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ABSTRACT

of the dissertation for the degree of Doctor of Science

BIODIVERSITY AND EFFECTIVE USE OF TREES AND SHRUBS DISTRIBUTED IN THE FOREST ECOSYSTEM OF NAKHCHIVAN AUTONOMOUS REPUBLIC

Specialty: 2417.01 – Botany

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INTRODUCTION

Relevance and degree of study of the topic: Population growth on earth and its impact on the environment has always been a problematic issue. Rapid population growth has forced people to use nature more to meet their food and shelter needs, in particular, it forced new lands to enter the economic cycle. Therefore, demographic factors and anthropogenic factors play an important role in the impact on nature. One of the main issues of the period is the organization and use of a comprehensive scientific study of natural plant resources to improve the living standards of the population at a time when the development of society at a modern stage, scientific and technological progress has a profound impact on the environment. In modern times, the efficient and purposeful use of natural resources is always in the center of attention in order to further improve the material well-being of the population and meet their growing needs to the maximum. The economic growth of any country depends, among other factors, on the comprehensive study and efficient use of its natural resources. Therefore, one of the urgent issues of the day is to scientifically study the biological resources of the Nakhchivan Autonomous Republic and identify opportunities for their efficient use.

Study, efficient use, restoration and protection of natural resources has become an urgent problem in the development of the economy of the Nakhchivan Autonomous Republic and is one of the important issues of state importance. This problem requires comprehensive measures to protect and restore natural resources. Conservation and efficient use of plant resources requires a comprehensive study of their main components, including trees and shrubs. *"Despite the fact that forest formations cover only 12% of the territory of the Nakhchivan Autonomous Republic"*[1], tree and shrub plants are richly represented here with economically important and rare species. Their study is of great scientific and practical

[1] http://www.serqqapisi.az/index.php/humanitar/sosial/6555-nakhdzh-van-yash-ll-zhlar-diyar-na-dzhevrilib.html

importance. Flora and vegetation of the forest ecosystem of the Nakhchivan Autonomous Republic attracted the attention of botanists, geographers and forestry scientists. Despite the fact that information on trees and shrubs of the Autonomous Republic is provided in general in the flora of the Caucasus and Azerbaijan, as well as in the research works conducted to study the vegetation cover, their systematic structure, taxonomic composition, distribution, exploring opportunities for efficient use and the problem of detection and conservation of rare species has not yet been comprehensively studied. In this connection, there is an urgent need for a comprehensive study of trees and shrubs in the forest ecosystem of the autonomous republic in modern times. Thus, the degradation of most forest formations in the acute relief conditions of the republic under the influence of anthropogenic factors has led to the deterioration of the hydrological regime and the strong development of erosion processes. As a result of erosion, the areal of some trees and shrubs has changed. As a result, most plants are now rare, and some have reached the degree of extinction. Issues on the dendroflora of the arid zone of the Nakhchivan Autonomous Republic have not been sufficiently studied, the regularities of the distribution of trees and shrubs have not been determined. The scientific basis for the introduction of trees and shrubs in the forest ecosystem has not been developed, the possibilities of efficient use of species of economic importance have not been studied. The potential for the efficient use of economically important and ornamental species has not been clarified.

In this regard, it is of great scientific and practical importance to clarify the taxonomic composition of trees and shrubs distributed in the forest ecosystem, to determine their useful properties, to calculate the natural resources of promising wild fruits, berries and medicinal species, and to study ways of efficient use.

Purpose and objectives of the study: The main purpose of the research is to determine the species composition of trees and shrubs distributed in the forest ecosystem of the Nakhchivan Autonomous Republic, to study their bioecological features, productivity, role in

the type of vegetation, and to develop recommendations for their effective use and protection.

The study of the following issues are planned in order to achieve the set goal:

- ✓ Clarification of the taxonomic composition of trees and shrubs distributed in the forest ecosystem;
- ✓ Botanical-geographical analysis of trees and shrubs;
- ✓ Clarification of the ecobiomorphic structure of trees and shrubs, identification of life forms in different ecological conditions;
- ✓ Study of regularities of vertical distribution of woody plants;
- ✓ Study of the useful properties of trees and shrubs in the forest ecosystem;
- ✓ Calculation of natural resources of wild fruits, berries and trees and shrubs of medicinal importance and indication of ways of their effective use;
- ✓ Development of principles for the creation of arid dendroparks, identification of ways to protect and restore rare and endangered species;
- ✓ Exploring ways to effectively use promising trees and shrubs in landscaping and afforestation.

Methods of research: The material of the research was to determine the species composition of trees and shrubs distributed in the forest ecosystem of the Nakhchivan Autonomous Republic. For this purpose, in 2004-2017, short-term and long-term expeditions were conducted to the areas of the forest ecosystem of the autonomous republic and herbarium materials were collected. Classical and modern - botanical, floristic, systematic, areological, ecological, statistical methods were used in the development of materials, the species composition of trees and shrubs distributed in the forest ecosystem was clarified, as well as their bioecological and useful properties were studied.

The flora of Azerbaijan, the former USSR, the Caucasus and neighboring republics was used in the determination of the species. Determination of productivity and natural resources of wild fruits,

berries and medicinal plants of economic importance distributed in the forest ecosystem was carried out according to generally accepted methods. *IUCN (2001)* version 3.1 [2] was used to determine the categories of rare and endangered plants according to hazard criteria.

Main provisions of the defense:

1. Compilation of modern taxonomic spectrum by determining that the forest ecosystem of the Nakhchivan Autonomous Republic includes 247 taxa (241 species, 4 variations and 2 forms) belonging to 35 families and 61 genera;
2. Recommendation of trees and shrubs for the protection and restoration of important and rare species, as well as for widespread use in various types and categories of landscaping and afforestation;
3. Zoning of the Nakhchivan Autonomous Republic in connection with the purpose of afforestation and determination of the composition of trees and shrubs for each region;
4. Determination of useful properties of trees and shrubs in forest ecosystems, calculation of natural resources of promising wild fruits, berries and species of medicinal importance and study of ways of their efficient use;
5. Identification of rare and endemic species in the area, preparation of action plans and compilation of areal maps for their protection and restoration;

Scientific novelty of the research: For the first time, the forest ecosystem of the Nakhchivan Autonomous Republic was studied on a scientific basis, more detailed information was provided about the biodiversity of trees and shrubs, their current condition and ways of efficient use were identified. The species composition of trees and shrubs distributed in the forest ecosystem has been clarified, and a geographical analysis has been carried out along with the identification of the main floristic elements that make it up. New species have been discovered in the flora of the Autonomous Republic. A comparative analysis of trees and shrubs distributed in

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[2]. IUCN Red List Categories and Criteria: Version 3.1. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK.2001, 31 pp.

different areas was carried out, their characteristic features and possibilities of introduction were revealed.

It was determined that the forest ecosystem of the Nakhchivan Autonomous Republic includes 247 taxa (241 species, 4 variations and 2 forms) grouped into 35 families and 61 genera, of which 109 are trees, 120 are shrubs, 5 are semishrubs, 10 subshurbs, and 3 lianas. During the research, for the first time, 29 species, 5 variations and 2 forms belonging to 6 families and 9 genera were identified, of which 17 species, 2 variations and 2 forms were shown as new for the flora of Azerbaijan - *Acantholimon acerosum* (Willd.) Boiss., *A. festucaceum* (Jaub. & Spach) Boiss., *A. trautvetteri* Kusn., *A. puberulum* Boiss. et Bal., *A. takhtajanii* Ogan., *A. calvertii* Boiss., *A. vedicum* Mirzoeva, *A. manakyanii* Ogan., *A. tragacanthinum* (Jaub. & Spach) Boiss., *Malus orientalis* var. *subalpina* Ponomarenko, *Pyrus pseudosyriaca* Gladkova, *P. caucasica Fed.* var. *schuntukensiz* Tuz., *P. chosrovica* Gladkova, *P. demetrii* Kuth., *P. fedorovii* Kuth., *Sorbus albovii* Zinserl., *S. armeniaca* Hedl., *S. buschiana* Zinserl., *Tamarix litwinowii* Gorschk, *Berberis vulgaris* f. *alba* West., *Berberis vulgaris* f. *lutea* Regel, 12 species, 3 variations for the flora of the Nakhchivan Autonomous Republic - *Acanthol*imon *lepturoides* (Jaub. et Spach) Boiss., *Cotoneaster meyeri* Pojark., *C. transcaucasicus* Pojark, *Malus orientalis* var. *montana* (Uglitzk.) Langenf., *Pyrus georgica* Kuth., *P.salicifolia Pall.* var. *latifolia* Alexenko, *P. salicifolia* Pall. var. *angustifolia* Kuth., *Sorbus caucasica* Zinserl., *S. fedorovii* Zaikonn., *S. kusnetzovii* Zinserl., *S. migarica* Zinserl., *S. tamamschjanae* Gabr., *Tamarix florida* Bunge, *T. litwinowii* Gorschk, *Viburnum opulus* L., *Lonicera caucasica* Pall. The status of the species of *B. integerrima* Bunge., *B. orientalis* C.K.Schneid. of genus *Berberis* L. and species *Rosa azerbajdzhanica* Novopokr. & Rzazade of genus *Rosa* L. were restored.

Life forms of trees and shrubs in different ecological conditions, distribution patterns on altitude zones were studied, ecobiomorphic analyzes were analyzed. Rare and endangered species have been identified and ways to protect and restore them have been developed. Rare species listed in the Red Book of Azerbaijan and the

Nakhchivan Autonomous Republic have been identified, identified on the basis of protected statuses, categories and relevant criteria, and species distribution maps have been compiled. Prospective species of economically important trees and shrubs for landscaping and afforestation have been identified.

Two types (forest, bush), 4 subtypes, 7 formation classes, 35 formations and 69 associations have been identified for the vegetation of forest ecosystems.

The principles developed in connection with the creation of arid arboretums form the scientific basis for the effective use of wild tree and shrub species in forest reclamation and afforestation in the autonomous republic, as well as the protection of rare and endangered species.

The collection consisting of aboriginal trees and shrubs created in the "Botanical Garden" of the Institute of Bioresources of the Nakhchivan Branch of ANAS will be considered as a primary material for widespread use in the cultivation of a number of plants, landscaping, afforestation and other activities in the arid conditions of the autonomous republic. The natural resources of economically important trees and shrubs in the forest ecosystem have been studied and the scientific basis of efficient use has been shown.

Theoretical and practical significance of the research: Determining the species composition and distribution patterns of trees and shrubs distributed in the forest ecosystem of the Nakhchivan Autonomous Republic is an important scientific basis for further large-scale monitoring research. It can be used in the development of practical measures for the conservation of rare and endangered species and complex programs for the protection of the environment, in determining the biodiversity of the flora of the Nakhchivan Autonomous Republic. Identified species of economic importance can be useful in various fields of industry, scientific medicine, agriculture, as well as in meeting the needs of the autonomous republic for natural raw resources.

Decorative trees and shrubs can be widely used in the landscaping of the autonomous republic. In addition to the

organization of natural areas and reserves in accordance with the prepared proposals and recommendations, by propagating some trees and shrubs in *ex situ* (Botanical Garden) conditions and reintroducing them *in situ* (Special Protected Areas), it is possible to expand their habitats and protect their gene pool. It can be recommended to use the introduced species in the creation of new varieties for hybridization, and the fruits in canning, caramel and juice enterprises.

Approbation and application: The results of the dissertation work are presented in the annual reports of the Institute of Bioresources of the Nakhchivan Branch of the Azerbaijan National Academy of Sciences, scientific seminars, international conferences and symposiums held in our republic and abroad, as well as: Nakhchivan today: perspectives and reforms. Proceedings of the International Symposium (Nakhchivan, 2008), "Problems of Botany of Southern Siberia and Mongolia". Materials of the 8th International Scientific and Practical Conference (Barnaul, 2009), Materials of the international conference "Natural protection of botanical gardens at the modern stage" Mardakan Arboretum of the Azerbaijan National Academy of Sciences (Baku, 2010), Materials of the V International Scientific Conference "Landscape Architecture in Botanical Gardens and Arboretums" Mardakan Arboretum of the Azerbaijan National Academy of Sciences (Baku, 2013), "Environmental changes and conservation of plant diversity" International Conference (Baku, 2013), International conference "Conservation, enrichment and rational use of the gene pool of flora and fauna of Uzbekistan" (Tashkent, 2014), International scientific-practical conference "Prospects for the development of beekeeping in the region" (Nakhchivan, 2014), II International sympozium on wild realatives of subtropical and temperate fruit and nut crops (Baku, 2014), International scientific-practical conference "Innovative development of agrarian science and education: world experience and modern priorities" (Ganja, 2015), International scientific-practical conference "Development of agriculture: realities and perspectives" (Nakhchivan, 2015), SEAB -2015. Symposium on Euro Asian

Biodiversity (Baku, 2015), International scientific conference "Actual problems of modern biology and chemistry" (Ganja, 2016), 8th International Scientific-Practical Conference on "International Cooperation on Development of Agrarian Science, Food Security and Environmental Protection" (Ganja, 2016), SEAB-2016. Symposium on EuroAsian Biodiversity (Antalya, 2016), International Conference. Innovative Approaches to Conservation of Biodiversity dedicated to the 80th Anniversary of the Institute of Botany, Azerbaijan National Academy of Sciences (Baku, 2016), International scientific conference "Actual problems of modern biology and chemistry" (Ganja, 2017), International Scientific Conference "Impact of Climate Change on Plant Biodiversity" of Mardakan Arboretum of the Azerbaijan National Academy of Sciences (Baku, 2017), SEAB-2017. The 3rd İnternational Symposium on Euro Asian Biodiversity (Minsk, 2017), 4. National Botanical Congress (Turkey, Trakya University, 2017), International scientific conference "Actual problems of modern natural and economic sciences" (Ganja, 2018), Institute of Botany of ANAS and Society of Azerbaijan Botanists. Symposium dedicated to the 120th anniversary of academician V.I. Ulyanishev (Baku, 2018), SEAB-2018. The 4th International Symposium on Euro-Asian Biodiversity (Kiev, 2018), International scientific conference "Actual problems of modern natural and economic sciences" (Ganja, 2019), Republican Scientific Conference "Development Directions of the Agrarian Sector" (Nakhchivan, 2019).

Organization in which the dissertation work is carried out: The dissertation work was carried out at the Institute of Bioresources of the Nakhchivan Branch of the Azerbaijan National Academy of Sciences.

Published scientific works: Four books and 62 works (15 conference materials, 9 theses) containing the main provisions of the dissertation were published, including one book and 21 works in foreign journals.

Structure and scope of the dissertation: The dissertation consists of 408 pages with an introduction, 10 chapters, results,

suggestions and recommendations, bibliography and appendices: title page, table of contents and introduction - 15 pages- 10 pages, I chapter- 23 pages, II chapter - 7 pages, III chapter - 7 pages, IV chapter - 61 pages, V chapter - 54 pages, VI chapter- 47 pages, VII chapter- 7 pages, VIII chapter- 33 pages, IX chapter- 51 pages, X chapter- 6 pages, results - 3 pages, suggestions and recommendations - 2 pages, appendices - 48 pages. 402 references were used in the list of literature, 181 of them are Russian, 5 Turkish and 30 English sources. The dissertation contains 53 tables (3 in the appendix), 97 figures (6 in the appendix), 1 map and 4 map-schemes. The volume of the dissertation consists of 424937 characters (excluding figures, tables, maps, maps-schemes, appendices and list of literature).

CHAPTER I. HISTORY OF STUDY AND FORMATION OF FOREST ECOSYSTEM IN THE NAKHCHIVAN AUTONOMOUS REPUBLIC

The territory of the Nakhchivan Autonomous Republic has natural resources, and forests have a special place among these natural resources. Such specificity is directly related to the historical-geological, soil and climatic features of the area. References to foreign classical and modern literature sources are made in the dissertation. The literature review provides detailed information on the study of the forest ecosystem of the autonomous republic. Despite the diversity of scientific research conducted in the Nakhchivan Autonomous Republic and the discovery of new species, no research has studied the exact habitats of trees and shrubs distributed in the forest ecosystem, modern systematics of species and a comprehensive study of the possibilities of use.

Therefore, there is a great need for botanical and geographical analysis of trees and shrubs distributed in the forest ecosystem, study of their distribution areas, biological characteristics, identification of rare and endangered species and phytomeliorative measures in the area. For this purpose, as a result of research conducted since 2004, a systematic review of trees and shrubs distributed in the forest ecosystem has been compiled, bioecological features have been

studied, rare and endangered species have been identified and potential opportunities for their efficient use have been clarified.

CHAPTER II. PHYSICAL-GEOGRAPHICAL FACTORS AFFECTING THE FORMATION OF FOREST ECOSYSTEM IN NAKHCHIVAN AUTONOMOUS REPUBLIC

This chapter provides brief information on the natural geographical conditions, geographical position, relief, orographic features, climate and soil cover of the forest ecosystem of the Nakhchivan Autonomous Republic on the basis of literature data.

CHAPTER III. MATERIAL AND METHODOLOGY OF RESEARCH

In 2004-2017, short and long-term expeditions were conducted to the forest ecosystems of the autonomous republic, and more than 1500 herbarium materials were collected. Classical and modern - botanical, floristic, systematic, ecological, statistical methods were used in the development of materials, the species composition of trees and shrubs distributed in the forest ecosystem was specified, as well as the biological features of some species were studied. Determinants as *"Trees and shrubs of Azerbaijan (1961-1970)"*[3], *"Higher plants of Azerbaijan (2005-2008)"*[4], *"Dendroflora of the Caucasus (1959-1986)"*[5], *"Trees and shrubs of the USSR (1949-1965)"*[6], *"Flora of Azerbaijan (1950-1961)"*[7], *"Flora of the*

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[3] Azərbaycanın ağac və kolları. 1961-1970: [3 cilddə]. – Bakı: Elm, c. 1. – 1961. – 322 s.; c. 2. – 1964. –221 s.; c. 3. – 1970. – 323 s.

[4] Əsgərov, A.M. Azərbaycanın ali bitkiləri (Azərbaycan florasının konspekti). 2005-2008: [3 cilddə] / A.M.Əsgərov. – Bakı: Elm, – c.1. – 2005. – 247 s.; – c.2. – 2006. – 247 s.; c.3. – 2008. – 240 s.

[5] Дендрофлора Кавказа (Дикорастущие и культурные деревья и кустарники). 1959-1986: [в 6 томах.]. – Тбилиси: Изд-во АН Груз СССР, – т. 1. – 1959. – 406 с.; – т. 2. – 1961.– 335 с.; – т. 3. – 1963.– 309 с.; – т. 4.– 1965. – 399 с.; – т. 5. – 1970. – 303 с.; – т. 6. – 1986. – 306 с.

[6] Деревья и кустарники СССР. Дикорастущие, культивируемые и перспективные для интродукции. 1949-1962 [в 6 томах.]. – Москва: Ленинград: Изд-во АН СССР, – т. 1.– 1949.– 463 с.; – т. 2.–1951.–611 с.; – т. 3. –1954.– 872 с.; – т. 4.– 1958.– 975 с.; – т. 5.– 1960.– 545 с.; – т. 6. – 1962.–380 с.

[7] Флора Азербайджана. 1950-1961: [в 8 томах]. – Баку: Изд-во АН Азерб. ССР, – т. 1. – 1950. – 370 с.; т. 2. – 1951. – 318 с.; т. 3. – 1952. – 407 с.; т. 4. –

Caucasus (1939-1967)"[8], *"Flora of Turkey (1965-2001)"*[9] as well as books and monographs by local and foreign authors have been used in the determination of the species. Life forms of trees and shrubs were determined according to *"I.G.Serebryakov (1964)"* [10] and *"C.R.Raunkier (1934)"* [11], ecological groups to *"A.R.Sennikov (1964)"*[12], type, class and groups of the areal to *"A.A.Grossheim (1936)"* [13] and *"N.N.Portenier (2000)"* [14]. The names of taxa, nomenclature changes were given on the basis of works *"S.K. Cherepanova (1995)* [15] *"* and *"Abstract of flora of the Caucasus (2003-2012)* [16] *"*. According to the classification [17] adopted in

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1953. – 402 с.; т. 5. – 1954. – 580 с.; т. 6. – 1955. – 540 с.; т. 7. – 1957. – 648 с.; т. 8. – 1961. – 690 с.

[8] Гроссгейм А.А. Флора Кавказа. 2-е изд.: 1939-1967: [в 7 томах, не окончено]**.** – Баку: АзФАН СССР, – т. 1. – 1939. – 404 с.; – т. 2. – 1940. – 284 с.; т. 3. – 1944 – 322 с.; – т. 4. – 1950. – 314 с.; – т. 5. – 1952. – 456 с.; – т. 6. – 1962. – 424 с.; – т. 7. – 1967– 894 с.

[9] Flora of Turkey and the East Aegean Islands: [in 11 vol.] (suppl. vol. 10–11) / ed. by P.H.Davis (vol. 1–10), A.Guner (vol. 11).– Edinburgh:– 1965- 2001. vol. 1. – 1965. – 567 p.; – vol. 2. – 1967.– 581 p.; – vol. 3. – 1970.– 628 p.; – vol. 4. – 1972. – 657 p.; – vol. 5.– 1975. – 890 p.; – vol. 6. – 1978.– 825 p.; – vol. 7. – 1982. – 947 p.; – vol. 8. – 1984. – 632 p.; – vol. 9. – 1985. – 724 p.; – vol. 10, suppl. – 1988. – 590 p.; – vol. 11, suppl.– 2001. – 656 p.

[10] Серебряков, И.Г. Жизненные формы высших растений и их изучение // – Москва – Ленинград: Полевая геоботаника, – 1964. т. 3, – с. 146-205.

[11] Raunkiaer, C.R. The life forms of plants and statistical plant geography / C.R.Raunkiaer. – Oxford: Clarendon Press, – 1934, – 729 p.

[12] Шенников, А.П. Введение в геоботанику / А.П.Шенников. – Ленинград: Изд-во Ленинградского Университета, – 1964. – 447 с.

[13] Гроссгейм, А.А. Анализ Флора Кавказа // – Баку: Труды Ботанического Института Аз ФАН СССР, – 1936. т. 1, – 260 с.

[14] Портениер, Н.Н. Система географических элементов флоры Кавказа // – Ленинград: Ботанический журнал, – 2000, №9, – с. 26-33.

[15] Черепанов, С.К. Сосудистые растения России и сопредельных государств (в пределах бывшего СССР) / С.К.Черепанов. – С-Петербург: Мир и семья-95, – 1995. – 992 с.

[16] Конспект флоры Кавказа: [в 3 томах]. – СПб.: Из-во С. Петербургского университета, – т. 1, – 2003. – 204 с.; – т. 2, – 2006. – 267 с.; – т. 3. ч. 1, – 2008. – 469 с.; – т. 3. ч. 2, – 2012. – 623 с.

[17] Лесная энциклопедия [в 2 томах.]. / Гл. редактор Г. И. Воробьёв. – Москва: Советская энциклопедия, – т.1. – 1985. – 563 с.

dendrology, trees and shrubs are divided into the following groups according to their height: For wood plants: I group (A_1)- height over 25 m; II group (A_2) - 10-25 m; III group (A_3) - 5-10 m; IV group (A_4) – up to 5 m. For shrub plants: I group (K_1) - High (2-5 m); II group (K_2) - Middle (1-2 m); III group (K_3) - Low (0,5-1 m).

Phytocenological analysis of the main formations of tree vegetation was carried out in accordance with the methodical instructions on forest biocenology [18] .

Sample areas were selected in areas richer in trees and shrub plants (Shahbuz, Ordubad) to study the vertical distribution of individual tree species as well as their formations. Observations in the selected sample areas were made at absolute heights every 100 m. The main objects of detailed study of tree plants in the conditions of introduction were also "Wild fruit plants" garden consisting of newly planted trees and shrubs collected in the "Botanical Garden" of the Institute of Bioresources of Nakhchivan Branch of ANAS. Seedlings, shoots and seeds collected during the introduction of trees and shrubs distributed in the forest ecosystem to the "Botanical Garden" of the Institute of Bioresources of the Nakhchivan Branch of ANAS were used. Seeds were collected from different regions of the autonomous republic. Hard-germinated seeds were stratified at different stages before sowing. Stratified seeds were sown in boxes before planting in seed plot or in prepared areas in the exposition area.

Phenological observations on the collections, study of plant height and development were carried out in accordance with the methodologies of *"P.I.Lapin (1973)"* [19] and *"L.C.Plotnikov (2002)"*[20].

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[18] Сукачев, В.Н. Методические указания к изучению типов леса / В.Н.Сукачев, С.В.Зонн – Москва: Изд-во АН СССР, – 1961. – 144 с.

[19] Лапин, П.И., Соднева, С.В. Оценка перспективности интродукции древесных растений по данным визуальных наблюдений // – Москва: Опыт интродукции древесных растений, – 1973. – с. 7-67.

[20] Плотникова, Л.С. Перспективы интродукции редких видов древесных растений в Москве в связи с их экологической характеристикой // – Москва: Бюллетень Главного ботанического сада,– 2002. №183, – с. 3-8.

Assessment of protection status of rare and endangered species was mainly compiled based on *"IUCN Red Data Book"* [21] categories and criteria, *"Red Book of the Republic of Azerbaijan (2013)"* [22], *"Red Book of Nakhchivan AR (2010)"* [23] and *"V.M.Alizade's data (2018)"* [24].

Determination of productivity and natural resources of wild fruits, berries and medicinal plants of economic importance spread in forest ecosystems was carried out according to *"N.A.Borisova, "A.I.Shreter (1966)"* [25], *"Q.K.Shreter (1972)"* [26], *"A.B.Kalinina (1974)"*[27], *"A.I.Shreter (1986)"*[28] and other methodologies. Also, the method of visual assessment given by "*A.V. Kalinina (1971)*" [29] was used in the study of the productivity of species and forms of wild fruit and berry plants.

Map schemes of species on distribution areas and altitude zones were developed on the basis of a comparative analysis with

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[21] IUCN Red List Categories and Criteria: Version 3.1. IUCN Species Survival Commission. IUCN, Gland, Switzerland and Cambridge, UK.2001, 31 pp.

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CHAPTER IV. GENERAL CHARACTERISTICS OF FOREST ECOSYSTEM

4.1. Forest vegetation. Although the Nakhchivan Autonomous Republic is considered one of the least forested areas in Azerbaijan, it is very rich in species composition. Forests are distributed at altitudes of 1600-2400 meters, depending on the vertical and horizontal zoning. Sometimes trees and shrubs rise to high mountain peaks (2500-2700 m) in the area, and sometimes fall down to 1100-1700 m along the river basin. Forest massifs have been found in Bichenak and Batabat areas of Shahbuz district, Arafsa and Lakatagh (Khazinadara, Garatorpaglig, Vanlidere, Gavik, Ganja, Kola and Duman) in Julfa district and around villages Nasirvaz and Nurgut (Tillak, Palidlidara, Yukhari and Ashagi Jalil, Talalar, Aznamer) of Ordubad district. Hanging birch was noted on the right bank of the Pazmari and Paragachay rivers (2100-2400 m above sea level) and at the foot of the Soyugdag (2400-2600 m above sea level) of the Ordubad region. Of these, park-type natural forests develop in the northern, north-western, north-eastern areas, moistened by the influence of branches of Nakhchivanchay, Paragachay, Tivichay, Nasirvazchay, Saggarsuchay and Ayrichay, springs and groundwater. Currently, natural forests in the territory of Nakhchivan AR cover an area of 4126 ha. The main forest massifs are Bichenak (2289 ha), Zarnatun (424,79 ha), Garagush-Khanbulagi (250 ha), Gavik-Khazinadere-Kola (262 ha), Bist (350 ha), Tillak (117 ha) forests. Besides, Soyuqdag birch forest (3,5 ha), Ardıcdag sparse arid forest (4,5 ha), Darıdag sparse juniper forest (8,5 ha), Paradash sparse juniper forest (4,2 ha), Pazmari arid forest (4,8 ha), Ilanlidag sparse juniper arid forest (1,5 ha), Kechilidag spindle - hawthorn forest (3,5 ha) are main components of the forest ecosystem of the Autonomous Republic. As can be seen, the Autonomous Republic is almost

forestless due to its forest cover. The total amount of forests covers only 0,63 % of the area. Of them, oak occupies 1305 ha (83,89 %), common ash-tree 226 ha (14,06 %). The share of other genera is only 1,6 %. Main formations as *Quercetum*, *Fraxinetum*, *Juniperetum*, *Fraxineto-Quercetum*, *Crataegeto-Quercetum* are found in the natural forests of the Autonomous Republic, *Salicetum*, *Junipereto-Pyreto-Crataegetum* in mountain and river valleys, *Celtietum* in rocky slopes and dry valleys, *Tamarietum* in river valleys and *Hippophaetum* etc. around high mountain rivers.

Thus, as a result of the research, 2 types (forest, bush), 4 subtypes, 7 formation classes, 35 formations and 69 associations were identified for the vegetation cover of forest ecosystems.

4.1.1. Mountain forests. Spreading at altitudes of 1500-2000 m above sea level and the main creator is *Quercus macranthera* Fisch. & C.A.Mey. ex Hohen and sometimes species *Q. iberica* Stev. mixed with it. *Fraxinus excelsior* L., *Acer ibericum* Bieb., *Pyrus caucasica* Fed., *Populus tremula* L. etc. tree and shrubs were encountered in their composition.

4.1.2. Broad-leaved mountain forests. Although the dominant species of broad-leaved forests in the mountainous area is the oriental oak, the subdominant species *Fraxinus excelsior* L., *Crataegus meyeri* Pojark., *Pyrus salicifolia* Pall. are of special importance in the formation of the forest. Subdominant species of Tillak, Talalar, Aznamer forests are *Juniperus polycarpos* C.Koch, *Malus orientalis* Uglitzk., *Pyrus salicifolia* Pall., *Viburnum lantana* L. plants. These species form various associations with dominant species *Quercus macranthera* Fisch. & C.A.Mey. ex Hohen and *Q. iberica* Stev. Meyer hawthorn is the main subdominant species of many forests.

4.1.3. Upper mountain oak forests (*Querceta*). It is spread in the form of pure and mixed oak wood, covering wider areas than other forest formations. Here *Querceta macrantherae* Fisch. & C.A.Mey. ex Hohen are considered main forest forming species. Oak forests are formed on the south-eastern, north-eastern and north-western slopes of the mountains and rise to an altitude of 1600-2400

(2600) m. Pure oak forests are found in Bichenak, Batabat, Khazinadere, Tillak, Azmaver, Talalar, Ashagi and Yukhari Jalilli, Palidlidara, Gavik. The following tree and shrubs are found in these forests: *Fraxinus excelsior* L., *Acer ibericum* Bieb., *Crataegus orientalis* Pall. ex Bieb., *Malus orientalis Uglitzk.*, *Juniperus exselsa* Bieb., *J. polycarpos* C.Koch, *Prunus divaricata* Ledeb., *Pyrus salicifolia* Pall., *Viburnum lantana* L., *Padellus mahaleb* (L.) Vass., *Betula pendula* Roth, *Sorbus persica* Hedl., *R. canina* L., *Rhamnus pallasii* Fisch. & C.A.Mey. Mixed forests consisting of *Fraxineta*, *Crataeguetum*, *Quercetum-Sorbuosum*, *Quercetum-Fraxinosum*, *Quercetum-Crataegosum*, *Quercetum-Ulmosum* formed mainly from oak, ash-tree, hawthorn, mountain ash, elm species play an important role in the formation of forest formations in the autonomous republic.

4.1.4. Pine wood (*Pineta*). Pine forest (Kochi pine) grows only in the territory of Bichenak forest in the form of a small glade in the oak wood near Kecheldag on the left bank of Nakhchivanchay. The main element of this association *Pinus kochiana* Klotzsch ex C.Koch trees with 35 pieces locate at an altitude of 2100 m above sea level.

4.1.5. Birch wood (*Betuleta*). It forms small woods at the height of 2400 (2600) m in the subalpine zone at the foot of Soyuk mountain in Ordubad region. It is also found in small groups in the Gilanchay valley, near the villages of Bilav, Paraga, Pazmari, Behrud, Rumus, in the forests of Tillak, Talalar, Ashagi and Yukhari Jalil. Trees and shrubs such as *Quercus macranthera* Fisch. et C.A. Mey. ex Hohen., *Q. iberica* Stev., *Fraxinus exelsior* L., *Viburnum lantana* L., *Acer ibericum* Bieb., *Malus orientalis* Uglitzk., *Prunus divaricata* Ledeb., *Ulmus minor* Mill., as well as some species of *Sorbus* L., *Pyrus* L., *Salix* L., *Populus* L., *Rosa* L., *Crataegus* L. genera are widespread in birch woods.

4.1.6. Sparse mountain forests. These are open cenoses with trees and shrubs, and the elements that make up the forest are spaced apart. Although main characteristic elements are plants such as *Pyrus salicifolia* Pall., *P.oxyprion* Woronow, *Amygdalus fenzliana* (Fritsch) Lipsky, *Crataegus orientalis* Pall. ex Bieb., tree plants as *Juniperus foetidissima* Willd. and etc. from coniferous plants are often included

to this composition.

4.1.7. *Juniper woods (Junipereta).* Located at altitudes of 1800-2400 m, and and mainly distributed in scattered form around Ardijdag (4.5 ha), Daridag (8.5 ha), Paradash (4.2 ha), Ilandag (1.2 ha), Vang (4.2 ha), Soyugdag (1.5 ha), Pazmari (4.8 ha) and Bichenak forests. Although species of the genus *Juniperus* L. form the basis of juniper forests, the composition is often mixed with tree and shrub plants such as *Acer ibericum* Bieb., *Ephedra procera* Fisch & C.A. Mey., *Sorbus graeca* (Spach) Lodd. ex Schauer, *Pyrus salicifolia* Pall., *Lonicera iberica* Bieb., *Pistacia mutica* Fisch. & C.A.Mey., *Rhamnus pallasi* Fisch. & C.A.Mey., *Amygdalus fenzliana* (Fritsch) Lipsky and form mixed associations with the main dominant species (*Juniperus foetidissima* Willd., *J.exelsa* Bieb.).

4.1.8. Xerophytes sparse forests. Such forests developed in arid areas consisting of drought-resistant trees and shrubs. The cenoses of wood xerophytes in themselves combine associations that are highly tolerant of climate. These shrubs are distributed in the mountainous zone of the autonomous republic at an altitude of 1500-2000 m together with the associated transitional cenoses and their mixtures.

4.1.9. Secondary shrub forests. These forests usually develop as a secondary type in areas where the integrity of the primary forests is compromised and usually consist of more or less dense shrubs of the main components of the forest. Secondary shrub forests are mostly developed in Zarnatun, Khinzirak massifs, around Bichenak, Kolani, Kuku, Kechili, Gejazur, Gomur, Nurgut, Nasirvaz, Tivi, Paraga, Gilanchay villages and in Alinjachay valleys, mainly in felled forest areas.

The following tree and shrubs are often encountered in shrub in brushwood: *Quercus macranthera* Fisch. & C.A.Mey. ex Hohen, *Viburnum lantana* L., *Euonymus latifolia* (L.) Mill., *Acer ibericum* Bieb., *Lonicera iberica* Bieb., *Juniperus hemisphaerica* (J. & Presl) Nym., *J. polycarpos* C.Koch, *Sorbus graeca* (Spach) Lodd. ex Schauer, *Cotoneaster melanocarpus* Fisch. ex Blytt, *Rosa canina* L., *R. buschiana* Chrshan., *Padus avium* Mill., *Rhamnus cathartica* L.

Pyrus oxyprion Woronow, *P. salicifolia* Pall., *Amygdalus fenzliana* (Fritsch) Lipsky, C*rataegus orientalis* Pall. ex Bieb., *Prunus divaricata* Ledeb, *Spiraea crenata* L.

4.1.10. Forests and bushes. Covers large areas in the Zarnatun, Khinzirak, Alchalig and Gizilgaya massifs of the Bichenak area, around the villages of Kuku, Badamli, Guney and Gizil Qishlag, and are secondary woodland formed on the area of felled forests and park-shaped forest areas and widespread in the form of glades with the predominance of *Quercus macranthera* Fisch. et C.A. Mey. ex Hohen., *Acer ibericum* Bieb., *Pyrus oxyprion* Woronow, *Amygdalus fenzliana* (Fritsch) Lipsky, *Crataegus orientalis* Pall. ex Bieb., *Prunus divaricata* Ledeb., *Rosa canina* L. and *Padus avium* Mill. species. These phytocenoses include *Euonymus latifolia* (L.) Mill. species in river valleys and relatively humid dense shrubs.

4.2. Tugai forests. Tugai forests are located along the Araz River, Shargi Arpachay, Nakhchivanchay, Gilanchay, Paragachay, Duylunchay, Ordubadchay rivers of the autonomous republic and form a green cover. The main trees and shrubs that form the tugai forests include *Elaeagnus angustifolia* L., *Hyppophae rhamnoides* L., *Berberis vulgaris L., Ulmus minor* Mill., *Tamarix* L., *Salix* L., *Populus* L. and etc. species.

4.3. Shrub vegetation. Independent shrub formations formed in both deciduous broad-leaved and evergreen coniferous *Juniperieta* shrubs. Some mixed shrub formations widespread at an altitude of 1200-2700 m in Garatorpaglar of Sadarak region, in Ardicdag of Sharur district, in Lizbirt valley, Garagush mountain of Babek region, in Nursu, Kuku, Kolani, Agbulag, Gomur, Kechili, Kulus villages of Shahbuz region, around Kukudag, Kecheldag, Ganligol, in Bayahmed, Lakadag, Teyvaz, Arafsa of Julfa district, around Paraga, Tivi, Gilanchay, Nasirvaz and Nurgut villages of Ordubad region.

Juniperus pygmae C.Koch, *J. exselsa* Bieb., *J. polycarpus* C.Koch, *Pistacia mutica* Fisch. et C.A.Mey., *Tamarix meyeri* Boiss., *Ephedra procera* Fisch. et C.A. Mey., *Lonicera iberica* Boiss. et

Buhse, *Rhamnus pallasii* Fisch. et C.A. Mey., *Crataegus caucasica* C. Koch, *Rosa canina* L., *R. buschiana* Chrshan., *Berberis vulgaris* L., *Sorbus persica* Hedl., *Cotoneaster melanocarpus* Fisch. et Blytt, *Spiraea hypericifolia* L. and etc. species are encountered here.

4.3.1. Coniferous shrubery. The composition of phytocenoses *Juniperus foetidissima* Willd., *J.exelsa* Bieb., *J.sabina* L., which are more common in forest ecosystems include shrub plants as *Spiraea crenata* L., *Cotoneaster melanocarpus* Fisch. ex Blytt, *Lonicera iberica* Bieb., *Rhamnus pallasi* Fisch. & C.A.Mey., *Cerasus avium* (L.) Moench, *Rosa canina* L., *R. floribunda* Stev., *Sorbus graeca* Fisch. & C.A.Mey. ex Hohen, *Pyrus oxyprion* Woronow etc.

4.3.2. Broad-leaved shrubs. They are noted at the altitudes of 1800-2200 m around Batabat, Zarnatun, Khinzirak areas and Tivi, Nasirvaz, Nurgut villages, on mountain slopes, river valleys and wet places. They participate as a component in mixed shrub phytocenoses consisting of some species of genera *Lonicera iberica* Bieb., *Prunus divaricata* Ledeb., *Acer ibericum* Bieb., *Viburnum lantana* L., *Juniperus* L., *Spiraea* L., *Salix* L., *Amygdalus* L., *Pyrus* L., *Rosa* L., *Berberis* L., *Crataegus* L., *Sorbus* L., *Cotoneaster* Medik. Broad-leaved shrubs play an important role in the national economy and, in part, in agriculture.

4.3.3. Deciduous mixed shrubs. It was recorded at the altitudes of 2000-2500 m around Agbulag, Kolani, Arafsa, Bist, Bilav, Tivi, Teyvaz, Nasirvaz, Bayahmed and Buzgov villages. *Berberis vulgaris* L., *Crataegus caucasica* C. Koch, *C. orientalis* Pall. ex Bieb., *Sorbus graeca* Fisch. & C.A.Mey. ex Hohen, *S. persica* Hedl., *Prunus divaricata* Ledeb., *Padellus mahaleb* (L.) Vass.. *Padus avium* Mill., *Rosa nisami* Sosn., *R. rapinii* Boiss. et Bal., *R. brotherorum* Chrshan., *R. zangezura* P. Jarosch., *Spiraea crenata* L., *Ribes biebersteinii* Berl. ex DC., *Viburnum lantana* L. and etc. species form independent undergrowths.

4.4. Oasis-shaped forests. Oasis vegetation located in the area of 1000-2200 m consists of gardens, melons and irrigated fields. Tree and shrubs *Platan orientalis* L., *Juglans regia* L., *Salix alba* L., *Populus nigra* L., *Fraxinus excelsior* L., *Ulmus glabra* Huds.,

Crataegus meyeri Pojark., *Prunus divaricata* Ledeb., *Elaeagnus angustifolia* L., *Rosa canina* L., *Rubus ibericus* Juz. and etc. predominate in the composition of oasis. In recent years, especially since independence, planting materials of various ornamental trees, shrubs and valuable plants of economic importance from Iran, Turkey and other countries are widely used by local population. Their introduction and cultivation have significantly enriched the vegetation of oasis gardens. On the other hand, many orchards,flower gardens, artificial forests (Uzunoba, Khalkhal, Vaykhir, Rustam, etc.) have been planted in the area.

4.5. Distribution patterns of trees and shrubs on the vertical belts. As a result of research conducted during 2004-2017, based on some bioecological features of trees and shrubs, the number composition, the regularities of distribution depending on the height were studied. (Table 1)

Table 1

Distribution of trees and shrubs along vertical belts

Belts	Height, in m	Number of species		According to the form of life				
		Number	In % of the total number	Tree	Shrub	Semishrub	Subshrub	Liana
Plain	600-1000	59	24,3	21	25	5	8	-
Low mountainous and sloping plains	1000-1400	108	43,7	62	34	4	6	2
Arid sparse forests of the middle mountains	1400-1700	69	27,9	29	23	4	10	3
Mixed broad-leaved forests of the middle mountains	1700-2300	169	68,4	83	74	5	4	3
Sparse forests of high mountains	More than 2300	26	10,5	11	13	2	-	-

The results of the research show that forests distrubuted at the

altitudes of 1000-1400 m (108 species) and 1700-2300 m (169 species) are richer from a dendrological point of view. All life forms of trees and shrubs are found here. The study of the vertical distribution of trees and shrubs in the Autonomous Republic showed that they have completely different ecological plasticity and can be found in various formations in the composition of forest ecosystem, starting from the Low Mountains to the subalpine belt.

4.6. Upper and lower boundaries of trees and shrubs distributed in forest ecosystems. As a result of research conducted during 2004-2017, the upper border of the distribution of trees and shrubs in the Nakhchivan Autonomous Republic varies between 2350-2500 m above sea level. However, dog rose bushes, junipers, pallas buckthorns, etc. species can spread up to 3000 m. Starting at an altitude of 1600-1800 m, they condense on trees and shrubs and towards the slopes of watersheds along depressions and ravines, forming light or closed forests. The upper border of the forest (2600 m) in some places in the territory of Ordubad region consists of a mixture of mountain ash,cherry plum, barbery together birch and oak. The upper border of the forest (2400 m) in the territory of Shahbuz district is represented by tree plants consisting of oriental oak.

CHAPTER V. SYSTEMATIC, BIOMORPHOLOGICAL AND ECOGEOGRAPIC ANALYSIS OF TREE AND SHRUB PLANTS DISTRIBUTED IN THE FOREST ECOSYSTEM OF THE NAKHCHIVAN AUTONOMOUS REPUBLIC

Trees and shrubs distributed in the forest ecosystem of the autonomous republic during 2004-2017 were studied in detail, as a result for the first time, 29 species, 5 variations and 2 forms belonging to 6 families, 9 genera were determined, of these, 17 species, 2 variations and 2 forms were shown for the first time for the flora of Azerbaijan, 12 species and 3 variations for the flora of the Nakhchivan Autonomous Republic.

5.1. Systematic analysis. Based on the results of research conducted during 2004-2017, it was determined that the forest

ecosystem of the Nakhchivan Autonomous Republic includes 247 taxa (241 species, 4 variations and 2 forms) grouped into 35 families and 61 genera, of these, 109 are trees, 120 shrubs, 5 semishrubs, 10 subshrubs and 3 lianas (Table 2).

Table 2

Taxonomic analysis of trees and shrubs in forest ecosystems

No.	Families	Genus	In % of the total number	Species number	Variation	Form	In % of the total number
1	2	3	4	5	6	7	8
1.	*Pinaceae* Adans.	1	1,64	1			0,40
2.	*Cupressaceae* S.F.Gray	1	1,64	8			3,24
3.	*Ephedraceae* Dumort.	1	1,64	4			1,62
4.	*Berberidaceae* Juss.	1	1,64	6		2	3,24
5.	*Ranunculaceae* Adans.	1	1,64	2			0,81
6.	*Plumbaginaceae* Juss.	1	1,64	19			7,69
7.	*Platanaceae* T. Lestib.	1	1,64	1			0,40
8.	*Fagaceae* Dumort.	1	1,64	3			1,21
9.	*Betulaceae* S.F.Gray	1	1,64	1			0,40
10.	*Corylaceae* Mirb.	1	1,64	2			0,81
11.	*Juglandaceae* DC ex Perleb	1	1,64	2			0,81
12.	*Tamaricaceae* Link.	2	3,28	8			3,24
13.	*Salicaceae* Mirb.	2	3,28	16			6,48
14.	*Capparaceae* Juss.	1	1,64	1			0,40
15.	*Ulmaceae* Mirb.	1	1,64	2			0,81
16.	*Moraceae* Link.	2	3,28	3			1,21
17.	*Celtidaceaea* Link.	1	1,64	3			1,21
18.	*Thymelaeaceae* Juss.	1	1,64	2			0,81
19.	*Grossulariaceae* DC.	2	3,28	3			1,21
20.	*Rosaceae* Adans.	16	26,23	110	4		46,15
21.	*Punicaceae* Horan.	1	1,64	1			0,40
22.	*Fabaceae* Lindl.	1	1,64	7			2,83
23.	*Aceraceae* Juss.	1	1,64	3			1,21
24.	*Anacardiaceae* Lindl.	2	3,28	2			0,81
25.	*Zygophyllaceae* R.Br.	1	1,64	1			0,40

Continuation of Table 2

1	2	3	4	5	6	7	8
26.	*Celastraceae* R.Br.	1	1,64	3			1,21
27.	*Rhamnaceae* Juss.	3	4,92	5			2,02
28.	*Elaeagnaceae* Adans.	2	3,28	3			1,21
29.	*Vitaceae* Juss.	1	1,64	1			0,40
30.	*Cornaceae* Dumort.	2	3,28	2			0,81
31.	*Viburnaceae* Raf.	1	1,64	2			0,81
32.	*Caprifoliaceae* Adans.	1	1,64	4			1,62
33.	*Asteraceae* Dumort.	1	1,64	1			0,40
34.	*Solanaceae* Adans.	2	3,28	5			2,02
35.	*Oleaceae* Hoffmgg.& Link	2	3,28	4			1,62
	Total:	61		241	4	2	

All species of wild trees, including the ones that were cultivated in the Nakhchivan Autonomous Republic since ancient times and are now became wild (*Platan orientalis* L., *Acer platanoides* L., *Juglans regia* L., *J. nigra* L., *Ficus carica* L., *Morus alba* L., *M. nigra* L., *Amygdalus communis* L., *Armeniaca vulgaris* Lam., *Cydonia oblonga* Mill., *Malus domestica* Borkh., *Prunus domestica* L., *P. spinosa* L., *Pyrus communis* L. and *Vitis vinifera* L.) in many regions have been included to the forest ecosystem by us. Of these, 13 species are wild fruit trees.

As can be seen from the table, 180 taxa (72,87%) are mainly concentrated in 7 families: *Rosaceae* 114 taxa (46,15 %), *Plumbaginaceae* 19 species (7,69 %), *Salicaceae* 16 species (6,48 %), *Cupressaceae* 8 species (3,24 %), *Berberidaceae* 8 taxa (3,24 %), *Tamaricaceae* 8 species (3,24 %), *Fabaceae* 7 species (2,83 %). At the same time, two families are represented with 10 (4,05 %) species by being five species, 18 families with 49 (19,84 %) species by being 2-4 species. In the remaining eight families, the number of species does not exceed one (Figure 1).

Numerical composition of species in genera is not evenly distributed. Thus, 157 taxa are concentrated in 12 genera, the number of which varies from 6 to 30. According to the number of species *Rosa* L. (30 species), *Pyrus* L. (17 species,3 variation), *Acantholimon*

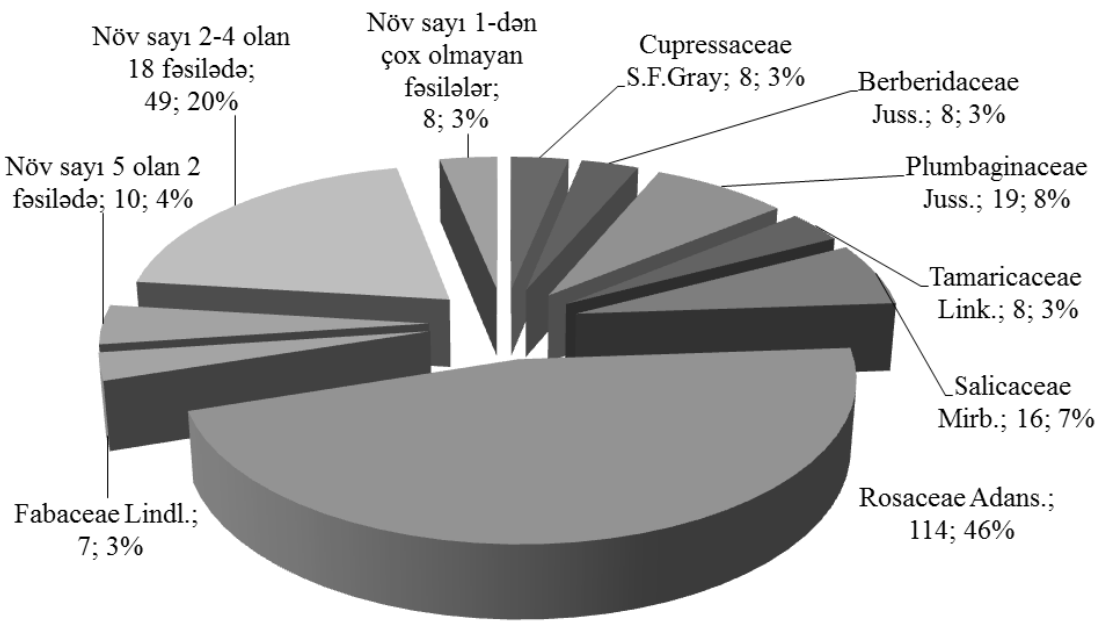

Figure 1. Leading families of trees and shrubs

Boiss. (19 species), *Crataegus* L. (18 species), *Sorbus* L. (17 species), *Salix* L. (10 növ), *Juniperus* L. (8 species), *Berberis* L. (6 species, 2 forma), *Tamarix* L. (7 species), *Cotoneaster* Medik. (7 species), *Astragalus* L. (7 species), *Populus* L. (6 species) genera make up 63,56% of the trees and shrubs distributed in the forest ecosystem. In the remaining 49 genera, the number of taxa ranged from 1 to 5 and made up 36,44% (90 species) of trees and shrubs (Figure 2).

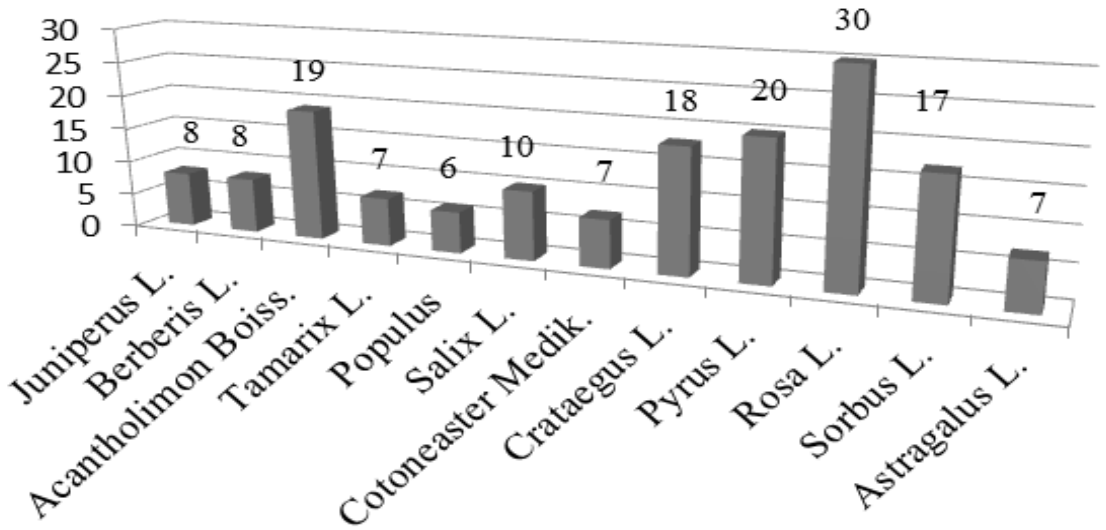

Figure. 2. Leading genera of trees and shrubs distributed in forest ecosystems

Of these, species belonging to *Juniperus* L., *Quercus* L., *Betula* L., *Tamarix* L., *Populus* L., *Salix* L., *Amygdalus* L., *Crataegus* L., *Malus* Mill., *Prunus* L., *Pyrus* L., *Rosa* L., *Acer* L., *Elaeagnus* L., *Lonicera* L., *Fraxinus* L. etc. genera are dominant and subdominant species in the formation of forest ecosystems. During the study of life forms of trees and shrubs, they are grouped by height according to the classification adopted in dendrology (Table 3).

Table 3

Grouping of trees and shrubs by height

Grouping of trees and shrubs by height	Number of species			According to the number of species, in %
	General	Including		
		On groups	In %	
Trees	109			44,13
I group (A_1)-height over 25 m		14	12,84	5,67
II group (A_2) - 10-25 m		23	21,10	9,31
III group (A_3) - 5-10 m		33	30,28	13,36
IV group (A_4) – up to 5 m		39	35,78	15,79
Shrubs	120			48,58
I group (K_1) - height (2-5 m)		25	20,83	10,12
II group (K_2)-medium(1-2 m)		51	42,5	20,65
III group (K_3) - low (0,5-1 m)		44	36,67	17,81
Semishrub	5			2,02
Subshurb	10			4,05
Lians	3			1,22
Total	247			100

Analysis of tree plants by height groups shows that most of them (72 species) are short (groups III-IV). The main creators of sparse forests are short species belonging to *Juniperus polycarpos* C.Koch, *Pistacia mutica* Fisch. & C.A.Mey., *Celtis caucasica* Willd., *Amygdalus fenzliana* (Fritsch) Lipsky, *Padellus mahaleb* (L.) Vass., *Crataegus* L., *Pyrus* L. and etc. genera. They grow in the dry and heavily eroded areas of the low and middle mountain ranges of the area. Species belonging to group I in terms of height are very low (14 species or 12.84%). They are mainly forest-forming genera and

occupy the first tier: *Pinus kochiana* Klotzsch ex C.Koch, *Juniperus communis* L., *J. foetidissima* Willd., *Quercus macranthera* Fisch. & C.A.Mey. ex Hohen, *Populus alba* L., *Pyrus caucasica* Fed., *Fraxinus excelsior* L. and etc. During the observations, 95 species (79,17%) of low shrubs were found here. This is due to the increase in drought in recent years, as well as intensive deforestation and harvesting.

5.2. Biomorphological analysis. The analysis of life forms of trees and shrubs distributed in the forest ecosystem of the Nakhchivan Autonomous Republic was carried out according to the system "I.G. Serebryakov (1964)" [30] (Table 4).

Table 4

Life forms of trees and shrubs according to the Serebryakov system (1964)

Divisions	Number of species	Number of species by life forms				
		Tree	Shrub	Semishrub	Subshurb	Liana
Gymnosperm	13	6	7	-	-	-
Angiosperms	234	103	113	5	10	3
Total	247	109	120	5	10	3
On total number, in%		44,13	48,58	2,02	4,05	1,22

13 species (5,26%) of trees and shrubs distributed in the forest ecosystem of the Autonomous Republic belong to gymnosperms, and 234 species (94,74%) belong to angiosperms. Biomorphological analysis revealed that representatives of all life forms of woody plants: trees, shrubs, semishrubs, subshrubs and woody lianas participate in the formation of the forest ecosystem of the autonomous republic. The biomorphological characteristics of trees and shrubs distributed in the forest ecosystem are very diverse. Thus, although trees are found in the lower parts of the subalpine zone, small shrubs, as well as evergreen and deciduous subshrubs and prickly thrifts can be found in high mountain meadows. Thus, the life forms of plants, the shoots of which grow in relation to the soil

[30] Серебряков, И.Г. Жизненные формы высших растений и их изучение // – Москва – Ленинград: Полевая геоботаника, – 1964. т. 3, – с. 146-205.

surface, were classified and analyzed on the basis of "C. Raunkier (1934)" [31] (Table 5).

Table 5

Life forms of trees and shrubs according to the Raunkier system (1934)

№	Life forms	Species number	On total number, in %
1	Phanerophytes (Ph)	232	93,93
	Megaphanerophyte (Phmg)	7	2,83
	Mesophanerophyte (Phms)	26	10,53
	Microphanerophyte (Phm)	96	38,87
	Nanophanerophyte (Phn)	103	41,70
2	Chamaephyte (Ch)	15	6,07
Total:		247	100,0

As can be seen from the table, phanerophytes are represented by 232 species, which are also divided into mega-, meso-, micro- and nanophanerophytes by their size. Phanerophytes are spread in sufficient quantities in the forest ecosystem of the autonomous republic, and all its subtypes can be found. There are 15 species of chamephytes, consisting of semishrub, subshurb and dwarf semishrub.

5.3. Ecological analysis. As a result of studying the vertical distribution and phytocenological features, as well as the conditions of the growing locations of individual tree and shrub species, all tree plants of the autonomous republic were divided into 6 groups by us according to attitude to moisture. Ecobiomorphic analyses revealed that the majority of trees and shrubs belong to xerophytes and mesophytes (72 species and 86 species) (Table 6).

In the process of studying the ecological features of trees and shrubs, their relationship to different growing areas was also studied. It has been established that most species are found in various formations of broadleaf forests.

[31] Raunkiaer, C.R. The life forms of plants and statistical plant geography / C.R.Raunkiaer. – Oxford: Clarendon Press, – 1934, – 729 p.

Table 6

Ecobiomorphic analysis of trees and shrubs distributed in the forest ecosystem

Ecological groups	Number of species		According to life forms											
	In pieces	According to the total number, in %	Trees					Shrubs				Semishrub	Subshurb	Lian
			Total	From them				Total	From them					
				A_1	A_2	A_3	A_4		K_1	K_2	K_3			
Xerophyte	72	29,15	20	2	3	7	8	44	5	15	24	1	7	-
Xeromesophyte	33	13,36	13	1	1	2	9	18	4	8	6	1	1	-
Mesoxerophyte	40	16,19	18	1	2	7	8	19	3	12	4	1	2	-
Mesophyte	86	34,82	47	8	13	14	12	36	13	13	10	2		1
Mesohygrophytes and hygromesophytes	11	4,45	6	2	2	2		3	1	2	-			2
Hygrophytes	5	2,02	5	-	2	1	2		-	-	-		-	-
Total:	247	100	109	14	23	33	39	120	25	51	44	5	10	3

However, they form mixed forest formations together with some trees and shrubs in mountain xerophytic vegetation, brushwood of mountain-steppe zone, subalpine and alpine meadows, rock and stones deposits, arid sparse forests of leafy and coniferous genera and in riverine forests.

5.4. Geographical analysis. During the research, six genetic (ancient, boreal, steppe, xerophilous, desert, Caucasian) areal types of the species were identified (Figure 3).

In general, the predominance of trees and shrubs of xerophilous, boreal and Caucasian areal types in the forest ecosystem is due to the physical and geographical conditions of the area. Thus, the distribution of geographical elements represented in the tree vegetation of the forest ecosystem of the Nakhchivan Autonomous Republic by areal types shows that representatives of the Central Asian, Iranian-Turanian, Mediterranean, Caucasus and Asia Minor, Caucasus groups of areals play a leading role in the formation of xerophytic formations.

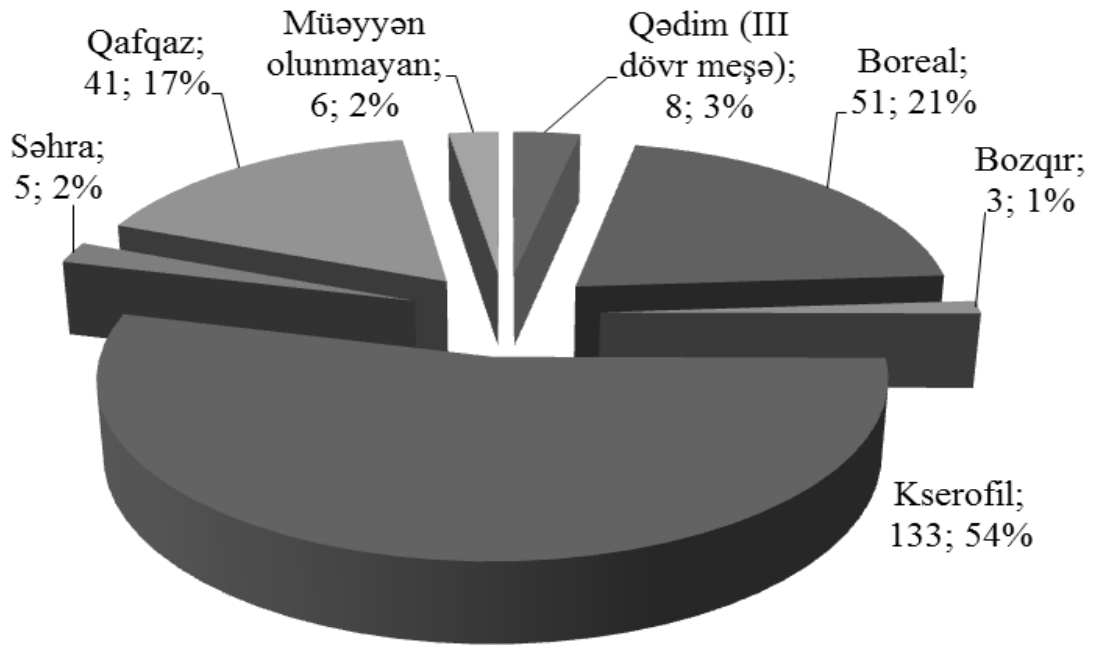

Figure 3. Geographical area spectrum of trees and shrubs

This is formed mainly due to the migration of species, the formation of species and the preservation of ancient relicts to the present day.

5.5. Endemics and relicts. There are 37 species of endemic trees and shrubs in the forest ecosystem, of which 33 species (89,19%) are endemic to the Caucasus, and 4 species (10,81%) endemic to Azerbaijan (including one species Nakhchivan). During the research, it was determined that 16 relict species included in various geographical elements are spread in the forest ecosystem of the Nakhchivan Autonomous Republic. Nine species of them (*Ficus carica* L., *Paliurus spina-christi* Mill., *Pistacia mutica* Fisch. & C.A.Mey., *Platanus orientalis* L., *Juglans regia* L., *Pyrus communis* L., *Populus euphratica* Oliver, *Punica granatum* L., *Quercus macranthera* Fisch. et C.A. Mey. ex Hohen.) are relicts of the Tertiary period, seven (*Clematis orientalis* L, *C.vitalba* L., *Daphne transcaucasica* Pobed., *Lonicera caprifolium* L., *Pinus kochiana* Klotzsch ex C.Koch, *Salix aegyptiaca* L., *Vitis sylvestris* L.) species of Quartenary period.

CHAPTER VI. ZONING OF NAKHCHIVAN AUTONOMOUS REPUBLIC FOR THE PURPOSE OF AFFORESTATION AND LANDSCAPING

6.1. Zoning of the Nakhchivan Autonomous Republic in connection with afforestation. As a result of the research, the autonomous republic has been zoned in connection with afforestation and the area has been divided into 4 - Arazboyu plain afforestation area, Sadarak-Ordubad foothill afforestation area, Akhura-Kotam middle mountain afforestation area, Daralayaz-Zangazur high mountainous afforestation area and map-scheme has been provided and the list of trees and shrubs corresponding to the natural-climatic conditions of the area has been compiled.

6.1.1. Afforestation region of the Arazboyu plain. Arazboyu plain makes up 32% of the territory of the autonomous republic and joins the Agri plain in the north-west. In order to prevent erosion of intensively irrigated arable lands in the region, as well as in the foothills, afforestation should be developed in the following directions:

1. Laying of protective forest strips, preferring more fruit plants (walnut, apricot, mulberry, cherry) when choosing trees and shrubs;
2. Establishment of coastal reinforcing forests along the rivers of the Nakhchivan Autonomous Republic (Arpachay, Nakhchivanchay, Alinjachay, Gilanchay, Ordubadchay, etc.)
3. Planting mulberry, willow, elaeagnus, sea buckthorns, pear and other trees along the irrigation channels;
4. Laying of anti-erosion strips consisting of bushes with more developed root system;
5. Establishment of forest massifs consisting of alternate plantings of various species of poplar, ash-tree and other trees that can be used by the population.

6.1.2. Sadarak-Ordubad foothill forestry region. Sadarak-Ordubad foothill afforestation region is located at an altitude of 1100-1500 m, starting from the Validagh, Dahna, Ucubiz, Saridagh and Bozagil mountains in the north-west and extending in the form of a narrow strip. It is expedient to establish specialized forest farms

in the Sadarak-Ordubad foothills with the participation of almonds, walnuts, cherry plum and sour cherry. It is better to use the indicated aboriginal trees and shrubs suitable for the local climate for afforestation. The main direction of afforestation is afforestation of field protection forest strips, protective forest glades, around irrigation channels and floodplains, restoration of tugai forests. The use of different species of selected trees and shrubs (heat-resistant, drought-resistant) suitable for local climatic conditions should be taken into account.

6.1.3. Akhura - Kotam middle mountain forest region. Akhura - Kotam middle mountainous afforestation area covers the central and south-eastern part of the Nakhchivan Autonomous Republic, covering altitudes up to 1500-2200 meters. The region is characterized by high development of xerophil- phryganoid vegetation. Local trees and shrubs should be used for afforestation of slopes and laying anti-erosion strips. It is important to carry out extensive measures for afforestation of slopes, protection and restoration of existing forests in the region. These measures are as follows:

1. By applying reclamation measures in ancient undergrowth areas, it is possible to create more favorable conditions for the development of fruit growing and viticulture in those areas;

2. In order to increase the discharge of rivers and springs, it is possible to reduce evaporation by laying forest strips around them;

3. Coping with floods, soil washing and erosion. To this purpose, agrotechnical planting of trees and shrubs with more developed root system in this region, which is more susceptible, can prevent these natural processes;

4. Planting of trees that are more valuable and economically viable due to their economic importance. For this purpose, it is considered promising to plant more important trees and shrubs such as almonds, walnut, dogwoods, hawthorn, elaeagnus, sea-buckthorn, barberry, sumac and etc. on the edges of highways, river valleys and slopes. Particular attention should be paid to the creation of orchards consisting of local wild plants (pistachio, wild almonds, pears,

apples, cherries, etc.), especially in the central regions. Protective afforestation measures on the inclined slopes of the region can also be carried out by transverse plowing. The use of wild trees and shrubs, which are mainly specific to the area, may be more effective.

6.1.4. Daralayaz - Zangazur high mountain forest region. Daralayaz-Zangazur high mountain afforestation region covers the Daralayaz range, which is a continuation of the Anadolu mountain system, which differs sharply from each other in terms of orography, and the Zangazur range, which is part of the Lesser Caucasus. Depending on climatic factors, the afforestation process is partially possible due to the lack of necessary agrometeorological conditions. However, as a result of the research, it was determined that afforestation measures can be carried out at altitudes of 2200-3000 m, mainly in river valleys and slopes in areas not affected by prevailing winds, in the northern exposure of mountains. It is more appropriate to use aboriginal trees and shrubs suitable for the local climate for afforestation purposes. In order to carry out afforestation in a large area in the autonomous republic, it is expedient to establish appropriate seed-plots in the relevant regions.

In general, isolated afforestation areas should be considered as a guiding tool in forestry regulations and forest plantations.

6.2. Zoning of the Nakhchivan Autonomous Republic for landscaping. In order to green the Nakhchivan Autonomous Republic, zoning consisting of 5 districts and 9 semi-districts was carried out.

Forest vegetation of the region is taken as a basis for zoning of the area due to landscaping. Each greenery area or semiregion has its own climate. In this case, the role of green areas, greenery norms and, most importantly, the diversity of species of trees and shrubs to be selected were taken into account.

6.2.1. Desert, semi-desert and arid sparse wood area. It covers the Arazboyu plain at an altitude of 600-1100 m. For this region, it would be expedient to establish a green zone consisting of drought-resistant trees and shrubs. These areas can be turned into entertainment and recreation areas for the surrounding population.

The region is divided into 3 - desert, semi-desert and arid sparse wood semi-regions.

6.2.2. Mountain-steppe region. It covers an area of 1100-2000 m and is characterized by a sharp continental climate, long summers and cold winters. As this region is one of the most active floodplains of the autonomous republic, landscaping is one of the most important issues here. Mountain-steppe region is divided into 2- moderately humid and moderately dry semi-regions.

6.2.3. Forest-shrub region of the middle mountains. The climate is temperate. It is relatively humid in all seasons of the year. This region mainly includes woodlands located along river beds and green zones with orchards around settlements and forested shrubs in recent years. The green zones in these areas should consist of trees and shrubs of natural forests that are suitable for the local climate. Forest-bush zone of mid-mountainous area is divided into 2 semi-regions: mesophilic forests and high mountainous mesophilic forests.

6.2.4. Mountain-meadow region. It mainly forms summer pastures of the autonomous republic. This area, where grazing is intensive, is often exposed to anthropogenic influences. To prevent this, it is advisable to establish green zones around subalpine meadows. Region is divided into two semi-regions with relatively humid, cold and dry summers.

6.2.5. Nival region of high mountains. It is completely devoid of vegetation, covering the heights of the Daralayaz and Zangazur range mountains. It is impossible to carry out landscaping measures here.

6.3. Prospects for the use of valuable trees and shrubs in landscaping and afforestation of the Nakhchivan Autonomous Republic. In the context of the acute continental climate and water scarcity of the Autonomous Republic, great difficulties are faced during the introduction of imported woody plants. Therefore, special attention should be paid to aboriginal species in the planting of different categories of greenery. Most of them are distinguished by not only high decorativness, but also drought resistance. 91 species of trees and shrubs are used in the landscaping of Nakhchivan, of

which 79 species are deciduous, 3 species evergreen, and 9 species coniferous. Trees and shrubs in the flora of Azerbaijan were not used adequately in the planting of parks, gardens, alleys and roadside greenery in Nakhchivan (Figure 4).

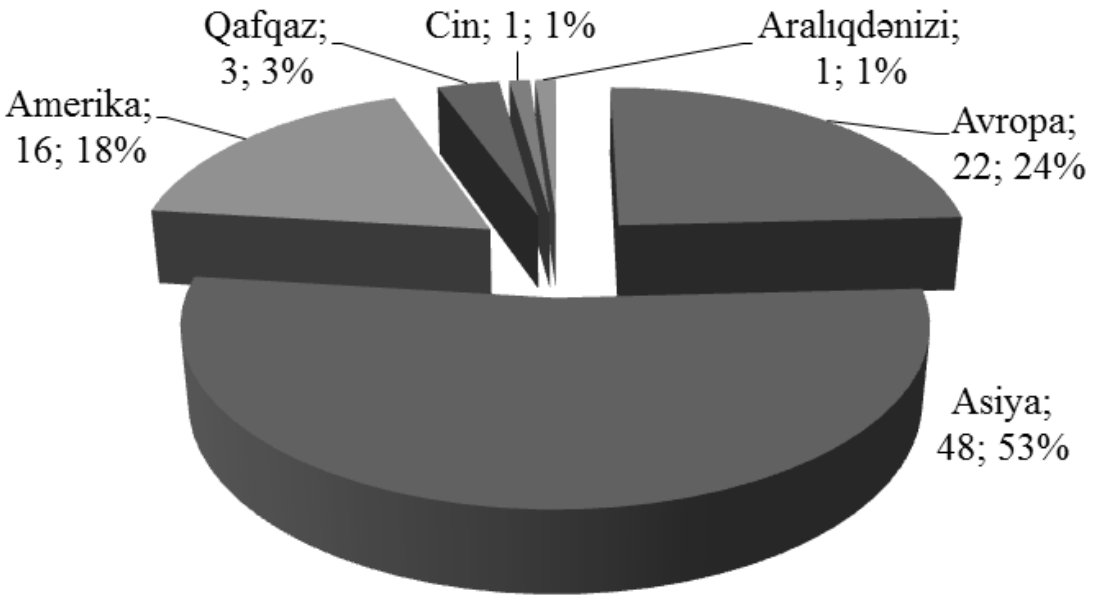

Figure 4. Natural distribution areas of introduced trees and shrubs

Although aboriginal species are rarely used in landscaping, of them some species of *Acer platanoides* L., *Carpinus betulus* L., *Berberis vulgaris* L., *Elaeagnus angustifolia* L., *Fraxinus excelsior* L., *Celtis caucasica* Willd., *Rosa* L., *Populus* L., *Salix* L., *Quercus* L., *Juniperus* L. etc. genera were found in most areas. During the establishment of anti-erosion forests in the Autonomous Republic, the main attention should be paid to aboriginal trees and shrubs. Meyer hawthorn, Greek and Persian mountain ash, smooth hackberries, samuc and other species are very promising in planting anti-erosion crops. In addition, some endangered species (*Amygdalus nairica* Fed. et Takht., *Cotoneaster saxatilis* Pojark, *Pyrus pseudosyriaca* Gladkova, *P.raddeana* Woronow, *Crataegus cinovskisii* Kassymova, *Roza azerbaidzhanica* Novopokr. et Rzazade, *R.nisami* Sosn., *R. zangezura* P. Jarosch., *Rubus ibericus* Juz., *Acantholimon vedicum* Mirzoeva, *Celtis caucasica* Willd., *Quercus iberica* Stev. etc.) in the forest ecosystem can be used for

afforestation due to their drought and frost tolerance, and such work will allow them to be protected and restored.

Thus, as a result of the distribution of aboriginal trees and shrubs according to the altitude zones and the study of the bioecological characteristics of some species, recommendations were made for their use in landscaping and afforestation. Aboriginal trees and shrubs to be planted in forest reclamation works, afforestation, roadside greenery, parks and alleys have been identified. At the same time, trees and shrubs used in the landscaping of new highways and bridges in our city are a key factor in the restoration of the gene pool in the country and increase of the biodiversity.

CHAPTER VII. PRINCIPLES OF CREATION OF ARID DENDROPARKS

7.1. Principles of creation of arid dendroparks. It was determined that arid areas of about 117000 ha prone to desertification covering Babek (17000 ha), Julfa (37000 ha), Ordubad (36000 ha), Sharur and Sadarak (27000 ha) districts in the Nakhchivan Autonomous Republic are available. It should be noted that at the beginning of the XX century, of the area of about 30,000 hectares with forest cover in the plains and mountainous parts of the Nakhchivan Autonomous Republic, currently there are 4126 hectares left. Therefore, serious attention should be paid to the creation of arid dendroparks using local and imported trees and shrubs in regions such as Babek, Julfa, Kangarli and Sadarak in the Arazboyu plain with a sharp continental climate.

7.2. Selection of aboriginal species for arid dendroparks. It is expedient to organize arid dendroparks in the foothills and low mountainous areas, near settlements at an altitude of 700-1000 m (Arazboyu plain, Babek, Julfa, Kangarli and Sadarak districts, around Uzunoba water reservoir) and within the range of 1100-1400 m (Around Bananiyar, Sirab lakes and H. Aliyev water reservoir)r. During the creation of dendroparks, trees and shrubs which are drought and heat tolerant (*Celtis caucasica*, *Pistacia mutica*, *Pyrus salicifolia*, *Amygdalus fenzliana*, *Juniperus polycarpos* etc.) and with

high decorative value (species of *Jasminum fruticans*, *Rhus coriaria*, *Berberis vulgaris*, *Sorbus*, *Crataegus*, *Pyrus* genera and etc.) should be used. It is also possible to create conditions for their protection and restoration by using rare and endangered species.

CHAPTER VIII. PROTECTION AND INTRODUCTION OF TREES AND SHRUBS DISTRIBUTED IN THE FOREST ECOSYSTEM

8.1. Rare and endangered species distributed in the forest ecosystems. As a result of the research, 85 species (34,41% of the total species) belonging to 21 families and 36 genera in the forest ecosystem were identified as rare and endangered trees and shrubs. Of the species of trees and shrubs distributed in the forest ecosystem with identified protection status, 11 (12,94%) are CR, 17 (20,0%) - EN, 28 (32,94%) - VU, 21 (24,71%) - NT, 5 (5,88%) LR, 1 (1,18%) - LC, and 2 (2.35%) – DD categories. Areal map-schemes of some rare and endangered species distributed in forest ecosystems were developed.

8.2. Ways to preserve and restore the gene pool of rare and endangered species distributed in forest ecosystems. Of the 85 species of rare and endangered trees and shrubs distributed in the forest ecosystem, 50 are trees, 32 - shrubs, 2 subshrubs, and one is liana, of which 16 species are listed in the Red Book of Azerbaijan and 36 in the Red Book of the Nakhchivan Autonomous Republic. As a result of the research, the distribution zones of rare and endangered species have been clarified, ways of their restoration and protection have been indicated.

8.3. In situ (in specially protected areas of the Autonomous Republic) and ex situ (in the Botanical Garden) protection of economically important and rare species of trees and shrubs. Although trees and shrubs distributed in the forest ecosystem make up about 10% of the flora of the autonomous republic, their use in agriculture is high. However, as a result of anthropogenic impacts, the protection and preservation of the gene pool of trees and shrubs in the natural environment can not be fully implemented. Because

anthropogenic influences lead to the reduction or destruction of natural habitats of plants. Therefore, the development of effective methods of introduction of plants, their protection in both nature and culture is one of the urgent issues.

8.3.1. *In situ* (In the specially protected areas of the Autonomous Republic) protection. It is known that the best way to protect individual representatives of biodiversity is to protect them in natural areas. Currently, there are specially protected areas such as Zangazur National Park named after Academician Hasan Aliyev (42797,4 ha), "Arpachay" State Nature Reserve (68911,18 ha), "Arazboyu" State Nature Reserve (9118,0 ha) and Ordubad State Nature Reserve (27869,0 ha) in the autonomous republic, the area of which is only 148695,6 ha, which is 27,0% of the total area. In order to protect rare and endangered species in the territory of Zangazur National Park, special areas were allocated for the restoration of species, seeds and seedlings of some species were planted during the research.

8.3.2. *Ex situ* (Botanical Garden) protection. *Malus orientalis*, *Pyrus syriaca*, *P.medvedevii, P.zanqezura, Sorbus persica*, *Cotoneaster melanocarpus*, *Prunus divaricata*, *Crataegus meyeri, C. orientalis*, *Amygdalus fenzliana*, *Berberis vulgaris*, *Rubus ibericus*, *Lonicera carpifolium*, *Salix alba*, *Jasminum fruticans*, *Pinus kochiana*, *Juniperus foetidissima* and etc. species were planted and introduced to the "Wild Fruit Plants" area, which was created to collect the gene pool of wild fruits and berry plants, along with other trees and shrubs suitable for soil and climatic factors, in the "Botanical Garden". During 2004-2017 reintroduction of the rare and endangered species such as *Juniperus polycarpos*, *Pyrus syriaca*, *P. medvedevii, Sorbus persica*, *Amygdalus fenzliana*, *Prunus divaricata* etc. was carried out in natural conditions and seeds and seedlings were planted in the natural distribution zones. In general, in order to protect rare and endangered species, it is necessary to take special control of the areas where they are distributed, to restore them *in-situ* and *ex-situ*, and to use them efficiently and continuously.

CHAPTER IX. ECONOMIC IMPORTANT TREES AND SHRUBS OF FOREST ECOSYSTEM OF NAKHCHIVAN AUTONOMOUS REPUBLIC, THEIR NATURAL RESOURCES AND EFFECTIVE USE

9.1. Trees and shrubs of economic importance of the forest ecosystem of the Nakhchivan Autonomous Republic. One of the important issues in the study of economically important trees and shrubs distributed in the forest ecosystem of the Nakhchivan Autonomous Republic was the identification of promising species, clarification of distribution zones, mapping, identification of biological and operational resources. The useful properties of trees and shrubs were studied and they were grouped into the following 18 useful groups that play an important role in the economic life of the autonomous republic: food (56 species), melliferous (121 species), phytomeliorative (138 species), decorative (96 species), medicinal (72 species), feed (19 species), vitaminous (34 species), greasily (33 species), with vaccine ingredients (25 species), dyeing (23 species), poisonous (18 species), woody (17 species), technical (16 species), essential oily (15 species), fibrous (13 species), cellulose (5 species), gummy (6 species). The territory of the Nakhchivan Autonomous Republic has really large reserves of raw materials, but they are not used enough or are used inefficiently. Along with the planned use of natural resources, great attention should be paid to the transfer of promising, ornamental, medicinal, technical, fruit and berry and other valuable useful plants to culture.

9.2. Natural resources and ways of efficient use of wild fruits and berry plants. In the territory of the Autonomous Republic, wild fruits and berries are not only a natural resource, but also a source of reserve food. Many of these plants have a special place in human diets since ancient times. At present, the population uses very little of these natural resources, and hundreds of tons of products remain unused.

Wild fruit and berry plants, which are rich in natural resources in the biodiversity of the flora of the Autonomous Republic, are not only food, ornamental, melliferous plants, but also have an

exceptional importance as subdominant plants in the formation of forest ecosystems.

The analysis revealed that there are 128 species (51,42%) of trees and shrubs with food and medicinal importance in the forest ecosystem. They are mainly species included in the families *Berberidaceae* (*Berberis*), *Rosaceae* (*Amygdalus*, *Cerasus, Crataegus, Malus*, *Prunus*, *Pyrus*, *Rosa*, *Rubus*, *Sorbus*), *Punicaceae* (*Punica), Anacardiaceae* (*Pistacia, Rhus), Elaeagnaceae* (*Elaeagnus, Hippophae*) and etc. Wild fruits and berries, which are part of our life and used by our people, are considered valuable products both for their healing properties and nutritional value. Due to the richness of biologically active substances and microelements in these species, they even surpass cultural varieties. Depending on its quality, wild fruits and berries (barberry, apple, pear, hawthorn, cherry plum, elaeagnus, dog rose, blackberry, etc.) are eaten by the population both fresh and dried, as well as can also be used as a raw material in the food industry. The vast majority of them are also of industrial importance. During the research, the areas of distribution of wild fruits and berry plants were identified, their natural productivity was calculated and the annual supply volume was determined.

9.3. Natural resources of some trees and shrubs of medicinal importance and ways of efficient use. As a result of our many years of botanical and geobotanical research, it has become clear that 72 species with abundant natural resources in the forest ecosystem are widely used in scientific medicine and folk medicine. These are mainly some trees and shrubs including the *Juniperus*, *Ephedra*, *Viburnum*, *Berberis*, *Betula*, *Salix, Populus*, *Celtis*, *Amygdalus*, *Crataegus, Malus*, *Pyrus*, *Prunus*, *Rosa*, *Rubus*, *Sorbus*, *Astragalus*, *Rhamnus*, *Vitis*, *Solanum*, *Elaeagnus*, *Hippophae*, *Punica, Rhus* and etc.genera. During the expeditions carried out in 2004-2017, the distribution zones of all useful plants were studied, productivity, natural resources were calculated in accordance with the methodologies and opportunities for their efficient use were investigated. As a result of the analysis, the total area of some wild

fruits, berries and trees and shrubs of medicinal importance distributed in the forest ecosystem were identified on the regions, productivity was determined and reserves were calculated (Table 7).

Table 7

Calculated final productivity and reserves of promising wild fruits, berries and medicinal-importance trees and shrubs by regions

№	Name of plants	Total area, ha	Natural resources, t		
			Biological resource	Operational reserve	Annual supply volume
1	*Berberis vulgaris* L.	260	34,78	13,91	3,48
2	*Amygdalus fenzliana* Lypsky.	818	242,05	145,23	21,78
3	*Cotoneaster melanocarpus* Fisch. ex Blytt.	242	17,53	7,01	2,80
4	*C. meyeri* Pojark.	699	660,04	264,02	39,60
5	*C. monogyna* Jacq.	495	232,93	137,62	20,64
6	*C. orientalis* Pall.ex Bieb.	585	452,35	180,94	27,14
7	*C. pentagyna* Waldst. et Kit.	585	373,76	149,50	22,43
8	*Crataegus sanguinea* Pall.	543,6	14,90	5,96	2,38
9	*Malus orientalis* Uglitzk.	445	423,20	169,28	25,39
10	*Prunus divaricata* Ledeb.	713	872,51	349,00	52,35
11	*Pyrus salicifolia* Pall.	713	591,33	236,53	35,48
12	*Rosa canina* L.	928	405,80	243,48	36,52
13	*Rosa corymbifera* Borkh.	568	223,41	134,05	20,11
14	*Sorbus greaca* (Spach) Lodd. ex Schauer	304	27,15	10,86	3,26
15	*Rubus ibericus* Juz.	151	10,25	6,15	0,61
16	*Rhamnus cathartica* L.	861	82,42	49,44	24,72
17	*Rhus coriaria* L.	90	3,38	2,03	0,81
Total		9000,6	4667,79	2105,51	339,5

Thus, 339,5 tons of crops can be harvested annually from 9000,6 hectares of area identified in the forest ecosystem of the autonomous republic. The main areas of distribution of fruits, berries

and medicinal-importance trees and shrubs cover the territory of Sharur (around Garagush Mountain), Shahbuz, Julfa and Ordubad districts. It is expedient to create supply points in these regions and make efficient use of rich natural fruit resources. In accordance with existing standards and specifications, wild fruits and berries can be harvested only during the ripening period. Therefore, during the collection of fruits, depending on the absolute height of the area, the big difference in the ripening period of the fruit should be taken into account. The most favorable period for fruit collection in the middle mountain range is the second half of September, and in the highlands - the first half of October. At present, the population uses very little of these natural resources, and hundreds of tons of products remain unused.

The reserve of medicinal plants of Nakhchivan AR is an inexhaustible, rich natural treasure. It is important to preserve this treasure, to increase its wealth, to direct it to the proper, efficient and sustainable improvement of human health and ability to work. It is necessary to achieve the treatment of human diseases not with synthetic drugs prepared by artificial means, but with herbal medicines rich in biologically active substances necessary for the body.

CHAPTER X. DEVELOPMENT OF PRACTICAL MEASURES FOR IMPROVEMENT, RESTORATION AND EFFECTIVE USE OF FOREST ECOSYSTEM

At present, more than 12% of the total territory of the autonomous republic is covered with greenery. In the early 1990s, this figure was within 0,6 percent. During this period, the amount of greenery per capita increased from 0,012 hectares to 0,021 hectares. In order to further improve the ecological situation in the Autonomous Republic, landscaping, afforestation and reforestation works were carried out on 11,372 hectares in 2001-2017, more than 5 million 843 thousand trees and flower bushes were planted.

Taking into account the unique soil and climatic conditions of

the Nakhchivan Autonomous Republic, the bioecological features in the landscaping works have been thoroughly studied and species resistant to local conditions have been widely used. In general, the forest ecosystem of the Nakhchivan Autonomous Republic is rich in plant resources that can be raw materials for various industries such as - food, medicine, perfume, leather, cosmetics, agriculture, cocoons and etc. They just need to be used effectively.

CONCLUSIONS

1. For the first time, the forest ecosystem of the Nakhchivan Autonomous Republic was studied on a scientific basis, the current condition of trees and shrubs and ways of their effective use were studied. It was determined that the forest ecosystem of the Nakhchivan Autonomous Republic includes 247 taxa (241 species, 4 variations and 2 forms) grouped into 35 families and 61 genera, of which 109 are trees, 120 shrubs, 5 semishrubs, 10 subshurbs, 3 lianas [13,14,15,18,20,27,34,42,65].
2. For the first time, 29 species, 5 variations and 2 forms belonging to 6 families and 9 genera were identified, of which 17 species, 2 variations and 2 forms- *Acantholimon acerosum* (Willd.) Boiss., *A. festucaceum* (Jaub. & Spach) Boiss., *A. trautvetteri* Kusn., *A. puberulum* Boiss. et Bal., *A. takhtajanii* Ogan., *A. calvertii* Boiss., *A. vedicum* Mirzoeva, *A. manakyanii* Ogan., *A. tragacanthinum* (Jaub. & Spach) Boiss., *Malus orientalis* var. *subalpina* Ponomarenko, *Pyrus pseudosyriaca* Gladkova, *P. caucasica Fed.* var. *schuntukensiz* Tuz., *P. chosrovica* Gladkova, *P. demetrii* Kuth., *P. fedorovii* Kuth., *Sorbus albovii* Zinserl., *S. armeniaca* Hedl., *S. buschiana* Zinserl., *Tamarix litwinowii* Gorschk, *Berberis vulgaris* f. *alba* West., *Berberis vulgaris* f. *lutea* Regel are new for the flora of Azerbaijan, 12 species, 3 variations- *Acanthol*imon *lepturoides* (Jaub. et Spach) Boiss., *Cotoneaster meyeri* Pojark., *Cotoneaster transcaucasicus* Pojark, *Malus orientalis* var. *montana* (Uglitzk.) Langenf., *Pyrus georgica* Kuth., *P.salicifolia Pall.* var. *latifolia* Alexenko,

P.salicifolia Pall. var. *angustifolia* Kuth., *Sorbus caucasica* Zinserl., *S. fedorovii* Zaikonn., *S. kusnetzovii* Zinserl., *S. migarica* Zinserl., *S. tamamschjanae* Gabr., *Tamarix florida* Bunge, *T. litwinowii* Gorschk, *Viburnum opulus* L., *Lonicera caucasica* Pall. for flora of the Nakhchivan Autonomous Republic. Also, the status of species *B. integerrima* Bunge., *B. orientalis* C.K.Schneid. belonging to genera *Berberis* L. and *Rosa azerbajdzhanica* Novopokr. & Rzazade species of *Rosa* L. genera has been restored [6,7,8,9,12,23,31,45,48,49,52,57,66].

3. In the forest ecosystem *Rosaseae* (110 species, 4 variations, 46,15%), *Plumbaginaceae* (19 species, 7,69 %), *Salicaceae* (16 species, 6,48 %), *Cupressaceae* (8 species, 3,24 %) , *Berberidaceae* (6 species, 2 forms, 3,24 %), *Tamaricaceae* (8 species, 3,24 %), *Fabaceae* (7 species, 2,83 %) are represented as the leading families. Main places according to the species composition of the genera are kept by the genera *Rosa* (30 species, 12,15 %), *Pyrus* (17 species, 3 variation, 8,11 %), *Acantholimon* (19 species, 7,69 %), *Crataegus* (18 species, 7,29 %), *Sorbus* (17 species, 6,88 %), *Salix* (10 species, 4,05 %), *Juniperus* (8 species, 3,24 %), *Berberis* (6 species, 2 form, 3,24 %), *Astragalus* (7 species, 2,83 %), *Cotoneaster* (7 species, 2,83 %) and *Tamarix* (7 species, 2,83 %). The richer species diversity of trees and shrubs is dominated by forest ecosystems located in Shahbuz, Ordubad and Julfa districts [2,33,35,50,54].
4. Ecobiomorphological analysis of forest ecosystems revealed that 72 (29,15 %) of the ecological groups of trees and shrubs were composed of xerophytes, 33 (13,36 %) of xeromesophytes, 40 (16,19 %) of mesoxerophytes, 86 (34,82 %) of mesophytes, 11 (4,45 %) of mesohygrophytes and hygromesophytes, 6 (2,43 %) of hygrophytes [5,11,41,56,61].
5. Trees and shrubs distributed in the forest ecosystem were analyzed geographically, seven genetic groups of the range have been identified: xerophile (113 species; 53,85 %), boreal (51 species; 20,65 %), Caucasian (41 species; 16,60 %), ancient (8 species; 3,24 %), desert (5 species; 2,02 %), steppe (3 species;

1,21%). At the same time, habitat types of six (2,43 %) species have not been identified in the forest ecosystem. Phytogeographic studies have shown that the trees and shrubs distributed in the forest ecosystem are composed of species of Caucasian, Central Asian, Iranian and Mediterranean origin [26,37].

6. Two types (forest, bush), 4 subtypes, 7 formation classes, 35 formations and 69 associations have been identified for vegetation of forest ecosystems. Of these, 3 formations, 9 association were shown for the first time for forest ecosystems [27,30].
7. It was determined that the territory of the autonomous republic is one of the oldest centers of foci of species formation of tree and shrub species. This is confirmed by the number of narrow endemics between species of the *Pyrus*, *Sorbus, Rubus, Crataegus, Astragalus* and etc. genera [26].
8. The protection status of trees and shrubs distributed in the forest ecosystem was analyzed, 37 species of endemic (33 in the Caucasus, 4 in Azerbaijan (1 in Nakhchivan), 16 species of relicts (9 of the Tertiary period), 85 species of rare and endangered plants were identified. 36 of rare and endangered species are included in the Red Book of the Nakhchivan Autonomous Republic, and 16 species in the Red Book of the Republic of Azerbaijan [1,19,25,39,40,46,47,53,58,59]
9. For the first time, the Nakhchivan Autonomous Republic was zoned in connection with afforestation, and depending on the soil and climatic conditions, it was divided into 4 (Afforestation region of Arazboyu plain, Sadarak-Ordubad foothill afforestation region, Akhura-Kotam middle mountain afforestation region, Daralayaz-Zangazur highland afforestation region) forest cover regions and a map-scheme was prepared [16,55].
10. For the first time, the territory of the Nakhchivan Autonomous Republic was zoned in connection with landscaping consisting of 5 regions and 9 semi- regions. The composition of trees and shrubs by regions was determined and a map-scheme was prepared [17,28,29,64].

11. For the first time, the issue of establishing dendroparks in arid regions of the autonomous republic was investigated and aboriginal trees and shrubs important for the area were identified. [38,43].
12. Measures for the protection of valuable and rare species of trees and shrubs *in situ* (in specially protected areas of the Autonomous Republic) and *ex situ* (Botanical Garden) have been developed [1,47,58].
13. For the first time, the useful properties of trees and shrubs in the forest ecosystem were studied and they were combined into 18 useful groups that play an important role in the economic life of the autonomous republic. The natural resources of promising wild fruits, berries and medicinal trees and shrubs have been calculated and the ways of their efficient use have been shown. It was found that the average natural reserves of wild fruits, berries and medicinal trees and shrubs are 339,5 tons [3,10,21,22,24,32,36, 44,51,60,62,63].

SUGGESTIONS AND RECOMMENDATIONS

1. Due to its high decorative, beautiful appearance and environmental sustainability, some aboriginal trees and shrubs can be recommended for planting in the form of groups and strips in the landscaping of industrial facilities, schools, kindergartens, hospitals, as well as in parks, gardens and alleys.
2. Decorative species with height and beautiful umbrellas can be used to create alley plantations.
3. It is recommended to use widespread productive species and forms of wild fruit and berry plants in the forests to be planted in the mountainous and foothill regions of the Nakhchivan Autonomous Republic.
4. All species of wild fruit and berry plants are less demanding on soil, drought-resistant, frost-resistant, so they can be used as a rootstock in hybridization and acquisition of new varieties.
5. To protect the gene pool of rare and endangered trees and

shrubs, seed-plots and seed-growing should be organized for cultivation, introduction and reintroduction in the Botanical Garden, dendrological parks, alleys or areas suitable for the natural conditions in which the plant grows.

6. Seedlings should be grown in forest plantations by supplying seeds from high-quality species and forms of some trees and shrubs, and shall be widely used in forests to be planted in the middle mountain belts.

7. Species with strong and branched root systems can be used as planting material in anti-erosion measures. For this reason, depending on the physical and geographical conditions in the territory of the autonomous republic, phytomelioration works with the use of selected trees and shrubs are expedient, first of all, in strengthening the area around reservoirs and in Nakhchivanchay, Arpachay, Chahrichay, Paragachay, Gilanchay, Alinjachay and etc. valleys.

8. One of the ways to protect and restore areas where rare and endangered species are distributed is to create arid dendroparks. It is expedient to build these parks at the base of trees and shrubs spreading in the foothills (Nakhchivan, Babek, Julfa, Givrag, Ordubad) at an altitude of 700-1000 m, in the low and middle mountain belts at an altitude of 1100-1400 m (Sadarak, Sharur, Shahbuz).

9. Collection of wild fruits, berries and medicinal trees and shrubs shall be carried out on a scientific basis, establish supply points in the main distribution areas Sharur (around Garagush Mountain), Shahbuz, Julfa and Ordubad districts and make efficient use of rich natural fruit resources.

10. Establishment of seedbed in appropriate areas for the cultivation of phytomeliorants that will be used to strengthen the areas subject to erosion, cultivated phytomeliorants can be used in the studied areas, as well as in similar areas of the Autonomous Republic, in landscaping and restoration.

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