

P.U. Abdikarimova, A.K. Kali, M.Yu. Ishmuratova\*, A.K. Ramazanov, A.T. Nurkenova

Karaganda Buketov University, Karaganda, Kazakhstan

\*Corresponding author: margarita.ishmur@mail.ru

## The morphological features of above-ground parts of *Juniperus sabina* in Central Kazakhstan

In the article the results of the study of morphological parameters of vegetative organs of *Juniperus sabina* growing in the vicinity of Karaganda city, Karkaraly and Ulytau Mountains, hills of Zhanaarka district were presented. The results of research are based on complexly conducted field and experimental materials, scientifically substantiated methods and modern statistical analyses evaluating the reliability criterion. It is noted that for the leaf length indicator the maximum values were for individuals from Zhanaarka district, the minimum values were for the vicinity of Karaganda city. For leaf width and annual growth value, no reliable difference was observed between individuals from different growing points. The maximum size of plants was observed in the vicinity of Karaganda city, the minimum size was observed for individuals from Zhanaarka and Ulytau districts. The obtained data are conditioned by different degree of environmental pollution and climatic conditions.

**Keywords:** *Juniperus sabina*, morphology, plant height and diameter, leaf length and width, annual growth size.

### Introduction

Cossack juniper (*Juniperus sabina* L., family Cupressaceae) is a coniferous shrub, a dioecious creeping shrub 1–1.5 meters high. Bushes grow rapidly in width, forming dense thickets. The bark is red-brown, flaky. The shoots contain essential oil and are poisonous [1]. The needles are of two types: in young plants and on shady branches, needle-shaped, straight, pointed, 4–6 mm long, bluish-green above, soft, with a pronounced middle root; in adult plants, the needles are scaly, lamellar. A characteristic feature of the species is a pungent odor. It is drought-resistant, phytophilous, unpretentious to soils, resistant to smoke and gas, has protective properties in relation to soils. Shoots are rich in glycosides, saponins and flavonoids [2].

In Central Kazakhstan, the species grows on hillsides, stony screes, on granite outcrops, under the canopy of coniferous forests [3]. On the surface of the soil layer, the roots grow rapidly in horizontal conditions (Fig. 1).



Figure 1. *Juniperus sabina* in natural conditions of Central Kazakhstan

*J. sabina* is used in the traditional Chinese medicine system to prevent or treat various diseases as anti-cholinesterase, antidiabetic, and anti-drug resistant bacteria activity [4]. In particular, *J. sabina* is rich in podophyllotoxin, a synthetic precursor of the first-line anticancer drug etoposide [5]. Aqueous suspension of dried needles of *J. sabina* causes hemorrhagic and necrotic changes in malignant tumors and also has signifi-

cant antimicrobial activity against Gram-positive bacteria [6]. The leaves of *J. Sabina* are used in traditional Uygur medicine for the treatment of rheumatism and arthritic pain [7].

*J. sabina*, despite its wide distribution in the forests of Kazakhstan, remains one of the least studied conifers. Detailed studies on the study of form diversity, biometric and morphometric variability of the Cossack juniper, the features of their renewal in the Karaganda region were not carried out. Therefore, it is necessary to consider the issue of factors leading to changes in the environmental conditions of its growth over the past decades. *J. sabina* has a healing effect in the forest environment, produces more phytoncides than other conifers, forms the microclimate of the surface layer of the atmosphere and promotes the natural renewal of coniferous woody plants [8].

The purpose of this study is to study the features of the morphological structure of the vegetative organs of *J. sabina*, growing in the territory of Karaganda (surrounding of Karaganda city, Karkaraly and Zhanaarkinsky district) and Ulytau (Ulytau district) regions. All selected areas have different levels of pollution. So, Karaganda is an industrial city, and Ulytau and Karkaraly Mountains are an environmentally friendly area.

#### Materials and Methods

The object of the study is samples of *J. sabina* growing in the Karaganda and Ulytau regions. They differ from each other in the level of air pollution. In field research, samples of *J. sabina* were collected from four research plots: i) surrounding of Karaganda city, ii) Zhanaarkinsky district, iii) Karkaraly Mountains, iv) Ulytau Mountains (Fig. 2).

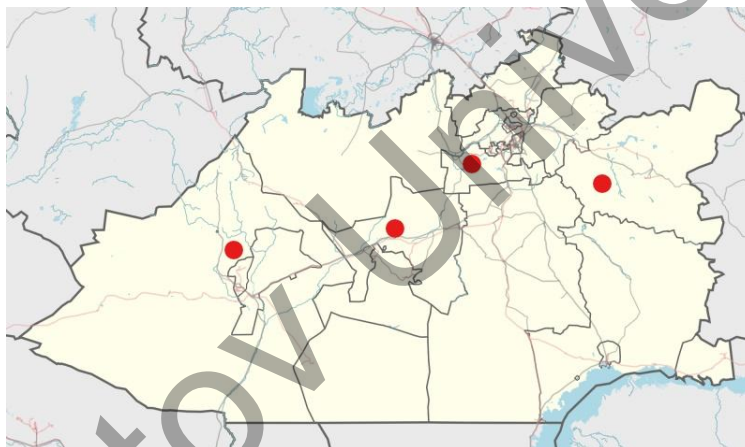


Figure 2. Map of sampling point for *Juniperus sabina* in Karaganda and Ulytau regions

At least five objects were obtained from each study area. For each point, 10-fold measurements of 10-year-old plants were taken. In the course of the research work, a comparative morphological study of *J. sabina* was carried out for the following indicators: shrub width and height; the length of the annual shoots and needles. All data were processed statistically, and the reliability criterion was calculated according to Mann-Whitney. Statistical processing of the material was carried out according to the generally accepted method of G.N. Zaitsev [9], as well as using the computer program Microsoft Office Excel.

#### Results and Discussion

Some researchers [2] pay considerable attention to the flexibility of the morphological features of the Cossack juniper. This is due to the fact that the juniper stalk is one of the most sensitive organs, it instantly reacts to any environmental conditions. The study of its variability makes it possible to understand the direction of the forthcoming micro-evolution.

In most cases, the level of variational characters plays an important role in solving taxonomic problems. When describing the juniper family, such features as the length, width and shape of the needles are necessarily used. Needle length is one of the most variable traits. It usually continues to change regardless of the place of growth, regions. The needles are scaly, 0.7–1.5 cm long, 0.5–1.7 mm wide. According to the research, the following data were obtained: the length of coniferous specimens collected from the Zhanaarka region ranged from 4.9 mm to 5.01 mm (Fig. 3–6). Of the studied objects, the shortest conifers are found in the city

of Karaganda. However, the populations in this region are ahead of other regions in their distribution in width of needles.

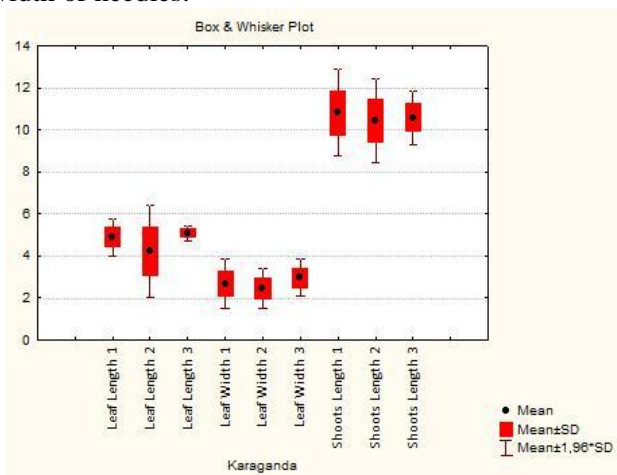


Figure 3. Morphological parameters of *Juniperus sabina* in surrounding of Karaganda city

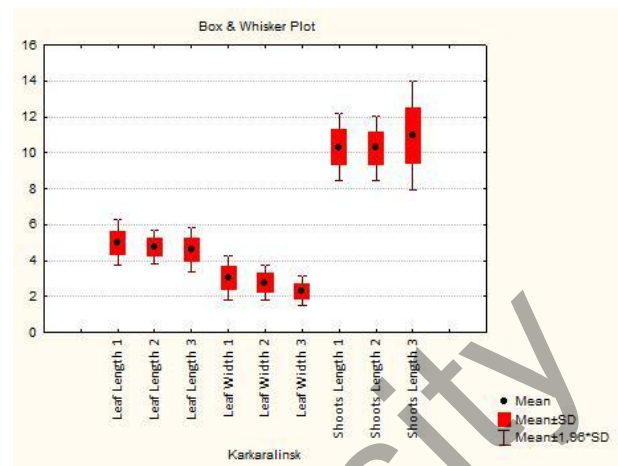


Figure 4. Morphological parameters of *Juniperus sabina* in Karkaraly Mountains

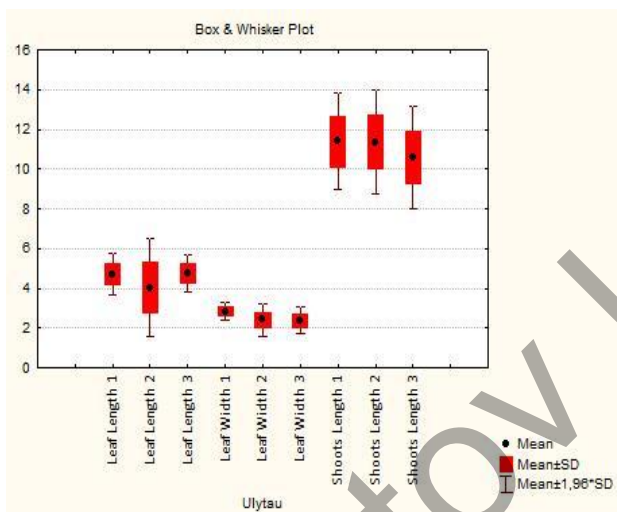


Figure 5. Morphological parameters of *Juniperus sabina* in Ulytau Mountains

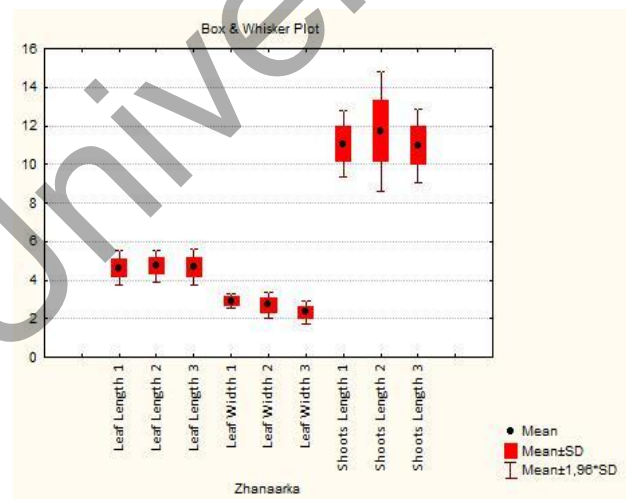


Figure 6. Morphological parameters of *Juniperus sabina* in Zhanaarka district

In the Ulytau Mountains, needle length varied from 4.56 to 4.79 mm, leaf width — from 0.9 to 0.98 mm, shoot growth ranged from 11.02 to 12.55 cm. In the vicinity of Karaganda city, the minimum sizes of leaf length and width were noted: 4.09–4.42 mm and 0.89–0.95 mm, respectively. The shoots growth ranged from 9.74 to 12.61 cm.

Comparison of indices allowed distinguishing that the greatest length of juniper leaf was noted for individuals from Zhanaarka district, on the second place — individuals from Karkaraly Mountains, on the third place — from Ulytau Mountains. The minimum values of this trait were recorded for the vicinity of Karaganda city.

The leaf width index showed no significant differences between individuals growing in different habitats. Maximum values of annual growth were observed for individuals from the Ulytau Mountains; no reliable differences in annual growth were found between the other habitats.

However, the maximum metric sizes of juniper individuals were observed in the vicinity of the Karkaraly Mountains (Fig. 7), and the minimum ones — in the Zhanaarka district. In terms of plant height, no reliable differences were found in the height of individuals, and in terms of the diameter of individuals, plants from the Ulytau Mountains were reliably smaller than individuals from the Karkaraly Mountains.

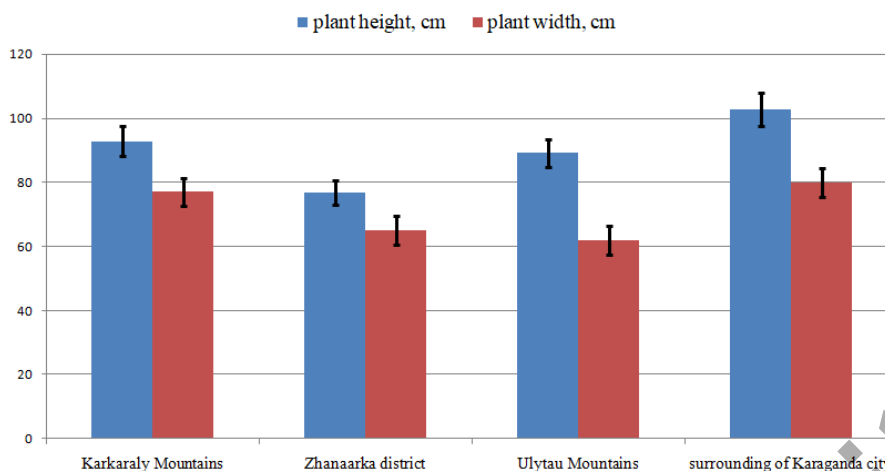


Figure 7. Indices of *Juniperus sabina* shrubs length and width at different growing points

### Conclusion

Since *J. sabina* is influenced by the general anthropogenic factor, but the level of phenotypic variability of morphological traits as an indicator of intraspecific differentiation, one can see that the signs of the vegetative organs of objects collected from Karaganda are significantly less compared to species growing in forests. It should be noted that common juniper is more resistant to technogenic impact than other plant representatives. Also, the results of the work are based on comprehensively conducted field and experimental materials, scientifically based methods and modern statistical analyzes that evaluate the reliability criterion.

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### References

- 1 Farjon A. World checklist and bibliography of conifers / A. Farjon. — England: The Royal Botanic Gardens, 2001. — P. 309.
- 2 Джанаева В.М. Определитель семейства можжевельных / В.М. Джанаева. — Фрунзе, 1969. — С. 94.
- 3 Гроздова Н.Б. Деревья, кустарники и лианы / Н.Б. Гроздова, В.И. Некрасов, Д.А. Глоба-Михайленко // Лесная промышленность. — 1986. — С. 349.
- 4 Xu S. Effects of age and tissue of *Juniperus sabina* L. on its phytochemical characteristics, anti-cholinesterase, antidiabetes, and anti-drug resistant bacteria activities / S. Xu, Q. Chen, N. Luo, J. Yang, D. Li // Front. Plant Sci. — 2023. — Vol. 14. — Article ID 1174922. <https://doi.org/10.3389/fpls.2023.1174922>
- 5 Ivanova D. Anticancer podophyllotoxin recovery from juniper leaves at atmospheric and high pressure using eco-friendly solvents / D. Ivanova, P. Nedialkov, A. Tashev, Z. Kokanova-Nedialkova, M. Olech, R. Nowak // Plants. — 2023. — Vol. 12. — Article ID 1526. <https://doi.org/10.3390/plants12071526>
- 6 Новиков О.О. Применение растений рода *Juniperus* L. в народной медицине. Перспективные научные данные (обзор) / О.О. Новиков, Д.И. Писарев, Е.Т. Жилиякова, Б.В. Трифонов, Н.В. Автина, В.Е. Левченко, И.В. Корниенко // Научные ведомости. Сер. Медицина. Фармация. — 2013. — № 25(168), Вып. 24/1. — С. 29–34.
- 7 Zhao J. Evaluation on Analgesic and anti-inflammatory activities of total flavonoids from *Juniperus sabina* / J. Zhao, A. Maitituersun, Ch. Li, Q. Li, F. Xu, T. Liu // Evidence-Based Complementary and Alternative Medicine. — 2018. — Vol. 2018. — 9 pp. <http://doi.org/10.1155/2018/7965306>
- 8 Asili J. Chemical and Antimicrobial Studies of *Juniperus Sabina* L. and *Juniperus foetidissima* Willd. Essential Oils / J. Asili, A. Emami, M. Rahimizadeh, B.S. Fazly-Bazzaz, M.K. Hassamzadeh // Journal of Essential Oil Bearing Plants. — 2013. — Vol. 13(1). — P. 25–36. <http://doi.org/10.1080/0972060X.2010.10643787>
- 9 Зайцев Г.Н. Методика биометрических расчетов. Математическая статистика в экспериментальной ботанике / Г.Н. Зайцев. — М.: Наука, 1973. — С. 89–132.

П.У. Абдикаримова А.К. Қали, М.Ю. Ишмуратова, А.К. Рамазанов, А.Т. Нуркенова

### Орталық Қазақстандағы *Juniperus sabina* жерүсті бөліктерінің морфологиялық ерекшеліктері

Мақалада Қарағанды қаласының маңында, Қарқаралы және Ұлытау тауларында, Жаңаарқа ауданының шоқыларында өсетін *Juniperus sabina* вегетативтік органдарының морфологиялық параметрлерін зерттеу нәтижелері келтірілген. Зерттеу нәтижелері кешенді жүргізілген далалық және эксперименттік материалдарға, ғылыми негізделген әдістемелерге және сенімділік критерийін бағалайтын заманауи статистикалық талдауларға негізделген. «Жапырақ ұзындығы» көрсеткіші бойынша ең жоғары мәндер Жаңаарқа ауданының дарактары үшін, ең аз мәндер — Қарағанды қаласының маңы үшін болғандығы атап өтілді. «Жапырақ ені» және «жылдық өсу мөлшері» көрсеткіштері бойынша әр түрлі өсу нүктелеріндегі дарактар арасында сенімді айырмашылық байқалмайды. Өсімдіктердің ең үлкен мөлшері Қарағанды қаласының маңы үшін, ең аз мөлшері — Жаңаарқа және Ұлытау аудандарының дарактары үшін белгіленді. Алынған мәліметтер қоршаған ортаның ластануының әртүрлі дәрежесіне және климаттық жағдайларға байланысты.

*Кілт сөздер:* *Juniperus sabina*, морфология, өсімдіктің биіктігі мен диаметрі, жапырақтың ұзындығы мен ені, жылдық өсу мөлшері.

П.У. Абдикаримова, А.К. Кали, М.Ю. Ишмуратова, А.К. Рамазанов, А.Т. Нуркенова

### Морфологические особенности надземных частей *Juniperus sabina* в Центральном Казахстане

В статье представлены результаты исследования морфологических параметров вегетативных органов *Juniperus sabina*, произрастающих в окрестностях города Караганды, горах Карқаралы и Улытау, сопках Жанаарқинского района. Результаты исследований базируются на комплексно проведенных полевых и экспериментальных материалах, научно обоснованных методиках и современных статистических анализах, оценивающих критерий надежности. Отмечено, что по показателю «длина листа» максимальные значения были для особей из Жанаарқинского района, минимальные — для окрестностей города Караганды. По показателям «ширина листа» и «величина годичного прироста» не отмечено достоверной разницы между особями из разных точек произрастания. Максимальные размеры растений отмечены для окрестностей города Караганды, минимальные — особей из Жанаарқинского и Улытауского районов. Полученные данные обусловлены разной степенью загрязнения окружающей среды и климатическими условиями.

*Ключевые слова:* *Juniperus sabina*, морфология, высота и диаметр растения, длина и ширина листа, величина годичного прироста.

#### References

- 1 Farjon, A. (2001). *World checklist and bibliography of conifers*. England: The Royal Botanic Gardens, 309.
- 2 Dzhanyayeva, V.M. (1969). *Opredelitel semeistva mozhzhevelovykh [Juniper family definitions]*. Frunze, 94 [in Russian].
- 3 Grozdova, N.B., Nekrasov, V.I., & Globa-Mihajlenko, D.A. (1986). Derevia, kustarniki i liany [Trees, shrubs and vines]. *Lesnaia promyshlennost — Forest Industry*, 349 [in Russian].
- 4 Xu, S., Chen, Q., Luo, N., Yang, J., & Li, D. (2023). Effects of age and tissue of *Juniperus sabina* L. on its phytochemical characteristics, anti-cholinesterase, antidiabetes, and anti-drug resistant bacteria activities. *Front. Plant Sci.*, 14; 174922. <https://doi.org/10.3389/fpls.2023.1174922>
- 5 Ivanova, D., Nedialkov, P., Tashev, A., Kokanova-Nedialkova, Z., Olech, M., & Nowak, R. (2023). Anticancer podophyllotoxin recovery from juniper leaves at atmospheric and high pressure using eco-friendly solvents. *Plants*, 12; 1526. <https://doi.org/10.3390/plants12071526>
- 6 Novikov, O.O., Pisarev, D.I., Zhiliakova, E.T., Trifonov, B.V., Avtina, N.V., Levchenko, V.E., & Kornienko, I.V. (2013). Primenenie rastenii roda *Juniperus* L. v narodnoi meditsine. Perspektivnye nauchnye dannye (obzor) [Application of plants of the genus *Juniperus* L. in folk medicine. Prospective scientific data (review)]. *Nauchnye vedomosti. Seriya Meditsina. Farmatsiya — Science Bulletin. Series medicine. Pharmacy*, 25(168), 24/1; 29–34 [in Russian].
- 7 Zhao, J., Maitituersun, A., Li, Ch., Li, Q., Xu, F., & Liu, T. (2018). Evaluation on Analgesic and anti-inflammatory activities of total flavonoids from *Juniperus Sabina*. *Evidence-Based Complementary and Alternative Medicine*, 2018, 9. <http://doi.org/10.1155/2018/7965306>

8 Asili, J., Emami, A., Rahimizadeh, M., Fazly-Bazzaz, B.S., & Hassamzadeh, M.K. (2013). Chemical and Antimicrobial Studies of *Juniperus Sabina* L. and *Juniperus foetidissima* Willd. Essential Oils. *Journal of Essential Oil Bearing Plants*, 13(1), 25–36. <http://doi.org/10.1080/0972060X.2010.10643787>

9 Zaitsev, G.N. (1973). *Metodika biometricheskikh raschetov. Matematicheskaya statistika v eksperimentalnoi botanike [Methodology of biometric calculations. Mathematical statistics in experimental botany]*. Moscow: Nauka [in Russian].

#### Information about the authors

**Abdikarimova Perizat Uzakovna** — Master of biology, senior lecturer of Botany Department, Karaganda Buketov University, Karaganda, Kazakhstan; e-mail: picon\_04\_93@mail.ru;

**Kali Almagul Kaliyevna** — Candidate of biological sciences, associated professor of Botany Department, Karaganda Buketov University, Karaganda, Kazakhstan; e-mail: a-aelbekova@mail.ru;

**Ishmuratova Margarita Yulayevna** — Candidate of biological sciences, professor, professor-researcher of Botany Department, Karaganda Buketov University, Karaganda, Kazakhstan; e-mail: margarita.ishmur@mail.ru;

**Ramazanov Alibek Kairidenovich** — Master of biology, senior lecturer of Physiology Department, Karaganda Buketov University, Karaganda, Kazakhstan; e-mail: kairidenovich\_rak@mail.ru;

**Nurkenova Ainur Toleutayevna** — Candidate of biological sciences, professor assistant of Botany Department, Karaganda Buketov University, Karaganda, Kazakhstan; e-mail: nuraitul@mail.ru.