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Article

Features of flora species composition in communities with *Acer negundo* in Kuzbass

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Abstract. The article presents the study results of the species composition of vascular plants in phytocenoses with *Acer negundo* located in the mountain-taiga and forest-steppe zones of Kemerovo Oblast. We have identified 41 species of vascular plants from 36 genera and 17 families. Under the canopy of *A. negundo*, ruderal species (*Cirsium setosum*, *Elytrigia repens*, *Urtica dioica*) prevailed, however, beyond this zone the number of meadow species (*Achillea millefolium*, *Dactylis glomerata*, *Festuca pratensis)* increased. Species diversity in the plant communities with box elder involvement was on average 55% lower than in those where this species was absent. In the mountain-taiga and forest-steppe zones, species diversity of plants declined by 1.7 and 2.8 times, respectively.

Keywords: box elder, projective cover, phytogenic zones, invasion, transformation of plant communities

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Научная статья

Особенности видового состава флоры в фитоценозах с участием *Acer negundo* в Кузбассе

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Аннотация. В статье представлены результаты изучения видового состава сосудистых растений в фитоценозах с участием *Acer negundo*, расположенных в горно-таежной и лесостепной зонах Кемеровской области. Выявлено присутствие 41 вида сосудистых растений из 36 родов и 17 семейств. Под пологом *A. negundo* преобладали рудеральные виды – *Cirsium setosum*, *Elytrigia repens*, *Urtica dioica*, тогда как во внешних зонах возрастало количество луговых видов – *Achillea millefolium*, *Dactylis glomerata*, *Festuca pratensis*. Видовое разнообразие в сообществах с участием клена ясенелистного было в среднем на 55% ниже, чем в растительных сообществах без данного вида. В горно-таежной и лесостепной зонах видовое разнообразие уменьшилось в 1.7 и 2.8 раза соответственно.

Ключевые слова: клен ясенелистный, проективное покрытие, фитогенные зоны, инвазия, трансформация растительных сообществ

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Introduction

A high-rate expansion of alien plant species and displacement of native plants from natural communities may occur when invaders are introduced to new regions under favorable conditions. These are so-called invasive species. Among them is the box elder *Acer negundo* L., which penetrates into Siberia ecosystems and transforms their structure and functioning. In Kuzbass, its spread began in the middle of the 20th century mainly due to the box elder use as an adornment plant in urban landscaping and in creation of shelter forests for agroforestry nurseries. Currently, *A. negundo* is included in the Black Book of the Siberian Flora (Chernaya kniga..., 2016).

Due to high productivity and germination of seeds, box elder became an absolute dominant in many regions already at the initial stage of succession owing to the formation of dense plantations and active displacement of native species (Gusev et al., 2017). In addition to the increased reproductive capacity, *A. negundo* deserves praise for its high biological productivity and full adaptability to harsh conditions in the secondary range, high growth rate, resistance to local pests and pathogens, and plant growth inhibitors released into the environment (Saksonov, 2018; Porte et al., 2011; Zhao et al., 2020). Box elder forms the degraded (depleted) communities thus providing a drop out of many species from the natural flora composition, including native plants, which have moved from their natural habitats to the areas associated with human economic activity (arable lands, crops, plantings, pastures, etc.). However, to date, such changes in the structure of the box elder-involved communities have been studied insufficiently. We have 'pioneered' such a study in Kemerovo Oblast.

The aim of this work is to identify the features of the species composition of the vascular plants flora in phytocenoses with *A. negundo* in various landscape zones of Kuzbass.

Materials and methods

The objects of the study are plant communities with the *A. negundo* participation. The have studied two sites in different zones of forest ecosystems of Kemerovo Oblast:

- a site of the mountain-taiga zone − Tashtagol urban-type settlement of the Mountain Shoria located in the mountain-taiga zone, in the south of Kemerovo Oblast (N 52°45'56" E 87°53'21");
- a site of forest-steppe zone – Kemerovo city, the administrative center of Kuzbass situated in the forest-steppe zone of the Kuznetsk Basin, in the southeast of Kemerovo Oblast (N 55°21'55" E 85°09'45").

The climate of the study area is sharply continental with long cold winters and short, but hot summers. The average annual air temperature varies from −14° to +10 °C. In the Mountain Shoria, which occupies a southern part of Kemerovo Oblast, the average annual air temperature is lower than in the forest-steppe zone of the Kuznetsk Basin. For instance, in Tashtagol it makes up −0.4 °C, while in Kemerovo +0.4 °C. On average, last spring frosts in the Kuznetsk Basin fall on the 3^{d} decade of April – 1st decade of May, and in the Mountain Shoria – on the 3^{d} decade of May – 1st decade of June. The relief type is largely responsible for uneven distribution of precipitation. In the Kuznetsk Basin, the average annual precipitation fluctuates from 43 to 63 mm, in the Mountain Shoria – from 71 to 86 mm.

The floristic composition of the communities was studied in places within the projective cover of *A. negundo* crowns, whereas the sites beyond served as controls.

The standard method (Lavrenko and Korchagin, 2013) was applied to floristic descriptions of the community composition. In sites under study, we recorded the species composition and projective cover in the communities with *A. negundo*. In the herbaceous layer, a species having a projective cover above 60% was considered dominant, and 15–25% – subdominant. For ranking a projective cover of species, we employed the scale by B.M. Mirkin et al. (1989). Floristic data were processed with the use of the Integrated Botanical Information System (IBIS) developed by A.A. Zverev (Zverev, 2007). The taxa nomenclature is given in accordance with The International Plant Names Index (http://www.ipni.org/).

Results and discussion

In the studied plots, the plantation structure is of a mosaic type, the area of the massif with box elder reaches 15–30% of the total area, the trees age is 25–30 years and their average height in stands – 12–14 m. Trees develop a spreading crown of 10–12 m in diameter. A living ground cover consists of a forb-grass community with the total projective cover of 20–85%.

In sites under study, 41 species of vascular plants from 36 genera and 17 families were identified. In terms of species number, the families Asteraceae, Fabaceae and Poaceae prevailed. Previous studies of species diversity of vascular plants in the box elder communities are evidence of significant reduction in plant diversity because of invasion (Abramova et al., 2019, 2022; Golovanov and Abramova, 2022; Gusev et al., 2017; Emelyanov and Frolova, 2011; Eremenko, 2014; Kostina et al., 2015; Lanta et al., 2013; Veselkin and Dubrovin, 2019). Our results obtained in Kuzbass confirm this conclusion and suggest that in the communities dominated by *A. negundo* the species number of plants declines by 55% on average, as compared to the control sites. In the communities of the mountain taiga zone, species diversity drops by 1.7 times, whereas in the forest-steppe zone – by 2.8 times. Such a reduction in species number of plants recorded under *A. negundo* crowns is presumably associated with the conditions formed under the invader's canopy.

In the mountain-taiga and forest-steppe zones, the species spectrum of the herbaceous layer in phytocenoses with *A. negundo* is represented by forest, meadow, ruderal, and meadow-steppe components. Single representatives of meadow-steppe species found in herbage are accidental and, therefore, there is no sense to discuss the related data in this paper.

The proportion (33–45%) of ruderal species, with the prevalence of *Cirsium setosum*, *Elytrigia repens*, *Urtica dioica*, was significant in the under-crown space of *A. negundo* of the studied plots. In the outer zones, the number of meadow species greatly increased – by an average of 40%. Here, the dominants were *Achillea millefolium*, *Dactylis glomerata*, *Festuca pratensis*. The number of forest species in the communities with the presence of the invasive species was on average less than 10%.

In the studied site of the mountain-taiga zone (Kemerovo Oblast), 25 species of vascular plants were encountered (Table 1). Species from the family Asteraceae prevailed. The dominants in the herbaceous layer were *Dactylis glomerata* and *Taraxacum officinale*, while subdominants – *Achillea millefolium*, *Elytrigia repens* and *Veronica chamaedrys*. Under the *A. negundo* crown zone, 11 species of higher plants, with the meadow species *Dactylis glomerata* (65%) in the lead, were discovered. The projective cover of *Urtica dioica* and *Veratrum lobelianum* was under 10%, for other speciesit made up less than 1%. In the outer zone, 19 plant species were discovered. The height of the herbaceous layer reached 15–40 cm. *Taraxacum officinale* and *Achillea millefolium* dominated.

A total of 27 vascular plant species were identified in the forest-steppe zone (Table 2). Species from the families Asteraceae and Poaceae were most common. In the under-crown zone of *A. negundo*, we encountered nine plant species with the ruderal species *Urtica dioica* (65%) as a dominant. In the outer zone, we detected 25 plant species. Among them, the share of meadow species, with the predominance of *Dactylis glomerata*, *Festuca pratensis*, *Galium boreale*, exceeded 60%. Among ruderal species, *Elytrigia repens*, *Cirsium setosum*, *Urtica dioica*, and *Taraxacum officinale* were most common. Other species were represented singly**.**

A characteristic feature of the studied plots was the depressed state of the grass layer (average height less than 30 cm) under the crown of the invasive species. In the external zone, the higher grass layer (up to 40–50 cm) was formed. The number of species in the outer zone was twice as much than in the communities located under the canopy of box elder. We did not find significant differences in the species composition between the study sites of the mountain-taiga and forest-steppe zones. Listed in the Red Book of Kuzbass *Erythronium sibiricum* was noted in the plant community of the Mountain Shoria (Krasnaya kniga..., 2021).

Table 1. The species composition of studied vascular plants from the mountain-taiga zone of Kuzbass. Projective cover of species: + – up to 1%; I – from 2 to 5%; II – 6–15%; III – 16–25%; IV – 26–50%; V – 51–100%; "–" – the species was not found.

Species	Family	Projective cover	
		Phytocenosis with *A. negundo*	Control
*Achillea millefoliu*m L.	Asteraceae	–	III
Aconitum septentrionale Koelle	Ranunculaceae	+	–
Amoria hybrida (L.) C. Presl	Fabaceae	+	–
Arctium lappa L.	Asteraceae	+	–
Barbarea vulgaris R. Br.	Brassicaceae	–	+
Bunias orientalis L.	Brassicaceae	–	+
Chelidonium majus L.	Papaveraceae	+	–
Cirsium vulgare (Savi) Ten.	Asteraceae	+	–
Corydalis bracteata (Steph. ex Willd.) Pers.	Fumariaceae	–	I
Dactylis glomerata L.	Poaceae	V	+
Elytrigia repens (L.) Nevski	Poaceae	+	II
Erythronium sibiricum (Fisch. et C.A. Mey.) Krylov	Fumariaceae	–	+
Galium verum L.	Rubiaceae	–	+
Geranium sibiricum L.	Geraniaceae	–	+
Leucanthemum vulgare Lam.	Asteraceae	–	+
Melilotus albus Medikus	Fabaceae	–	+
Plantago lanceolata L.	Plantaginaceae	–	+
Plantago media L.	Plantaginaceae	–	II
Poa supina Schrad.	Poaceae	+	I
Ranunculus repens L.	Ranunculaceae	–	+
Rumex longifolius DC.	Polygonaceae	–	+
Taraxacum officinale F.H. Wigg.	Asteraceae	+	V
Urtica dioica L.	Urticaceae	I	+
Veratrum lobelianum Bernh.	Melanthiaceae	I	–
Veronica chamaedrys L.	Scrophulariaceae	–	II

Table 2. List of studied vascular plant species from the forest-steppe zone of Kuzbass. Designations are given as in Table 1.

Species	Family	Projective cover	
		Phytocenosis with *A. negundo*	Control
Achillea millefolium L.	Asteraceae	–	II
Agrostis gigantea Roth	Poaceae	–	I
Angelica sylvestris L.	Apiaceae	–	I
Amoria hybrida (L.) C. Presl	Fabaceae	–	+
Arctium tomentosum Mill.	Asteraceae	+	+
Artemisia vulgaris L.	Asteraceae	–	I
Chelidonium majus L.	Papaveraceae	–	+
Cirsium vulgare (Savi) Ten.	Asteraceae	–	+
Cirsium setosum (Willd.) Besser	Asteraceae	I	I
Dactylis glomerata L.	Poaceae	+	V
Elytrigia repens (L.) Nevski	Poaceae	–	II
Festuca pratensis Huds.	Poaceae	–	II
Galium boreale L.	Rubiaceae	+	II
Glechoma hederacea L.	Lamiaceae	I	–
Lathyrus pratensis L.	Fabaceae	–	I
Leucanthemum vulgare Lam.	Asteraceae	–	I
Melilotus officinalis (L.) Pall.	Fabaceae	–	I
Oberna behen (L.) Ikonn.	Caryophyllaceae	I	+
Phleum phleoides (L.) H. Karst.	Poaceae	–	I
Plantago media L.	Plantaginaceae	–	II
Prunella vulgaris L.	Lamiaceae	–	I
Stellaria graminea L.	Caryophyllaceae	–	I
Tanacetum vulgare L.	Asteraceae	–	+
Taraxacum officinale F.H. Wigg.	Asteraceae	+	III
Urtica dioica L.	Urticaceae	V	I
Veratrum lobelianum Bernh.	Melanthiaceae	I	–
Vicia cracca L.	Fabaceae	–	I

Conclusion

In phytocenoses with box elder located in the mountain-taiga and forest-steppe zones of Kuzbass, 41 species of vascular plants with the predominance of ruderal species (*Cirsium setosum*, *Elytrigia repens*, *Urtica dioica*) in the under-crown space of *A. negundo* were identified. The outer zones demonstrated the increase in proportion of meadow species (*Achillea millefolium*, *Dactylis glomerata*, *Festuca pratensis)*. It was found that in the communities with *A. negundo* involvement the species diversity of vascular plants was on average 55% lower, as compared to that in sites not invaded by alien species.

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