

**SYSTEMATIC ANALYSIS AND BIOMORPHOLOGICAL CHARACTERISTICS
OF THE EQUISETACEAE MICH. EX DC. FAMILY IN THE FLORA
OF NAKHCHIVAN AUTONOMOUS REPUBLIC**

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**СИСТЕМАТИЧЕСКИЙ АНАЛИЗ И БИОМОРФОЛОГИЧЕСКАЯ ХАРАКТЕРИСТИКА
СЕМЕЙСТВА EQUISETACEAE MICH. EX DC.
ВО ФЛОРЕ НАХЧЫВАНСКОЙ АВТОНОМНОЙ РЕСПУБЛИКИ**

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Abstract

Most of the world's flora and vegetation types have been formed in the rich flora of Nakhchivan Autonomous Republic. One of the ancient (relict) plant groups included in the local flora is Equisetaceae Mich. The genera and species included in the section have not been accurately studied from the systematic, phylogenetic and florogenetic point of view. For this reason, systematic and biomorphological analysis of Equisetaceae Mich ex DC plants in Nakhchivan Autonomous Republic is relevant. The article provides information on the distribution of 6 [Equisetum arvense L., Equisetum fluviatile L., Equisetum hyemale L., Equisetum telmateia Ehrh., Equisetum ramosissimum Desf., Equisetum palustre L.] of the 25 species of the family Equisetaceae Mich. ex DC. in the regions of the autonomous republic from the lower mountain belt to the high mountain belt.

Аннотация

Большинство мировых флор и типов растительности сформировались в богатой флоре Нахчыванской Автономной Республики. Одной из древних (реликтовых) групп растений, входящих в местную флору, является Equisetaceae Mich. Роды и виды, входящие в раздел, недостаточно изучены с систематической, филогенетической и флорогенетической точек зрения. По этой причине систематический и биоморфологический анализ растений Equisetaceae Mich ex DC в Нахчыванской Автономной Республике является актуальным. В статье приводятся сведения о распространении 6 [Equisetum arvense L., Equisetum fluviatile L., Equisetum hyemale L., Equisetum telmateia Ehrh., Equisetum ramosissimum Desf., Equisetum palustre L.] из 25 видов семейства Equisetaceae Mich. ex DC. в регионах автономной республики от нижнего горного пояса до высокогорного пояса.

Keywords: Nakhchivan Autonomous Republic, Equisetaceae Mich. ex DC., family, genus, species, distribution zones.

Ключевые слова: Нахчыванской Автономной Республике, Equisetaceae Mich. ex DC., семейство, род, вид, зоны распространения

Introduction. Nakhchivan Autonomous Republic differs from other regions of Azerbaijan with its geographical position, orographic features, relief and unique flora. One of the main natural resources of the region is its rich flora and vegetation. This richness was created, developed and formed from time to time due to the combined effect of natural-historical, ecological and anthropogenic factors in the long process of evolution. At present, more than 2,835 species of high-spore, gymnosperm and flowering plants are distributed in the territory of the Nakhchivan Autonomous Republic, which are grouped into 8 classes, 104 orders, 170 families and 874 genera. Out of 2835 species of plants, 114 species belonged to

mosses, 7 species to Mules, 17 species to Ferns, 11 species to Angiosperms, 2 species to Ephedra and 2691 species to flowering plants. This makes up 56.7% of the species in the flora of Azerbaijan [Talibov T.H., Ibrahimov A.Sh., 2021].

There are many groups of useful plants in the department of higher spore plants, as fodder plants, vitamin, vaccine, food, technical, decorative, and medicinal plants are widely distributed among these plants. In addition to useful plants, there are not a few rare, endemic, relict and endangered species included in the "Red Book" among high-spore plants. The family Equisetaceae Mich. ex DC., which we studied, occupies a special place in the flora of the autonomous

republic. In the territory of the autonomous republic, 7 species of the family included in one genus are known. [Ibrahimov A.Sh. 2005].

Material methodology: The main material for the study was the representatives of the Equisetaceae family distributed in the mountainous and plain areas of the Nakhchivan Autonomous Republic. The following methods were used to study this vegetation. Determining ecological groups using digital cameras for research, GPS devices for accurate coordinates determination, specifiers, magnifiers and microscopes was carried out based on A.P. Shennikov's methods, and phenological observations on plants were carried out based on I.N. Beydeman's methods. The works of T.H. Talibov, E.M. Gurbanov, and V.Sh. Novruzov from the Azerbaijani scientists were used in the study of the species included in the Equisetaceae family.

Discussion of results. Although the idea of systematization of plants was put forward from ancient times (Aristotle, Theophrastus, etc.), systematics as a science emerged after the works of D. Ray (1686-1704) and K. Linnaeus (1735 and later). Earlier, spontaneous, then artificial, and later natural and phylogenetic systematics appeared. For this purpose, several classification systems have been created by naturalists from time to time. It is from this point of view that the systematic composition of the Equisetaceae family has been changed several times. 26-30 species of mule-tails distributed in the forest zones of the Earth are known. There are 6 species of thistle spread in Azerbaijan, including the Nakhchivan Autonomous Republic. As a result of the conducted researches, despite the fact that there are many representatives of higher spore plants in the territory of the Nakhchivan Autonomous Republic, they are distributed in separate ecotopes and have different life forms, each of them has its own important characteristics. There have been changes in the systematic composition of the Equisetaceae family. Thus, A.A. Grossheim devoted a lot of space to the family in volume I of his Caucasian and Azerbaijani flora, and showed the distribution zones of these plants in the territory of the Nakhchivan Autonomous Republic. He showed that 7 species of this family included in one genus (*Equisetum* L.) are distributed in Azerbaijan, and 7 species of this family included in one genus are distributed in the territory of Nakhchivan Autonomous Republic [Grossheim A.A., 1957, Talibov T.H., Ibrahimov A.Sh. 2021].

In the work "Synopsis Flora of the Caucasus", 9 species of the family included in one genus and 2 subgenera (*Equisetum*, *Hippochaete* (Milde) Baker) are shown, of which 6 species are distributed in the territory of the Nakhchivan Autonomous Republic [Abstract of the flora of the Caucasus, 2012].

A systematic analysis of 6 species of the Equisetaceae family, included in one genus, is given in A.M. Askerov's work "Plants of Azerbaijan". 7 species *E. arvense* L. (*E. boreale* Bong.); *E. fluviatile* L. (*E.*

heleocharis Ehrh.; *E. limosum* L.); *E. hyemale* L. (*Hippochaete hyemalis* (L.) Bruhin); *E. palustre* L.; *E. pratense* Ehrh.; *E. ramosissimum* Desf. (*Hippochaete ramosissima* (Desf.) Boern.; *E. telmateia* Ehrh. (*E. majus* Gars.)) of these, have been shown to be characteristic of the territory of the autonomous republic [Asgarov A.M., 2005, 2016].

Elshad Gurbanov described the characteristic features of some species included in the Equisetaceae family in the textbooks "Systematics of Higher Plants", "Laboratory Exercises on Systematics of Higher Plants" [Gurbanov E.M., 2009].

A.Smith, P.Korall and others in 2006, while conducting a molecular phylogenetic analysis of higher spore plants, included the family Equisetaceae in the order Equisetales, which is the only order of the class Equisetopsida according to the modern classification [Smith, Alan R., 2006].

According to a 2009 study by Chase and Reveal, the order Equisetales is the only order included in the subclass Equisetidae. A 2011 study by Christens and colleagues was based on the experiments of Chase and Reveal [Chase, Mark W., 2009].

Kristens and Chase in 2014 conducted a molecular, genetic and phylogenetic analysis of higher spore plants and placed the subclass Equisetidae in the subclass Equisetales in 2016 in the APG I classification system.

During the excavation, the remains of species belonging to the genera Calamites, Archaeocalamitacea and Phyllothea of the genus Calamites were found in the Devonian period approximately 375 million years ago. However, as a result of climate changes, these genera and species included in the family have been destroyed. Currently, the only genus *Equisetum* L. of the Equisetaceae family is distributed on Earth. The species included in the genus are annual, biennial, and sometimes perennial herbs.

As a result of research conducted by T.H.Talibov and A.Sh.Ibrahimov, who studied the vegetation and flora of the Nakhchivan Autonomous Republic, 7 species included in one genus were shown in the taxonomic spectrum of the family [Ibrahimov A.Sh., Talibov T.H., 2021].

Thus, as a result of the conducted research, the systematic composition of the Equisetaceae Mich. ex DC. family was fully determined in the territory of the Nakhchivan Autonomous Republic, and it was known that 6 species of the family belonging to one genus were distributed in the area. The systematic composition of plants distributed in the area is as follows.

Phylum: *Equisetophyta*

Classis: *Equisetopsida*

Subclassis: *Caryophyllidae*

Ordo: *Equisetales*

Fam: *Equisetaceae* Mich. ex DC.

Genus: *Equisetum* L.

1. *E. arvense* L. (*E. boreale* Bong.)

2. *E. fluviatile* L. (*E. heleocharis* Ehrh.; *E. limosum* L.)

3. *E. hyemale* L. (*Hippochaete hyemalis* (L.) Bruhin)

4. *E. palustre* L.

5. *E. ramosissimum* Desf. (*Hippochaete ramosissima* (Desf.) Boern.

6. *E. telmateia* Ehrh. (*E. majus* Gars.)

The representatives of the *Equisetopsida* or *Sphenopsida* class are characterized by the division of their trunks into joints and inter-joints, and their lateral branches and leaves are arranged in bunches at the joints. The leaves are small. It is known from the Devonian period in the form of excavations. Arthropod tree forms together with other tree species formed large forests during the Coal Period. Modern arthropods are herbaceous plants. Their bodies are distinguished by having the same shape (monomorphic) and different shapes (bearing spores and without spores).

Representatives of the *Equisetaceae* family are perennial, branching, creeping rhizomes, the stem is jointed, the leaf is scaly, jointed, and the sporangia are collected in spike-like strobiles at the end of the stem. Spore-bearing (fertile) corms differ from vegetative (sterile) corms and develop in early spring. It is a monotypic family.

The stem of the species included in the genus *Equisetum* is divided into joints. The leaves are located in groups at the joints, the sporangia are located in groups on the underside of shield-shaped special sporangia carriers (sporangiophore, sporophyll). The sporangia are collected in a strobile (spore spike) at the

end of the stem. Of the 26-30 species distributed in the forest zones of the Earth, 10 species are found in the Caucasus, and 6 species are found in Azerbaijan, including the Nakhchivan Autonomous Republic. The vegetative stems of *Equisetum arvense* L. species are 15-50 cm tall, 1-3 mm thick, 6-19 tubes, furrowed, green. Its rhizomes are long, creeping, branched, go deep into the soil, have blackish-brown colored, ball-shaped tubers with a diameter of one millimeter. Sheaths are 5-12 mm long, cylindrical, sparsely located on the stem, the edges are triangular-lanceolate, blackish in color and with a whitish border at the tip, the joints are 2 times shorter than the sheaths. The branches are thick, 3-4 grainy, jagged, triangular or lanceolate. Spore bearing pods are 15-30 cm tall, simple, reddish or brown in color. The spikes are up to 3.5 cm long, pedunculate, thin, cylindrical. The plant produces spores in March-April. Chromosomes $2n=216$.

Equisetum arvense L. (*E. boreale* Bong.) can be found in humid places from Aarid to subalpine zones, in mountain meadows, around dams, in gardens. It has a Holarctic geographic type.

General distribution: Widespread in the temperate climate zones of the Earth. Distribution in Azerbaijan: distributed in Gobustan, Kura-Araz plain, Kura plain, Greater Caucasus, Lesser Caucasus, Lankaran and Nakhchivan regions.



Şəkil 1. *Equisetum arvense* L.

Distribution in Nakhchivan Autonomous Republic: Dirnis, Paraga, Mazra villages of Ordubad region, Ebragunus, Arafsa villages (Khazinadare) of Julfa region, Ayrinc, Nursu, Küku, Bichenak villages of Shahbuz region, subalpine meadows of Batabat region, Karagush mountain of Kangarli region. The stem of *Equisetum fluviatile* L. is up to one meter high, 5 mm thick, with 8-30 ribs, empty in the middle, simple or branched, grayish-green, smooth. Roots are large, 2-5 mm thick, dark brown. Sheaths are 2 cm long, dark-colored, shiny, compressed towards the body, with 10-20 triangular-bead-shaped, blackish-brown bicuspid

teeth on the edges. The branches have 4-11 ribs, the ribs are triangular. The tooth is branched from the base, shiny black-red-brown. Stamens are up to 2 cm long, almost sessile, cylindrical. The plant produces spores in June-July. Chromosomes $2n=216$.

Equisetum fluviatile L. species grows around rivers, lakes, swamps from the lower mountain belt to the middle mountain belt. It has a Holarctic geographical type.

General distribution: distributed in North America, North Africa, Turkey, Iran and the Caucasus.



Şəkil 2. *Equisetum fluviatile* L.

Distribution in Azerbaijan: It is spread in almost all regions. Distribution in Nakhchivan Autonomous Republic: It is found in the villages of Mazra and Dirnis of Ordubad region, Khazinadare area of Arafsa village of Julfa region (by the river), Batabat zone of Shahbuz region, Kuku, Kulus, Nursu villages, Daresham area of Babek region.

The stem of *Equisetum hyemale* L. is a perennial plant with a height of 120 cm. The sheath is cylindrical, compressed to the stem, black as a whole, with a transverse green stripe at the base or in the middle. Strobies (spore spikes) are sessile, ovate, pointed or oblong-ovate, 2 cm long. The tooth are shed early, the stem is unbranched. Spore ripening period is June-August.

The *E. hyemale* L. species grows in the low to upper mountain belt, along the water's edge, in the coastal sand dunes. It is a mesophyte plant, the category and status of the species according to the IUCN Red List is "Vulnerable to Extinction". – VU D2. It is a rare species of Azerbaijan. It is a medicinal plant of Holarctic geographical type. Chromosomes $2n=108$, 216.

General distribution: distributed in North America, North Africa, Turkey, Iran and the Caucasus.

Distribution in Azerbaijan: Samur-Devachi lowland (Khachmaz district, Shabran district), Nakhchivan plain.

Distribution in Nakhchivan Autonomous Republic: Collected from the vicinity of Uzunoba village.

The stem of *Equisetum palustre* L. is 60-100 cm tall, green, smooth, weakly branched at the base, the

branches in bunches are short and few in number. Stem sheaths are 16-18 mm long, 7-8 mm wide, cylindrical green. The teeth are narrow, triangular-lanceolate, 10-20 in number, sessile with strobiles, sharp-pointed, 2-2.5 times smaller than the sheath tube. In the transverse section of the trunk, there are 22-24 transmission balls, the sclerenchyma layer is continuous. The plant produces spores in July-August. Chromosomes $2n=216$.

E. palustre L. grows in marshy and humid areas from lowland to subalpine zone. It has a Mediterranean-Iranian-Turanian geographical type.

General distribution: distributed in all areas of North America, Asia, Europe and the Caucasus.

Distribution in Azerbaijan: Spread in almost all regions.

Distribution in the Autonomous Republic of Nakhchivan: It is found in the villages of Dirnis, Mazra, Paraga, Pazmari, Nurgut of the Ordubad region, Arafsa, Teyvaz, Erezin, Gulustan villages of the Julfa region, Kuku, Bichenak, Batabat massive of the Shahbuz region, around Vaikhir village of the Babek region.

The stem of the species *Equisetum ramosissimum* Desf. is up to 60 cm high, bluish-green in color, deeply furrowed, unbranched from the rule, blunt at the end with strobis. Stem sheaths are 8-10 mm long, 4-5 mm wide, cylindrical-bell-shaped. The teeth are broad, lancet-shaped, 8-10, wide on the outside, whitish-membranous. Strobil is pedunculate, 2 times shorter than sheath tube. In the transverse section of the trunk, there are 5-6 transmission balls, the sclerenchyma layer is located only in the tines. Chromosomes $2n=216$.



Şəkil 3. *Equisetum ramosissimum* Desf.

The species *Equisetum ramosissimum* Desf. grows in humid places from the low to mid-mountain belt, in forests and thickets, around reservoir. It belongs to the European-Mediterranean geographical type.

General distribution: Southern Europe, Mediterranean Sea, America, Iran, Turkey, Central Asia, Africa. Distribution in Azerbaijan: Kura-Araz lowland, Kura plain, mountainous and plain areas of Lankaran and Nakhchivan AR. Distribution in the Autonomous Republic of Nakhchivan: the area called Sulu plain of Tivi village of Ordubad district, Nurgut, Nasirvaz villages, Gulistan village of Julfa district, Nehrem, Vaykhir, Garababa villages of Shahbuz district, Garababa villages of Shahbuz district, Kangarli, Chalkhangala village, Ardic mountain areas of Saderak district.

The stem of *Equisetum telmateia* Ehrh. (*E. majus* Gars.) Deser. Vert. Et Usag. is 120-200 cm high, 10 mm in diameter, and is large in size. Spore pods are 15-30 cm high, pinkish-brown in color, teeth 4-6, obtusely triangular. It differs from sporeless gourds by the absence of side branches, they dry up and die during the spore ripening period. Sporeless pods are up to 50 cm high, green in color, with 6-10 scaly protrusions on top. Stem sheaths are 8-10 mm long, 4-5 mm wide, teeth are light-black, usually with a white border along the edge, 2 times shorter than the sheath tube. In the transverse section of the stem, the epidermis is smooth on the outside, the transmission balls are numbered 9, and the sclerenchyma layer is located in the form of balls, separated from each other. The plant produces spores in April-May. Chromosomes $2n=216$.

Equisetum telmateia Ehrh. species grows in low to mid-alpine forests and thickets, moist areas, and as a weed in gardens and orchards. It has a European-Mediterranean geographical type.

Common distribution: Common in Central Europe, North America, Iran, Turkey and the Caucasus.

Distribution in Azerbaijan: It is found in the Greater Caucasus, Kura and Kura-Araz plains, in the mountainous and plain areas of Lankaran, in all areas of the Lesser Caucasus, as well as in Nakhchivan AR. Distribution in the Autonomous Republic of Nakhchivan: It is found near the villages of Ustupu, Dirnis, Nasirvaz, Nusnus, Paraga of the Ordubad region, Ebragunus, Arafsa, Lekatag, Boyahmed villages of the Julfa region, Ayrinc, Bichenak villages

of the Shahbuz region, Chalkhangala village of the Kangarli region.

Result: As a result of our research, the systematic composition, biomorphological, characteristics and distribution of the *Equisetaceae* Mich. ex DC family in the flora of the Nakhchivan Autonomous Republic were determined and the following results were obtained.

In the flora of the Autonomous Republic of Nakhchivan, systematic changes in the family *Equisetaceae* Mich. ex DC. were investigated and the systematic composition of the family was compiled based on the latest data and the APG IV system. It was determined that 6 of the 25 species of the genus [*Equisetum arvense* L., *Equisetum fluviatile* L., *Equisetum hyemale* L., *Equisetum telmateia* Ehrh., *Equisetum ramosissimum* Desf., *Equisetum palustre* L.] originated from the lower mountain belt of the autonomous republic. It is spread in the areas up to the high mountain belt.

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