

## Conference Paper

# Invasions of Alien Plant Species in the South Urals: Current State of the Problem

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## Abstract

**Aim:** assessment of the current state of the introduction of alien species into the territory of the Bashkortostan Republic. **Objectives:** identification of aggressive neophyte invasion centers, mapping their distribution in the region, the description of communities containing such neophytes, assessment of the population, and reproductive characteristics of these species and the development of recommendations about controlling invasive processes. The characteristics of the adventive component of the flora of the Bashkortostan Republic (457 species) are provided in the article. The most aggressive invasive species (*Ambrosia trifida*, *A. psyllostachya*, *Cyclachaena xanthiifolia*, *Hordeum jubatum*, *Bidens frondosa*, etc.), which take root in sinantropic and natural communities in proportions of between 18% and 99%, are considered. The biomass of invasive plants is up to 6 kg/m<sup>2</sup>, while the density is over 1,000 escapes per 1 m<sup>2</sup>. Data on the ecology, phytocenotic confinedness and distribution of these species are presented. Ecological harm is connected with the replacement of local plants, the contamination of lands and the allergenicity of the pollen from a number of invasive species.

**Keywords:** South Urals, Bashkortostan Republic, alien species, invasions, controlling numbers

## 1. Introduction

The invasions of alien species are a real environmental problem around the world: such invasions cause enormous economic damage, as these plants quite often become hazardous weeds in most ecosystems, can constitute a health risk to people and may cause floristic pollution [1–6]. The problem of alien species invasion is also very relevant for the South Urals. In the recent decades in the region, the activization of aggressive neophyte (of mainly North American origin) invasion has been observed [7, 8].

Work purpose: assessment of current state of the introduction of alien species into the Bashkortostan Republic (RB). Main objectives: identification of the centers of

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aggressive neophyte invasion, mapping their distribution in the region, description of the communities in which they are present, assessment of the population and reproductive characteristics of these species and the development of recommendations about controlling invasive processes.

## 2. Methods

Floristic research was conducted by means of a route method throughout the RB, which consists of 3 large natural zones (provinces): the Bashkir Cis-Urals (about 65% of the area), the South Urals (29%) and the Bashkir Trans-Urals (6%). In order to identify species, we used the books *Determinant of the Higher Plants of the Bashkir ASSR* [9, 10] and *Flora of the European Part of the USSR and Eastern Europe* [11, 12]: the names of species were provided in the work *Vascular Plants of Russia and Adjacent States* [13].

Phytocenotic research was conducted via the Braun–Blanquet method [14]: relevés of communities containing invasive species were carried out on sample plots measuring 4–100 m<sup>2</sup>. In order to make syntaxonomic decisions, the syntaxa received as a result of processing were compared to units earlier described in the RB [15].

The main population indicators were studied by means of 10 sample plots 1 m<sup>2</sup> in size at each invasion center. The research into the population included assessment of the height, density, and biomass of invasive plants, as well as their proportional presence in communities [16].

## 3. Results

### 3.1. Adventive flora of the RB

Long-term (more than 20 years) research has shown that the adventive flora of the RB contains 457 alien plant species from 234 genera and 69 families [17]. In relation to the natural flora of the republic, they make up about 22% of the plant life. Since the beginning of the 20<sup>th</sup> century in the RB, more than 300 alien species have appeared. The majority of alien plant species belong to eucenophytes (308 species, 67.4%), which were introduced over the course of the last 100 years. The proportion of species brought during earlier historical periods is much lower.

The prevalence of thermophilic families is characteristic of the ranges of leading families with an adventive component: *Apiaceae* (66 species, 14.4%), *Brassicaceae* (46 species, 10.0%), *Chenopodiaceae* (33 species, 7.2%), *Fabaceae* (28 species, 6.1%).

These species are peculiar to more southern arid regions and so suggests an active drift of alien plant species from Central Asian and Mediterranean regions. The high position of the *Rosaceae* family is connected with introduced species running wild and resettling elsewhere.

### 3.2. Black list of flora

The black list of flora of the RB includes 55 species of plants that constitute a danger to local ecosystems: they are either widely settled or tending toward resettlement [18]. All alien species are divided into 3 groups: (1) invasive species, (2) potentially invasive species, and (3) fluctuating alien species with the status of ephemerophytes on the naturalization scale. In the first group of invasive neophytes are 7 wood and shrub species, 34 annual plants, 6 biannual plants, 1 long-term hydrophyte and 7 long-term herb species. In the second group, there are 45 more alien species that are invasive in other regions and are found in a small number of localities in the RB: their resettlement is possible in the near future. These are species that are potentially dangerous to the republic's ecosystems. Thus, the groups of invasive and potentially invasive plants are constituted by about 100 species.

### 3.3. Active species

Among invasive plant species, the greatest danger to the RB's ecosystems is constituted by species with invasive status (1). We have revealed and surveyed over 200 invasion centers populated by 10 aggressive neophytes: distribution maps were made and over 250 relevés in communities containing these species were executed. The population and reproductive characteristics of the species were estimated. We give the main characteristics of these species' distribution and ecologo-biological features as follows.

- (i) *Ambrosia trifida*. The secondary area of this species in the RB is not stable. The main center of resettlement is located in the southwest of the Cis-Urals in steppe and forest-steppe zones: the tendency for further resettlement in more northern areas has been observed [19]. The species is found mainly in communities of the *Stellarietea mediae* class. Communities with *Ambrosia trifida* in the RB are presented by *Ambrosietum trifidae* association [20] and a row the derivate communities. *Ambrosia trifida* has widely naturalized in the flood plains of the rivers in the southern part of the RB and the Orenburg region, where it takes root in

shaded riverbed habitats belonging to the *Galio-Urticetea* class. Quite often, the species grows in disturbed meadow and coastal communities belonging to the *Molinio-Arrhenatheretea* and *Phragmito-Magno-Caricetea* classes.

- (ii) *Ambrosia psyllostachya*. The secondary area of this species in the RB is rather stable [17]. The species is met less frequently than *Ambrosia trifida*: the main centers of invasion are located in the flood plains of rivers in the steppe zone and on highways and railways [19]. It grows in a wide range of ecological conditions, such as in the disturbed steppes of the *Festuco-Brometea* class and in the moist habitats of the *Bidentetea tripartitae* class. In the RB, it is typically associated with the domination of *Ambrosia psyllostachya*: *Carduo acanthoidis*-*Ambrosietum psyllostachyae* has been described [20].
- (iii) *Cyclachaena xanthiifolia*. Today, this is one of the most aggressive invasive species, with an unstable secondary area in the South Urals. It has spread along highways and railways extremely quickly and has begun naturalization in the flood plains of rivers. The main centers of the invasions are the steppe zone in the south of the Cis-Urals and the Trans-Urals. The species is typical for communities belonging to the *Stellarietea mediae* class and forms phytocenosis associated with *Ivaetum xanthiifoliae* [21].
- (iv) *Hordeum jubatum*. One of the more aggressive invasive species in the RB, this has a high level of adaptability and the ability to resettle: invasive populations have been noted in all natural zones of the territory concerned [17]. The area has not stabilized and has expressed a progressive tendency. The species has settled in large quantities in steppe pastures around settlements in the south of the Trans-Urals. The species' high resistance to soil salinization allows it to occupy natural halophytic habitats. Communities dominated by this species belong to the *Polygono arenastri-Poëtea annuae* and *Scorzonero-Juncetea gerardii* classes.
- (v) *Xanthium albinum*. This species has a wide stabilized secondary area in the RB. In the Cis-Urals, *Xanthium albinum* is almost everywhere, although it is slightly rarer in the Trans-Urals and the RB's mountain and forest zones. The species has quite widely naturalized in settlements with nitrophilous substrates, in the flood plains of rivers, in moist riverbed habitats and coastal sands. The species has 2 types of derivate community, which are dated in terms of the different types of habitats: *Xanthium albinum* [*Stellarietea mediae*] and *Xanthium albinum* [*Potentillion anserinae*/*Bidentetea tripartitae*,21].

- (vi) *Acer negundo*. This was initially introduced at the beginning of the 20<sup>th</sup> century as decorative wood culture: subsequently, it was widely settled throughout a large portion of the RB. The secondary area of the species shows a tendency toward further expansion, especially in the flood plains of rivers. Within the republic, it has spread widely into settlements and roadsides: it has demonstrated prolific self-sowing in various sinantropic habitats. Spontaneous wood plantings with the participation of *Acer negundo* have been described as an independent unit (the *Acerion negundae* union of the *Robinietea* class). In natural communities, the species has actively naturalized in the inundated woods belonging to the *Salicetea purpureae* class.
- (vii) *Elodea canadensis*. This species has a stabilized secondary area within the RB. It has naturalized in practically all types of water objects – from rivers and lakes to technogenic reservoirs in various natural zones. To a lesser extent, one can find it in mountain and forest zones. Typical communities with domination of species carry to *Elodeetum canadensis* association of *Potametea* class. It has been noted that *Elodea canadensis* is found in practically all syntaxa of water vegetation: this suggests the considerable phytocenotic amplitude of the species [22].
- (viii) *Echinocystis lobata*. This is an invasive species with a progressively expanding secondary area in the RB: it has spread widely along the rivers and streams of the RB and can be found in coastal thickets. It generally forms extensive populations. On the banks of the steppe rivers of the Cis-Urals, cases have been noted of osier-beds drying out: this is because their development is fully suppressed by this invasive species. It is rarely found in boreal and forest zones or in the northern part of the Trans-Urals [17]. Coenosis with domination of species are considered by as derivate community *Echinocystis lobata* [*Convolvuletalia sepium*] of *Galio-Urticetea* class.
- (ix) *Bidens frondosa*. This species is one of the most dynamically settled invasive species in the RB. It is mainly found near the middle and lower courses of the River Belaya and its inflows (the Dyoma and Ufa rivers) [17]. The species easily naturalizes in moist broken habitats. It will continue to spread. Communities with domination of species in RB are carried to *Bidens frondosa* variant of *Polygonetum hydropiperis* association of *Bidentetea tripartitae* class [23].
- (x) *Heracleum sosnowskyi*. The resettlement of this dangerous invasive species in the northwest of the RB has caused concern: as such, it has been included in the list of species with invasive status (1) [17]. In the majority of habitats, the species

naturalizes in coastal meadows and among nitrophilous communities along rivers, although it can also be found along roads. Similar shady nitrophilous communities along reservoirs are described as *Urtica dioicae-Heracleetum sosnowskyi* association.

### 3.4. Population aspects

The generalized results of the conducted research devoted to some species in the invasive groups (1) and (2) are given in the following table. One can see that these invasive species are powerful, highly competitive weed plants. Upon introduction into communities, they quickly take the lead positions and dominate, making up between 50% and 99% of plant life. The density of the herbage of the invasive species is high (in most cases, more than 100 escapes; in separate cenopopulations, over 1,000 escapes/1 m<sup>2</sup>). Many of these invasive species have a large biomass, from 1 to 6 kg/m<sup>2</sup>.

TABLE 1: Some characteristics of invasive neophytes in the RB.

Species	Number of the studied populations	Height, cm	Number of plants/ escapes on 1 m <sup>2</sup> piece	Elevated biomass of invasive species, kg/m <sup>2</sup> (crude weight)	Share in community, %
<i>Ambrosia trifida</i>	56	120–190	30–950	1.3–5.3	49–99
<i>Ambrosia psyllostachya</i>	7	20–50	180–600	0.1–0.9	31–93
<i>Bidens frondosa</i>	11	30–140	10–190	0.1–1.8	20–90
<i>Cyclachaena xanthiifolia</i>	57	140–220	40–1000	1.8–6.5	46–98
<i>Helianthus tuberosus</i>	2	150–250	70–100	2.2–2.7	90–100
<i>Heracleum sosnowskyi</i>	3	150–250	1–10	1.2–2.1	69–88
<i>Hordeum jubatum</i>	32	15–50	350–800	0.2–0.7	50–70
<i>Lupinus polyphyllus</i>	8	80–110	4–10	0.4–1.0	70–85
<i>Solidago canadensis</i>	8	100–140	20–90	0.9–2.8	80–95
<i>Xanthium albinum</i>	15	20–90	5–100	0.3–2.3	18–95

**Source:** Authors' own work.

Analysis of the most aggressive invasive plant species in the RB shows that most of them – tall one-year or long-term species, with the high growth rate and biomass, other weed and native plants overtaking on these indicators. Some species from this

group, however, form dense thickets at the expense of the system of branched rhizomes (*Ambrosia psyllostachya*) or numerous seed posterity (*Hordeum jubatum*) in conditions where herbage is rarefied as a result of anthropogenic disturbances. The potential for the further distribution of these species across the region and the occupation of new territories is enormous.

## 4. Conclusion

The emergence and rapid resettlement of new invasive species in the South Urals is a current environmental problem, as these species form almost monodominant communities, force out native species and reduce the quality of forage and the efficiency of pastures. The universal introduction and naturalization of aggressive alien species leads to changes in existing vegetable communities on grown poor replacing (derivate): the expressed domination of alien species has an adverse effect on the region's biodiversity. Besides, the injuriousness of invasive species is defined by the allergenicity of pollen (for example, all species of *Ambrosia*, *Cyclachaena*, etc.): this presents a serious threat to the health of the population. Further monitoring and the development of control methods for current invasion centers are necessary [24, 25].

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