

THE REPUBLIC OF AZERBAIJAN

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ABSTRACT

of the dissertation for the degree of Doctor of Philosophy

**PLANTS OF *GYMNOSPERMAE* DIVISION OF THE FLORA
OF NAKHCHIVAN AUTONOMOUS REPUBLIC:
SYSTEMATICS, BIOECOLOGY AND PHYTOCENOLOGY**

Specialty: 2417.01-Botany

Field of science: Biology

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Baku - 2022

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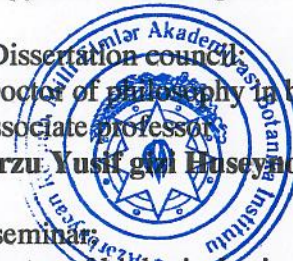

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GENERAL CHARACTERISTICS OF THE WORK

Relevance and degree of development of the topic: The recent rapid development of science and technology, global climate anomalies, environmental, anthropogenic, zoogenic factors that directly affect the flora and fauna, the protection of nature and the environment are among the main problems of the world community. At the same time, flora, especially plants that play the role of environmental filter, less demanding on fertile soils, better purify the atmosphere and enrich it with oxygen, have always been in the focus of researchers¹. From this point of view, the study of gymnosperm plants which grow in different ecological conditions in the vegetation of Nakhchivan AR and, which distribution areas have declined sharply in recent years, form a major part of the world's forests, especially coniferous, mixed and sparse arid forests, restoration of their natural resources, efficient use and strengthening of their protection are of great importance. In accordance with the order of the President of the Republic of Azerbaijan "State program on afforestation and reforestation development in the Nakhchivan Autonomous Republic in 2016-2020" was implemented. Last year alone, landscaping, afforestation and reforestation measures were carried out in 586.0 hectares, and 35,727 evergreen seedlings were used during these measures. In the "Climate Room" commissioned for the Nakhchivan Landscaping Service on June 7, 2020, gymnosperm plant species for use in landscaping in Nakhchivan have also started to be grown in special conditions².

All this makes it necessary to specify the number of species of gymnosperm plants in the territory of Nakhchivan AR, study their distribution areas, identify species which numbers are declining or endangered, organize their protection, as well as use in landscaping as a source of beauty, oxygen, phytoncides, as a noise-reducing means. On the other hand, the study of these plants, which have been used in

¹ <https://prezi.com/j-wfvfwbeoal/qlobal-iqlim-dyisimsi-problemi>

² <http://din.nmr.az/2019/06/08/naxcivanda-muasir-agacyetisdirm%C9%99-sah%C9%99si-iqlim-otagi-f%C9%99aliyy%C9%99t%C9%99-baslayib/>

folk medicine since ancient times during pandemic, which is the world's trouble, is a topical issue that can open wide doors for pharmacologists and phytochemists.

Aims and objectives of the research: Due to insufficient research of gymnosperm plants of Nakhchivan AR flora, the main purpose of the study was to determine the number of species, systematics, bioecology, phytocenology and distribution zones, development of scientific bases for protection of rare species and identification of opportunities for effective use. For this purpose, the following goals and objectives have been set:

- ✓ Study of geographical position, climate, land cover of the regions in Nakhchivan AR;
- ✓ Clarification of species composition of gymnosperms distributed in Nakhchivan AR;
- ✓ Identification of distribution zones of gymnosperms;
- ✓ Study of systematics, bioecology of plants of *Gymnospermae* division and phytocenoses formed by them;
- ✓ Investigation of protection opportunities of arid and sparse juniper forests, identification of zones where dense juniper forests locate;
- ✓ Identification of ways to protect rare and endangered species on a scientific basis;
- ✓ Phytochemical analysis of some of gymnosperm plants distributed in the territory of the Autonomous Republic and study of opportunities for their efficient use;
- ✓ Measures for the introduction of new species in the territory of the Autonomous Republic.

Research methods: The route observation method was used to accurately study the habitat during the implementation of the dissertation work. Experimental field measurements were performed with a Tomshco TM device, the number and determination of plants on steep and impassable rocks by Mavic Mini Flyc Cam drone, coordinates with a GPS device and the photos were taken with Nikon cameras. Trunk measurements were made using a Yahimovich callipers, the approximate age of old trees was determined, and the taxation of the species in plant communities was determined. The last systematic determinants were used to identify plant species. The

diagnosis of the families in the classification is done according to T.S. Mammadov³, and genera and species according to V. Farzaliyev⁴, and M. Gurbanov⁵.

The main provisions of the defense:

- ✓ Identification, study and preparation of the final taxonomic spectrum of species included in the *Gymnospermae* division in the flora of the Nakhchivan Autonomous Republic;
- ✓ Study of bioecological and phytocenological properties of plants included in the *Gymnospermae* division in Nakhchivan AR;
- ✓ The role of species included in the *Gymnospermae* division in vegetation, especially forest vegetation;
- ✓ Investigation of phytocenological significance of species belonging to the genus juniper - *Juniperus* L., the main component of arid and sparse forests distributed in Nakhchivan AR;
- ✓ Improving the current status and conservation capabilities of rare species included in the *Gymnospermae* division;
- ✓ Introduction and useful properties of some new species included in the *Gymnospermae* division.

Scientific novelty of the research: For the first time in the territory of the Nakhchivan Autonomous Republic the species composition of plants of *Gymnospermae* division was studied and clarified, the final systematic position and distribution zones were determined. It was clarified that gymnosperms are represented by 35 species belonging to 7 families and 19 genera in the area, of these, 9 species are found in the form of excavations, 16 species are cultivated, and 10 species are found in the wild form.

Four species out of found 10 new species: *Cycas revoluta* Thunb. - sago cycas, *Araucaria araucana* (Molina) C. Koch. - monkey-puzzle, *Pinus nigra* Arnold - Black pine and common yew - *Taxus baccata* L. and new “Glauca” form of *Cupressus arizonica* Greene species were cultivated, 2 species: *Ginkgo biloba* L. -

³ Məmmədov T.S. Azərbaycan dendrologiyası. Cild I, Bakı: Elm, 2011, s.122-296

⁴ Fərzəliyev V.S. Azərbaycanın iynəyarpaqlı bitkilərinin növmüxtəlifliyi və bioekoloji xüsusiyyətləri. Bakı: Elm, 2020, 244 s.

⁵ Qurbanov M.R., Fərzəliyev V.S. Ardicların biomorfoloji, taksonomiki və rengenoloji qiymətləndirilməsi. AMEA Mərkəzi Nəbatat Bağı. Bakı: Elm, 2021,s.

Maidenhair tree, *Picea pungens* Engelm - Blue spruce were introduced by us, in the wild condition *Juniperus depressa* Stev. (= *Juniperus communis* L. var. *depressa* Pursh; *J. communis* L. var. *communis*; *J. hemisphaerica* C. Presl.) - common juniper, *Juniperus oblonga* Bieb. (*J. communis* L. var. *oblonga* Medw.; *J. communis* L. var. *saxatilis* Pall.) – Oblong juniper and *Juniperus pygmaea* K.Koch (*Juniperus communis* L. var. *pygmaea* auct. non (C. Kosc) Imch.; *J. pygmaea* auct. non K. Koch) - short-growing juniper species and variations have been added to the flora, *Juniperus polycarpus* C.Koch (= *J. excelsa* Bieb. var. *polycarpus* C.Koch) - polycarpous juniper species is reincluded in the flora.

For the first time, sparse juniper forests were inspected using new technologies, the current condition of these forests was studied on the basis of the obtained materials, and the ways of protection were clarified. The role of the species included in the genera pine, juniper and ephedra in the vegetation of the Nakhchivan AR and the formations and associations they formed were studied. Forests are divided into 4 subtypes, 6 formation classes and 27 formations as a vegetation type (Lignosa). Three formations and four associations of arid sparse forest sub-type of forest vegetation type and two formations and three associations of sparse juniper forest class (*Junipereta*) were found. The pine and ephedra species were studied and it was noted and described that the *Pineta* formation formed two associations and the *Ephedraeta* formation - 7 associations.

Possibilities of protection and reproduction of *Pinus kochiana* Klotzsch – Kochi pine belonging to the Pine family in Batabat forest were studied. Experiments for the introduction of the species *Pinus pinea* L. - pine-tree, *P. montana* Mill. – mountain pine and *P. halepensis* Mill. - Aleppo pine continues in the Botanical Garden of the Institute of Bioresources of the Nakhchivan Branch of ANAS.

Kochi pine and juniper species listed in the Red Book of Nakhchivan AR were monitored periodically and four old juniper trees certified and given to the Ministry of Ecology and Natural Resources of Nakhchivan AR and recommended for protection as a natural monument.

Theoretical and practical significance of the research:

- ✓ Taking into account the suitability of the Kochi pine to the soil and climatic factors of autonomous republic, it was considered expedient to apply it in landscaping;
- ✓ The current state of species belonging to gymnosperms in nature was studied, the status of rare species was clarified, and the possibilities of their use were noted;
- ✓ Areas of arid sparse forests in the territory of the Autonomous Republic were clarified, mapped, and opportunities for restoration and protection were noted;
- ✓ *Picea pungens* - Blue spruce and *Ginkgo biloba* - Maidenhair tree introduced in the territory of the Autonomous Republic was recommended to be used by Nakhchivan City Greening Economy Union.

Approbation and application of the work: The main provisions of the dissertation were discussed in “International Duzdag Research Congress” (May 25, 2021); “Nakhchivan International Conference on History, Culture, Natural Resources and Modern Development, July 9, 2021”; III International Scientific and Practical Conference “Innovations and prospects of world science”, Vancouver 4-6 november; IX International Scientific and Practical conference “Results of modern scientific research and development”, Madrid 14-16 November; “Prospects for the introduction of innovative technologies in medicine and pharmacy.” VIII All-Russian scientific-practical conference, dedicated to the Year of Science and Technology, November 26, 2021; “International scientific conferences on actual problems of modern natural sciences”

The organization where the dissertation work is carried out:

The dissertation work was carried out at the Department of Biology of Nakhchivan State University.

Published scientific works: Based on the research materials, 14 scientific articles (9 articles, 5 conference materials) containing the main provisions of the dissertation were published, of which 5 articles, 2 conference materials were published abroad.

The structure and scope of the dissertation: The dissertation work consists of an introduction, 6 chapters, conclusions, suggestions

and recommendations, a list of references and appendices of 208 pages. 4 maps, 10 tables, 61 original images, a photo album depicting species and biotopes in nature and “natural monuments“ were attached to the dissertation work.

The volume of the thesis is 239184 characters (excluding figures, tables, maps, appendices and references), title page and table of contents combined 3715 characters, introductory section 11638 characters, chapter I - 37683 characters, chapter II - 9635 characters, chapter III chapter IV - 54909 characters, chapter V - 16401 characters, Chapter VI - 27652 characters, results - 3344 characters, suggestions and recommendations - 1827 characters.

CHAPTER I. REVIEW OF THE LITERATURE ON THE STUDY OF SPECIES INCLUDED IN THE DIVISION *GYMNOSPERMAE* IN THE TERRITORY OF THE NAKHCHIVAN AUTONOMOUS REPUBLIC

1.1. Review of literature on the study of species of the Gymnosperms - *Gymnospermae* division in the territory of the Nakhchivan Autonomous Republic. The research works carried out in the field of study of the types of *Gymnospermae* division in the world and in Azerbaijan were investigated, comparative analysis and obtained measures were widely interpreted in the dissertation work.

1.2. Systematic division of plants of *Gymnospermae* division. *Gymnospermae* - gymnosperm plants are one of the oldest seeded plants, formed during the Upper Devonian period. According to the modern classification, six classes found in the excavations and living in modern times are included in the *Pinophyta* and *Gymnospermae* - Gymnosperm division, of them species belonging to *Cycadopsida* - Cycadeoids, *Ginggoopsida* – Ginkgoids, *Pinopsida* or *Coniferopsida* - Pinophyta or Conifers are found in the study area.

CHAPTER II. NATURAL GEOGRAPHICAL CONDITIONS OF NAKHCHIVAN AUTONOMOUS REPUBLIC, RESEARCH MATERIAL AND METHODOLOGY

2.1. Physical and geographical conditions of the territory of the Nakhchivan Autonomous Republic. Brief information is given

about the natural and geographical conditions, geographical position, relief, topographic features, climate and soil cover of the Nakhchivan Autonomous Republic.

2.2. Research material and methodology. *Gymnospermae* (*Pinophyta*) – gymnosperms distributed in the territory of Nakhchivan AR were taken as a research material. For the purpose of Botanical research, ecological, biomorphological study of naked plant species, expeditions were organized, 108 botanical routes were passed and materials were collected. The measurement of experimental zones was carried out by the Tomshko device, the number of plants on impassable rocks, their determination by a drone, coordinates by a GPS device, and taking pictures by a Nikon camera. Trunk measurements were made using a specially designed callipers, the approximate age of old trees was determined, and the taxation of the species in plant communities was determined. Determinants were used to determine the species. Clarification of systematic taxa was made according to International Botanical Nomenclature Code⁶, Angiosperm Phylogeny Group (APG IV)⁷, works of T.H.Talibov, A.Sh.Ibrahimov and A.M.Ibrahimov⁸. Conservation status of rare species was given according to IUCN “Red List”⁹ and “Red list of The Endemic Plants of the Caucasus. Armenia, Azerbaijan, Georgia, Iran,

⁶ Международный кодекс ботанической номенклатуры (Венский кодекс), принятый Семнадцатым Международным ботаническим конгрессом, Вена, Австрия, июль 2005 года: пер. с англ. / отв. ред.: Макнилл Дж. (пред. редкол.) и др. - М.: КМК, –2009. –282 с..

⁷ *Angiosperm Phylogeny Group* - APG IV, "An update of the Angiosperm Phylogeny Group classification for the orders and families of flowering plants: /by editor M.W. Chase, M. J.M. Christenhusz, M.F.Fay [et al] //APG IV, Botanical Journal of the Linnean Society, – 2016, Volume 181, Issue 1, – p.1-20.

⁸ Talibov, T.H. Naxçıvan Muxtar Respublikası florasının taksonomik spektri (ali sporlu, çıpaqtoxumlu və örtülütoxumlu bitkilər) / T.H. Talibov, Ə.Ş. İbrahimov, Ə.M. İbrahimov – Bakı: Şirvanəşr, – 2021. –426 s.

⁹ IUCN. Guidelines for Application of IUCN Red List Criteria at Regional and National Levels: Version 4.0./–Gland, Switzerland and Cambridge, -UK.: IUCN. – 2012. – 41p.

Russia, and Turkey”¹⁰

Species *Juniperus oblanga* Bieb. and *Ephedra aurantiaca* Takht et Pachom selected for phytochemical analysis were collected during expeditions, cleaned and dried to constant weight, then weighed and prepared for analysis. The study of phytochemical composition was carried out in the Laboratory of Biochemical Research of the Institute of Bioresources of Nakhchivan Branch of ANAS using chromatographic and spectrophotometric methods. Spectral analyzes were performed using Hitachi U-2900 UV-VIS spectrophotometer, and chromatographic analyzes were performed using column 60108-712 HYPERSEP SI, 10G/75ml/10PKG and DC-fertigfolien ALUGRAM SIL G/UV254 thin layer. The following literature has been used as a methodological tool or determinant to identify and evaluate materials obtained during field research: “Flora of Azerbaijan” (1950)¹¹, “Flora of Turkey” (1965)¹², “Flora Iran” (1968)¹³, “Abstract of the flora of the Caucasus”(2003)¹⁴, Asgarov A.M. (2016)¹⁵ and Beideman I.N. (1954)¹⁶, life forms were checked according to Serebryakov I.G. (1964)¹⁷, areal type, classes and groups according to Grossheim A.A. (1936)¹⁸ and Porteniere N.N. (2006)¹⁹

¹⁰ Red list of the endemic plants of the Caucasus. Armenia, Azerbaijan, Georgia Iran, Russia, and Turkey Copyright /by Missouri Botanical Garden Press P.O. Box 299, – 2014. – 451 p.

¹¹ Флора Азербайджана. Баку: Из-во АН Азерб. ССР, Т.1, 1950, с. 53-80

¹² Flora of Turkey / Edited by P.H. Davis. Edinburgh at the University Press., 1965, p. 67-85

¹³ Flora Iranica. Flora des Iranischen hochlandes und der umrahmenden qebirqe. /Von univ. Prof. Dr. Karl Heinz Rechinger. Erster Direktor des Naturhistorischen Museums in Wien (emertus). Akademische Druck- u Verlagsanstalt. –Graz-Austria, –1968, p.1-10

¹⁴ Конспект флоры Кавказа. С. Петербург: Из-во С. Петербургского университета, Т.1, 2003, с. 173-190.

¹⁵ Əsgərov, A.M. Azərbaycanın bitki aləmi (Ali bitkilər - Embryophyta) /A.M.Əsgərov, – Bakı: TEAS Press, – 2016, –s.70-73.

¹⁶ Бейдеман И.Н. Методика фенологического наблюдений при геоботанических исследованиях. Москва - Ленинград: Из-во АН СССР, 1954, с. 95-96

¹⁷ Серебряков, И.Г. Жизненные формы высших растений и их изучение. В кн. "Полевая геоботаника"/И.Г.Серебряков, –Москва - Ленинград, 1964, т. 3, с.146-205.

¹⁸ Гроссгейм, А.А. Анализ флоры Кавказа /А.А. Гроссгейм, –Баку: Аз.ФАН СССР, –Т.1, –1936,–с.37-75

¹⁹ Портениер Н.Н. Флора и ботаническая география Северного Кавказа/ Н.Н.Портениер Портениер. Москва, -2012, -293

CHAPTER III. STUDY OF SPECIES INCLUDED IN THE DIVISION OF *GYMNOSPERMAE* IN THE NAKHCHIVAN AUTONOMOUS REPUBLIC

Gymnosperms are divided into 6 divisions: *Cycadophyta*, *Ginkgophyta*, *Gnetophyta*, *Pinophyta* (also known as *Coniferophyta*), *Pteridospermales* and *Cordaitales*, of which the last two division plants have already been destroyed.

3.1. General characteristics of the *Gymnospermae* division.

The gymnosperms living in modern times includes 4651 species belonging to 12 families and 88 genera, of which 1104 species are universally accepted species (Christenhusz, M.J.M)²⁰. Families are as follows: *Araucariaceae*, *Cupressaceae*, *Cycadaceae*, *Ephedraceae*, *Ginkgoaceae*, *Gnetaceae*, *Pinaceae*, *Podocarpaceae*, *Sciadopityaceae*, *Taxaceae*, *Welwitschiaceae*, *Zamiaceae*. The largest group of gymnosperms are conifers (pine, cypress, juniper, etc.), and the smallest is Ginkgo, found in China²¹.

3.2. Study of species belonging to the *Ephedraceae* Dumortier – *Ephedra* family in the flora of Nakhchivan AR. In the area belonging to this family, there are only species belonging to the genus *Ephedra*, and this genus is represented by 3 species: *Ephedra procera* Fisch et Mey. - Tall *Ephedra*, *Ephedra aurantica* Takht. et Pachom. - Pink *Ephedra*, *Ephedra distachya* L. - Joint-fir *Ephedra*²².

3.3. *Pinaceae* Lindley – Pine family in the flora of Nakhchivan AR. Four species belonging to three genera of Pine family are found in the Caucasus in the wild form, two species belonging to one genus in Azerbaijan. Both species growing wild in Azerbaijan are hard pines belonging to the *Diploxylon* subgenus.

²⁰ Christenhusz, M. J. M.; Byng, J. W. *The number of known plants species in the world and its annual increase // Phytotaxa: journal. Magnolia Press, 2016. Vol. 261, no. 3. P. 201-217*

²¹ Quliyeva, G.F. *Naxçıvan Muxtar Respublikasında Gymnospermae şöbəsi bitkilərinin tədqiqi vəziyyəti // – Lənkəran: LDU Elmi xəbərləri, Təbiət elmləri seriyası, – 2017, – s.101-103.*

²² Guliyeva, G.F. *Systematic composition and Phytocenological Features of Ephedra L. Species in Nakhchivan Autonomous Republic // III International Scientific and Practical Conference, –Vancouver: – 4-6 november, – 2021, – p.63-70.*

Endemic and relict *Pinus eldarica* Medw. and *Pinus kochiana* described by Y.S. Medvedev also belongs to this subgenus. Samples of Pine and White Pine, the species of which has not yet been determined, were found in excavated forms, only *Pinus kochiana* was found in the wild form, the remaining 4 species are cultivated in parks and alleys of cities and settlements, in the Botanical Garden of the Institute of Bioresources of the Nakhchivan Branch of ANAS. Thus, in the territory of the autonomous republic, the Pine family is represented by 4 genera, 9 species, 2 of which are found in excavations, 6 in cultural, and 1 in wild flora.

3.4. Cupressaceae Bartlett - Cypress family in the flora of Nakhchivan AR. *Cupressaceae* Bartlett family includes a total of 130-145 species of juniper and reddish-brown trunks of 27-30 genera (17 monotypes). They are monoecious or dioecious trees and shrubs up to 116 m high. Of the existing genera of the family, only 3 genera (*Cupressus*, *Callitris* and *Juniperus*) have more than 75 species. The remaining genera are either monotypic or oligotypic. The cypress family is divided into 3 subfamilies and 6 tribes according to the structure of the female cones. Juniper genus is divided into 3 subgenera. *Caryocedrus* subgenus has one species, *Juniperus* subgenus - 14 species and *Sabina* subgenus - 40 species. According to the collected materials and literature, in the territory of Nakhchivan AR, the family is represented by 12 species, 1 of which is found in excavations, 5 in culture, and 6 in the wild form²³. Bioecological features of all species of the genus, the formations and associations they formed were studied. Special studies were conducted in relatively dense juniper forests in Ardıjdag, Garagush, Paradash, Darıdag and İlandag. Taxation of sparse juniper forests in Ardıjdag was studied and it became clear that the forest's ability to regenerate itself is very weak, the main factor was the extreme variability of climatic factors, critical drought conditions. Old juniper trees were found in Paradash, Armammad sanctuary and Tiri sanctuary areas.

²³ Talıbov T.H., Quliyeva G.F. Naxçıvan Muxtar Respublikasının Cupressaceae S.F. Gray fəsiləsi bitkilərinin sistemətik vəziyyəti və bioloji xüsusiyyətləri //– Naxçıvan: NDU Elmi əsərlər jurnalı Təbiət və Texniki elmlər seriyası, – .2020. N3 (104), – s. 3-9

CHAPTER IV. THE ROLE OF SPECIES INCLUDED IN THE DIVISION OF *GYMNOSPERMAE* IN THE FORMATION OF FOREST ECOSYSTEMS IN THE NAKHCHIVAN AUTONOMOUS REPUBLIC

4.1. The role of species included in the *Gymnospermae* division in Nakhchivan AR in the forest ecosystem. The role of the *Gymnospermae* species in the formation of forest cover on the territory of the autonomous republic with a sharply continental climate, the study, protection and improvement of the ecosystem structure has been studied.

4.2. Formations formed by pine - *Pinus* L. and ephedra - *Ephedra* L. species in the vegetation types. In connection with the discovery of a pine forest in the form of a steppe at an altitude of 1800 m above sea level in the Shahbuz State Nature Reserve, a new formation has been added to the classification of forest vegetation - a pine formation (*Pineta kochiana*) with the participation of Kochi pine. This formation describes 2 associations formed with other plant species: Association: Pure pine wood (*Pinetum purum*); Association: Pine - oak - hawthorn (*Pinetum - Quercetosum - Crataecosum*). The subdominant species of the pine forest are *Crataegus meyerii*, *Pyrus salicifolia*, *Quercus macranthera*. Three species belonging to the genus *Ephedra* L. were noted in the territory of Nakhchivan AR. These species are *Ephedra procera*, *E. aurantiaca* (*E. equisetina* Bunge) and *E. distachya*. *Ephedra procera* species forms unique formations in vegetation types. Under natural conditions *Ephedra procera* presents in plant groups of arid sparse forest, as well as in the composition of juniper- pistachio- Fenzil almond and in mixed shrubs formed on dry rocky slopes. Often form a pure ephedra - *Ephedraeta porum* formation. Three associations have been identified and described in the pure ephedra formation formed by tall ephedra in the area. Studies have also shown that this species forms one small association with *Juniperus sabina* L., *Lonicera iberica* Bieb. and *Cerasus microcarpa* (C.M. Mey.) Boiss.

The following species were also involved in the formation of the

joint-fir ephedra found in the Duzdag area of the Babek region: *Artemisia vulgaris*, *Atriplex aucheri*, *Salsola australis*, *Salsola cana*, *Salicornia europaea*, *Acantholimon lepturoides*, *Acantholimon hohenackeri*, *Seidlitzia florida*, *Aegilops biuncialis*, *Aegilops cylindrica*.

The association formed by the pink ephedra in the Validag area of the Sadarak region is a relatively simple community: Association: *Ephedraeta auranticae* + *Atraphaxis angustifolia* + *Astragalus prilipkoanus* + *Artemisia lerchiana* + *Carex riparia* + *Thymus nummularis* + *Aegilops cylindrica*.

4.3. Formations formed by juniper - *Juniperus* L. species in the vegetation types. In the sparse juniper forests of Ardijdag, Daridag, Ilandag and Paradash, plant species formed in 5 formations and 6 associations formed by juniper species were noted²⁴.

4.3.1. Phytocenological features of Ardijdag sparse forested area. Research work was carried out in Ardijdag area of Arpachay State Nature Reserve in Sharur district and in the sparse juniper forest cover of the area, the phytocenological features of the gymnosperms, especially the juniper species, were studied and the general features of the sparse juniper forest characteristic of the area were clarified²⁵. The method of trial fields was used to study the phytocenological role of juniper species, their ability to regenerate under natural conditions, relationships with other plants and competitiveness. In Ardijdag sparse juniper forest, there are a small number of old trees, mainly middle-aged and young, the distance between them is 5-10 m. Trial area № 1 (13.VII.2018). On the experimental site, the number of trees of the species of juniper multiparous was counted and evaluated according to the classes indicated in the table, and the diameter of the tree trunks was also measured and the average diameter was found. In this test area, the smallest diameter tree is 6-8 cm and the largest diameter tree is 43-44 cm (Table 1).

²⁴ Guliyeva, G.F. Ecological analysis of Juniper (*Juniperus* L.) distributed in the territory of the NAR // G.F. Guliyeva – İtalia: Annali d'İtalia Biological sciences, – 2021. N19 vol1, – p. 75 -77.

²⁵ Guliyeva, G.F. Phytosenological features of Ardijdag sparse juniper forest in the Nakhchivan Autonomous Republic // G.F. Guliyeva –İndia: international Journal of Botany Studies, – 2021. vol. 5, issue 3, – p. 594-597

Table 1.**Determination of trunk diameter of polycarpous juniper**

Steps of trunk thickness, cm	Quantity of trees	Sum of the diameters
8	9	72
12	10	120
16	7	112
20	15	300
24	10	240
28	27	756
32	35	1120
36	20	720
40	6	240
44	4	176
Total	143	3856

The average diameter is $3856:143 = 26.97$ cm, so the average diameter is about 27 cm. Due to the sparse forest, trees are mostly found in class II and III, but trees of class I and V are also found. In the test area, the height values of the polycarpous juniper by the classes are recorded in the table (Table 2).

Table 2.**Height indicators of the polycarpous juniper on the steps**

Steps	Polycarpous juniper					Total	Height, m
	I class	II class	III class	IV class	V class		
8				6	3	9	1,5; 1,6; 1,8
12				9	1	10	2,0; 2,4; 2,6
16				6	1	7	2,8; 2,9; 3,0
20			2	11	2	15	3,2; 3,4; 3,6
24			9	1		10	3,8; 3,9; 4,0
28		5	16	6		27	4,2; 4,5; 4,6
32		4	26	5		35	5,0; 5,5; 5,7
36		3	15	2		20	5,8; 5,9; 6,0
40	1	3	2			6	6,2; 6,4; 6,6
44		3	1			4	7,0; 7,1; 7,3

To find the average height of the trees, the height of three trees from each thickness steps was measured and marked on the graph. The line of abscissa indicates the steps of thickness, and the ordinate indicates the height of the trees.

The curve obtained from the combination of the points of intersection separates the points of height into two parts. The average height was found for this curve and the average diameter. Conventionally, the total number of trees in the area is taken as 10. Based on this indicator, the share of each tree is determined. 143 juniper and 15 pear trees were found in the trial area. Based on this, the formula of the tree layer can be shown as follows: 9Ard,1Arm. The fullness of the forest is 0.3. Although the average age of the trees is 119, there are many trees in this forest that reach a height of 12-14 m, a trunk diameter of 40-44 cm and are over 200 years old (Table 3). The density of the underwood is 0.4. Shrub species *Pistacia mutica*, *Pyrus salicifolia*, *Crataegus pentagyna*, *Euonymus euopaea*, *Berberis vulgaris*, *Rosa canina*, *Rhamnus cathartica*, *Lonicera iberica*, *Ephedra aurantiaca* are also found in an area close to polycarpous juniper trees. The following tables show the altitude, viability and phenophase of the species and species that make up the forest floor. The viability of a species is understood as the level of development of a species in a phytocenosis.

Table 3.

**Taxonomic indicators of the tree tier of
Ardijdag sparse juniper forest**

Tree plants	Height, m		Trunk diameter, sm		middle age	Bonitet	Fullness
	middle	max.	middle	max.			
<i>Juniperus polycarpus</i>	4,3	11	19	44	119	III	0,3
<i>Juniperus foetidissima</i>	4	10	14	40	90	III	0,1
<i>Pyrus salicifolia</i>	2	3,5	13	35	87	III	0,2

At this time, vitality scale of Voronov A.Q. (1973)²⁶ was used. According to this scale, plants are divided into 4 groups according to their development in the phytocenosis:

Species that undergo full development, normal development and fruiting in the studied phytocenosis - 3a; Although the species goes through all stages of development, it does not reach normal size - 3b; The species is well developed vegetatively, but does not bear fruit - 2; The species does not bear fruit and is poorly developed vegetatively. According to this scale, it seems that the species that form the underwood of the Ardijdag sparse juniper forest belong mainly to indicators 3a and 3b (Table 4).

Table 4.

Description of underwood of Ardijdag sparse juniper forest area in trial area No.1

Species	Tier	Height, m	Vitality	Phenophase
<i>Juniperus polycarpus</i>	II	2-2,5	3a	Three years of fruit have been shed, two years have not yet ripened
<i>Juniperus foetidissima</i>	II	1,5-2	3a	Three years of fruit have been shed, two years have not yet ripened
<i>Pyrus salicifolia</i>	II	1,5-2	3a-3b	The fruit is not fully ripe
<i>Berberis iberica</i>	II-III	1	3a	The fruit is not fully ripe
<i>Cerasus microcarpa</i>	II	1-1,2	3a	The fruit is not fully ripe
<i>Ephedra aurantiaca</i>	III	0,5	3a	The fruits are ripe and fallen
<i>Rosa canina</i>	II	0,7-1,5	3a	The fruit is not fully ripe

Trial area №2 (30.VII.2020). The site is located in the western part of Ardijdag at an altitude of 1200-1600 m above sea level. Due to

²⁶ Воронов А.Г. Геоботаника. Москва: Высшая школа, 1973, 382 с.

the rocky area, it is taken approximately $65 \times 25 = 1625\text{m}^2$. The soil is mountain-forest, light brown, carbonate. Tree tier: Content 9Jun.,+1Pyr.,+ Pis.

The number of juniper trees is 27, mainly young trees predominate. One old juniper tree was recorded in the field area. The average age of other trees reaches 80-90 years, of the 27 juniper trees, 25 are polycarpous junipers and two are stinking junipers. Other than these species in the tier of the tree, shrubs such as *Pyrus salicifolia*, *Pistacia mutica*, *Prunus dilcis*, *Malus orientalis*, *Ephedra aurantiaca*, *Cerasus microcarpa*, *Berberis iberica*, *Zygophyllum atriplicoides*, *Atraphaxis angustifolia* Jaub. et Spach, *Reaumuria persica* (Boiss.) Boiss., *Capparis spinosa* L., *Rosa canina* were also noted. Their number was 25. The tree cover in this area includes two oriental oaks - *Quercus macranthera* Fisch. et C.A. Mey ex Hohen. (Table 5). It should be noted that sparse forests are not satisfactory due to the level of natural regeneration. Thus, very few juniper sprouts are found under tree umbrellas, 3-4 juniper seedlings were found in the open areas between the trees (Table 6).

Table 5.

Taxonomic indicators of the tree tier in the trial area No.2

Tree species	Height, m		Trunk diameter, sm		Middle age	Bonitet	Fullness
	mid dle	maximum	mid dle	maximum			
<i>Juniperus polycarpus</i>	4	8	14	40	85	III	0,4
<i>Juniperus foetidissima</i>	3,5	4	10	25	77	III	0,1
<i>Pistacia mutica</i>	2,5	3,5	10	15	75	III	0,1
<i>Pyrus salicifolia</i> Pall.	2,5	4	10	30	80	III	0,2
<i>Quercus macranthera</i>	3	4	20	30	12	III	0,1

Table 6.
Description of self-restoration of tree tier in trial area No. 2

Species	Tier	Abundance	Height, sm	age	Phenophase
<i>Juniperus polycarpus</i>	II-III	0,4	15-100	10-25	There is no fruit or it is not ripe
<i>Juniperus foetidissima</i>	II-III	0,1	15-90	10-25	There is no fruit or it is not ripe
<i>Pistacia mutica</i>	II-III	0,1	15-90	10-15	There is no fruit or it is not ripe
<i>Pyrus salicifolia</i>	II	0,1	20-100	15-20	The fruit is not ripe
<i>Quercus macranthera</i>	II	0,1	2-5	10-15	There is no fruit

Given that the natural regeneration of the forest is not going normally, and therefore it is difficult to predict that in a few years it will turn into a full-fledged forest. Three seedlings were registered under the crown of oak tree. The density of the underwood is 0.4. There are 3 species of shrubs (Table 7).

Table 7.
Description of underwood in Ardijdag sparse juniper forest trial site No. 2

Species	Tier	Height, m	Vitality	Phenophase
<i>Juniperus polycarpus</i>	II	1-1,5	3a	Biennial fruit is not fully ripe or there is no fruit
<i>Juniperus foetidissima</i>	II	1-1,5	3a	There is no fruit or biennials are not fully ripe
<i>Pyrus salicifolia</i>	II	0,7	3a-3b	The fruit is not fully ripe
<i>Berberis iberica</i>	II-III	1	3a	The fruit is not ripe
<i>Prunus dilcis</i>	II	1-1,2	3a	The fruit is not ripe
<i>Ephedra procera</i>	III	0,5	3a	The fruits are ripe and fallen
<i>Rosa canina</i>	II	0,7-1,5	3a	The fruit is not fully ripe

4.3.2. Phytocenological features of Daridag, Ilandag and Paradash sparse juniper forests. Gymnosperms, especially juniper sparse forests, were studied and evaluated (Fig. 1). The Daridag ridge is close to the Garayokhush ridge, and in both ridges sparse juniper forests form only on the northern slopes of the mountain^{27, 28}. During the research carried out in Daridag *Juniperus polycarpus*, *J. foetidissima* and *J. depressa* Stev., *Ephedra procera* species belonging to gymnosperm genus were found. Almost no juniper plants were found in the areas extending to the north-eastern part of Daridag, on the north-eastern (southern) slope of the mountain, about 7-8 junipers are found per hectare, sometimes more than 100 juniper trees in the area of 160 m² as a glade form a pure juniper forest - *Juniperetum porum* formation.



Figure 1. Juniper forest on the north-eastern slope of Daridag

Ilandag is one of the most important areas inhabited by gymnosperm plants. Despite its small area, Ilandag, which is considered a natural monument, is covered with steep and impassable rocks, its flora is unique, it is surrounded only by stinking and polycarpous juniper bushes. In addition, here *Ephedra procera*,

²⁷ Guliyeva, G.F. Phytocenological features of Daridagh and Ilandagh sparse Juniper Forest // G.F. Guliyeva –India: International journal of Botany studies, – 2021. vol. 6, issue 6, – p. 294-297.

²⁸ Talibov T., Guliyeva G. Phytocenosis involved with Foetid Juniper (*Juniperus foetidissima*) on the territory of Paradash in the Nakhcivan Autonomous Republic / T. Talibov, G. Guliyeva // Bulletin of science and practice, – 2020, vol 6., issue 7, – p. 66-74

Zygodontia atriplicoides, *Caragana grandiflora*, *Sempervivum caucasicum* Rupr. ex Boiss., *Thymus collinus* Bieb. and some grasses were defined. In general, the number of junipers in juniper wood as glades in Ilandag is about 80. The oldest juniper tree is about 100 years old (Figure 2).



Figure 2. Juniper forest in Ilandag

As the Daridagh and Ilandagh territories are included in the Ordubad State Nature Reserve, the juniper species here are fully protected. But the future of plants in both mountains will be possible with the normal snowfall and rainfall in the area and the elimination of severe drought. Starting from Yarpagli, juniper plants are relatively densely formed only on the northern slopes of Paradash, where polycarpous juniper tree with a trunk diameter of 52 cm and a age of 260 years was found here. There are about 520 large and small juniper trees in this area, and about 17-20 trees in the south. Most of these are young trees, ranging in age from 3 to 20 years (Figure 3).



Figure 3. Juniper forest in Paradash

There are mainly polycarpous, stinking and tall juniper species

in the area. The dominant species of sparse juniper forest in Paradash is polycarpous juniper, subdominant species are willowleaved and Caucasian pear, oriental apple and fenzil almond and Araz cherry. Five associations in three formations belonging to the formation class “Shrubs that shed their leaves” have been described. These associations are very rich and include about 10-15 species.

CHAPTER V. RARE AND ENDANGERED SPECIES OF GYMNOSPERM PLANTS OF THE FLORA OF NAKHCHIVAN AR, OPTIMAL WAYS OF THEIR PROTECTION

Dendrological indicators of 4 old juniper trees were certified and recommended to the Ministry of Ecology and Natural Resources of Nakhchivan AR for protection. Passporting was carried out using the ArcCis program, which has international access. This program allows to create an electronic cadastre by conducting automatic passporting when biometric, reserve, space indicators are added.

Pinus kochiana is enlisted in the Red Book of the Nakhchivan Autonomous Republic with the status “Endangered” - EN B1ab (ii, iii), and in the Red Book of the Republic of Azerbaijan as an endangered species, with the status “Near Threatened” - NT.

Juniperus oblonga Bieb. This species is in danger of extinction, continuing to decline in nature is included in the Red Book of Nakhchivan AR with a status of Endangered - EN A2acd; B1ab(i,ii,iii).

Juniperus foetidissima Willd. This species is included in the Red Book of Nakhchivan AR in the category of Critically Endangered - CR A4acd, as the number dynamics in nature has been steadily declining, the situation in nature has reached a crisis point and as a species that is likely to become extinct.

Juniperus polycarpus K. Koch. species is listed in the Red Book of Nakhchivan AR as could be in danger of extinction with a status of Endangered - EN A2acd; B1ab (i,ii,iii). Although it is widespread, it is sparsely populated.

Ephedra aurantiaca Takht. et Pachom. included in the Red Book of Nakhchivan AR with the status of Lower Risk - LR [a - Conservation Dependent - CD].

It is recommended to include *Juniperus depressa* Stev. and *Juniperus pygmaea* K.Koch species in the Red Book of the Nakhchivan Autonomous Republic as an endangered species with Near Threatened - NT status, and *Juniperus sabina* L. as Vulnerable - VUC2a (ii).

CHAPTER VI. PHYTOCHEMICAL COMPOSITION AND EFFICIENT USE OF SOME SPECIES INCLUDED IN THE GYMNOSPERMAE DIVISION

6.1. Study of phytochemical composition and useful properties of *Juniperus depressa* - common juniper and *Ephedra aurantiaca* - Pink ephedra. During the expeditions in different directions in 2016-2021, it was also observed that species belonging to the genus juniper and ephedra were exposed to pests in the territory of our autonomous republic. *Cinara tujaefilina* - Thuja aphid on the thuja cultivated in city parks and alleys make small holes in the leaf and suck its juice. These juices fall on the edges of the thuja and form black spots. The area around the plant is completely juicy black spots, which negatively affects the beauty of parks and alleys in the city. Massively breeding aphids suck out the juice and overwinter in the form of pupa. Thuja aphid is already widespread in the territory of the autonomous republic, and measures to combat it must be taken. Medication through drugs such as “Methoxychlor”, “Kelthan” and etc. against pests shall be carried out in early spring²⁹.

Chromatographic and spectrophotometric methods were used to study the phytochemical composition of the species. Spectral analysis methods are used to study substances of plant origin - flavonoids, carotenoids, anthocyanins, alkaloids and other compounds. Spectral

²⁹ Quliyeva, G.F. Naxçıvan Muxtar Respublikası çilpaqtoxumlu bitkilərin zərərvericiləri// – Naxçıvan tarixi, mədəniyyəti, təbii sərvətləri və müasir inkişafı beynəlxalq konfrans, –Naxçıvan: AMEA Naxçıvan Bölməsi, –9 iyul–2021, s.1-5.

analyzes were performed using Hitachi U-2900 UV-VIS spectrophotometer, and chromatographic analyzes were performed using column 60108-712 HYPERSEP SI, 10G/75ml/10PKG and DC-fertigfolien ALUGRAM SIL G/UV254 thin layer. Column and thin layer chromatography were performed to determine the qualitative analysis of the extracts and acetic acid + n-butanol + water (1:4:5) ratio was used as the solvent system. As a result of studying its phytochemical composition rhamnetin, isorhamnetin 3-O- β -D-glucopyranoside, isorhamnetin 3-O- β -glucopyranoside, plant pigments chlorophyll a, chlorophyll b and β -carotene compounds belonging to flavonoids have been identified in the species *Juniperus depressa*. The amount of total phenolic compounds was calculated as 54,2 mg of galic acid equivalent. Alkaloids and phenolic compounds of the *Ephedra aurentica* genus have been studied. Plant pigments were studied, apigenin-glucoside, acacetin-glucoside, flavanon related to flavones and dihydrocampherol compounds related to dihydroflavonol were found (Table 8).

Table 8.

Rf values of leaf chromatography of common juniper

Leaf (thorn) extract	
Obtained compounds	Rf values
Isorhamnetin 3-O- β -D-glucopyranoside	0,54
Isorhamnetin 3-O- β -glucopyranoside	0,31
β -carotene	0,97
Chlorophyll a	0,59
Chlorophyll b	0,42

The amount of total phenolic compounds was calculated as 51.2 \pm 0.1 mg of galic acid equivalent (Fig.4,5). *Ephedra aurantica*, chosen as the object of study, was collected during the expeditions and prepared for analysis in the biochemical research laboratory. Samples were weighed after drying to constant weight.

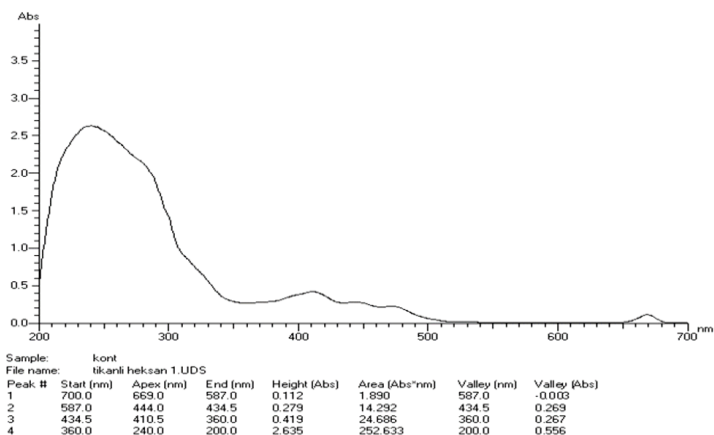


Figure 4. UV spectrum of hexane extract of *Juniperus depressa*

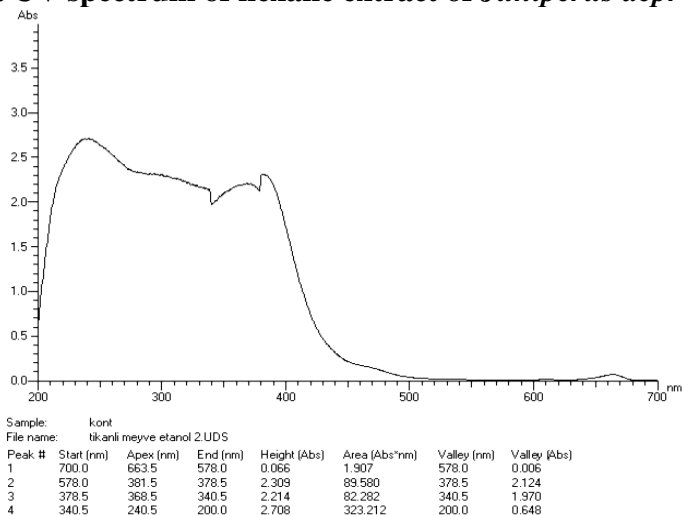


Figure 5. UV spectrum of ethanol extract of *J. depressa* generative cones

To study the phytochemical composition of species, chromatographic and spectrophotometric methods were used. The sum of total phenolic compounds is calculated as 51.2 ± 0.1 mg gallic acid equivalent. Coumaric acid with a wavelength of 228 and 328 nm was determined from phenolic acids in the extract (Fig. 6).

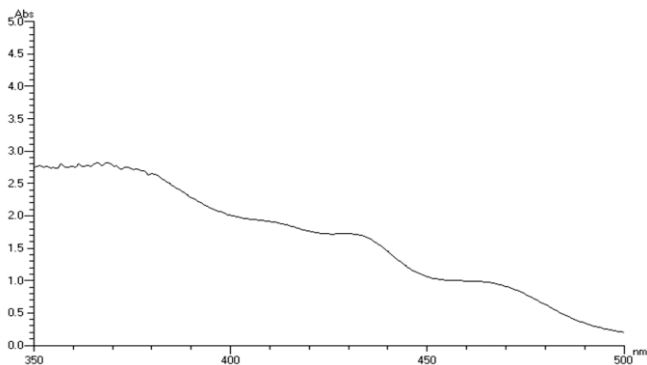


Figure 6. UV spectrum of phenolic compounds of the species *Ephedra aurantica*

Chlorophyll with a wavelength of 663 nm and carotenoid pigments with a wavelength of 449, 478 nm were found in the ethanol extract of the plant (Figure 7).

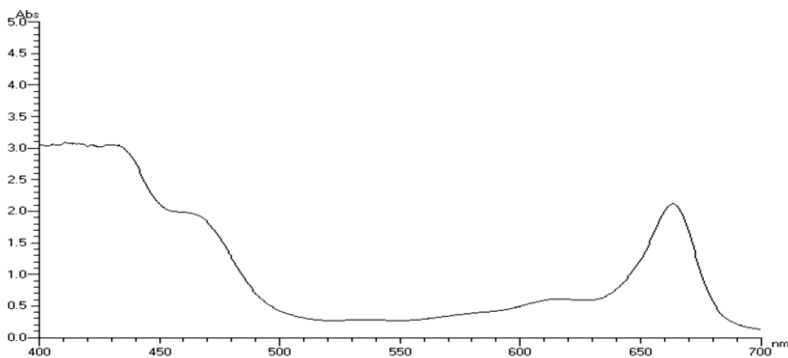


Figure 7. UV spectrum of plant pigments in *Ephedra aurantica* ethanol extract

Alkaloids with a wavelength of 224, 240 and 305 nm were found in the ethanol extract of the plant. In plant extracts apigenin-glucoside belonging to flavones with a wavelength of 267 nm, acacetin-glucoside in 268 nm and dihydrocampherol compounds with a wavelength of 291 nm belonging to flavanon and dihydroflavonol were found.

The plant stem was extracted using various solvents, the extracts were filtered, concentrated in a rotary evaporator, and wavelengths were obtained on a UV spectrophotometer. Alkaloids and phenolic compounds have been identified in the ethanol extract of the plant. The amount of total phenolic compounds was calculated as 51.2 ± 0.1 mg of galic acid equivalent. Coumaric acid with a wavelength of 228 and 328nm was determined from phenolic acids in the extract content. Chlorophyll with a wavelength of 663 nm and carotenoid pigments with a wavelength of 449, 478 nm were found in the ethanol extract of the plant. In the ethanol extract of the plant alkaloids with wavelengths of 224, 240 and 305 nm, apigenin-glucoside belonging to flavones with a wavelength of 267 nm, acacetin-glucoside in 268 nm, dihydrocampherol compounds with a wavelength of 291 nm belonging to flavanon and dihydroflavonol were found.

6.2. Ways of efficient use of species included in the division of *Gymnospermae*. The juniper plant is also of great importance in the economy, as the wood of some species of this plant is very strong and resistant to rot, so it is used in carpentry. Natural yellow dye is obtained from the immature fruits of juniper and used it in dyeing wool yarn in carpet weaving. Juniper bushes also have great water-regulating and soil-protective properties and this plant acts as a strong and reliable barrier and saves the forest belts below it from the negative effects of nature in the Nakhchivan Autonomous Republic, a typical mountainous country with a high slope. Their strong surface parts and root system protect the soil from erosion, especially during heavy rains in autumn. We observed the process of sharp erosion at the edges of the Garagush, Batabat, Ilandagh, Paradash and Tillak forests, where the soil layer is soft, without stone-gravel and, most importantly, without turf. Plants of this division have wide range of effective uses both in phytochemical, pharmacological, gastronomic and industrial use.

RESULTS

1. As a result of the research, the taxonomic spectrum of gymnosperm plants was clarified by families in the territory of the Nakhchivan Autonomous Republic for the first time. It became clear that in the area there are three species belonging to one genus of *Ephedraceae* - Ephedra family, one species belonging to one genus of *Ginkgoaceae* – Maidenhair-tree family, five species belonging to three genera of *Araucariaceae* - Araucaria family, nine species belonging to four genera of *Pinaceae* Spreng. ex Rudolphi – Pine family, 12 species belonging to five genera of *Cupressaceae* – Cypress family and four species belonging to four genera of *Taxodiaceae* - Taxodium family;

2. 9 out of 35 species belonging to 7 families and 19 genera of gymnosperm plants were found in excavated forms, 16 species are cultivated and 10 species are found in the wild;

3. Four (*Cycas revoluta*, *Araucaria araucana*, *Pinus nigra*, *Taxus baccata*) out of found or introduced ten new species belonging to gymnosperm plants are cultivated, two species (*Ginkgo biloba*, *Picea pungens*) were introduced by us, in the wild condition *Juniperus depressa*, *J. oblonga*, *J. Pygmaea* species and variations are newly introduced into the flora and *J. polycarpus* species is added again to the flora.

4. Due to the fact that the dynamics of species numbers continue to decline in nature and are near threatened species, they are included in the Red Book of Nakhchivan AR with the following statuses: *Pinus kochiana* Endangered - EN B1ab(ii,iii), *Juniperus oblonga* Near Threatened - NT, *Juniperus polycarpus* Endangered - EN A2acd;B1ab (i,ii,iii), *Juniperus foetidissima* Critically Endangered - CR A4acd and *Juniperus sabina* - Endangered - EN B1ab(ii,iii). It was considered important to maintain the status of these species by studying the current state of nature;

5. The method of trial fields was used to study the phytocenological role of juniper species, their ability to regenerate under natural conditions, relationships with other plants and competitiveness in Ardijdag sparse juniper forests and taxation of the species in plant communities was determined. Although the density of

the studied forest is 0.3, the average diameter of 143 trees was 26.97 cm, the average age of the trees is 119, trees up to 12-14 m high, 40-44 cm in diameter and over 200 years old were also found in the forest.

6. For the first time in the territory of the Nakhchivan AR, the structure of gymnosperm plants in the existing vegetation was studied at the level of formation and association, specific and coeno-forming species of plants were identified. In the forest vegetation two associations in Pine - *Pineta* formation, and seven associations in Ephedra – *Ephedraeta* formation and plants related to them are described.

7. In Ardijdag, Daridag, Ilandag and Paradash sparse juniper forests, plant species formed in 5 formations and 6 associations formed by juniper species were noted, phytocenological features were presented.

8. As a result of studying its phytochemical composition rhamnetin, isorhamnetin 3-O- β -D-glucopyranoside, isorhamnetin 3-O- β -glucopyranoside belonging to flavonoids, chlorophyll a, chlorophyll b and β -carotene compounds belonging to plant pigments have been identified in the species common juniper- *Juniperus depressa*. The amount of total phenolic compounds was calculated as 54,2 mg of galic acid equivalent. Alkaloids and phenolic compounds of the genus *Ephedra aurantica* have been studied. Plant pigments were studied, apigenin-glucoside, acacetin-glucoside, flavanon related to flavones and dihydrocampherol compounds related to dihydroflavonol were found. The amount of total phenolic compounds was calculated as 51.2 ± 0.1 mg of galic acid equivalent.

PROPOSALS AND RECOMMENDATIONS

1. The coordinates of four species *Juniperus foetidissima* (2 trees), *Juniperus polycarpus*, *Juniperus oblonga* aged 225-780 years found in the studies are determined, certified and given to the Ministry of Ecology and Natural Resources of Nakhchivan AR and recommended to be marked as a natural monument;

2. In order to restore Ardijdag, Daridag, Ilandag, Paradash and Soyugdagh sparse juniper forested area, which have relatively dense

juniper forests, seedlings must first be grown and reintroduced to the area using the “Climate Room” operating in the Greenery Department Nakhchivan;

3. The existing Kochi pine forest in the Batabat forest area should be restored by propagating the obtained seeds, and critical areas should be fenced off to protect against the harmful effects of bears and pigs;

4. The number dynamics of the *Juniperus sabina* continues to decrease in nature as in other junipers, natural resources decline, therefore, it is recommended to keep it as an endangered species with the status of Endangered - EN B1ab (ii, iii) in the Red Book of Nakhchivan AR;

5. Given that the state of *Juniperus polycarpos* in nature is a near-threatened, it is recommended to keep it in the Red Book of NAR with the status Endangered - EN A2acd; B1ab(i,ii,iii).

6. According to the studies, the number dynamics of *Juniperus depressa* – sort-growing juniper and *Juniperus pygmaea* - draft juniper continue to decrease in the nature, their natural resources decline, therefore it is recommended to include it into the new edition of the Red Book of Nakhchivan AR as an endangered species with Near Threatened - NT status.

7. Treatment with drugs such as “Methoxychlor”, “Kelthan” and etc. against *Cinara tujafilina* - Thuja aphid on the thuja grown in city parks and alleys should be carried out in early spring. Towards the end of the summer, during the period of mass reproduction of aphids, the trees should be inspected and re-treatment should be continued. It should be borne in mind that these chemical poisons also destroy beneficial insects, in this regard, spraying should be carried out in accordance with all precautionary measures during treatment

List of published works on the topic of the dissertation

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The defense of dissertation will be held at 11⁰⁰ on 30 september, 2022
at the meeting of the Dissertation council ED1.26 operating at the
Institute of Botany of Azerbaijan National Academy of Sciences

Address: Badamdar highway 40, AZ1004, Baku, Azerbaijan

Dissertation is accessible at the Library of the Institute of Botany
of Azerbaijan National Academy of Sciences.

Electronic versions of dissertation and its abstract are available on the
official website of the Institute of Botany of Azerbaijan National
Academy of Sciences (<http://www.botany.az/>)

Abstract was sent to the required addresses on 29 june 2022.

Signed for print: 23. 06. 2022.

Paper format: 60x84¹/16

Volume: 38634

Number of hard copies: 20