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# Bioecological Characteristics of Cossack Juniper *(Juniperus Sabina)* in Kazakhstan

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**ABSTRACT**

The work assessed the bioecological characteristics of the rare species Juniperus sabina in Kazakhstan. The significance of the research is that it provides knowledge about the morphological and adaptive characteristics of juniper. The purpose of the research is to study the morphoanatomical features of the vegetative organs of Cossack juniper in the Karaganda and Ulytau regions. Samples were selected from Karaganda, Zhanaarkinsky, Karkaraly and Ulytau regions. The following indicators were determined: juniper length and width, height and thickness; length of annual growth of shoots, cross-sectional area, size of the vascular bundle, average diameter of the receptacle, width of the epidermis; size of the conductive bundle. As a result, it was established that Cossack juniper (Juniperus sabina) has a low level of variability in the morphological parameters of vegetative organs. The growth of individuals was observed in the populations of the Ulytau and Karkaraly regions, although the development of subcutaneous tissue was not so great. And in the populations of Cossack juniper in the Zhanaarka region, subcutaneous tissue, cuticle and epidermis are developed. This reflects the adaptation of plants to growing conditions in arid regions. The results make it possible to organize measures to protect juniper as a rare species.

## 1. INTRODUCTION

Cossac juniper (*Juniperus sabina*) is a species of juniper native to various regions, particularly in Central Asia and Eastern Europe. In Kazakhstan, this species is included in the Red Book, which provides for biological species that must be protected. In the Red Book, Cossack juniper is considered in category III-rare, found in small quantities [1]. This species is of significant ecological importance due to its adaptability to harsh environments and its role in local ecosystems. The Cossack juniper (*Juniperus sabina*) is a rare mountain species forming small scattered populations. The bushes grow rapidly in width, forming dense thickets. Shrubs die when shaded by taller tree species, such as spruce. The wide distribution of the species could be facilitated by the dryness of the climate during the Boron period [2]. Small trees with curved trunks are rarely found in nature. The bark is red-brown, peeling. The shoots contain essential oil and are poisonous. Needles are of two types: in young plants and on shady branches, needle-shaped, straight, pointed, 4-6mm long, bluish-green, soft, with a pronounced middle root; in adult plants, the needles are scaly, lamellar. This type of conifers perfectly tolerates air pollution and dry climate, is well suited for growing in urban areas. Cossack juniper is used as an air purifier, it fights environmental pollution and microbes well. It is characterized by high winter hardiness and is less susceptible to spring burns than other representatives of the Cypress family [3]. Numerous scientific studies have established their role in improving the composition of the air-enrich-ing it with oxygen and purifying it from harmful impurities, beneficial effects on temperature and humidity, protection from strong winds, reducing urban noise. A very valuable quality of shrubs is their ability to strengthen the soil with their root system. This property is taken into account when selecting rocks to strengthen sands, mountain slopes and ra-vines, rocky scree, landslides. But not all plants can be successfully used for these purposes. Only those species that have a branched root system that forms a large number of root offspring are able to consolidate the soil. The Cossack juniper, which has high ecological plasticity, decorative effect in steppe conditions and durability (50-80 years) [4, 5]. A characteristic feature of the species is a pungent smell. Drought-resistant, light-loving, unpretentious to soils, resistant to smoke and gas, has protective properties in relation to soils. The shoots are rich in glycosides, saponins

and flavonoids [6]. Juniper has a healing effect on the forest environment, releasing more phytoncides than other conifers. It also promotes the natural renewal of coniferous trees on the cutting sites. The toxic property of Cossack juniper excludes the possibility of its use in therapeutic conditions. A shrub growing mainly in woodlands or foothills [7, 8]. On the surface of the soil layer, the roots grow rapidly in horizontal conditions (Figure 1).

**Figure 1.** Cossack juniper

The Cossack juniper (*Juniperus sabina*), despite its wide distribution in the forests of Kazakhstan, remains one of the least studied conifers. Detailed studies on the study of the form diversity, biometric and morphometric variability of the Cossack juniper, the peculi-arities of their renewal in the Karaganda region have not been conducted. Therefore, it is necessary to consider the factors that lead to changes in the environmental conditions of its growth over the past decades. The Cossack juniper has a healing effect in the forest environment, produces more phytoncides than other coniferous trees, forms the microclimate of the surface layer of the atmosphere and promotes the natural renewal of coniferous woody plants [9-11].

Due to the fact that this species is included in the Red Book as a rare species found in small numbers, measures to protect this species are needed in the country. Our research results are aimed at studying species that are adapted to arid environmental conditions and have their own distinctive morphological features. Therefore, the research question is what are the bioecological characteristics of Cossack Juniper in the harsh climatic conditions of Central Kazakhstan. Hypothesis is The Cossack Juniper in several parts of the Central Kazakhstan has bioecological differences. The significance of these studies is that the results will add fundamental knowledge to the morphological characteristics of junipers and their potential to influence the environment by creating a microclimate in the surface atmosphere.

## 2. MATERIALS AND METHODS

The objects of this study are the Cossack juniper (*Juniperus sabina*), which grows on the territory of the Karaganda and Ulytau regions. Samples were selected from the following geographical regions: Karaganda, Zhanaarkinsky, Karkaralinsky and Ulytau districts (Figure 2). The sample from each population consisted of 5-7 individuals depending on the population size. A total of 28 individuals were examined from 4 districts random sampling technique. All morphological measurements were carried out in triplicate.

In field research, individuals of Cossack juniper were collected from four research zones (Karaganda, Zhanaarkinsky district, Karkaralinsky district, Ulytau district). In the course of the research work, a comparative morphological and anatomical study of the Cossack juniper was carried out on the following indicators: the length and width of the juniper, height and thickness; the length of the annual growth of shoots, the cross-sectional area, the size of the conductive bundle, the average diameter of the receptacle, the width of the epidermis; the size of the conductive bundle [12].

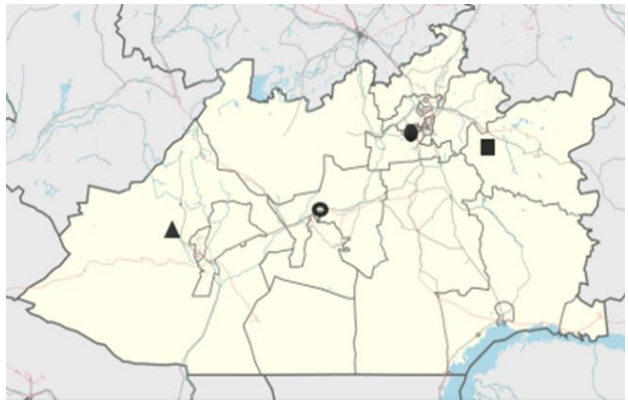

**Figure 2.** Map of the sampling point of Cossack juniper in the Karaganda and Ulytau regions

Notes: ●-the city of Karaganda; **o**-Zhanaarkinsky district; ■-Karkaralinsky district; ▲-Ulytau district.

Cossack juniper (*Juniperus sabina*) was stored in ethyl alcohol for at least a day (20°C, 50% ethanol), after which a cross-section was made. The resulting sections were placed in a drop of glycerin and photographed by viewing under a Biomed-4 microscope. All data were processed by the statistical method, and the reliability criterion was calculated by Manne-Whitney. Statistical processing of the material was carried out according to the generally accepted methodology of Zaitsev [13]. The data collected were descriptively and statistically analyzed using the Excel program, which involved generating frequency distribution tables. Furthermore, the Mann-Whitney test, utilizing the Microsoft Office Excel computer program.

## 3. RESULTS

Many scientists pay considerable attention to the flexibility of morphological features of the Cossack Juniper. This is due to the fact that the juniper stem belongs to one of the most sensitive organs, instantly reacts to any environmental conditions. Studying its variability allows us to understand the direction of the upcoming microevolution. The level of variation features plays an important role in solving taxonomic problems in most cases. When describing the juniper family, signs such as length, width and shape of needles are necessarily used. *Juniperus sabina* is a shrub 1-1.5m high, a dioecious plant [14, 15]. The length of the needles belongs to one of the most variable signs. It usually continues to change regardless of where it grows, regions. The needles are scaly, 0.7-1.5cm long, 0.5-1.7mm wide. According to the conducted studies, the following data were obtained: the length of conifers collected from the Zhanaarkinsky district ranged from 4.9mm to 5.01mm (Table 1). Of the studied objects, the shortest coniferous plants are found in the city of Karaganda.

Nevertheless, populations in this region are ahead of other regions in their breadth distribution.

**Table 1.** Absolute values of vegetative organs of Cossack juniper (*Juniperus sabina*)

| Research Instances | Indicators of Needles | | |
|---|---|---|---|
| | $l_n$, mm | $w_n$, mm | $g_{sh}$, cm |
| Karkaralinsky district | | | |
| 1 | 4.91±0.21 | 0.89±0.03 | 11.12 |
| 2 | 4.83±0.69 | 0.9±0.08 | 9.06 |
| 3 | 4.27±0.32 | 0.95±0.01 | 10.02 |
| Student's Coefficient | 61.9 | 34.6 | |
| Coefficient of variation | 7.26% | 8.51% | |
| Zhanaarkinsky district | | | |
| 1 | 4.9±0.17 | 0.9±0.01 | 10.84 |
| 2 | 5.01±0.34 | 0.88±0.06 | 12.43 |
| 3 | 4.96±0.18 | 0.92±0.03 | 9.68 |
| Student's Coefficient | 76.7 | 39.1 | |
| Coefficient of variation | 7.9% | 8.23% | |
| Ulytau district | | | |
| 1 | 4.56±0.2 | 0.9±0.04 | 12.55 |
| 2 | 4.71±0.74 | 0.98±0.03 | 11.02 |
| 3 | 4.79±0.21 | 0.98±0.1 | 11.94 |
| Student's Coefficient | 68.2 | 35.9 | |
| Coefficient of variation | 7.44% | 8.62% | |
| Karaganda | | | |
| 1 | 4.09±0.37 | 0.89±0.01 | 9.74 |
| 2 | 4.42±0.64 | 0.95±0.06 | 12.61 |
| 3 | 4.23±0.31 | 0.98±0.03 | 10.27 |
| Student's Coefficient | 69.7 | 33.8 | |
| Coefficient of variation | 7.31% | 8.53% | |

Notes: $l_n$- needles length, $w_n$- needles width, $g_{sh}$- Current growth of shoots.

**Table 2.** Biometric indicators of Cossack juniper (*Juniperus sabina*)

| Research Area | Ph, cm | $d_h$, mm | Pd, pcs/ha |
|---|---|---|---|
| Karkaralinsky district | 92.8±5.8 | 7.7±0.6 | 937 |
| Zhanaarkinsky district | 76.8±5.9 | 6.5±0.5 | 550 |
| Ulytau district | 89.1±5.1 | 6.2±0.3 | 181 |
| Karaganda | 102.8±3.6 | 8.0±0.3 | 40 |

Notes: Ph - Plant height, $d_h$- Diameter ½ by height, Pd - Plant density.

The total length, width of coniferous trees, and length of coniferous trees do not depend on the age of the coniferous juniper. These features were observed in populations in all regions of the study.

The thickest thickets of Cossack juniper are characteristic of the forests of the Karkaraly district compared to all the regions studied (Table 2). The average area of the total crown projection was 1.01±0.3$m^2$ in Karaganda and 1.8±0.21$m^2$ in Karkaraly district. The formation of the crown depends on the growing environment and genetic char-acteristics of the Cossack juniper, the crown of most of the experimental objects is loose. The main complex adverse factors of vegetation include drying of lateral shoots. Mechanical damage to Cossack juniper, such as falling bushes and breaking by people, occur in 0.5-11.8% of plants, stem or root rot in 1.2-8.1% of plants.

Such indicators of coniferous plants as the thickness of the epidermis, hypodermis and the diameter of the receptacles were also studied. A cross-section was made to the object of the study and a study was conducted. At the end of the study, the following signs were described below.

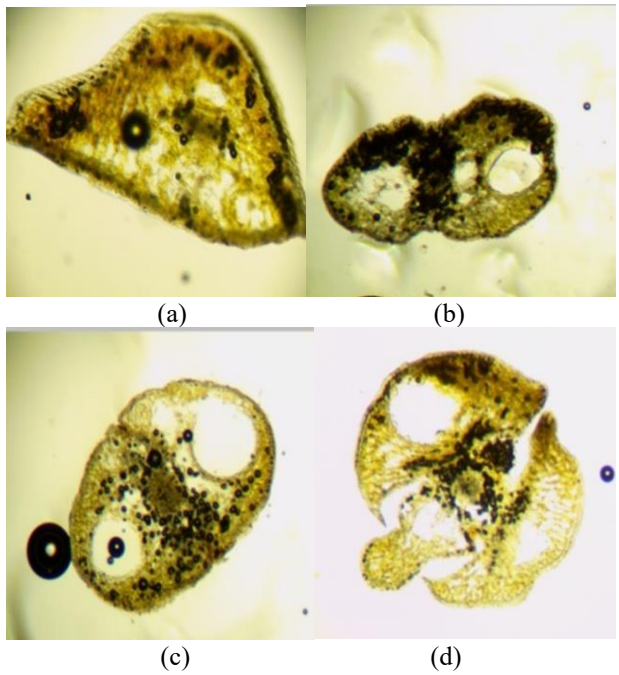


**Figure 3.** Cross section of needles of Cossack juniper (*Juniperus sabina*). (a)-an object from the city of Karaganda; (b)-an object from the Zhanaarkinsky district; (c)-an object from the Karkaralinsky district; (d)-an object from the Ulytau district

**Table 3.** Anatomical indicators of Cossack juniper (*Juniperus sabina*) growing in dry conditions

| Research Area | $d_a$, mm | w, mkm | sb, mkm |
|---|---|---|---|
| Karkaralinsky district | 1.5 | 0.5 | 1.7 |
| Zhanaarkinsky district | 1.8 | 0.6 | 1.5 |
| Ulytau district | 1.5 | 0.5 | 1.7 |
| Karaganda | 1.9 | 0.5 | 2.5 |

Notes: $d_a$ - The average diameter of the place of receptacles, w- Width of the epidermis, sb - The size of the conducting beam

The studied anatomical features have less variability and therefore belong to low or very low variability. The medium and high level of variation are characterized by the size of the conducting beam [16-19]. The total length, width of coniferous trees, the length of coniferous trees, the width of the epidermis do not depend on the age of the coniferous juniper [18, 20]. But the cross-sectional area and the area of the conducting beam tend to increase (Figure 3). These features were observed in populations in all regions of the study. The cuticle of a young juniper thickens, as a result of which the size of the cross-section becomes larger.

If we focus on the anatomical parameters of the Cossack juniper growing in arid conditions in the studied regions (Table 3), then in all regions the epidermis of the Cossack juniper has a width of one size, and the size of the conductive bundles in the Karkaralinsky, Zhanaarkinsky and Ulytau districts is 1.5-1.7 microns, then the size of the conductive bundles of the collected object was 2.5 microns.

The Cossack juniper (*Juniperus sabina*) experiences large anthropogenic loads in urban conditions (Table 4). The above results obtained by the coefficients of variation of signs show that the Cossack juniper has a low level of variability of anatomical features of vegetative organs. According to the

results, the calculated values of the Student's t-test are much higher than the tabular ones. According to the data obtained, the arithmetic mean values are quite reliable.

**Table 4.** Values of signs of needles of Cossack juniper (*Juniperus sabina*)

| Indicator | Signs of Needles, mkm | | | |
|---|---|---|---|---|
| | $l_n$ | $w_n$ | d | $w_e$ |
| | Karkaralinsky district | | | |
| | 5.32±0.75 | 3.8±0.41 | 1.5±0.05 | 0.52±0.02 |
| Coefficient of variation | 10.9% | 8.1% | 8.2% | 8.6% |
| Average sampling error | 0.26 | 0.14 | 0.05 | 0.02 |
| | Zhanaarkinsky district | | | |
| | 5.54±0.61 | 4.08±0.18 | 1.82±0.02 | 0.54±0.01 |
| Coefficient of variation | 2.1% | 2.7% | 4.6% | 10.1% |
| Average sampling error | 0.05 | 0.05 | 0.04 | 0.02 |
| | Ulytau district | | | |
| | 4.68±0.37 | 3.46±0.39 | 1.5±0.05 | 0.49±0.06 |
| Coefficient of variation | 10.8% | 27.7% | 12.5% | 4.6% |
| Average sampling error | 0.23 | 0.43 | 0.08 | 0.01 |
| | Karaganda | | | |
| | 5.1±0.11 | 3.82±0.63 | 1.76±0.04 | 0.52±0.03 |
| Coefficient of variation | 10.19% | 17.79% | 30.49% | 8.6% |
| Average sampling error | 0.23 | 0.3 | 0.24 | 0.02 |

Notes: $l_n$ - Length, $w_n$- Width, d- Diameter of the container, $w_e$- Width of the epidermis.

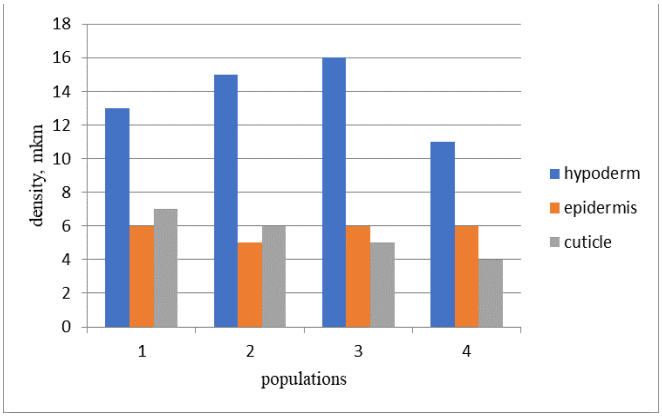


**Figure 4.** The main parameters of structural differences of *Cossack Juniperus* surface in different areas of Kazakhstan
Notes: 1-Karkaralinsky; 2-Zhanaarkinsky; 3-Ulytau; 4-Karaganda.

During the research work, it is possible to observe a good development of hypoderm in the populations of juniper of the Cossack Zhanaarkinsky district, and in the populations of juniper of the Cossack Ulytau and Karkaraly districts, the development of hypoderm is not so great (Figure 4). It should be noted that such characteristics as: length, width of the needles, length of the tip, width of the stomatal stripe, number of parietal cells, thickness of the hypodermis and epidermis, number, length, width of stomata, thickness and height of the keel did not change depending on the age of the needles. However, the thickness of the needles, the area of the cross-section, the area of the conductive bundle and resin channel, and the thickness of the cuticle tended to increase. The epidermis of Ulytau district is better developed than other regional facilities. It gives coniferous plants a protective ability in the event of adverse conditions.

These features were observed in all studied populations.

In the literature, as indicated in the introduction, there is scant data on the size of the life forms of the Cossack juniper, mainly they relate to the height of plants. In the works of Capper O. G., Dzhanaeva V. M. and Sokolov S. Ya. tree-like forms (from 4-8 to 10-15 meters in length) are found in Central Asia [21-23]. And in the works of Koropachinsky I.U. and Vstovskaya T.I. in the Altai regions, the Cossack Juniper grows as a 2.5-meter tree [24]. If we talk about shrubby forms, that is the information in the literature of Dzhanaeva V. M., Kolesnikov A.I., Mamaev S.A. and Yu.E. Alekseev they are as follows: erect shrubs reach a height of 2 meters, creeping (including semi-prostrate) -1-1.5 meters [25-27].

## 4. DISCUSSION

Among the many species of Juniperus, J. communis species has the largest distribution area and is very well studied. And mostly junipers growing in Russia, Armenia and Slovakia have been studied. The species have been little studied in the conditions of Kazakhstan; therefore, our results show the distinctive features inherent in junipers of arid territories [28]. While over the course of a century, juniper (Juniperus spp.) has been encroaching on the grasslands of the western United States, changing the landscape and reducing food resources [29-31], in Kazakhstan this species is considered a population as an important link in the ecosystem.

Cossac Juniper is a shrub or small tree that typically reaches heights of 1-5 meters. It has a distinctive conical or spreading form, with dense, scale-like leaves that are typically green to bluish-green. The bark is thin and fibrous, often peeling in strips. The species is dioecious, with separate male and female plants. Male plants produce pollen cones, while female plants produce berry-like seed cones, which are typically dark blue to black when mature [32]. In Kazakhstan, *Cossack Juniperus* exhibits morphological traits like those found in other regions.

Juniperus cossackia thrives in a variety of habitats, from rocky slopes and steppes to forest margins and scrublands. It is highly adaptable to different soil types, including calcareous, sandy, and rocky soils, often found in regions with low nutrient availability. This species is particularly well-suited to arid and semi-arid climates, exhibiting a high tolerance for drought conditions. It is commonly found at elevations ranging from sea level to 2500 meters [33].

*Juniperus sabina* thrives in the varied landscapes of Kazakhstan, from the lowland steppes to mountainous regions. The species is particularly common in the Tien Shan and Altai Mountains, where it grows on rocky slopes, forest margins, and steppes. It is highly adaptable to different soil types, including calcareous, sandy, and rocky soils, and often thrives in nutrient-poor conditions. The species is well-suited to the arid and semi-arid climates of Kazakhstan, showing a high tolerance for drought [34].

Cossac Juniper plays a vital role in its native ecosystems. It provides essential habitat and food for various wildlife species. The berries are a food source for birds and mammals, while

the dense foliage offers shelter. The species also contributes to soil stabilization and erosion control, particularly in mountainous and arid regions. Furthermore, Juniperus cossackia is involved in nitrogen fixation, improving soil fertility and promoting the growth of other plant species [35].

During our research work, it is possible to observe a good development of hypoderma in the populations of juniper of the Cossack Zhanaarkinsky district, and in the populations of juniper of the Cossack Ulytau and Karkaraly districts, the development of hypoderma is not so great. According to research of the adaptability of Juniperus cossackia to harsh environmental conditions there is attributed to several physiological and morphological traits:

(1). The species has deep root systems that access water from deeper soil layers, allowing it to survive prolonged dry periods. Additionally, the scale-like leaves reduce water loss through transpiration [36].

(2). Cossac Juniper can withstand a wide range of temperatures, from cold winters to hot summers. Its fibrous bark provides insulation against temperature fluctuations [32].

(3). The dioecious nature of the species promotes genetic diversity. The berry-like cones, dispersed by birds and mammals, ensure effective seed distribution over large areas [33].

(4). The species can grow in poor, rocky soils where other plants may struggle. Its ability to fix nitrogen helps it thrive in nutrient-poor environments [35].

In the conditions of increasing urbanization, the greening of cities with woody and shrubby plants, which create a more comfortable environment for human life, plays a great ecological, aesthetic and social importance. Conifers are used in urban landscaping in greater numbers, as they have unique properties: they heal the atmosphere and emit a large amount of phytoncides into the environment, and also retain their decorative qualities regardless of the time of year [37].

The authors also described environmental problems arising from heavy metal contamination of soils, especially in regions such as southern Kazakhstan, where hazardous materials have accumulated because of human activities, including mining, industry and agriculture. Experimental evidence on the phytoremediation potential of common pea (*Pisum sativum*) in gray soils of Southern Kazakhstan will make it possible to predict the effectiveness of phytoremediation measures [38].

The authors studied antimicrobial chemicals are compounds that can inhibit the growth or kill microbes. Leda (*Eucalyptus deglupta Blume*) is a medicinal plant that has the potential to be a safe antimicrobial agent. They showed the presence of alkaloid compounds, flavonoids, saponins, tannins, terpenoids and carotenoids in the Leda extract [39].

*Juniperus sabina* is quite promising for greening cities in the conditions of the steppe region. This plant is unpretentious to climatic conditions: cold-resistant, highly fire-resistant, undemanding to soils, light-loving, smoke- and gas-resistant, does not suffer from burns [40].

*Juniperus sabina L*. (Cossack juniper) is a dioecious shrub, up to 2 m tall. Needle–like needles in young plants, later - scaly, 1-2mm long, with a sharp unpleasant odor. The bark is red-gray in color. The fruits are oval, brown-black, 5-8mm in diameter, with a blu-ish bloom, ripen in the second year. Seeds in shishkoyagoda from 2 to 6 pieces [41].

Some authors examine the symbiotic dynamic between agricultural and forestry interests, highlighting the challenges and successes encountered across three generations of SF programs. Community forestry in Lampung provides farmers with security of land tenure, increased income and reduced fire incidence, but success depends on specific factors and technical support [42].

According to our results, the thickness of the needles, the area of the cross-section, the area of the conductive bundle and resin channel, and the thickness of the cuticle tended to increase. All junipers have a similar needle structure. They are characterized by a centric type of mesophyll, thickened epidermal membranes, stomata only on the upper side of the needles, submerged to the level of the hypodermis, a thick layer of cuticle, single-row hypodermis (less often 2-4 rows), location of the vascular bundle in the center of the needles, transfusion tissue on both sides of the bundle, one resin channel. Different growing conditions contribute to the emergence of peculiarities in the structure of needles.

The results of the study allowed us to determine that the Cossack juniper (*Juniperus sabina*) has a low level of variability of morphological parameters of vegetative organs. Growing individuals were observed in the populations of Ulytau districts and Karkaraly districts, the development of subcutaneous tissue is not so great, and in the populations of juniper of the Cossack Zhanaarka district, good development of subcutaneous tissue, cuticle and epidermis can be observed. *Juniperus sabina* in the Karkaraly region differs more developed mesophyll, cuticle, epidermis and hypodermis, large resin canals and conducting bundles, which reflects the adaptation of plants to harsh climatic conditions.

In futher studies, it is worth measuring which populations have greater potential for use as medicinal raw materials. For example, some studies have measured the antifungal and phytochemical properties of *Juniperus Phoenicea* against apple diseases caused by *Colletotrichum gloeosporioides* and *Alternaria alternata*. In addition, *Juniperus phoenicea* extract showed very noticeable antioxidant activity. Phytochemical analysis revealed various abundant phenolic acids in the three plants studied, namely quinic acid, gallic acid, chlorogenic acid and caffeoylquinic acid, as well as other flavonoids, mainly quercetin and catechin [43].

## 5. CONCLUSIONS

According to the results obtained, the Cossack juniper (*Juniperus sabina*) experiences large anthropogenic loads in urban conditions. The results of the study allowed us to determine that the Cossack juniper (*Juniperus sabina*) has an average level of variability of morphological and anatomical parameters of vegetative organs. Considering the level of phenotypic variability of morphological features as an indicator of intraspecific differentiation, the signs of vegetative organs collected from Karaganda objects are much smaller in comparison with species growing in forests. If we consider the differences between the studied populations of the Cossack juniper, we notice that in the populations of the Ulytau and Karkaraly regions the development of the hypodermis is not so great, and in the populations of the Cossack juniper of the Zhanaarka region, good development of the hypodermis, cuticle and epidermis can be found. The Karkaraly region is distinguished by more developed mesophyll, cuticle, epidermis and hypodermis, large resinous conditions and vascular bundles, which reflects the adaptation of plants to harsh climatic conditions. This, in turn, reflects the adaptation of plants to the harsh growing conditions in such regions. All studied parameters of a cross section of needles

are stable characteristics and vary, as a rule, at a low level. There is a high correlation of anatomical features of needles in all studied populations.

It can also be noted that Cossack Juniper plays an important role in the ecosystem of Central Kazakhstan, because by releasing phytoncides, it has the potential of medicinal raw materials. Subsequent studies have opened questions about the content of biologically active substances in Cossack juniper in populations of various regions of Kazakhstan. The results of our research will be useful for understanding the adaptive abilities of plants in Central Kazakhstan. In a practical sense, the results can be the basis for studying the physiological and pharmaceutical properties of this species under growing conditions in harsh climatic regions of Asia.

Cossac Juniper, is a remarkable species with a wide range of bioecological characteristics that enable it to thrive in diverse and often challenging environments. Its role in ecosystem stability, soil fertility, and providing habitat for wildlife underscores its ecological importance. Understanding these characteristics is crucial for conservation efforts and managing habitats where this species is present. Further research into its adaptive mechanisms and ecological interactions will enhance our ability to protect and utilize this valuable species effectively.

## REFERENCES


[1] Ghorbanzadeh, A., Ghasemnezhad, A., Sarmast, M.K., Ebrahimi S.N. (2021). An analysis of variations in morphological characteristics, essential oil content, and genetic sequencing among and within major Iranian Juniper (*Juniperus* spp.) populations. Phytochemistry, 186: 112737. https://doi.org/10.1016/j.phytochem.2021.112737

[2] Farjon, A. (2001). World Checklist and Bibliography of Conifers. Royal Botanic Gardens, England.

[3] Farukshina, G.G., Putenikhin, V.P. (2016). Population structure of Common juniper in the Cis-Urals and Southern Urals. Contemporary Problems of Ecology, 9(7): 863-872. https://doi.org/10.1134/S1995425516070052

[4] Knyazeva, S.G. (2023). Morphological and anatomical features of the needles of intraspecific variations of Common Juniper. Siberian Journal of Forest Science, 2: 76-84. https://doi.org/10.15372/SJFS20230109

[5] Enescu, C.M., Durrant, T.H., Caudullo, G., de Rigo, D. (2016). Juniperus communis in Europe: Distribution, habitat, usage and threats. European Atlas of Forest Tree Species, e01d2de.

[6] Al-Jowary, H.S.J., Al-Sharefy, A.A. (2021). A comparative study of anatomical and taxonomical of Juniperus species grown in northern Iraq. IOP Conference Series: Earth and Environmental Science, 761: 012045. https://doi.org/10.1088/1755-1315/761/1/012045

[7] Abdel-Kader, M.S., Hamad, A.M., Alanazi, M.T., Alanazi, A.H., Ali, R., Foudah, A.I., Alqarni, M.N. (2019). Characterization and hepatoprotective evaluation of sesquiterpenes and diterpenes from the aerial parts of *Juniperus sabina* L. Saudi Pharmaceutical Journal, 27(7): 920-929. https://doi.org/10.1016/j.jsps.2019.06.006

[8] Adams, R.P., Morris, J.A., Pandey, R.N., Schwarzbach, A.E. (2005). Cryptic speciation between *Juniperus deltoides* and *Juniperus oxycedrus* (Cupressaceae) in the Mediterranean Biochemical Systematics and Ecology, 33(8): 771-787. https://doi.org/10.1016/j.bse.2005.01.001

[9] Andrade, E.H.A., Alves, C.N., Guimarães, E.F., Carreira, L.M.M., Maia J.G.S. (2011). Variability in essential oil composition of *Piper dilatatum* L.C. Rich. Biochemical Systematics and Ecology, 39(4-6): 669-675. https://doi.org/10.1016/j.bse.2011.05.021

[10] Carslaw, N. (2013). A mechanistic study of limonene oxidation products and pathways following cleaning activities. Atmospheric Environment, 80: 507-513. https://doi.org/10.1016/j.atmosenv.2013.08.034

[11] Hojjati, F., Sereshti, H., Hojjati, M. (2019). Leaf essential oils and their application in systematics of *Juniperus excelsa* complex in Iran. Biochemical Systematics and Ecology, 84: 29-34. https://doi.org/10.1016/j.bse.2019.03.004

[12] Semiz, G., Heijari, J., Isik, K., Jarmo, K. (2007). Holopainen Variation in needle terpenoids among *Pinus sylvestris* L. (Pinaceae) provenances from Turkey. Biochemical Systematics and Ecology, 35(10): 652-661. https://doi.org/10.1016/j.bse.2007.05.013

[13] Xu, H., Zhang, D., Li, J. (2019). Antibacterial nanoparticles with universal adhesion function based on dopamine and eugenol. Journal of Bioresources and Bioproducts, 4(3): 177-182. https://doi.org/10.12162/jbb.v4i3.006

[14] Zhang, Y., Feng, S., Jin, F. (2019). QML estimation of the matrix exponential spatial specification panel data model with fixed effects and heteroskedasticity Economics Letters, 180: 1-5. https://doi.org/10.1016/j.econlet.2019.03.034

[15] Zheljazkov, V.D., Semerdjieva, I., Martino, L.D., Cantrell, C.L., Astatkie, T., Francolino, R., Martino, M., Radoukova, T., Feo, V.D., Maneva, V., Atanasova, D., Caputo, L., Alzahrani, A., Borisova, D. (2024). *Juniperus sabina* L. essential oils and podophyllotoxin seasonal and interpopulation dynamics. Industrial Crops and Products, 219(1): 119128. https://doi.org/10.1016/j.indcrop.2024.119128

[16] Anastasaki, E., Psoma, A., Partsinevelos, G., Papachristos, D., Milonas, P. (2021). Electrophysiological responses of *Philaenus spumarius* and *Neophilaenus campestris* females to plant volatiles. Phytochemistry, 189: 112848. https://doi.org/10.1016/j.phytochem.2021.112848

[17] Napiórkowska, A., Aktaş, H., Szpicer, A., Górska-Horczyczak, E., Kurek, M.A. (2024). Optimization of oat protein and gum Arabic microcapsules containing juniper essential oil using Response Surface Methodology. Food and Bioproducts Processing, 145: 203-216. https://doi.org/10.1016/j.fbp.2024.04.001

[18] Al-Yasi, H.M., Al-Qthanin, R. (2024). Comparing genetic differentiation and variation using ISSR and SCoT among Juniper plant markers in Saudi Arabia. Plant Genetics, Epigenetics and Chromosome Biology. https://doi.org/10.3389/fpls.2024.1356917

[19] Abrha, H., Birhane, E., Hagos, H., Manaye, A. (2018). Predicting suitable habitats of endangered Juniperus procera tree under climate change in Northern Ethiopia. Journal of Sustainable Forestry, 37: 842-853. https://doi.org/10.1080/10549811.2018.1494000

[20] Kowalska, M. (1980). Chemical composition of common

juniper (Juniperus communis L.) fruits. Annalyis of the Agricultural University of Poznan, 117: 61-64.
[21] AL-Ghamdi, A.A., Jais, H.M. (2013). Interaction between soil textural components, flavonoids in the roots and mycorrhizal colonization in Juniperus procera in Saudi Arabia. African Journal of Microbiology Research, 7(12): 996-1001. https://doi.org/10.5897/AJMR12.290
[22] Marchand, P.A. (2018). Novel plant protection regulation: New perspectives for organic production. Organic Farming, 4(1): 3-6. https://doi.org/10.12924/of2018.04010003
[23] Salih, A.M., Al-Qurainy, F., Khan, S., Tarroum, M., Nadeem, M., Shaikhaldein, H.O., Alabdallah, N.M., Alansi, S., Alshameri, A. (2021). Mass propagation of *Juniperus procera* Hoechst. Ex Endl. from seedling and screening of bioactive compounds in shoot and callus extract. BMC Plant Biology, 21: 1-13. https://doi.org/10.1186/s12870-021-02946-2
[24] Colle, C., Madoz-Escande, C., Leclerc, E. (2009). Foliar transfer into the biosphere: Review of translocation factors to cereal grains. Journal of Environmental Radioactivity, 100(9): 683-689. https://doi.org/10.1016/j.jenvrad.2008.10.002
[25] Yermagambetova, M.M., Abugalieva, S.I., Turuspekov, Y.K., Almerekova, S.S. (2022). Conspectus of the genus Juniperus L. growing in Kazakhstan. In Proceedings on applied botany, genetics and breeding, 183(3):161-170. https://doi.org/10.30901/2227-8834-2022-3-161-170
[26] Maksutbekova, G.T. (2019). Study of resistant peculiarities of Juniperus sabina and Juniperus communis in the conditions of Zhezkazgan industrial region. Series Biology, Medicine, Geography, 96(4): 27-32.
[27] Alekseev, Y.E., Alekseev, E.B., Gabbasov, K.K., et al. (1988). Determinant of higher plants of the Bashkir ASSR. In International Scientific and Practical Conference “VAVILOV READINGS-2023” (VVRD 2023), 67.
[28] Galgóci, M., Kormuťák, A., Klobučník, M., Gömöry, D., Lukáčik, I., Boleček, P. (2024). Pollen viability and longevity in Juniperus taxa native to Slovakia. Scientific Reports, 14(1): 3706. https://doi.org/10.1038/s41598-024-53152-7
[29] Mulim, H.A., Walker, J.W., Waldron, D.F., Quadros, D.G., Benfica, L.F., de Carvalho, F.E., Brito, L.F. (2024). Genetic background of juniper (*Juniperus spp*.) consumption predicted by fecal near-infrared spectroscopy in divergently selected goats raised in harsh rangeland environments. BMC Genomics, 25(1): 107. https://doi.org/10.1186/s12864-024-10009-7
[30] Engle, D.M., Coppedge, B.R., Fuhlendorf, S.D. (2008). From the dust bowl to the green glacier: Human activity and environmental change in Great Plains grasslands. In: Western North American Juniperus Communities, pp. 253-271. https://doi.org/10.1007/978-0-387-34003-6_14
[31] Ansley, R.J., Pinchak, W.E., Ueckert, D.N. (1995). Changes in redberry juniper distribution in northwest Texas (1948 to 1982). Rangelands Archives, 17(2): 49-53.
[32] Adams, R.P. (2014) Junipers of the World: The Genus Juniperus. Trafford Publishing.
[33] Abdikarimova, P.U., Atikeeva, S.N. (2023). Anatomic features of Juniperus sabina growing in the central Kazakhstan. Bulletin of Karaganda University “Biology. Medicine Geography Series”, 2(110): 15-21. https://doi.org/10.31489/2023BMG2/15-21
[34] Mazur, M., Botarynski, A., Botarynska, K., Maecysiak, K. (2021). Weak geographical structure of *Juniperus sabina* (Cu-pressaceae) morphologt despite its discontinuous range and genetic differentiation. Diversity, 13(10): 470. https://doi.org/10.3390/d13100470
[35] Asili, J., Emami, S.A., Rahimizadeh, M., Fazly-Bazzaz, B.S., Hassanzadeh, M.K. (2013). Chemical and antimicrobial studies of *Juniperus sabina* L. and *Juniperus foetidissima* Willd. essential oil. Journal of Essential Oil-Bearing Plants, 13(10): 25-36. https://doi.org/10.1080/0972060X.2010.10643787
[36] West, N.E. (1999). Synecology and disturbance regime of sagebrush steppe ecosystems. Studies in Asian Biology, 20: 15-26.
[37] Xu, F., Zhao, J., Xu, F., Ji, T., Ma, L. (2013). Study of chemical constituents from twig and leaf of Juniperus sabina. Journal of Chinese Medicinal Materials, 36(12): 1957-1959.
[38] Naimanova, A., Akhmetova, S., Issayeva, A., Vyrakhmanova, A., Alipbekova, A. (2024). Phytoaccumulation of heavy metals in south kazakhstan soils (Almaty and Turkestan Regions): An evaluation of plant-based remediation potential. International Journal of Design & Nature and Ecodynamics, 19(2): 451-464. https://doi.org/10.18280/ijdne.190211
[39] Hapid, A., Ariyanti, A., Erniwati, E., Adrianta, K.A., Yuniarti K., Suena N.M.D.S., Zulkaidhah Z. (2024) Antioxidant and anti-bacterial activity of medicinal plant leda (Eucalyptus deglupta Blume) extract. International Journal of Design & Nature and Ecodynamics, 19(2): 505-512. https://doi.org/10.18280/ijdne.190216
[40] Potemkina O.V. (2015). Morphological variation in Juniperus sabina L. (Cupressaceae) from the south of west Siberia. In XIV International Scientific and Practical Conference: "Problems of Botany of Southern Siberia and Mongolia", pp. 105-109.
[41] Shimanyuk, A.P. (1974) Dendrology. Moscow: Forest Industry, 264. http://dendrology.ru/books/item/f00/s00/z0000002/index.shtml, accessed on Aug. 9, 2024.
[42] Nurlia, A., Martin., Kaskoyo, H., Pieter, L.A.G., Palmolina, M., Ulya, N.A. (2024) Symbiosis in the Canopy: Unraveling the evolution and impact of social forestry in Lampung, Indonesia. International Journal of Design & Nature and Ecodynamics, 19(2): 541-552. https://doi.org/10.18280/ijdne.190220
[43] Hajji-Hedfi, L., Rhouma, A., Hlaoua, W., Dmitry, K.E., Jaouadi, R., Zaouali, Y., Rebouh, N.Y. (2024). Phytochemical characterization of forest leaves extracts and application to control apple postharvest diseases. Scientific Reports, 14(1): 2014. https://doi.org/10.1038/s41598-024-52474-w

## NOMENCLATURE

| | |
|---|---|
| d | diameter of the container, mkm |
| $d_a$ | the average diameter of the place of receptacles, mm |
| $d_h$ | diameter ½ by height, mm |
| $g_{sh}$ | current growth of shoots, cm |

| | |
|---|---|
| $l_n$ | needles length, mkm |
| Pd | plant density, pcs/ha |
| Ph | plant height, cm |
| sb | the size of the conducting beam, mkm |
| $w_e$ | width of the epidermis, mkm |
| $w_n$ | needles width, mkm |