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Alien and invasive plant species in plant communities of floodplain forests of the Małopolska Upland

Obce oraz inwazyjne gatunki roślin w zbiorowiskach lasów łęgowych Wyżyny Małopolskiej

SUMMARY

During the field studies on the floodplain forests of the Małopolska Upland carried out in 2009–2013, the author tried to determine which species of alien and invasive plants could be a threat to the stability of these vegetation communities. Efforts were also made to answer the question, which floodplain forests are particularly vulnerable to the penetration of alien species and in which layers of the forest plant community are the best conditions for the development of the individual alien plant species. During the research, a total number of 344 reléves were made, of which 90 recorded the presence of alien species. The most common were: *Impatiens parviflora*, *Acer negundo* and *Padus serotina*. The highest percentage of reléves involving alien species was found in the riverside floodplain forests of *Salicetum albo-fragilis* and *Populetum albae*.

Keywords: invasive alien plant species, floodplain forests, Małopolska Upland

STRESZCZENIE

Podczas prac terenowych poświęconych szacie roślinnej lasów łęgowych Wyżyny Małopolskiej przeprowadzonych w latach 2009–2013, autor podjął próbę określenia, jakie gatunki roślin obcych oraz inwazyjnych mogą stanowić zagrożenie dla tych zbiorowisk roślinnych. Starano się również dać odpowiedź na pytanie, które zespoły lasów łęgowych są szczególnie podatne na wnikanie gatunków obcych oraz w jakich warstwach leśnego zbiorowiska roślinnego znajdują warunki do rozwoju poszczególne obce gatunki roślin. W ramach prac badawczych wykonano 344 zdjęcia fitosocjologiczne, spośród których w obrębie 90 powierzchni zanotowano występowanie gatunków obcych. Do najczęściej spotykanych należały: *Impatiens parviflora*, *Acer negundo*

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oraz *Padus serotina.* Największy odsetek zdjęć z udziałem gatunków obcych stwierdzono w fitocenozach nadrzecznego łęgu wierzbowego *Salicetum albo-fragilis* oraz nadrzecznego łęgu topolowego *Populetum albae*.

Słowa kluczowe: obce inwazyjne gatunki roślin, lasy łęgowe, Wyżyna Małopolska

INTRODUCTION

Invasions of alien species is now considered one of the most important problems of nature conservation on a global scale (11), which also has an increasing impact on the economic function of forests (17). Based on field studies on the floodplain forests of the Małopolska Upland, the presented work is an attempt to determine which species of alien and invasive plants could be a threat to the stability of these vegetation communities. Efforts were also made to answer the question, which communities of the floodplain forests are particularly vulnerable to the penetration of alien species and in which layers of the forest plant community create the conditions for the development of individual alien plant species.

Floodplain forests are a specific type of vegetation associated primarily with the valleys of watercourses. These communities were the subject of several monographs in Poland and among them are mentioned works by: Matuszkiewicz et al. (24), Faliński (9), Kasprowicz and Wojterska (16), Matuszkiewicz (22, 23). The floodplain forests of the Małopolska Upland areas currently do not have a collective monography, and information about them can be found in among others works by: Barański et al. (1), Fabijanowski and Zarzycki (7, 8), Głazek (12, 13, 14), Bróż, (3), Różański (33), Hereźniak (15) and Przemyski (29, 30, 31). There is also no separate research dedicated to participation and role of invasive alien species as a component of floodplain forests.

STUDY AREA, MATERIALS AND METHODS

The field studies were carried out between 2009 and 2013. The works included the entire area of the Małopolska Upland within the borders set by Kondracki (20). The research included, among other things, the valleys of the main rivers flowing through the area such as: the Pilica, Nida, Kamienna, Warta and Vistula.

In total, 344 reléves were made. The reléves were made for the characterisation of plant communities in floodplain forests. Next, an analysis on the prevalence of alien and invasive species was carried out on the entire phytosociological database.

A description of vegetation has been prepared in accordance with the methodology presented by Braun-Blanquet (2). The selection of research areas was made after earlier analysis of forest site types, soil and water conditions in the Małopolska Upland forests, using documents such as forest management plans, and available layers of digital maps [GIS] containing information about the diversity of vegetation. The nomenclature of species was accepted following Mirek et al. (25) and forest communities – Matuszkiewicz (23). The invasive alien species were considered according to the proposal of Tokarska-Guzik et al. (37).

RESULTS

As a result of phytosociological research, five floodplain forest associations were determined: *Ficario-Ulmetum minoris* Knapp 1942 em. J. Mat. 1976, *Fra-*

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xino-Alnetum W. Mat. 1952, *Carici remotae-Fraxinetum* Koch 1926, *Salicetum albo-fragilis* Tx. 1955 and *Populetum albae* Br.-Bl. 1931. In addition, the secondary forest communities (*Alnus glutinosa-Rubus idaeus*, *Alnus glutinosa-Urtica dioica*) related to floodplain forests (26, 27), as were indicated.

In all the floodplain forest communities, the presence of alien and invasive species has been identified. Among the 344 relèves, 90 recorded the presence of alien species (Fig. 1), which is 26% of all localities.

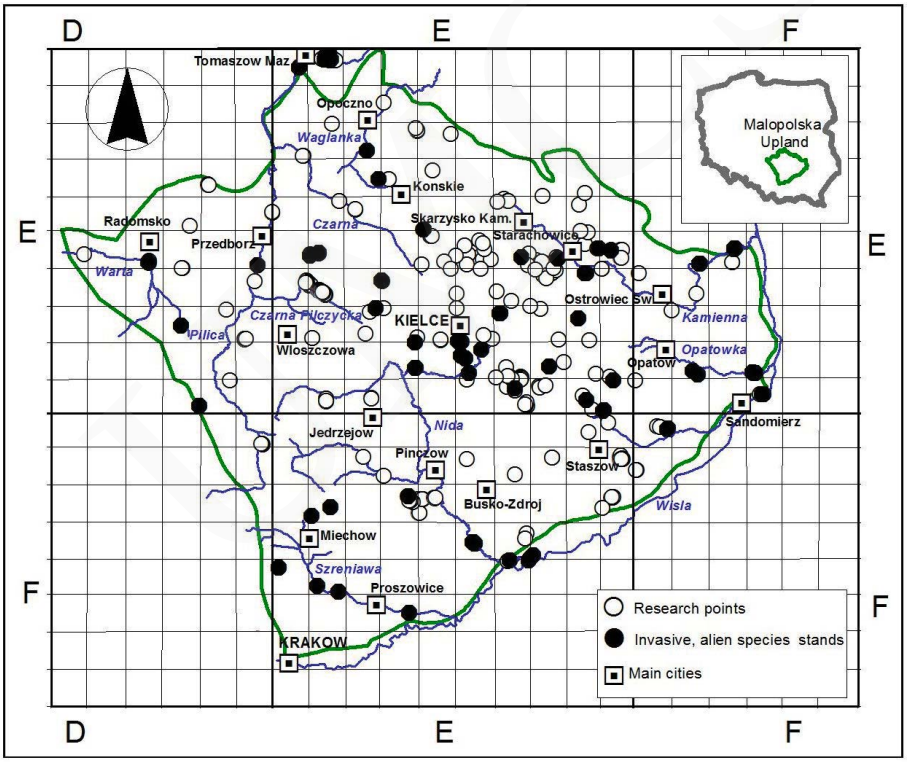


Fig. 1. Location of the study sites and sites of alien and invasive species in floodplain forests comprising in the boundary of the Małopolska Upland within the ATPOL grid [10 km x 10 km].

In total, 15 alien and invasive species of vascular plants were found (Tab. 1). Among the described plants are the following forms: nine species of trees, one shrub species, one species of climbers, two species of perennials and two species of annual plants. The majority of alien species habitats were near the banks of rivers and watercourses. The occurrence of alien species was quite often reported also within small forest patches separated from the major forest areas.

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Tab. 1. Alien and invasive species in communities of floodplain forests of the Malopolska Upland.

No.	Latin name of species	Family	Geographical -historical group	Current status	Number of sites [in relévés]
1.	*Acer negundo* L.	*Aceraceae*	Kn	invasive	16
2.	*Aesculus hippocastanum* L.	*Hippocastanaceae*	Kn	-----	3
3.	*Fraxinus pennsylvanica* Marshall	*Oleaceae*	Kn	invasive	1
4.	*Impatiens glandulifera* Royle	*Balsaminaceae*	Kn	invasive	2
5.	*Impatiens parviflora* DC.	*Balsaminaceae*	Kn	invasive	53
6.	*Juglans regia* L.	*Juglandaceae*	Kn	-----	2
7.	*Malus domestica* Borkh.	*Rosaceae*	Kn	-----	2
8.	*Padus serotina* [Ehrh]. Borkh.	*Rosaceae*	Kn	invasive	10
9.	*Parthenocissus inserta* [A. Kern] Fritsch	*Vitaceae*	Kn	invasive	2
10.	*Pyrus communis* L.	*Rosaceae*	Kn	-----	4
11.	*Quercus rubra* L.	*Fagaceae*	Kn	invasive	2
12.	*Robinia pseudacacia* L.	*Fabaceae*	Kn	invasive	2
13.	*Solidago canadensis* L.	*Asteraceae*	Kn	invasive	5
14.	*Solidago gigantea* Aiton	*Asteraceae*	Kn	invasive	8
15.	*Symphoricarpos albus* [L.] S.F. Blake	*Caprifoliaceae*	Kn	-----	1

Kn – kenophyte

The most common invasive species was *Impatiens parviflora*, which appeared in 53 relévés. The species also relatively frequent were: *Acer negundo*, *Padus serotina, Solidago gigantea* and *Solidago canadensis*.

Impatiens parviflora was most often found species in a community of *Fraxino-Alnetum* [28 localities] and *Ficario-Ulmetum minoris* [18 localities]. The second, in terms of the number of localities is *Acer negundo*, occurring mainly in *Salicetum albo-fragilis* and *Populetum albae.* In addition, *Acer negundo* was found quite frequently within a community of *Ficario-Ulmetum minoris*.

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Taking into account the percentage of the area affected by alien species in different communities (Tab. 2), it can be observed that the most common finding alien and invasive species [92% – 100% of the reléves in phytocoenosis] relate to

Tab. 2. Relation of occurrence of alien and invasive species and the communities of floodplain forests [number of sites in the associations].

No.	Invasive alien species	*Fraxino-Alnetum*	*Carici remotae-Fraxinetum*	*Ficario-Ulmetum minoris*	*Salicetum albo-fragilis*	*Populetum albae*	*The secondary communities*
1.	*Acer negundo* L.	1	-	7	2	6	-
2.	*Aesculus hippocastanum* L.	1	-	2	-	-	-
3.	*Fraxinus pennsylvanica* Marshall	1	-	-	-	-	-
4.	*Impatiens glandulifera* Royle	-	-	-	-	-	2
5.	*Impatiens parviflora* DC.	28	3	18	-	4	-
6.	*Juglans regia* L.	-	-	-	-	2	-
7.	*Malus domestica* Borkh.	2	-	-	-	-	-
8.	*Padus serotina* [Ehrh]. Borkh.	7	-	3	-	-	-
9.	*Parthenocissus inserta* [A. Kern] Fritsch	-	-	2	-	-	-
10.	*Pyrus communis* L.	3	-	1	-	-	-
11.	*Quercus rubra* L.	1	1	-	-	-	-
12.	*Robinia pseudacacia* L.	-	-	1	-	1	-
13.	*Solidago canadensis* L.	1	-	3	-	-	1
14.	*Solidago gigantea* Aiton	2	1	-	2	3	-
15.	*Symphoricarpos albus* [L.] S.F. Blake	1	-	-	-	-	-
Total number of reléves in association:		246	12	62	3	12	9
Number of reléves with invasive alien species in association:		41	5	27	3	11	3
Percentage (%) of reléves with invasive alien species in association:		17	42	44	100	92	33

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communities *Salicetum albo-fragilis* and *Populetum albae*. The average percentage [33% – 44% of all reléves] falls into the communities of *Ficario-Ulmetum minoris*, *Carici remotae-Fraxinetum* and secondary forest communities. The most frequent community in this study of *Fraxino-Alnetum,* is the subject of invasions, relatively to say the least, because the percentage of reléves with the participation of alien species is only about 17% in the total number of the studied locations.

Taking into account the presence and coverage of various alien species of trees and shrubs in forest layers – it should be noted that the highest degree of expansiveness had *Acer negundo* (Tab. 3). This species is encountered in all layers, from the herb one, to the canopy and reaching a maximum coverage of 20%. Another tree species with a relatively high degree of expansiveness is *Padus serotina*, and is present in herb and shrubs layers with a maximum coverage up to 30%. It should be noted, however, that this species did not occur in the tree layer. In addition, low levels of coverage listed in the herb layer may indicate a difficult sowing of *Padus serotina* in floodplain forests, which probably is connected with inadequate habitat conditions for this species.

Among herbaceous species, the greatest cover is up to 60% and is achieved locally by *Impatiens glandulifera*. This plant, however, was recorded in only two reléves. Definitely more frequent in the herb layer are alien invasive species, such as *Impatiens parviflora* and *Solidago canadensis*, which reach up to 40% coverage. These species are extremely affected by the physiognomy of the herb layer for floodplain forest communities. However, there is no evidence that these plants form within the surveyed area of clear single-species aggregations.

DISCUSSION

Research carried out within the flood forest communities of the Małopolska Upland, confirms the thesis of other authors (10, 21, 39), which indicate riverine habitats as particularly vulnerable to invasions of alien species. The spread of these species in the riverine alluvial forests is often associated with the thinning of plant communities, as well as with the presence of many routes, which was observed by the author in the valleys of the Warta, Pilica, Nida and Opatówka.

Studies conducted in the Małopolska Upland indicate, like the other works (18), that the *Fraxino-Alnetum* as a community is relatively mostly resistant to the penetration of alien and invasive species. The factors limiting processes of invasion are undoubtedly strong shading, variable moisture and less human impact caused by the unavailability of these forests. This association has the relatively smallest degree of degradation in comparison with other communities of floodplain forests. It can therefore be assumed, that a stable community of *Fraxino-Alnetum,* has a high degree of resistance to the expansion of alien species.

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Tab. 3. Alien and invasive species in layers of the floodplain forest communities.

No.	Invasive alien species in layers	Layers	Cover min. %	Cover max. %	Cover aver. %
Trees and shrubs					
1	*Acer negundo* L.	A1	1	20	9
		A2	1	20	11
		B	1	20	7
		C	1	5	2
2	*Aesculus hippocastanum* L.	A2	-	1*	-
		B	-	1*	-
		C	-	1*	-
3	*Fraxinus pennsylvanica* Marshall	A2	-	20*	-
4	*Juglans regia* L.	A2	-	1*	-
		B	-	1*	-
5	*Malus domestica* Borkh.	A2	-	1**	-
6	*Padus serotina* [Ehrh]. Borkh.	B	1	30	5
		C	1	1	1
7	*Pyrus communis* L.	B	1	1	1
		C	-	1*	-
8	*Quercus rubra* L.	B	-	1**	-
		C	-	1*	-
9	*Robinia pseudacacia* L.	B	-	1*	-
10	*Symphoricarpos albus* [L.] S.F. Blake	B	-	15*	-
Herbaceous plants, climbers					
11	*Impatiens glandulifera* Royle	C	15*	60*	-
12	*Impatiens parviflora* DC.	C	1	40	9
13	*Parthenocissus inserta* [A. Kern] Fritsch	C	1*	15*	-
14	*Solidago canadensis* L.	C	1	40	13
15	*Solidago gigantea* Aiton	C	1	15	7

* 1 stand; ** 2 stands

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A species, which is a significant threat to the natural structure of floodplain forest communities, is *Acer negundo*, and can be found in the Małopolska Upland habitat conditions similar to those that occur in the natural range in North America (4). Its presence in all layers of the forest community is noted especially in the riverine alluvial forests. This species, in extreme cases, changes the physiognomy of the landscape of river valleys, as observed by the author in the Opatówka, Szreniawa and Nida valleys. Another invasive species that can significantly modify the structure of floodplain forests is *Impatiens parviflora*. Together with *Acer negundo,* this species is potentially the greatest threat to the floodplain forests phytocoenoses of the Małopolska Upland.

All alien and invasive species found in floodplain forests of the Małopolska Upland were earlier reported by other authors from similar habitats (5, 6, 18, 19, 21, 28, 32, 34–36, 38). During the research conducted in the Małopolska Upland, no such invasive species as *Echinocystis lobata and Reyonutria spp* were found. This is in contradiction to facts being quite often reported from floodplain phytocoenoses by other authors (5, 18, 34). Limited possibilities for the spread of these taxons in the floodplain forests presented in this paper confirm the thesis put forward by the above authors, that these species spread intensively only in open areas or within heavily overexposed stands of forests. Their penetration into relatively dense, semi-natural phytocoenoses examined by the author is probably difficult.

CONCLUSIONS

1. The presence of alien and invasive species of vascular plants was confirmed in all types of floodplain forests in the Małopolska Upland.
2. Most susceptible to the processes of penetration of alien species are the following communities of riverside forests: *Salicetum albo-fragilis*, *Populetum albae*, and *Ficario-Ulmetum minoris.*
3. Alien species encountered most often in floodplain forests are: *Impatiens parviflora*, *Acer negundo*, and *Padus serotina*.
4. The greatest threat to the natural structure of floodplain forests are *Impatiens parviflora* and *Acer negundo* which can significantly disrupt the physiognomy of plant communities.
5. Phytocenosis most resistant to the penetration of alien species is *Fraxino-Alnetum*.

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