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Coenopulation of *Juniperus sabina* in Central Kazakhstan

The article presents the research and study of the peculiarities of morphological structure of vegetative organs of Cossack juniper (*Juniperus sabina*) growing in Karaganda (Karkarala and Zhanaarka districts) and Ulytau (Ulytau district) regions. Bioecological features of cenopopulations were studied based on the density of individuals in the population, the ratio of life states and age states. According to the age structure, all juniper populations were defined as middle-aged, stable and full-members. The majority of individuals in the cenopopulations are categorized as healthy. The state of *Juniper sabina* gene pool is relatively satisfactory, but the increased proportion of senile individuals, especially in Zhanaarka district, requires measures to preserve juniper populations.

Keywords: *Juniperus sabina*, morphology, coenopopulation, vital form, age composition.

Introduction

Juniperus sabina L. (*Cupressaceae* family) is the typical species of the subgenus *Sabina*. The life form is usually a creeping, occasionally an erect tree, even more rarely and a small gnarled multi-stemmed tree. Leaves are of two types, needle-shaped (6–10 x 0.5-1 mm) and scaly (1–2.5 x 0.6-1 mm); needle-shaped on seedlings and young plants up to 10 years old, on adult plants they are usually absent altogether. The leaves almost do not change color in winter. Cones are 4–8 mm in diameter, slightly less in length, with 1–4 seeds, most often 2 [1–3].

In the central, continental sector, the range of ecotopes occupied by *J. Sabina* is no less diverse. These are the flat steppes in northern Kazakhstan, mountain forest-steppes from the Kuznetsk Alatau in the Kuzbass to the Northern Tien Shan and from Elbrus in Iran to the mountains bordering the Alashan Desert in Central China, the southern slopes of the mountains in the forest belt of many mountain systems and even semi-deserts in the Gobi Altai. To the east, it is known in the region of the Kazakh Small Hills, where it grows on granite hills, sometimes overgrown with pine, and less often on clay cliffs along river banks [4–15].

The aim of our study was to examine populations and make a comparative analysis of the morphological features of *J. Sabina* in three places (Karkaraly, Zhanaarka districts, Karaganda region, and Ulytau district, Ulytau region (Central Kazakhstan).

Experimental

To study the distribution and compile a summary of the species of the genus *Juniperus* in Kazakhstan, herbarium collections for the period from 1993 to 2023 were analyzed. The materials of the herbarium fund of the Institute of Botany and Phytointroduction (AA) (Almaty, Kazakhstan) were studied — 107 herbarium sheets (Tab. 1). Since among the analyzed material there were repetitions of herbarium sheets of juniper species in certain geographical collection points, for this summary those herbarium materials that were collected and identified earlier were taken into account.

In three main areas of distribution of *J.sabina* in the region: the mountainous part of Karkaraly, Zhanaarka and Ulytau. All plots were studied in 2021–2024. The sizes of the experimental plots ranged from 0.10 to 0.25 ha, with the number of individuals from 120 to 358.

The density of cenopopulations, the composition of life forms, the age and sex structure, and the vital state were assessed [16–21]. When assessing the vital state, plants in the population were distributed into the following categories [2]: healthy, weakened, much weakened, dying, and deadwood.

When studying the age structure, in order to reduce the subjectivity of the assessments, individuals were distributed by age periods, without identifying age states [6]. According to N.V. Salakhov [19] (with our modifications), plants of the juvenile period included sprouts and individuals that had formed lateral shoots

of the II–III order; plants with shoots of the IV–VI orders were classified as virginal; fruit-bearing individuals with shoots of the VII–VIII orders and higher were classified as generative; and dying large-sized plants with a proportion of dead shoots of more than 50 % were classified as senile.

The age of the coenopopulation was determined as the sum of the products of the number of each age group by the corresponding coefficient (for the juvenile period — 0.018, virginal — 0.0833, generative — 0.5, senile — 0.9313), divided by the total number of the coenopopulation [16].

Results and discussion

The density of the coenopopulations of *J.sabina* in the studied area varied from 23 to 91 pcs./ha. For the Zhanaarka district, this average number was 23–62 pcs/ha, for the Ulytau district **—** 37–65 pcs/ha, for the Karkaralinsk mountains **—** 24–98 pcs/ha (Tab. 1).

Table 1

Characteristics of coenopopulations of *Juniperus sabina*

Cenopopulation	District	Composition of the forest stand	Forest type	Density, pcs/ha
Baktinskaya	Karkaraly district	2C3B	Geranium-cereal	24
Karkaralinskaya	Karkaraly district	1C9B	Potentilla-forb	98
Kuvskaya	Karkaraly district	2C7B2T	Juniper-herb	46
Kentskaya	Karkaraly district	9C1B2edV	Forest-steppe juniper-mixed	91
Ortauskaya	Zhanaarka district	1C3B3V	Herb-licorice	23
Aktauskaya	Zhanaarka district	2B2V	Juniper-herb	39
Kosmurynskaya	Zhanaarka district	2C3V	Juniper-shrub	62
Maitobenskaya	Ulytau district	3Б2V	Juniper-herb	65
Ulytauskaya	Ulytau district	2C5B2V	Potentilla-forb	37

The highest density of juniper populations was noted for Karkarala district, the lowest for Zhanaarka district. The obtained data can be explained by the difference in climatic conditions. Thus, mountainous areas of Karkarala and Ulytau districts are characterized by more mesophytic conditions and are more favorable for the growth of this species. In Zhanaarka district more arid conditions are formed, which reduces the density of growth.

Juvenile and generative individuals were clearly distinguished in the population. Moreover, there were quite a lot of young plants. On average, there were 63.5 juvenile individuals on a trial area of 1,600 m^2. Based on our data, the coenotic population of juniper in mixed forest conditions consists of individuals of juvenile and generative age periods. Of the juveniles, immature age individuals predominate. Sprouts and juveniles are slightly inferior in quantity. Generative ones are represented by female and male middle-aged individuals. The death of individuals is observed in single specimens. Ontogenetic development can last up to 300 years. Age states of Cossack juniper in forest communities, where it is represented by a tree form, were distinguished according to the method proposed by A.A. Uranov with additions [22–24].

During the population inventory, 4 groups of junipers of different ages were taken into account: juvenile individuals (of root-suckering origin), virginal (large individuals, but not having reached the generative period), generative; senile (Tab. 2).

Table 2

Age structure of coenopopulations of *Juniperus sabina*

Location	Frequency of plants by age periods, %			
	Juvenile	Virginal	Generative	Senile
Karkaraly district				
Baktinskaya	0	27.7	70.6	1.7
Karkaralinskaya	1.2	22.3	72.4	4.1
Kuvskaya	0	21.5	77.3	1.2
Kentskaya	4.2	20.4	73.0	2.4
Zhanaarka district				
Ortauskaya	2,1	11,6	63.9	22.4

Continuation of Table 2

Location	Frequency of plants by age periods, %			
	Juvenile	Virginal	Generative	Senile
Aktauskaya	1.7	11.8	62.9	23.6
Kosmurynskaya	2.3	12.1	63.8	21.8
Ulytau district				
Maitobenskaya	0.2	11.3	64.8	23.7
Ulytauskaya	0.4	11.2	64.2	24.2

The obtained data show that the quantitative composition of junipers in the areas is not the same. Thus, the largest number of specimens is noted for the Karkaraly district. In second place is the Ulytau district (Ulytau region), the smallest number of individuals is in the Zhanaarka district.

It is worth noting that the low number of juniper individuals in the Zhanaarka district is due to its small size. The size of the Karkaraly district, as the largest, explains the largest number of specimens of the studied species.

All populations are characterized as middle-aged stable with predominance of generative individuals and high proportion of virginil plants. However, in Zhanaarka and Ulytau districts the share of senile plants is high.

The distribution of generative age individuals in the coenopopulations of Juniperuscossackii by vital state is shown in Table 3. Healthy individuals predominate in all coenopopulations (50.8–70.7 %). The dispersion analysis as a whole indicates the absence of reliable differences in the vital state of juniper between the Karkaraly, Zhanaarka and Ulytau regions. So, all coenopopulations are characterized as “healthy”, and only Kuvskaya and Aktauskaya are defined as “weakened”: the proportion of dead wood is increased here (about 3.6 %), and the total number of weakened, very weakened and dying plants reaches 23 %.

Table 3

The vital state of the coenopopulations of the *Juniper sabina*

Location	Life categories of individuals, %					RVC
	he	we	v/we	dy	d/w	
Karkaraly district						
Baktinskaya	63.6	36.4	0.2	0.1	0.8	87.6
Karkaralinskaya	68.5	27.8	4.3	0	0	89.1
Kuvskaya	67.9	24.4	6.4	0.4	0.9	87.6
Kentskaya	70.7	24.5	4.9	0	0	88.9
Zhanaarka district						
Ortauskaya	58.8	33.1	8.1	0	0	85.2
Aktauskaya	50.8	36.4	5.6	3.6	3.6	78.7
Kosmurynskaya	56.0	36.0	6.0	2.0	0	83.7
Ulytau district						
Maitobenskaya	62.3	28.6	7.1	0	2.0	85.4
Ulytauskaya	57.0	33.5	6.7	1.4	1.4	83.3
*Note. He — healthy, we — weakened, v/we– very weakened, dy — dying, d/w — dead wood, RVS — relative vital state						

According to the assessment of the condition of the Cossack juniper, a fairly good vital condition of the studied coenopopulations may indicate a certain resistance of the Cossack juniper to existence in the Karkaraly and Ulytau districts. Upon entering the generative period, young plants pass into the life form of a small shrub, with a height of 2.3 to 8.7 m. The highest generative plants were found in the Karkaraly district. The height of the trunk of these plants increased to 47–51 cm, the diameter to 2.1.5–9.5 cm. The height of adult generative plants is described at a level of 4.1-4.55 m, the crown diameter from 4 to 6.9 m. The largest adult generative plants grow in the Karkaraly district, the smallest — in the Zhanaarka and Ulytau districts (Ulytau region). There is a direct relationship between the size of the crown and the age of the plants, that is, as the junipers mature, their height, crown diameter, height and diameter of the trunk increase.

The following parameters were measured on all individuals: bush height and crown diameter, shoot height and diameter, life form, trunk shape, method of renewal and general condition.

The results showed that all virginal juniper individuals in all growing points have a life form of a bush ranging in size from 1.65 to 1.85 m. The crown diameter ranged from 87 to 115 cm. The maximum sizes of young virginal individuals were noted in the Karkaraly district, the minimum — for areas of the Zhanaarka district and the Ulytau district (Ulytau region). The trunk height was 9.5–51 cm, with the largest trunks recorded for the Karkaraly district (Tab. 4).

Table 4

Indicators of individuals of the coenopopulations of the *Juniper sabina*

Cenopopulation	Individual indicators, %											
			Shoot		Life form			by the shape of the trunk				
	Height of bush, m	Crown diameter, cm	height, cm	diameter, cm	bush	tree	dwarfpine	direct	L-shaped	C-shaped	S-shaped	V-shaped
Karkaraly district												
Baktinskaya	3.7	87.0	47	2.1	98.2	1.8	-	2.6	39.8	43.5	14.1	-
Karkaralinskaya	7.6	97.4	49	4.5	98.8	1.2	-	-	54.5	27.3	18.2	-
Kuvskaya	4.1	84.0	48	3.1	94.0	3.0	1	0.1	51.9	19.2	27.9	-
Kentskaya	8.7	115	51	9.5	99.5	0.5	-	-	56.2	26.7	17.1	-
Zhanaarka district												
Ortauskaya	1.85	55.0	36	0.8	97.5	2.5	-	-	45.0	35.0	20.0	-
Aktauskaya	1.6	49.1	32	0.6	96.2	3.8	-	-	36.5	39.1	24.4	-
Kosmurynskaya	2.3	71.2	38	1.4	98.8	1.2	-	0.9	42.2	35.4	20.6	0.9
Ulytau district												
Maitobenskaya	4.55	89.9	49	3.6	100	-	-	-	54.5	27.3	18.2	-
Ulytauskaya	3.5	76.9	39	3.1	100	-	-	-	53.4	25.8	19.8	-

The bark on the trunks is usually reddish-brown, old shoots are reddish-brown, with a gray coating, branching is up to the 6th order. Young shoots are often light brown with a grayish coating or greenish-brown with a gray coating.

When examining natural populations, no diseases or pests of the Cossack juniper were found.

The degree of plant renewal varied depending on the location of growth. Thus, juvenile plants of seed origin were found in all areas, as well as those formed from root shoots. Self-seeding can be produced by both adult generative individuals and young generative ones, while root shoots are formed only from adult generative plants.

The observed difference in the onset and duration of the main phases of juniper vegetation in the areas was not significant — from 1 to 3-4 days. The difference is explained by different geographical growing conditions. Thus, the Karkaraly district is located next to each other on the Karkaraly ridge, which characterizes the simultaneous passage of the main phases of vegetation. The sites of Zhanaarkinsky district and Ulytau district (Ulytau region) are located in other conditions, differing in temperature conditions, moisture, soil, which leads to differences in phenology.

Conclusion

The following conclusions can be drawn from the survey results:

1) The surveyed populations of Cossack juniper are dominated by the low shrub life form. Single-trunk plants are most common, multi-trunk plants are less common. The rarest forms are double-trunk trees. In general, in the Karkaraly district areas, adult generative individuals reach a much larger habitus than in the Zhanaarka and Ulytau districts.

2) The ratio of age groups was determined, which made it possible to establish that the juniper populations were categorized as middle-aged stable.

3) The ratio of individuals in different life states was determined, which made it possible to establish the predominance of healthy individuals.

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Орталық Қазақстандағы *Juniperus sabina* ценопопуляциясы

Мақалада Қарағанды (Қарқаралы және Жаңаарқа аудандары) және Ұлытау (Ұлытау ауданы) облыстарының аумағында өсетін қазақ аршасының (*Juniperus sabina*) вегетативті мүшелерінің морфологиялық құрылымының ерекшеліктерін тексеру және зерттеу ұсынылған.

Ценопопуляциялардың биоэкологиялық сипаттамалары популяциядағы дарақтардың тығыздығы мен өміршеңдігі және жас ерекшелік күйі арақатынасы негізінде зерттелді. Жас ерекшелігі құрылымы бойынша барлық арша популяциялары орта жастағы, тұрақты және толық мүшелі болып анықталды. Ценопопуляциялардағы дарақтардың көпшілігі таза деп жіктелді. *Juniper sabina* тектік қорының жағдайы салыстырмалы түрде қанағаттанарлық, дегенмен кәрі дарақтардың үлес салмағының артуы, әсіресе Жаңаарқа ауданында арша популяциясын сақтау шараларын талап етеді.

Кілт сөздер: қазақ аршасы, морфология, ценопопуляция, тіршілік формасы, жастық құрамы.

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Ценопопуляции *Juniperus sabina* в Центральном Казахстане

В статье представлено исследование и изучение особенностей морфологического строения вегетативных органов можжевельника казацкого (Juniperus sabina), произрастающего на территории Карагандинской (Каркаралинский и Жанааркинский районы) и Улытауской (Улытауский район) областях. Изучены биоэкологические особенности ценопопуляций на основании плотности особей в популяции, соотношения жизненных и возрастных состояний. По возрастной структуре все популяции можжевельника определены, как средневозрастные, устойчивые и полночленные. Большинство особей в ценопопуляциях отнесены к категории здоровых. Состояние генофонда *Juniper sabina* относительно удовлетворительное, однако повышенная доля сенильных особей, особенно в Жанааркинском районе, требует проведения мероприятий по сохранению популяций можжевельника.

Ключевые слова: Juniperus sabina, морфология, ценопопуляция, жизненная форма, возрастной состав.

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