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## SUBENDEMIC PLANT DIVERSITY AND CONSERVATION ALONG THE CASPIAN COASTAL FLORA

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### Abstract

The purpose of the research is to present the ecology and taxonomic analysis of subendemic plants distributed along the Caspian coast, and to develop appropriate botanical strategies for the conservation of these species. The study also evaluates the international legal frameworks for the conservation of subendemic plants and their role in ecosystem protection. Floristic studies conducted along the Caspian coast have identified 43 subendemic plant species belonging to 20 families and 40 genera. The study analyzes the natural distribution and development of these species based on taxonomic and geobotanical methods. Subendemic plants along the Caspian coast are particularly found in saline soils, semi-desert, and mountainous areas. These species help preserve ecosystem biodiversity and ensure the genetic diversity of the region. The results of the study emphasize the importance of implementing conservation measures for subendemic plants, especially in Hirkan, Absheron, and Shirvan National Parks. The protection of these plants is essential for the sustainability of ecosystems and the conservation of biodiversity. The conservation of subendemic plants in the Caspian coastal area is closely linked not only to ecological aspects but also to the application of international legislation and conventions. The United Nations Convention on Biological Diversity (CBD), CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora), and agreements related to nature conservation included in the UNESCO World Heritage List, all provide important legal frameworks for the protection of Azerbaijan's ecosystems. These international documents support the implementation of measures for the conservation of subendemic species and ensure the sustainable development of ecosystems. The conservation of subendemic plants not only preserves ecosystem biodiversity but also contributes to strengthening the botanical mapping of the region. The results of the study highlight the importance of implementing relevant conservation measures and applying international legal frameworks for the protection of subendemic species. The protection of these species is of vital importance for the sustainable development of ecosystems and the long-term conservation of biodiversity along the Caspian coast.

**Keywords:** Subendemic plants; Caspian coast; biodiversity; ecology; conservation strategies; distribution area; flora; UN Convention on Biological Diversity; CITES; UNESCO; ecosystems

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### 1. Introduction

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Biodiversity is a vital indicator for the sustainability of ecosystems and the sustainable use of natural resources. The Republic of Azerbaijan, by joining the UN Convention on Biological Diversity (CBD) in 2000, has committed to the conservation of natural resources and the protection of its flora. These international commitments have made the conservation of Azerbaijan's floristic richness and its various elements even more crucial. In this context, the study and protection of the flora, especially on the Caspian coast, is of significant importance both ecologically and botanically.

The flora of the Caspian coast has developed due to the physical-geographical characteristics and the diversity of the natural and historical conditions of the area. This region has also been influenced by distant floristic provinces, presenting a rich and diverse vegetation cover. In Azerbaijan's flora, particularly along the Caspian coast, there are many plant species with specific taxonomic characteristics corresponding to the diversity of the natural environment. These plants are of great importance for the systematic and geobotanical zoning of the country's floristic map.

Additionally, endemic and subendemic species, which hold a special place in Azerbaijan's floristic wealth, play a significant role in the sustainability of ecosystems and the conservation of genetic diversity. The systematic analysis of these species and their role in local ecosystems along the Caspian coast requires thorough scientific and conservation studies. This research evaluates the ecology and systematic taxonomy of subendemic species found along the Caspian coast, as well as the proposed conservation strategies for their protection. This process also facilitates the enrichment of the country's flora and the development of conservation measures that align with international requirements.

## 2. Materials and Methods

In this research, various methods were used to study the floristic composition of the Caspian coast and the ecology of subendemic plants. The main object of the research is the subendemic plant species distributed along the Caspian coast, their distribution areas, and ecology.

**Research Area:** The research was conducted in various geographical areas covering the coastal regions of the Caspian Sea. These areas encompass different ecosystems of the Caspian coast, including saline soils, semi-desert, and mountainous regions. Specifically, the floristic composition and distribution of subendemic plant species were studied in the Samur-Yalama, Hirkan National Park, Absheron, and Shirvan regions [1, 2, 3].

**Floristic and Geobotanical Studies:** Floristic studies were conducted to identify the plant cover and species composition of the area. For this purpose, the observation and collection of plant species in different areas were carried out. The main tools used in the research included flora guides, geobotanical maps, and various floristic works [4, 5]. The collected plant specimens were identified according to floristic analysis and relevant herbarium sources [6].

**Herbarium Sample Collection:** The plant specimens collected during the research were identified based on the systematic classification presented in "Flora of Azerbaijan" [7], S.K. Cherepanova [8], and V.C. Hajiyev and T.E. Qasimova [9]. The collected herbarium specimens were also analyzed using various taxonomic and geobotanical methods [10].

**Ecological and Geographical Analysis:** To study the ecology of subendemic plants, the soil and climatic conditions of the area were carefully assessed. It was observed that these plants are distributed in various environments that suit their requirements, including saline soils and semi-desert ecosystems. The primary characteristics of the distribution areas and ecology of plant species in the ecosystems were evaluated [11, 12]. This also provided an opportunity to analyze the floristic diversity of the Caspian coast and the role of subendemic species in biodiversity [13].

**Taxonomic and Geobotanical Methods:** In the taxonomic analysis of subendemic plants, plant genera, families, and species were used as main tools. Based on geobotanical methods, the natural distribution areas, systematic, and geographical aspects of plant species were assessed [5]. Additionally, the development of these plants in natural conditions and the environmental factors affecting them were studied.

**Statistical Analysis:** Statistical methods were also used to gain a deeper understanding and generalize the results of the research. The obtained data were analyzed using statistical tools to assess species distribution density, interactions between different species, and the role of subendemic plants in biodiversity [17, 18].

The main goal of the research is to conduct a more in-depth study of the ecology, taxonomy, and conservation of subendemic plants distributed along the Caspian coast, as well as to gather essential data for developing relevant conservation measures. These methods and approaches ensured the successful implementation of the research.

### 3. Results and Discussion

The identification and taxonomic analysis of subendemic plants are of significant importance for the conservation of the flora on the Caspian coast.

In the flora of the Republic, there are 409 subendemic plant species belonging to 53 families and 193 genera [4, 5, 12].

A taxonomic analysis of the flora on the Caspian coast shows that the region's flora contains 1054 plant species from 124 families and 506 genera; of these, the subendemics comprise 43 species from 40 genera within 20 families [3, 4].

Based on the first floristic study, the systematic classification of subendemic plants found along the Caspian coast, as well as the categories and botanical-geographical zoning based on corresponding criteria, are shown in the following tables. In the first group, subendemic plants include trees and shrubs from the third geological period (relict subendemics), such as *Parrotia persica* C.A. Mey., *Quercus castanifolia* C.A. Mey., *Albizia julibrissin* Durazz., and the *Zelkova carpinifolia* (Pall.) C. Koch., among others. Most of these species are related to the Hirkanian flora from a florogenetic perspective [6]. Such relict endemics, whose range extends beyond Azerbaijan (spread), are called conditional subendemics.

According to A.M. Əsgərov's article "Subendemics of the Flora of Azerbaijan" [3], based on a critical systematic analysis of subendemic plants, it is indicated that there are 54 families and 193 genera of subendemic plant species in the flora of the Republic.

**Table 1.** Endemic subspecies of the Azerbaijani flora identified in the coastal flora of the Caspian Sea

No.	Families	No.	Genera	No.	Species
1	Poaceae Juss.	1	<i>Cutandia</i> Willk.	1	<i>Cutandia memphitica</i> (Spreng.) K. Richt.
2	Iridaceae Juss.	2	<i>Iris</i> L.	2	<i>Iris acutiloba</i> C.A.Mey.
3	Betulaceae S.F.Gray	3	<i>Alnus</i> Mill.	3	<i>Alnus barbata</i> C.A.Mey.
4	Amaranthaceae Juss. ( <i>ex Chenopodiaceae</i> Vent.)	4	<i>Salsola</i> L.	4	<i>Salsola nodulosa</i> (Moq.) Iljin
5	Caryophyllaceae Juss.	5	<i>Minuartia</i> L.	5	<i>Minuartia sclerantha</i> (Fisch. & C.A.Mey.) Thell.
		6	<i>Gypsophila</i> L.	6	<i>Gypsophila szovitsii</i> Fisch. & C.A.Mey. ex Fenzl
		7	<i>Dianthus</i> L.	7	<i>Dianthus cyri</i> Fisch. & C.A.Mey.
		8	<i>Saponaria</i> L.	8	<i>Saponaria cerastoides</i> Fisch. ex C.A.Mey.
6	Brassicaceae Burnett	9	<i>Erophila</i> DC.	9	<i>Erophila minima</i> C.A.Mey.
				10	<i>Erophila praecox</i> (Stev.) DC.
7	Rosaceae Juss.	10	<i>Pyrus</i> L.	11	<i>Pyrus hyrcana</i> Fed.
		11	<i>Rubus</i> L.	12	<i>Rubus persicus</i> Boiss.
8	Fabaceae Lindl.	12	<i>Medicago</i> L.	13	<i>Medicago caucasica</i> Vass.
		13	<i>Trifolium</i> L.	14	<i>Trifolium echinatum</i> Bieb.
		14	<i>Astragalus</i> L.	15	<i>Astragalus xiphidium</i> Bunge
		15	<i>Onobrychis</i> Mill.	16	<i>Onobrychis vaginalis</i> C.A.Mey.
		16	<i>Vicia</i> L.	17	<i>Vicia loiseleurii</i> (Bieb.) Litv.
9	Fagaceae Dumort.	17	<i>Quercus</i> L.	18	<i>Quercus castaneifolia</i> C.A.Mey.
10	Rutaceae Juss.	18	<i>Halopyrum</i> Juss.?	19	<i>Halopyrum villosum</i> (Bieb.) G. Don fil. ( <i>uncertain genus, possibly misidentified</i> )
11	Euphorbiaceae Juss.	19	<i>Euphorbia</i> L.	20	<i>Euphorbia iberica</i> Boiss.
12	Anacardiaceae Lindl.	20	<i>Pistacia</i> L.	21	<i>Pistacia mutica</i> Fisch. & C.A.Mey.
13	Malvaceae Juss.	21	<i>Alcea</i> L.	22	<i>Alcea hyrcana</i> (Grossh.) Grossh.
14	Trapaceae Dumort.	22	<i>Trapa</i> L.	23	<i>Trapa hyrcana</i> Woronow
15	Araliaceae Juss.	23	<i>Hedera</i> L.	24	<i>Hedera pastuchowii</i> Woronow

16	Oleaceae Hoffm. & Link	24	<i>Fraxinus</i> L.	25	<i>Fraxinus coriariifolia</i> Scheele
17	Boraginaceae Juss.	25	<i>Suchtelenia</i> Kar. ex Meissn.	26	<i>Suchtelenia calcina</i> (C.A.Mey.) A.DC.
		26	<i>Symphytum</i> L.	27	<i>Symphytum caucasicum</i> Bieb.
		27	<i>Nonea</i> Medik.	28	<i>Nonea flavescens</i> (C.A.Mey.)
				29	<i>Nonea decurrens</i> (C.A.Mey.) G. Don fil.
		28	<i>Echium</i> L.	30	<i>Echium amoenum</i> Fisch. & C.A.Mey.
18	Scrophulariaceae Juss.	29	<i>Veronica</i> L.	31	<i>Veronica crista-galli</i> Stev.
19	Rubiaceae Juss.	30	<i>Karamyschewion</i> Fisch. & C.A.Mey.	32	<i>Karamyschewion hedyotoides</i> Fisch. & C.A.Mey.
		31	<i>Galium</i> L.	33	<i>Galium apsheronicum</i> Pobed.
20	Asteraceae Dumort.	32	<i>Bellis</i> L.	34	<i>Bellis hyrcanica</i> Woronow
		33	<i>Cladochaeta</i> DC.	35	<i>Cladochaeta candidissima</i> (Bieb.) DC.
		34	<i>Senecio</i> L.	36	<i>Senecio grandidentatus</i> Ledeb. (?)
		35	<i>Calendula</i> L.	37	<i>Calendula persica</i> C.A.Mey.
		36	<i>Carduus</i> L.	38	<i>Carduus beckerianus</i> Tamamsch.
				39	<i>Carduus hystrix</i> C.A.Mey.
		37	<i>Carthamus</i> L.	40	<i>Carthamus oxyacanthus</i> Bieb.
		38	<i>Picris</i> L.	41	<i>Picris strigosa</i> Bieb.
		39	<i>Taraxacum</i> Wigg.	42	<i>Taraxacum desertorum</i> Schischk.
40	<i>Hieracium</i> L.	43	<i>Hieracium macroradium</i> Zahn		

**Table 2.** Spectrum of Subendemic Species of the Azerbaijani Flora Found in the Coastal Flora of the Caspian Sea

№	Families	Genera number	Genera %	Species number	Species %
1	Asteraceae Dumort.	9	22.5%	10	23.2%
2	Fabaceae Lindl.	5	12.5%	5	11.6%
3	Boraginaceae Juss.	4	10.0%	5	11.6%
4	Caryophyllaceae Juss.	4	10.0%	4	9.3%
5	Rosaceae Juss.	2	5.0%	2	4.7%
6	Rubiaceae Juss.	2	5.0%	2	4.7%
7	Brassicaceae Burnett	1	2.5%	2	4.7%
	Subtotal (7 families):	27	67.5%	30	69.8%
	Represented by 1 species each (13 families)	13	32.5%	13	30.2%
	Total (20 families):	40	100%	43	100%

As presented in Tables 1 and 2, a total of 43 subendemic species belonging to 40 genera and 20 families have been identified in the coastal flora of the Caspian Sea. These species constitute 4.1% of the total vascular plant diversity (1,054 species) in the studied area [6].

#### 4. Conclusion

This research emphasizes the fundamental role of endemic plants along the Caspian coast in preserving and enhancing ecosystem biodiversity. With 43 distinct endemic species identified across 20 families and 40 genera, these plants serve as key contributors to the ecological stability and floristic richness of the region.

The findings demonstrate that although endemic species comprise only 4.1% of the total plant species in the area, they are vital for maintaining the balance and uniqueness of local ecosystems.

The geographic distribution of these plants in diverse habitats, particularly in saline soils, semi-desert regions, and mountainous areas, further underscores their ecological importance. These plants contribute significantly to the overall biodiversity of the region, supporting not only the local flora but also the broader ecological framework. Families such as Asteraceae and Fabaceae, which make up a considerable portion of the endemic flora, are especially prominent in maintaining floristic richness and ensuring the sustainability of ecosystems.

Given the growing pressures on these habitats, it is critical to implement targeted conservation strategies for the protection of endemic plants. Such efforts will not only secure the survival of these unique species but also foster the long-term resilience of the ecosystems they inhabit. Effective conservation initiatives will enhance biodiversity, strengthen the region's ecological integrity, and support the sustainable management of the Caspian coast's natural resources.

In conclusion, the preservation of endemic plants along the Caspian coast is of paramount importance—not only for safeguarding plant diversity but also for the overall health, sustainability, and resilience of the region's ecosystems. Proactive conservation measures are essential to ensuring that these invaluable species continue to thrive, providing ecological, environmental, and socio-economic benefits for future generations.

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