and protection

- Study of distribution patterns of species of the family spurge in vegetation types, description of formations and associations with their domination, analysis of coenosis-forming species;

- Study of reserves and phytochemical composition of some species of the spurge family

Compilation of a map scheme of habitats in the territory of the Autonomous Republic.

Research methods. The researches were carried out in stationary and semi-stationary, photographs of rare species and formations were taken separately. Classical and modern botanical-floristic, systematic, ecological, areological, phytocenological and statistical methods were used during the research. The conservation status of rare species has been assessed, and the reserve and density of some species have been studied. Phytochemical analyzes were performed, the density of pigments was determined and the density was calculated.

The main provisions submitted to the defense:

- Bioecological and taxonomic research of species of *Euphorbiaceae* family distributed in the flora of Nakhchivan AR, compilation of identifying keys, development of area maps are the basis for use as a source in writing flora;

➤ Results of a resource assessment of some useful species are suitable for use as a raw material base;

➤ The species of *Euphorbiaceae* family most of which are resinous, medicinal, oil and dye plants are important for the production of bioactive substances and the development of various applications.

Scientific novelty of the research. The final classification spectrum of species included in the family, phytocenoses formed by them, perspectives of use and ways of protection of rare species of *Euphorbiaceae* Juss spread in the territory of Nakhchivan AR are studied at the first time.

4 new species belong to 2 genus for the family: *Acalypha australis* L. - Southern akalifa, *A.hispida* Burm. f. - *Fibrous akalifa*, *Euphorbia marginata* Pursh - Bordered euphorbia and *E.milii* Des Moul. - Milius breast was found for the first time. It that 35 species of 5 genus of the *Euphorbiaceae* family are distributed in the local flora has been clarified. A systematic review and taxonomic spectrum of the representatives of the family was compiled, their bioecological and phytocenological features were studied, and their role in the formation of flora and vegetation of the region was determined. Ecobiomorphological and phytogeographic analysis of natural ecosystems was carried out, rare and endangered species were identified, reserves of some species were calculated and phytochemical composition was analyzed, and the dynamics of pigment accumulation was studied.

For the first time, new distribution zones were discovered for two species whose distribution is not shown in mountainous and high mountain belts, and the plant cenosis formed were described. Modern phytocenological classification of vegetation in summer pastures, subalpine meadows and steppes, in which plant species are dominant, subdominant or component has been given.

8 plant types, 29 formation classes, 87 formations and 128 associations were identified in the classification. 25 phytocenoses were newly discovered for the vegetation of Nakhchivan AR during the study period.

Genus and species of the *Euphorbiaceae* family have been identified according to the main diagnostic features, regularity of distribution in altitude zones, abundance, quantity ratios, life forms, cenosis pathogens, geographical-genetic relations, efficient use of biological resources of useful species, protection methods analyzed and scientifically substantiated.

Phytocenoses of the studied species exposed to natural and anthropogenic influences have been identified, relevant proposals and recommendations have been prepared for their improvement, increase of productivity and protection.

Theoretical and Practical significance of the research. Changes and additions to the family, as well as systematic and taxonomic analysis, information on rare and useful species can be found in the new edition of "Flora of Azerbaijan", "Useful Plants of Azerbaijan" and "Red Book of Azerbaijan". The results and proposals of the research can be used as a country study material in the teaching of "Biology" and "Ecology" in the institutions of the Ministry of Education of Nakhchivan AR. Numerous plant samples collected during field research are useful for their enrichment by being handed over to the Herbarium funds of the Institute of Bioresources of the Nakhchivan Branch of ANAS, the Institute of Botany of ANAS and Nakhchivan State University. At the same time, plants of the *Euphorbiaceae* family can be used in the manufacture of medicines.

Approbation. The main provisions of the dissertation were covered at local and international conferences: at the Conference of Young Scientists and Researchers on "Innovation and Traditions in Modern Botany" - Baku, Azerbaijan (December 20, 2019); "Tropical issues of the development of modern science" Abstracts of VII International Scientific and Practical Conference, - Sofia, Bulgaria (March 11-13, 2020); The 5th Symposium on EuroAsian Biodiversity – Almaty, Kazakhstan, –Mugla, Turkey (SEAB; 01-03 July, 2021) and was discussed at the seminars of Nakhchivan State University and the Institute of Botany of ANAS.

In general, 10 scientific works reflecting the main provisions of the dissertation were published, 7 of which are papers.

Name of the organization where the dissertation work is performed. The dissertation work was carried out at the Department of Botany of Nakhchivan State University.

Volume and structure of the dissertation: The dissertation is written in the Azerbaijani language and consists of 193 pages. It includes an introduction, a main consisting of 6 chapters, conclusions, suggestions and recommendations (total volume with signs - two hundred and eight thousand), a list of 190 references and appendices used. In the dissertation 36 figure (additional 37), 33 tables, 7 maps are given. The appendices include a complete classification of vegetations of the to which the members of the family belong and pictures of the plant groups they encounter.

CHAPTER I. RESEARCH SITUATION OF *EUPHORBACEAE* JUSS. FAMILY DISTRIBUTED IN THE NAKHCHIVAN AUTONOMOUS REPUBLIC

The research work for the study of *Euphorbiaceae* family carried out in the territory of the Nakhchivan Autonomous Republic by botanists has been evaluated so far. It became clear that this family has not been studied as a separate object of research for many years, and is reflected only in floristic-systematic works. No work to study the biomorphological and phytocenological characteristics of the representatives of the family, the identification of useful species, as well as the study of the reserves and phytochemical composition of some species has been done in the territory of the Autonomous Republic.

CHAPTER II. PHYSICAL-GEOGRAPHICAL CONDITIONS, MATERIALS AND METHODS OF THE NAKHCHIVAN AUTONOMOUS REPUBLIC

2.1. Physical and geographical conditions of the area. The relief, climate, average annual temperature, amount of precipitation during the year, water networks and geological structure of the Autonomous Republic were studied on the basis of literature data.

2.2. Research materials and methods. The research was carried out in short, long-term expeditions on 230 routes in 7 districts of Nakhchivan AR in spring, summer and autumn of 2016-2019 years. "Flora of Azerbaijan" (1955), "Planter of the Caucasus" (1949) and etc. determinants were used in the development of the collected herbarium materials. The taxa are named after modern nomenclature changes, and the conservation status of rare species is based on the IUCN's Red List Criteria (2003; 2012) and the Red Data Book of Azerbaijan (2013). Life forms of plants determined by I.G. Serebryakov (1964) and C.R.Raunkier (1934) methods, phenological observations by I.N.Beydeman (1979) and O.V.Yanser (2018), ecological groups by V.V.Alekhin (1950), A.R.Shennikov (1964), area types, classes, and groups have been classified according to separate studies by A.A.Grossheim (1936; 1962) and N.N.Portenier (2000). The classification of vegetation is based on the principles of ecological, phytocenological and dominance. The researches of V.V.Alekhin (1950), B.A.Bikov (1978), E.M.Lavrenko (1982), T.A.Rabotnov (1992) were used. Plant reserves and densities were studied according to the methods of I.A. Krylov and A.M.Schreter (1971). Extracts from different parts of plant samples during phytochemical analysis were developed on the basis of modern methods (Godnev, 1952; Shlyk, 1968; 1971; Harborne, 1998; Popova et al., 2009).

CHAPTER III. INVESTIGATION OF *EUPHORBIACEAE* JUSS. FAMILY DISTRIBUTED IN THE NAKHCHIVAN AUTONOMOUS REPUBLIC

3.1. An overview of the general classification of *Euphorbiaceae* Juss. family. The *Euphorbiaceae* family is one of the most diverse species of evergreen plants, including trees, shrubs, lianas, and grasses. There are more than 7,500 species of 300 genus on Earth. Different scientists have different views on the classification of *Euphorbiaceae* family in the flora of Azerbaijan.

A.A.Grossheim's for the first time is noted in "Flora of Azerbaijan" (1935) that from 34 species of 5 genus of the family, 22 species and 4

genus of the family are distributed in the territory of the Autonomous Republic. 23 out of 46 species of the 6 genus of the family according to “Flora of Azerbaijan” (1955) and E.M. Gurbanov's “Systematics of Higher Plants” (2009), including some species introduced in cultural flora from 54 species of 8 genus 29 species of 4 genus are distributed in the territory of the Autonomous Republic according to A.Asgarov (2016).

3.2. Taxonomic structure of *Euphorbiaceae*. The taxonomic structure of the *Euphorbiaceae* family for the territory of the Autonomous Republic includes 1 order, 1 suborder, 3 sub-family, 4 tribes, 5 genus, 11 sectors and 35 species. In terms of the number of species. The *Euphorbia* L. genus is superior to 26 species (74.29%) and is considered superpolymorphic. The remaining 4 genus account for 9 species (25.71%). One of the other species was considered polymorphic (11.43%), two were considered moderate (11.43%), and one genus was considered minor (2.86%) (Table 1).

Table 1.

The position of species according to genus in the *Euphorbiaceae* Juss. family

№	Genus	Species	In% of the total number (35)
1.	<i>Andrachne</i> L. - <i>Andrachne</i>	4	11,43
2.	<i>Chrozophora</i> A. Juss. - <i>Chrozophora</i>	2	5,71
3.	<i>Acalypha</i> L. - <i>Acalypha</i>	2	5,71
4.	<i>Ricinus</i> L. - <i>Ricinus</i>	1	2,86
5.	<i>Euphorbia</i> L. - <i>Euphorbia</i>	26	74,29
	Total:	35	100

CHAPTER IV. BIOECOLOGICAL CHARACTERISTICS OF THE *EUPHORBIACEAE* FAMILY IN THE TERRITORY OF NAKHCHIVAN AR

4.1. Biomorphological features of species of the *Euphorbiaceae* Juss. family. Biomorphological features of the species of the *Euphorbiaceae* Juss. family widespread in the Autonomous Republic were studied, and keys by genus and species were compiled

(comments are given in the dissertation). The flowers of the genus are unisexual or bisexual, as well as monoecious or dicotyledonous plants. Male flower - $*P_0A_1G_0$, female flower - $*P_0A_{(0)}G_{(3)}$ is shown by the formula (3). The seeds are endospermic (Figure 1-2).

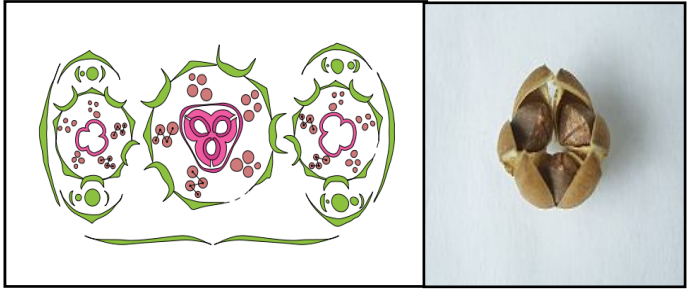


Figure 1. Flower scheme and fruit structure of *Euphorbiaceae* family

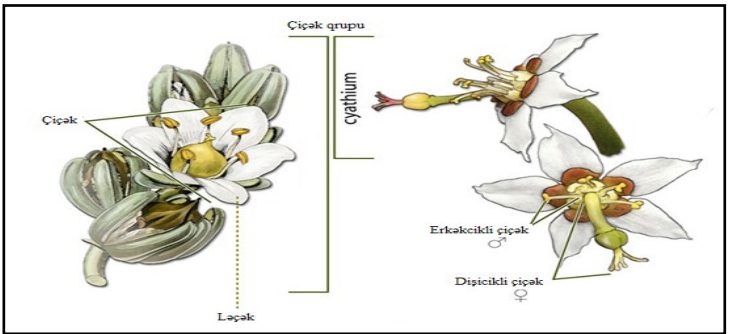
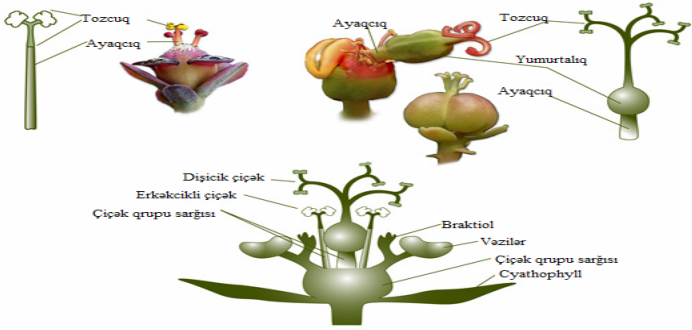


Figure 2. Flower structure of *Euphorbiaceae* family

4.2. Geographical (areological) and ecological analysis of the *Euphorbiaceae* family. Representatives of the family belong to 14 classes or groups of 7 vegetation types according to their geographical and genetic connections. Among them, the predominance of Mediterranean-Iran-Turan, Central Asia, Caucasus, Atropatan and Adventive floragenetic elements was observed. Life forms of plants were studied according to I.G.Serebryakov methods (1964) and 4 out of 35 species are semi-shrubs, 3 are shrubs, 10 are perennials, 18 are monocotyledons (Figure 3) were found.

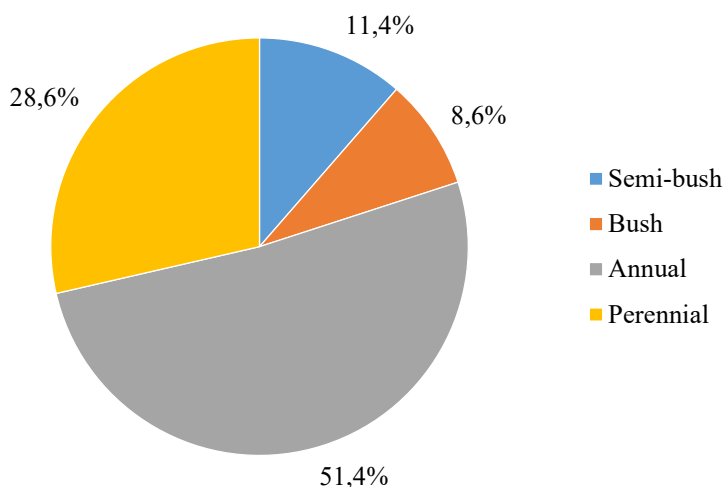


Figure 3. Life forms of the species included in the family (according to Serebyakov)

Species of the *Euphorbiaceae* family also have been analyzed for life forms developed by Raunkier (1934) (Table 2).

Phanerophytes-megaphanerophytes are not found in the genus as can be seen from the table. The 3 shrubs (8.57%) mentioned in the genus belong to nanophanerophytes. Therophytes include 17 species (48.57%) and rank first in the number of species. Hemicyptophytes are second with 9 species (25.71%). Hamephytes include 5 species

(14.29%) of hemispheres and armpits. Only 1 species (2.86%) *Euphorbia condylocarpa* belongs to cryptophytes.

Table 2.

**Vital forms of species of *Euphorbiaceae* family
(according to Raunkier)**

Vital forms	Number of species	In% of the total number
Phanerophytes (Ph)	-	-
Nanophanerophytes (Nph)	3	8,57
Khamephytes (Kh)	5	14,29
Hemicryptophytes (Hc)	9	25,71
Cryptophytes (C)	1	2,86
Therophytes (T)	17	48,57
Total:	35	100

The role of soil-climatic factors in the life of plants was also studied. The plants belonging to the *Euphorbiagenus*, distributed in Nakhchivan AR, were divided into 3 eco-biological groups and 14 subgroups according to their attitude to light, humidity and nutrients. There are 17 species of heliophytes in terms of light (48.6%), 14 species in terms of xerophytes (40%) in terms of humidity, and 12 species (34.2%) in terms of nutrients.

4.3. Regularity of distribution of *Euphorbiaspecies* on vertical zoning and species richness.The spurge, which is mainly xerophytic plant, and more common in dry, well-lit areas have shown geobotanical studies. In this regard, the first place is occupied by plains and low and middle mountain ranges, the second place is occupied by foothills, the upper mountain range and the third place is occupied by high mountains. Only one species is also found in the lower borders of the subnival zone. They are distributed as a component, dominant and subdominant in different plant types in the subalpine and alpine belts, starting from the plains. Some spurge species in the area have been proven by factual material to be found in higher mountain ranges.

Depending on the diversity of soil and climatic factors, geographical location, orography of the Autonomous Republic, wild

Euphorbia species are unevenly distributed in different altitude zones: in the plains - 10 (28.6%), in the foothills - 1 (2.9%), in the lower mountain range - 11 (31.4%), in the middle mountain range - 6 (17.1%), in the upper mountain range - 4 (11.4%), in the subalpine belt - 2 (5.7%), alpine and in subnival mountain belts 1 (2.9%) species from subalpine mountain belts are rare. For comparative analysis by zones, the species richness of some members of the family was assessed: Boyukduz plain (*E.seguieriana*) in Babek districts; Nakhchivan plain (*E. granulata*); Gulustan plain in Julfa district (*E.marschalliana*); Yayci and Desta plains (*E. helioscopia*) in Ordubad district; in the area of Bichenak-Batabat (*E.iberica*), (Table 3).

Table 3

Assessment of *Euphorbia* species variety in some areas

Regions	Number of species	Total number of individuals	Species richness index
Boyukduz plain	13	98	1,31
Nakhchivan plain	25	121	2,3
Gulustan plain	22	110	2,1
Deste plain	17	132	1,5
Yaychi plain	28	127	2,5
Bichenak-Batabat	35	165	2,9

Species richness index (2017) is the lowest in the Boyukduz Plain and Yaychi Plain, 1.31 and 1.5, respectively was determined. This indicates the poverty of species in those areas. The index of species richness was 2.9 in Bichenak-Batabat. Species richness in arid plains is low or high or normal in relatively humid mountainous areas.

CHAPTER V. PHYTOSENOLOGICAL CHARACTERISTICS OF *EUPHORBIA* SPECIES SPREAD IN THE NAKHCHIVAN AUTONOMOUS REPUBLIC

5.1. Phytocenological study of *Euphorbia* species and classification of plant species they include. The study of

phytocenological characteristics of species belonging to the family of spurge and the determination of the classification of plant species to which they belong plays a very important role in terms of studying the current state of vegetation in the area. The abundance and edifice of individual plant species often play a key role, rather than the abundance of individual genus and species in the complexity and physiognomy of plants. Modern phytocenological classification of plants in summer pastures, subalpine meadows and steppes, where *Euphorbia* are dominant, subdominant or component in plant types, has been studied by us^{7,8}. Dominant species of the family have been identified in the area flora (Table 4).

Table 4

Dominant species by the genus of the *Euhorbiaceae* Juss.family

№	Genus	Number of species	By %	Dominant species	According to the total number, by %
1	<i>Andrachne</i> L.	4	11,43	2	5,71
2	<i>Chrozophora</i> Adr. Juss.	2	5,71	1	2,86
3	<i>Euphorbia</i> L.	26	74,29	8	22,86
4	<i>Acalypha</i> L.	2	5,71	-	-
5	<i>Ricinus</i> L.	1	2,86	-	-
	Total:	35	100	11	31,43

11 species of cenosis plants are combined in 5 genus, which are mainly dominant species, but can also participate in groupings as

⁷Talibov, T.H., Khudaverdiyeva, S.F. Morphobiological and phytocenological features of species belonging to the *Andrachne* L.genus in the territory of the Nakhchivan Autonomous Republic // Proceeding of the Azerbaijan State Agrarian University. –Ganja: –2018. –№1, –p.18-23.

⁸Khudaverdiyeva, S.F. Phytocenological research of some species of the *Euhorbiaceae* Juss.family in the territory of the Nakhchivan Autonomous Republic and the vegetation they include.// - Nakhchivan: Scientific works of Nakhchivan State University, - 2018. -n.7, - p.69-74.

edificators and subdominants as can be seen from the table. Examples of dominants and edificators from the *Euphorbiaceae* family that are more important in the formation of vegetation are the following species: *Euphorbia marschalliana*, *E.seguieriana*, *E.iberica* and others, the rest: *E.helioscopia*, *E.arvalis*, *E.chamaesyce*, *E.condylocarpa*, *E.humifusa*, *E.granulata*, *E.heteradena*, *Andrachne filiformis* are more subdominant species. In general, 8 vegetation types (forest, meadow, shrub, mountain xerophyte, mountain steppe, semi-desert, petrophilic, agrophytocenosis), 29 formation classes, 87 formations and 128 associations were identified in the terrestrial flora (Table 5).

Table 5

**Classification of plant groups created by species of
Euphorbiaceae Juss. family by plant types**

№	Vegetation type	Formation class	Subtype	Formation	Association
1	Forest vegetation	3	-	9	14
2	Shrubs	2	-	7	11
3	Meadow vegetation	14	5	44	51
4	Mountain-xerophyte vegetation	3	-	12	22
5	Mountain-steppe vegetation	3	-	10	19
6	Petrophilic vegetation	2	-	2	2
7	Semi-desert vegetation	1	-	2	9
8	Agrophytocenosis	1	-	1	-
Total:		29	5	87	128

For the first time, we described 25 phytocenoses, of which one is a formation class, 6 - formations, 15 - associations and 3 - groupings (Table 6). It should be noted that these groupings are formed by the dominance and subdominance of species of the spurge family.

Table 6

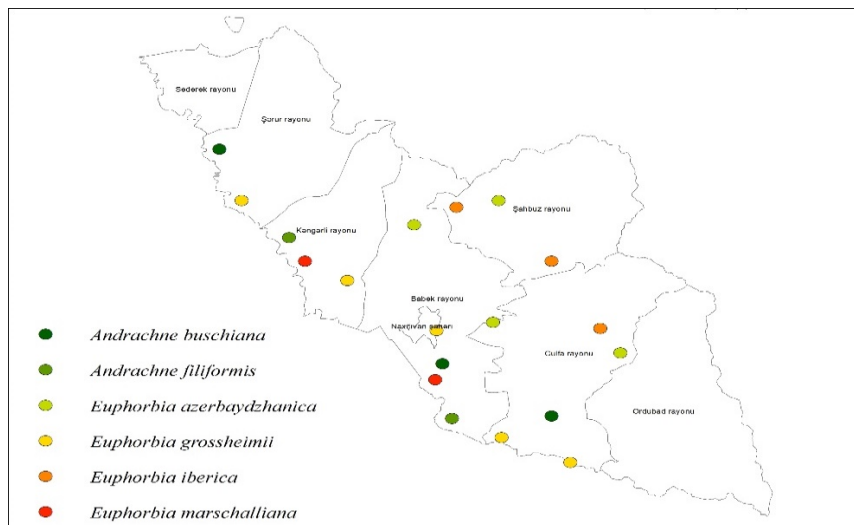
New phytocenoses formed with the participation of the species of the family Euphorbiaceae Juss.

№	Name of phytocenoses
Formation class	
1.	grain-sedge-motley grasses-spurge
Formations	
1.	tiled iris-spurge
2.	bush-grain-ephemeral-spurge
3.	goat's wheat-buckthorn-spurge
4.	spurge-sorrel-monkshood-scotch thistle
5.	spurge-blue grass- amoria
6.	spurge-gromwell-dogrose
Associations	
1.	motley grasses - ephemeral - sunflowered-spurge
2.	dog's tooth grass – motley grasses - spurge
3.	spurge - spirea - ajlet- apple
4.	goat's wheat - motley grasses – spurge-juniper
5.	spurge-peashrub- goat's wheat-bean caper
6.	spurge- wormwood-sage-pepperwort
7.	spurge-wormwood-feather grass
8.	segiyerov spurge-iranian tickseed-aegilops
9.	spurge-betony
10.	wormwood-tickseed-spurge
11.	spurge-speedwell-eastern poppy-blue grass
12.	spurge-giant fennel-blue grasses-eastern poppy
13.	spurge-blue grasses-peas
14.	spurge-chaerophylle-comfrey
15.	spurge-dandelion-crowfort-omum plant
Grouping	
16.	gravelly spurge-two –inch aegilops
17.	eastern spurge-blue knapweed
18.	spurge-bedstraw-valeriana-giant-fennel

5.2. Conservation of endemic and rare species of *Euphorbiaceae* family. Climate change in nature and increasing anthropogenic pressures can affect the elements of biodiversity in various ways, bringing some of them to critical levels. In this case, endemic and rare species that are poorly adapted to the conditions,

especially those belonging to the regions, become few in number or are in danger of extinction, unable to recover their populations. In this regard, the biodiversity of each region should be periodically inspected, the condition of the species should be monitored and an appropriate action plan should be developed for their protection⁹.

6 species of spurge are found in Azerbaijan only in the territory of Nakhchivan AR: *Andrachne filiformis*, *Andrachne buschiana*, *Euphorbia azerbaijdzhanica*, *E.grossheimii*, *E.iberica*, *E.marschalliana* most of which are subendemic species (map).



Map. Map-scheme of subendem species of spurge found in Nakhchivan AR

New distribution zone of *Euphorbia azerbaijdzhanica* species around the Chalkhangala village in the Kangarli district also has been discovered by us.

⁹ Гамбург, К.З., Казановский, С.Г., Верхозина, А.В., Кривенко, Д.А. Реинтродукция как способ сохранения редких и исчезающих растений Прибайкалья // Экологический риск и экологическая безопасность: Мат. III Всерос. науч. конф. с междунар. участием: В 2-х томах. –Иркутск: Инст. Геогр.им В.Б. Сочавы СО РАН. –2012. –Т. 2, –с.235-237.

The localities of *Andrachne filiformis* and *Andrachne buschiana*, the distribution of which is limited to the territory of Nakhchivan AR, have been determined by us.

Andrachne filiformis is found in Azerbaijan only in the territory of Nakhchivan AR in the lowland plains, in the vegetation of sparsely arid dry slopes. In the populations encountered, groupings are caused by internal faults, unfavorable soil and climatic conditions, which delay the natural recovery and reduce the reserves. *Andrachne buschiana* was revealed in the vegetation of stony, rocky and sparsely shrubbed dry slopes in Nehram-Darasham of Babek district and Daridagh areas of Julfa district. Since both species are represented by a small number of samples within the population, as well as the status of these species with representatives of another genus within the phytocenosis was assessed¹⁰ (Table 7) and the exact locations of each species on the map were clearly indicated.

Table 7

Assessment of rare and endangered *Euphorbia* species in the Autonomous Republic

No	Name of species	Red Book of the Republic of Azerbaijan (2013)	Red Book of the Nakhchivan AR (2010)	IUCN Red list evaluation
1	<i>Euphorbia marschalliana</i> Boiss.	VU D2		
2	<i>Euphorbia oblongifolia</i> (C.Koch) C.Koch	VU D2		
3	<i>Euphorbia azerbaijanzhanica</i> Bordz.		VU B2a	
4	<i>Euphorbia grossheimii</i> Prokh.			EN B1 ab (i,ii,iii,iv,v) + 2b (i,ii,iii,iv,v)
5	<i>Andrachne filiformis</i> Pojark.			VU D2
6	<i>Andrachne buschiana</i> Pojark.			VU D2

¹⁰ Talıbov, T.H. Naxçıvan Muxtar Respublikasında yayılan Süddüyükimilər fəsiləsinin nadir növləri /T.H.Talıbov, S.F.Xudaverdiyeva //AMEA Naxçıvan Bölməsi. Xəbərlər, Təbiət və texniki elmlər seriyası, –Naxçıvan:Tusi, –2018. –Cild 14, –№4,–s. 74 -81.

CHAPTER VI. SIGNIFICANCE, PRECAUTIONS AND PHYTOCHEMICAL COMPOSITION OF SPECIES OF *EUPHORBIACEAE* Juss. FAMILY DISTRIBUTED IN THE NAKHCHIVAN AUTONOMOUS REPUBLIC

6.1. Importance of species of the *Euphorbiaceae* family. All *Euphorbia* species contain resin and rubber. Some species, like valuable ornamental plants have found a worthy application in landscaping and horticulture. Other species of the family are used in relevant industries as a source of raw materials rich in chemical composition and biologically active substances. 17 are resinous, 7 are ornamental, 6 are resinous and medicinal, 2 are ornamental and medicinal, 4 are dyes and medicinal, and 1 are oily, ornamental and medicinal species of the *Euphorbia* species distributed in the Autonomous Republic are considered.

6.2. Reserves of some species of the *Euphorbiaceae* family. The use of plant products in various industries has become widespread in the last century. In particular, the use of various plants as a source of biologically active substances in the protection of human health is an indispensable part of traditional medicine. In this regard, the identification of valuable species of spurge and the calculation of their reserves are relevant.

Reserves of *Andrachne telephioides*, *Chrozophora tinctoria*, *Chrosophora hierosolymitana*, *Euphorbia iberica*, *Euphorbia seguieriana*, *Euphorbia virgata* and *Euphorbia falcata* are assessment in the territory of the Autonomous Republic¹¹ (Table 8).

Chrozophora tinctoria (16.2-22.1 c/ha), *Chrozophora hierosolymitana* (14.3-15.4 c/ha) and *Euphorbia seguieriana* (12.37-15.9 c/ha) have higher annual operating reserves in the studied plant groups.

¹¹ Khudaverdieva, S.F. Stocks of some useful species of the *Euphorbiaceae* family, common in the Nakhichevan Autonomous Republic of Azerbaijan // Bulletin of Science and Practice. -2020. -vol. 6, -No. 5, -p. 46-52.
<https://doi.org/10.33619/2414-2948/54/05>

Table 8

**Raw material resources (raw weight) of some species of
Euphorbiaceae family in floristic regions**

Species name	Bioloji ehtiyat (gr/m ²)			Operational reserve (c/he)			Dry weight loss (c/he)		
	BD	JD	ShD	BD	JD	ShD	BD	JD	ShD
<i>Euphorbia seguieriana</i>	289± 12,87	-	361,1 +27,3	12,37 +1,5	-	15,9± 3,0	2,48± 0,10	-	3,19± 0,17
<i>Euphorbia virgata</i>	203,2 +20	-	181,7 +20,1	5,72± 1,12	-	9,48± 2,6	1,14± 0,7	-	1,90± 0,5
<i>Euphorbia iberica</i>	-	-	214± 14,3	-	-	4,82± 0,8	-	-	0,96± 0,16
<i>Euphorbia falcata</i>	-	192,9 +26,0	-	-	6,34± 2,4	-	-	1,27± 0,33	-
<i>Chrozophora hierosolymitana</i>	269± 15	-	223± 31,7	14,3± 4,2	-	15,4±5, 6	2,9± 0,8	-	3,1± 0,9
<i>Chrozophora tinctoria</i>	-	328± 16,9	311,4 +17,7	-	16,2± 2,7	22,1±7, 4	-	3,24± 0,78	4,42± 1,1
<i>Andrachne telephoides</i>	188,6 +26,3	173,5 +23,7	-	2,04 +0,62	3,79± 0,87	-	0,41± 0,12	0,76± 0,21	-

Note: BD-Babek district, JD-Julfa district, ShD-Sharur district

6.3. Phytochemical study of some species of *Euphorbiaceae* family. In general, *Euphorbia* species have bioactive compounds rich in chemical composition. Of these, *Chrozophora tinctoria* was selected for its variety of growing conditions, as well as its importance as a medicinal and dye plant. Extraction of individual substances from ethanol extract of fruits of *Chrozophora tinctoria* was carried out by column chromatography. A thin layer of plant ethanol extract was chromatographed, Rf values were obtained and the values obtained are shown in Table 9.

Table 9

Rf values on a thin-layer chromatogram of *Chrozophora tinctoria*

The resulting compounds	Rf assessment
Cyanide 3-glucoside	0,6
Cyanide 5-glucoside	0,6
Cyanide3-sophoroside-5-glucoside	0,53
Cemferol 3-O-(-6-α-O-ramnopyranosyl)-β-glucopyranosite	0,65
Cyanide 3,7,3'-triglycoside	0,67

The extract contains flavonoids 3-O-(6- α -O-ramnopyranosyl)- β -glucopyranoside, cyanide 3,7,3'-triglycoside, cyanide 3-sophoroside-5-glucoside, cyanide 3- glucoside and cyanide 5-glucoside were found.

6.3.1. Dynamics of changes in the amount of chlorophyll and carotenoid pigment in the leaves of *Chrosophora tinctora*. The adaptive response of plants to the environment is also reflected in their physiology^{12,13}. It is known that the activity of the pigment apparatus in plants varies not only depending on its structure, but also on climatic conditions, and most importantly, the level of insolation of sunlight¹⁴. Thus, high levels of insolation usually lead to low levels of chlorophyll in the plant, which indicates that the plant is light-loving, as well as adaptable to environmental conditions. So, the level of insolation is not the same everywhere, and the spectral distribution of sunlight occurs. This also affects the composition of photosynthetic pigments. The study of the amount of these pigments, and the analysis of their relative variability is a key indicator of the degree of adaptation of the plant to changing environmental conditions, as well as the ability of the photosynthetic apparatus to function.

For this purpose in order to study the dynamics of pigment changes in the leaves of *Chrosophora tinctora*, the centers of pigment absorption were identified and the dynamics of accumulation was determined in the extracts prepared on the basis of samples collected from Julfa, Kangarli, Shahbuz and Babek districts of the Autonomous Republic in 2017-2018¹⁵ (Figure 4-5).

¹²Maslova, T.G. Adaptive properties of the plant pigment systems /T.G.Maslova, I.A.Popova // Photosynthetica. –1993. –V. 29, –P. 195–203.

¹³Physiology of photosynthesis /ed.A.A.Nichiporovich. –M.:Nauka, –1982. –320p.

¹⁴Young, A.J., Gordon, L.L. “Carotenoids-Antioxidant Properties.” [Electronic resources] //Antioxidants, –Switzerland-Basel: –2018.–vol. 7(2), 28.

<https://doi.org/10.3390/antiox7020028>

¹⁵Khudaverdiyeva, S.F. Dynamics of change of chlorophyll and carotenoid pigments in leaves of *Chrosophora tinctora* species spread in Nakhchivan Autonomous Republic (Azerbaijan Republic) //International Journal of Scientific Reports. -2020. -6(8), -p.1-4. DOI:http://dx.doi.org/10.18203/issn.2454-2156

Chlorophyll-a pigment collected in the leaves of *Chrozophora tinctoria* is maximum in the territory of Shahbuz district (4.31-4.14mg/g by dry weight), minimum in the territory of Julfa district (2.23-2.54 mg/g by dry weight) was found. The highest amount of carotenoid pigment was determined in the samples collected from the territory of Julfa and Babek districts (1.42-1.63 mg/g; 1.65-1.59 mg/g by dry weight) every two years.

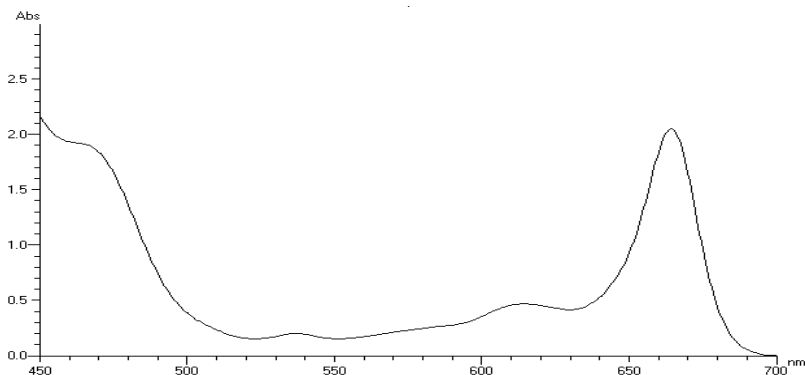


Figure 4. Absorption spectrum of chlorophyll pigment in *Chrozophora tinctoria*

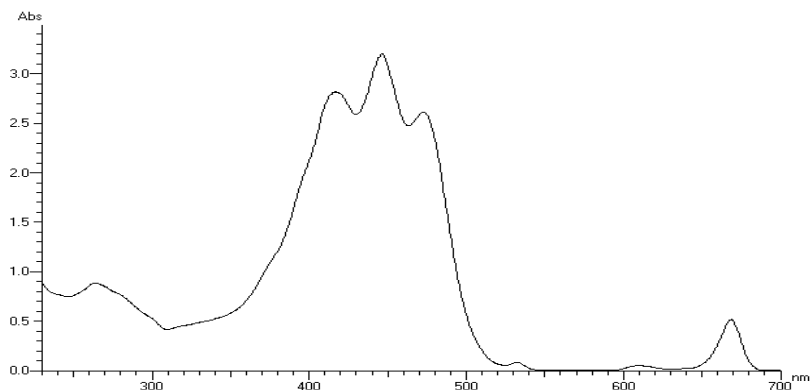


Figure 5. Absorption spectrum of carotenoid pigment of the *Chrozophora tinctoriagenus*

Due to the fact that leaf samples were taken during the growing periods of the plant, a decrease in the dynamics of the accumulation of chlorophyll b pigment relative to the chlorophyll a pigment was observed (Figure 6).

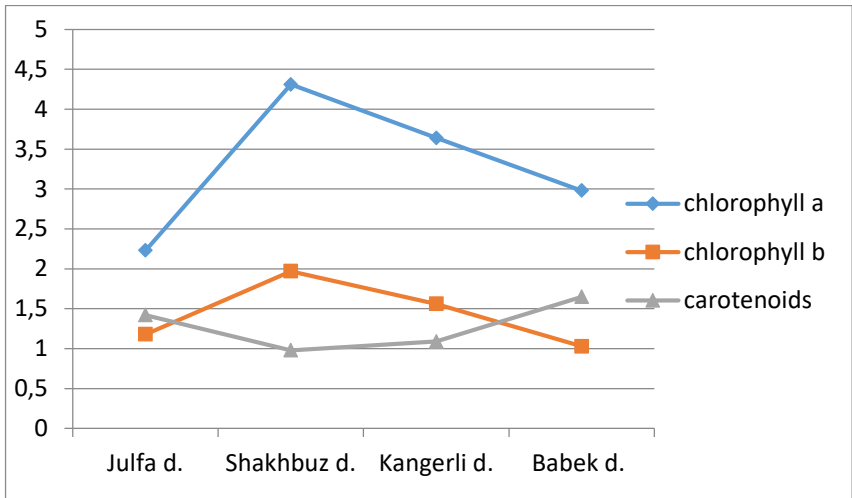


Figure 6. Dynamics of pigment accumulation in leaves of *Chrozophora tinctora* (2017)

To evaluate the performance of the plant's photosynthetic apparatus, the ratios of chlorophyll a pigment to chlorophyll b pigment (chl.a/chl.b) and chlorophyll pigments in carotenoids were determined and it was found that the chl.a/chl.b ratio was varied between 2,32-2,80 during the growing season (Table 10).

An increase in the amount of carotenoid pigment from 0.15 to 0.57 under high insolation conditions is an indication of the protection and adaptation of these pigments in the process of photosynthesis.

Table 10

Average annual amount of chlorophyll and carotenoid pigments in the leaves of *Chrosophora tinctora* (mg/g by dry weight)

No	Districts	Chlorophyll - a	Chlorophyll -b	Caratinoid	The total amount of pigments	chl.a /chl.b	chl.a+chl.b/ caratinoid
1	Julfad.	2,39± 0,07	0,87± 0,04	1,53±0,03	4,52±0,08	2,73	2,13
2	Shakhbuz d.	4,23 ± 0,05	1,82± 0,02	1,05±0,01	7,1±0,04	2,32	5,76
3	Kangarlid.	3,38±0,03	1,33±0,08	1,20±0,04	5,91±0,09	2,54	3,92
4	Babak d.	2,83±0,08	1,01±0,03	1,62±0,03	5,46±0,06	2,80	2,37

Conclusion

1. Determinants for the main diagnostic features of genus and species of the *Euphorbiaceae* family have been developed, a systematic review and a taxonomic spectrum of *Euphorbiaceae* Juss, which first spread in the territory of Nakhchivan AR have been compiled. The flora of the region is represented by 3 subspecies, 3 tribes, 2 sectors, 5 genus and 35 species, of which 4 new species belong to 2 genus (*Acalypha* L., *Euphorbia* L.) - *Acalypha australis* L., *A. hispida* Burm. f., *Euphorbia marginata* Pursh and one variation (*E. milli*. var. *splendes* (Bojer ex Hook.) Ursch & Leandri) were discovered for the first time.

2.4 out of 35 species are semi-shrubs, 3 are shrubs, 10 are perennials and 18 are annuals have been shown eco-biomorphological analysis of the representatives of the genus spread in the territory of the Autonomous Republic. From them 3 species are nanophanerophytes, 17 species are therophytes, 5 species are chamephytes, 9 species are hemicryptophytes and 1 species are cryptophytes. 14 subgroups: 17 species of heliophytes, 14 species of xerophytes and 12 species of basophils are dominated in terms of attitude to light, humidity and nutrients.

3. 14 classes and groups of 7 vegetation types: North Iran - 2 (5.7%), Mediterranean - 1 (2.9%), Mediterranean-Iran-Turan - 5 (14,3%), Mediterranean-Iran - 2 (5.7%), Palearctic - 1 (2.9%), Iran - 2

(5.7%), Central Asia - 5 (14.3%), Caucasus - 5 (14.3%), Atropatan - 5 (14.3%), Adventive - 7 (20%) species were identified as a result of the analysis of geographical and genetic relations.

4. The status of the species of the spurge family was assessed as rare and endemic and it was found that most of the 6 species are subendemic species found only in the territory of Nakhchivan AR. 4 species of the family have been included in the Red List, and 2 species have been assessed by us as rare plants in the flora of Azerbaijan.

5. Phytocenoses in which representatives of the family are dominant, subdominant, edifier or component in the formation of flora and vegetation of the region were identified, abundance, stratification was studied and 8 plant types, 29 formation classes, 87 formations and 128 associations were classified. Of these, 14 formations, 6 associations and 5 groups formed with the participation of *Euphorbia* were determined for the first time.

6. The regularity of the distribution of *Euphorbia* species in the altitude zones has been determined, and in the alpine and subnival mountain belts, 1 species from the subalpine belt has been rarely found. For the first time in the history of the study of two species that are not distributed in the alp and subnival mountain ranges, new distribution zones have been identified and formed the plant cenosis have been determined.

7. The useful properties of the *Euphorbia* species distributed in the territory of the Autonomous Republic were found and classified as resinous, ornamental, medicinal, dye and oil plants. Biological reserves of some species were also calculated: *Andrachne telephioides* 188.6 - 173.5 gr/m²; *Chrozophora tinctoria* 328 - 311.4 gr/m²; *Chrozophora hierosolymitana* 269 - 223 gr/m²; *Euphorbia falcata* 192.9 gr/m²; *Euphorbia iberica* 214 gr/m²; *Euphorbia virgata* 203.2 - 181.7 gr/m²; *Euphorbia seguieriana* 289 - 361.1 gr/m². *Chrozophora tinctoria* (16.2-22.1 c/he), *Chrozophora hierosolymitana* (14.3-15.4 c/ha) and *Euphorbia seguieriana* (12.37-15.9 c/he) have higher annual operating reserves.

8. Extracts from different parts of the *Chrosophora tinctoria* species were phytochemically analyzed and related to flavonoids 3-O-(-6- α -O-rhamnopyranosyl)- β -glucopyranoside, cyanide 3,7,3'-triglycoside, cyanide 3-sophoroside-5-glucoside, cyanidine 3-glucoside and cyanide 5-glucoside were found. Also, the richness of the pigment content as a dye plant was taken into account and the pigment composition and dynamics of pigment accumulation in the samples grown in different ecological conditions were studied.

SUGGESTIONS AND RECOMMENDATIONS

- *Euphorbiaceae* Juss. purposeful use of perspective species of nectar and pollen in the production of medicines, in the dye industry, as well as in beekeeping for the efficient and long-term use of perspective species;
- *Andrachne buschiana* Pojark. (VU D2) and *A.filiformis* Pojark. (VU D2) considering that species are found only in the flora of Nakhchivan AR and are distributed in a limited area, the inclusion of these species in the future edition of the Red List of Azerbaijan and special control of their main areas and reduction of restrictive factors;
- The use in the teaching of "Biology" and "Ecology" in the institutions of the Ministry of Education of Nakhchivan AR, informing farmers to prevent poisoning of dairy plants by cattle in winter and summer pastures, and to put warning signs in these areas is recommended.

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

1. Talibov, T.H., Khudaverdiyeva, S.F. *Euphorbiaceae* Juss., distributed in the territory of Nakhchivan Autonomous Republic. - On the study of the *Euphorbiaceae* Juss. family // - Nakhchivan: Tusi, Nakhchivan Branch of ANAS, "Xeberler", Natural and technical sciences series. - 2017. - vol. 13, - N.4, -p.86-91.
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- included in the family // Baku: Azerbaijan Agrarian Science, Scientific-theoretical journal. -2018. -№ 1, -p 75-78
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5. Khudaverdiyeva, S.F. Phytocenological research of some species of the *Euphorbiaceae* family in the territory of the Nakhchivan Autonomous Republic and the vegetation they include.// -Nakhchivan: Scientific works of Nakhchivan State University, -2018. -№.7, - p.69-74.
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<https://doi.org/10.33619/2414-2948/54/05>
9. Khudaverdiyeva, S.F. Dynamics of change of chlorophyll and carotenoid pigments in leaves of *Chrosophora tinctora* species spread in Nakhchivan Autonomous Republic (Azerbaijan Republic) //International Journal of Scientific Reports. -2020. -6(8), -p.1-4. DOI:<http://dx.doi.org/10.18203/issn.2454-2156>

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11. Khudaverdiyeva, S.F., Ibadullayeva, S.C. Ethnopharmacological features of *Euphorbia* L. species against cancer // The 5th Symposium on EuroAsian Biodiversity (SEAB-2021), -2021. -01-03 July, -p. 260.

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