

Morphometric study of *Cyclachaena xanthiifolia* (Nutt.) Fresen under the conditions of Kostanay Region

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Abstract. The morphometric characteristics of the North American invasive plant *Cyclachaena xanthiifolia* (Nutt.) Fresen were studied in the Kostanay region, Kazakhstan. Monitoring of plant populations has been ongoing since 2021. Vegetation begins in the first decade of May, ends in the second or third decade of September, lasting 146 days. Flowering occurs in late July and is prolonged, classifying the species as a late-summer flowering plant with long flowering duration. Fruiting is rapid, starting in the third decade of July, continuing until the end of August. The phenological phases of bud formation, flowering, and fruiting overlap, flowering and seed ripening are uneven. Analysis of variation coefficients shows that the amplitude of variability of traits in *C. xanthiifolia* does not differ widely, encompassing only 2 levels of variation - normal and significant, with the majority of parameters having normal Cv (%) values in all three months. The maximum Cv value in the *C. xanthiifolia* population does not exceed 47.7% (number of leaves on lateral shoots in July), the minimum is 10.58% (number of leaves in August). *Cyclachaena xanthiifolia* is a highly competitive weed that rapidly spreads throughout the region, quickly occupying dominant positions in plant communities, displacing all other plant species.

1 Introduction

The expansion of alien plant species is a pressing issue worldwide. Their introduction is the second most significant threat to biodiversity after habitat destruction.

Inventorying alien flora and its invasive component in regions of different levels is a key recommendation of the European Strategy on Invasive Alien Species: "In each region, the spread of the 100 most harmful alien species should be monitored" [1]. Due to the rapid spread of alien plant species, it is also important to identify potentially invasive species [2-4]. Nine international symposia have been dedicated to discussing issues of biological invasion. A global program, the Global Invasive Species Database (GISP), has been created in many countries around the world, and working groups are being formed to study them.

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The importance of studying these species is reflected in the 6th National Report of the Republic of Kazakhstan on Biodiversity: "The problem of invasions of alien species is one of the most important areas of fundamental and applied research and is an important aspect of ensuring the country's ecological security" [5].

The relevance of this study is dictated by the need to obtain up-to-date data on the species composition, distribution of alien flora and its invasive component, and for the Kostanay region, the problem of invasions of alien plant species is especially relevant, as it is being discussed for the first time.

2 Materials and Methods

The Kostanay Region (northern Kazakhstan) is a remarkable repository of biodiversity, encompassing a diverse range of ecosystems, from the vast red-grass steppes to plant communities reminiscent of northern forests. The region's unique ecological landscape is characterized by an intricate interplay between native and introduced flora, a dynamic that necessitates comprehensive scientific investigations to understand the species composition, distribution, ecological properties, and evolutionary trends of these plant communities. This is particularly crucial for understanding the ecological dynamics of anthropogenically disturbed areas. The Kostanay Region also holds significant economic importance, serving as a major source of iron ore [6] and bauxite, further emphasizing the need for in-depth ecological research to ensure sustainable resource management and environmental protection.

Along with this, it is necessary to consider the geographical position, which creates favorable conditions for the introduction of plants. The Kostanay Region borders Russia, "Black List" of which includes a hundred alien plants that require priority study to prevent biological invasions. It is important in border regions to identify a list of invasive species, assess the state of populations and their numbers, and make forecasts of their distribution.

The subject of this study is *Cyclachaena xanthiifolia* (Nutt.) Fresen, a North American invasive species in the Asteraceae Dumort family. The objective is to investigate the morphometric characteristics of the invasive plant *C. xanthiifolia* (Nutt.) Fresen. The following morphometric parameters were measured: plant height, number of leaves, length and width of leaf blade, petiole length, number of lateral shoots, leaves on lateral shoots, inflorescence length. Data were collected for each parameter from several plant specimens. Monitoring studies of cenopopulations in the Kostanay region have been conducted since 2021, and work on identifying new and studying old foci of invasions continues to this day. The study of cyclachena populations was carried out during the growing season using the method of registration sites. For each focus of invasion of this species, an assessment of morphogenesis parameters was carried out using representative samples [7].

The coefficient of variation (Cv), which is a standardized measure of dispersion of a probability distribution or frequency distribution, was employed to evaluate and analyze the overall variability of morphometric traits and parameters in the studied plants. In accordance with the selected method of Zaitsev, the variability of biological outcomes of plant trait measurements will be categorized as follows based on the quantitative value of the coefficient of variation: 1) small (0–4%); 2) -3) normal (5–55%); 4) significant (45–64%); 5) large (65–84%); 6) very large (85–104%); 7) anomalous (105% and above) [8].

3 Results and Discussion

Cyclachaena xanthiifolia was first recorded in Kazakhstan in 1983 in the city of Karaganda [9]. In the East Kazakhstan Region, *C. xanthiifolia* was first observed in 1991 in the village

of Bolshenarymsky, where the plant was found in small patches on wastelands. In the Pavlodar Region and in some districts of the East Kazakhstan Region, *C. xanthiifolia* completely transforms natural ecosystems, displacing native vegetation [10].

In 2006, Ivashchenko A.A. and co-workers discovered this species in West Kazakhstan, Zhambyl, and Almaty regions [11]. The species was also recorded by Sukhorukov A. on the territory of Kapchagai city, Almaty region in 2008 (MW). To date, there is a trend of *C. xanthiifolia* spreading across Kazakhstan; over the past decade, the species has been found in the Kostanay region as well [12]. New foci of invasion of the species have been identified on the territory of the Kostanay region: Aueliekol district, village Kushmurun; Aueliekol district, village Ozernoye; Kostanay, vicinity of the university, Abay 28, wasteland; Kostanay, vicinity of polyclinic No. 4, along Voinov-Internatsionalistov street; vicinity of Rudny [12].

The difficulties of controlling *C. xanthiifolia* are primarily associated with its morphobiological characteristics and ecological plasticity (Fig. 1). As a result, despite various control methods, the species well adapts to new conditions and successfully survives in both agrophytocenoses and untreated lands, expanding its range, densifying populations, and invading natural plant communities [13].



A - vicinity of Kostanay city;
 B - within the territory of Kostanay city (Kostanay region, vicinity of the university)

Fig. 1. *Cyclachaena xanthiifolia* (Nutt.) Fresen

Our research has revealed that the vegetation of the *Cyclachaena xanthiifolia* species in the Kostanay region begins in the first decade of May and ends after frosts in the second or third decade of September. Accordingly, the duration of vegetation is 146 days (Table 1).

Table 1. Phenological phase characteristics of *Cyclachaena xanthiifolia* (Nutt.) Fresen

Phenological phase	Date
Sprouting	05.05 – 13.05
Bud break	15.06 – 24.06
Initial flowering	25.07 – 10.08
Full bloom	20.08 – 27.08
Fruit set	30.07 – 20.08
Seed ripening	30.08 – 05.09
Seed maturity	20.09 – 28.09

Flowering of *C. xanthiifolia* was observed in late July. Flowering is extended, lasting 28 days. According to the timing of flowering, *C. xanthiifolia* belongs to late summer cycle plants, and according to the duration of flowering, it belongs to long-flowering species.

It was found that the fruiting of the species is rapid, starting in the III decade of July and continuing until the end of August. The phenological phases of bud formation, flowering, and fruiting overlap, and flowering and seed ripening are uneven.

Table 2 summarizes the results of studies on morphometric parameters of *C. xanthiifolia* growing in the territory of Kostanay city (university territory, Abai Ave. 28, wasteland). Plant parameters were measured within 3 months.

Table 2 Morphometric characteristics of *Cyclachaena xanthiifolia* (Nutt.) Fresen

Characteristics	Mean morphometric values					
	July	Cv, %	August	Cv, %	September	Cv, %
Plant height, cm	83.67±33.8	40.37	127.7±8.8	11.9	168.3±23.43	13.92
Number of leaves	13.33±2.89	21.71	16±2.8	17.52	12.93±1.79	10.58
Length of leaf blade, cm	9.13±4.32	26.8	12.93±2.76	21.37	12.93±2.76	21.37
Width of leaf blade, cm	7.07±6.35	36.79	7.0±0.8	17.4	6.7±0.6	15.8
Length of petiole, cm	7.0±5.8	24.16	8.0±0.6	12.8	8.13±1.12	13.84
Number of lateral shoots	6.8±1.6	23.48	12.2±2.07	17.03	13.07±1.58	12.09
Number of leaves on lateral shoots	2.9±1.37	47.27	3.9±0.4	17.2	4.33±1.11	25.68
Length of inflorescence, cm	—	—	6.2±1.01	16.36	—	—

It was found that the indicators increased steadily during the season. The greatest differences between the months of observation were observed in the following characteristics: plant height and the number of lateral shoots.

The table shows that the height of the plants gradually increases during the season and reaches 168.3 cm (average value) by September. The length and width of the leaf blade change slightly during the season. It was found that the average value of the leaf blade length increases by 3 cm by September, while the average value of the width practically does not change. In September, the lower leaves of the plants dry up and fall off, as a result of which the number of leaves decreases. The greatest number of lateral shoots and leaves on lateral shoots was observed in September. *C. xanthiifolia* is characterized by a complex inflorescence - a panicle. It is formed by single or simple spike-like inflorescences of baskets. Inflorescences are absent in July and September.

For morphometric parameters in natural conditions, the following levels of variability are characteristic (according to the classification of G.N. Zaytsev [8]: in July - significant (47.27%) for the number of leaves on lateral shoots, normal for all other parameters; in August and September - normal for all studied indicators.

4 Conclusion

Cyclachaena xanthiifolia is a highly competitive weed that is rapidly spreading across the region. It quickly occupies dominant positions in plant communities, displacing all other plant species. Analysis of the variation coefficients shows that the amplitude of variability of *C. xanthiifolia* traits does not differ within wide limits and covers only 2 levels of variation - normal and significant. Moreover, a majority of the parameters exhibit normal

CV (%) values in all three months. The maximum CV (%) value in *C. xanthifolia* populations does not exceed 47.7% (number of leaves on lateral shoots in July), while the minimum is 10.58% (number of leaves in August).

It should be noted that the morphometric parameters of *Cyclachaena xanthifolia* are variable and depend on the habitat conditions. This indicates that this plant is capable of adapting to various environmental conditions.

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