***BIDENS FRONDOSA* (ASTERACEAE), A NEW ALIEN INVASIVE PLANT SPECIES IN THE KURGAN REGION (RUSSIA)**

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Abstract: The annual weed *Bidens frondosa* L. (Asteraceae) has been registered for the first time in the Kurgan Region in 2020 during research on the riverine vegetation of the southwestern part of Western Siberia. This invasive species was found in ten locations along the Iset' River banks in the Kurgan Region. We have postulated that the Sverdlovsk Region serves as a source for the *B. frondosa* invasion into the Kurgan Region along the River Iset'. Despite a single short-term field survey, *B. frondosa* was found in several sites. In the Kurgan Region, this invasive species is characterized by low population density in all plots. Since *B. frondosa* populations are characterized by much higher density in other regions of European Russia, an increase in the number of locations and density of populations is expected in the Kurgan Region in the future.

Key words: biological invasions, distribution, invasion path, population density, riverine habitat, annual weed, Western Siberia.

Introduction

At the present time, the penetration of invasive alien plants into natural ecosystems is ever of high concern. Consequences of this process could be reflected in disruption of soil conditions [15] well-being of animals and people [2], and the structure of plant communities [1, 8]. *Bidens frondosa* L. (Beggerticks) is one of many annual weeds native to North America considered to be a highly invasive plant in Eurasia. In its native range, *B. frondosa* occupies a large area extending from Alaska into the central part of the continent. This species inhabits wet, nutrient-rich soils or muddy sand soils on roadsides or the shores of rivers and lakes, as well as in waste places. *Bidens frondosa* is considered one of the 50 most invasive species in Europe [14]. Recently, this plant species has been considered to be one of the most widely distributed invasive species in Russia [20]. In Europe, the intensive expansion of *B. frondosa* began after World War II, resulting in its naturalization in many European countries [3, 4, 10, 20, 21].

The relationships of the alien *B. frondosa* with its native congeners (e.g., *B. tripartita*, *B. radiata*, *B. pilosa*), as well as with its environment, have been intensively studied in Eurasia. It has been shown that *B. frondosa* has higher seed mass and productivity, as well as dry mass and growth rates as compared to *B. tripartita*, and *B. radiata* in European Russia [9, 18, 19] and Western Europe [5]. Various authors have demonstrated the higher resistance of *B. frondosa* to heavy metals [13], as well as larger morphological variability under influence of environmental factors [17, 22] in comparison to native *Bidens* congeners in the ecosystems of Eurasia.

In many regions of Russia, there is a lack of data on distribution and diversity of alien species and their environmental preferences. Therefore, research on alien plant diversity is relevant in many regions. In 2015, Ronzhina [18] demonstrated the high invasive activity of *B. frondosa* in the Sverdlovsk Region. However, in the adjacent Kurgan Region, this invasive species had not been recorded [16]. Since Kostrakiewicz-Gieralt & Zajac [12] noted that the river water flow serves an important factor in the seed dispersal of *B. frondosa*, we suggested that this plant could be introduced into riverine habitats of the Kurgan Region through the Iset' River flowing from the Sverdlovsk Region to the Kurgan Region. To test this hypothesis, we carried out comprehensive field investigations along the River Iset'.

Material and Methods

The study has been carried out in the Kurgan Region, located in the south-western part of West Siberian Plain (Russia) (between 54.18° N and 56.83° N, and between 61.97° E and 68.72° E) bordering Kazakhstan in south. In the Kurgan Region, the climate is temperate continental, and the Kurgan Region is characterized by an insufficient and unstable water regime. The highest moisture deficit occurs in the summer season. According to the classification of Dinerstein et al. [6, 7], the northern part of the Kurgan Region lies within the ecoregion of Western Siberian hemiboreal forests in the biome of temperate broadleaf and mixed forests. Its southern part corresponds to the ecoregion of Kazakh forest steppe in the biome of temperate grasslands, savannas and shrublands. The vascular plant flora of the Kurgan Region consists of more than 1200 species, including 118 wetland and 55 aquatic plant species [16, 23].

In 2020, we conducted field surveys along the River Iset' in the Kurgan Region (Western Siberia), with investigation of 13 locations in the riverbank habitats (Fig. 1). We aimed to find *B. frondosa* and to reveal the number of plants per population, and the population extent.

Fig. 1: Location of the study sites in the Kurgan Region, Western Siberia, Russia

Designations: black dots indicate sites where *Bidens frondosa* was found; red dots indicate sites where *Bidens frondosa* was absent. Biomes according to Dinerstein et al. [6, 7]: blue – boreal forests (taiga); green – temperate broadleaf and mixed forests; yellow – temperate grasslands, savannas and shrublands. Designations of the studied sites: 1 – Vodolazovo, 2 – Ipatova, 3 – Ushakovskoe, 4 – Sheveleva, 5 – Kataysk, 6 – Dalmatovo, 7 – Krasnoisetskoe, 8 – Krutikha, 9 – Kovriga, 10 – Shadrinsk, 11 – Maslyanskoe, 12 – Krestovskoe, 13 – Yuldus.

The investigation has been carried out by the traditional route-reconnaissance method [11]. Taking into account the nature of the habitats occupied by *Bidens* species, we examined banks of the Iset' River in inhabited localities from the village Vodolazovo on the border of the Sverdlovsk Region and Kurgan Region to the village of Yuldus. The total length of the route was about 140 km with intervals of 10–15 km. In each study site, we recorded the following parameters: 1) the geographical coordinates (GeoC); 2) total number of mature plant individuals (N); 3) area covered by each *B. frondosa* population (A). The last two parameters were used to calculate 4) the density of *B. frondosa* population as a ratio of number of individuals to the population area (D).

The map of the Kurgan Region with indicated research sites was created using software MapInfo Professional ver. 11.5. The GIS-layer of natural ecoregions was used in accordance with Dinerstein et al. [6, 7].

Results

During the field surveys, we found that the *B. frondosa* population density varied from 0.49 plants to 2.86 plants per 1 m². The main information about studied sites is presented below.

New records of *B. frondosa* in the Kurgan Region: 1) Site *Vodolazovo R354*, D has not been assessed, GeoC: 56.336774° N, 62.269470° E, 27.08.2020, D.A. Ronzhina, L.A. Ivanova, L.A. Ivanov; 2) Site *Ipatova*, D=1.50 plants per 1 m², GeoC: 56.295586° N, 62.352833° E, 27.08.2020, D.A. Ronzhina, L.A. Ivanova, L.A. Ivanov; 3) Site *Ushakovskoe*, D=0.63 plants per 1 m², GeoC: 56.287160° N, 62.449464° E, 27.08.2020, D.A. Ronzhina, L.A. Ivanova, L.A. Ivanov; 4) Site *Sheveleva*, D=1.44 plants per 1 m², GeoC: 56.292478° N, 62.467019° E, 27.08.2020, D.A. Ronzhina, L.A. Ivanova, L.A. Ivanov; 5) Site *Kataysk*, D=2.50 plants per 1 m², GeoC: 56.277226° N, 62.583173° E, 27.08.2020, D.A. Ronzhina, L.A. Ivanova, L.A. Ivanov (Fig. 2); 6) Site *Dalmatovo*, D=1.67 plants per 1 m², GeoC: 56.254391° N, 62.932273° E, 27.08.2020, D.A. Ronzhina, L.A. Ivanova, L.A. Ivanov; 7) Site *Krasnoisetskoe*, D=1.25 plants per 1 m², GeoC: 56.212800° N, 62.994510° E, 27.08.2020, D.A. Ronzhina, L.A. Ivanova, L.A. Ivanov; 8) Site *Krutikha*, D=0.49 plants per 1 m², GeoC: 56.155924° N, 63.178399° E, 27.08.2020, D.A. Ronzhina, L.A. Ivanova, L.A. Ivanov; 9) Site *Kovriga*, D=2.86 plants per 1 m², GeoC: 56.128730° N, 63.317214° E, 27.08.2020, D.A. Ronzhina, L.A. Ivanova, L.A. Ivanov; 10) Site *Shadrinsk*, D=2.00 plants per 1 m², GeoC: 56.076382° N, 63.641479° E, 27.08.2020, D.A. Ronzhina, L.A. Ivanova, L.A. Ivanov.

Sites where *B. frondosa* was not found: 1) Site *Maslyanskoe*, GeoC: 56.077304° N, 63.903207° E, 27.08.2020, D.A. Ronzhina, L.A. Ivanova, L.A. Ivanov; 2) Site *Krestovskoe*, GeoC: 56.078337° N, 64.023135° E, 27.08.2020, D.A. Ronzhina, L.A. Ivanova, L.A. Ivanov; 3) Site *Yuldus*, GeoC: 56.066566° N, 64.368941° E, 27.08.2020, D.A. Ronzhina, L.A. Ivanova, L.A. Ivanov. So, no one *B. frondosa* individual was found in all of three research sites remote from the border of Kurgan Region and Sverdlovsk Region.

Discussion

We previously registered *B. frondosa* locations along the Iset' River within the Sverdlovsk Region, where this invasive plant was known earlier (our unpublished data). However, our previous efforts in search of this invasive alien plant along the Iset' River in the Kurgan Region were unsuccessful. Our present findings of *B. frondosa* in the Kurgan Region may confirm our

hypothesis that the Iset' River serves as the invasion path of this alien species into inner part of the Kurgan Region. We may therefore assume that each year further spread of *B. frondosa* occurs along the riverbanks. Whether the invasion rates depend on the river flow rate, vegetation cover or other factors is still unknown and requires further investigation.

Fig. 2: *Bidens frondosa* L. on the bank of the Iset' River, environs of Kataysk town, Kurgan Region, Russia

The study of *B. frondosa* populations in the Kurgan Region demonstrates that this alien plant did still not realize its invasive potential in this area. This is supported by the relatively low value of population density (0.49–2.86 plants per 1 m²). It is much lower than in well-established *B. frondosa* populations in the centre of European Russia (Republic of Mordovia) representing 77.7–198.0 plants per 1 m² and 36.3 plants per 1 m² for all and mature individuals respectively [9].

Therefore, we may expect an increase in density of *B. frondosa* populations in the future, which will require continuous monitoring in the Kurgan Region. Moreover, adjacent sites along the river, where we have not yet found *B. frondosa*, are expected to be invaded by this alien plant in the future.

Conclusions

The present findings of *B. frondosa* supplement knowledge of the flora of the Kurgan Region. The invasive activity and distribution patterns of this alien plant are required to be further investigated for counteracting its invasion and biodiversity loss vis-à-vis native congeners, namely *B. tripartita* and *B. radiata*, which currently represent an important component of riparian ecosystems.

We propose further studies of alien plant distribution and biological invasions at the regional level to obtain a complete understanding a situation with regard to alien plant diversity in the whole of Russia. For this purpose, population studies of *B. frondosa* and other invasive plants are necessary to reveal their biological patterns and way to combat the biological invasions in various parts of its invaded range.

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BIDENS FRONDOSA (ASTERACEAE), O NOUĂ SPECIE INVAZIVĂ DIN REGIUNEA KURGAN (RUSSIA)

(Rezumat)

Specia ruderală anuală *Bidens frondosa* L. (Asteraceae) a fost confirmată pentru prima dată în regiunea Kurgan în 2020, în timpul studiului vegetației ripariene din partea sud-vestică a vestului Siberiei. Această specie invazivă a fost găsită în 10 locații de-a lungul malurilor râului Iset din regiunea Kurgan. S-a concluzionat că regiunea Sverdlovsk funcționează ca sursă pentru invazia de *B. frondosa* în regiunea Kurgan, de-a lungul râului Iset. Deși s-a făcut un singur studiu, de scurtă durată, *B. frondosa* a fost identificată în mai multe locații. În regiunea Kurgan, această specie invazivă este caracterizată de densități scăzute ale populației, în toate parcelele studiate. Deoarece populațiile de *B. frondosa* sunt caracterizate de densități mult mai mari în alte regiuni ale Rusiei Europene, se așteaptă în viitor o creștere a numărului de locații și a densității populațiilor în regiunea Kurgan.