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NEW INVASIVE FOREST COMMUNITIES IN THE RIPARIAN FRAGILE HABITATS – THE CASE STUDY FROM RAMSAR SITE CARSKA BARA (VOJVODINA, SERBIA)

NOVE INVAZIVNE ŠUMSKE ZAJEDNICE POPLAVNIH OSJETLJIVIH STANIŠTA – STUDIJA SLUČAJA IZ RAMSARSKOG PODRUČJA CARSKA BARA (VOJVODINA, SRBIJA)

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Summary

The phytosociological investigation of habitats with highly invasive tree species *Acer negundo* L. and *Fraxinus pennsylvanica* Marshall was performed in Ramsar site Carska bara (Vojvodina, Serbia). A total of 107 species were noticed within 32 relevés. Recorded relevés are georeferenced and analysed in detail. The results of the relevant numerical analyses suggest the existence of two floristically and coenologically well defined groups of stands defined as the forest communities: *Rubo caesii–Aceretum negundi* ass. nova and *Carici otrubae–Fraxinetum pennsylvanicae* ass. nova. The increasing dispersal rate of the invasive trees is detected as a problem amongst many fragile wet habitats across Serbia and SE Europe, alerting their urgent and effective control.

KEY WORDS: invasive trees, *Acer negundo*, *Fraxinus pennsylvanica*, forest communities, wetland.

INTRODUCTION
UVOD

It is known that invasive alien species are the second risk factor of biodiversity endangering, right after habitat destruction (Brennan and Withgott, 2011). According to the European strategy on invasive alien species, they are one of the biggest challenges in the preservation of biodiversity in Europe (Genovesi and Shine, 2003). Negative consequences of the presence and spreading of the invasive species were analyzed by numerous authors (Elton, 1958; Drake et al., 1989; Di Castri et al., 1990; Williamson, 1996; Starfinger et al., 1998; Tilman, 1999; Parker et al., 1999; Hejda et al., 2009; Pyšek and Richardson, 2010). Threats to the autochthonous biodiversity and degradation of the natural habitats become the most prominent when the invasive species become naturalized and form stable communities. Field studies and experiments confirmed that the presence of the alien species can be a threat to the native species, primarily due to the negative effects of the competition (Vilà and Weiner,

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2004). This can lead to the homogenization of ecosystems and decrease in autochthonous species diversity (D'Antonio and Vitousek, 1992). In the final outcome, this can results in "novel ecosystems" (Hobbs et al., 2006; Hobbs et al., 2009). A large number of invasive plants are the trees (Binggeli, 1996).

Twenty three alien tree species have been identified in forest ecosystems in Serbia (Medarević et al., 2008), 17 of which are invasive (Grbić et al., 2007). Due to their aggressive expansion abilities, some of them represent a serious threat to the natural regeneration and survival of the native trees. This fact especially refers to *Robinia pseudoacacia* L., *Acer negundo* L., *Ailanthus altissima* (Miller) Swingle and shrub *Amorpha fruticosa* L. However, more precise data on the distribution of the invasive woody species in Serbia still do not exist, particularly the ones related to protected areas. Except for the few recent literature sources on the topic of alien or invasive plants or communities in Serbia (Vrbničanin et al., 2004; Jarić et al. 2011; Lazarević et al., 2012; Anačkov et al., 2013), the data related to the protected Ramsar areas are still lacking (Panjković and Stojšić, 2001; Čavlović et al., 2011).

In the light of the fragility and vulnerability, as well as the rarity of the wetlands (Smart, 1997), alarmingly large presence of highly invasive species was observed, some of which are highly naturalized, such as the North American trees: *Acer negundo* L. and *Fraxinus pennsylvanica* Marshall. The species *Acer negundo* was introduced to Europe in 17th century (Mędzycki, 2011), and *Fraxinus pennsylvanica* was introduced in 18th century (Csiszár and Bartha, 2008). Since then, they have spread across the Europe, especially in the riparian habitats (DAISIE, 2013).

Since the literature sources for our teritorry provided no data on the exact time two analyzed invasive species have arrived to Serbia we looked up for these information in neighboring Hungary, which covers the biggest part of the Pannonian plain, where our study area belongs.

After its introduction, *A. negundo* became quite a popular garden tree and in the second half of 19th century it was widely recommended for planting, as a wind-break and shelter-belt tree across the Western, Central and Eastern parts of Europe (Mędzycki, 2011). In Hungary, it has been known since the second half of the 19th century. It was widely planted on flood areas of the Great Plains from where it escaped and established on riparian forests and black locust plantations, mainly along the rivers (lower Danube valley), marshy areas near Lake Balaton, and also on dry sandy soils of the Pannonian Plain (Udvardy, 2008). *A. negundo* inhabit wet places, such as our study area in the northern Serbia.

F. pennsylvanica was known since the very beginning of the 20th century in Hungary, when there were attempts of converting willow-poplar gallery forests to hardwood stands by using the green ash. Nowadays, this species is widely present, and concentrated in lowland river valleys and marshy or saline areas in Hungary, some of which are close, or bordering Serbia (Tiborcz et al., 2011). *F. pennsylvanica* inhabit the same wet places, such as our study area in the northern Serbia.

According to Török et al. (2003) Hungary represents the gateway for invasions into the rest of the Central and Eastern Europe, and one of the corridors for invasions are precisely the wet habitats (gallery forests, disturbed bogs and marshes). Since our study area is a floodplain, suitable for *A. negundo* and *F. pennsylvanica*, we consider that analyzed invasive tree species could spread from Hungary to the northern Serbia across these corridors.

Despite all the negative impacts the invasive plant species can exibit, paradoxically, the level of the exploration of invasive plant communities, especially those dominated by woody species, is small. However, except for the ass. *Sambuco nigrae–Aceretum negundo* Exner 2004, described in the potential broad-leaved woodland areas of Austria (Exner and Willner, 2004), there are no other literature data on the communities built up by the two observed invasive woody species. Invasive species *Acer negundo* and *Fraxinus pennsylvanica* have established stable communities in the Special Nature Reserve Carska bara (Vojvodina, Serbia), which are analyzed and described in this paper.

MATERIALS AND METHODS
MATERIJALI I METODE

Study area – *Područje istraživanja*

The investigated area Carska bara is located on the alluvial plain between the rivers Tisa and Begej, in the central Banat (Vojvodina, Serbia), southwest of Zrenjanin city. It belongs to the UTM Grid zone 34T, UTM square 10x10 km DR50 and DR51 (**Figure 1**), presenting one of the preserved floodplains in this part of Serbia. According to the pedological map of Vojvodina (Naugebauer et al., 1971) and ArcGIS 10.2 Software, the alluvial saline soil is mostly present within the study area. The area belongs to the temperate climate zone with emphasized continental characteristics (Stevanović and Stevanović, 1995; Kovačev, 2010). Habitats are presented as the mosaic of the wetlands, ponds, (salt) marshes, wet meadows, steppes and forests, intersected by rivers, canals and dikes. Over 230 bird species (including all European heron species and cormorants), 17 of which are internationally important were recorded here (Puzović et al., 2009). Total of 277 taxa of the higher plants (on species and subspecies level) are noticed in the study area, two of which are the Pannonian endemics – *Aster tripolium* L. subsp. *pannonicus* (Jacq.) Soó and *Cirsium brachycephalum* Juratzka. Also some relict species of marshy flora and of

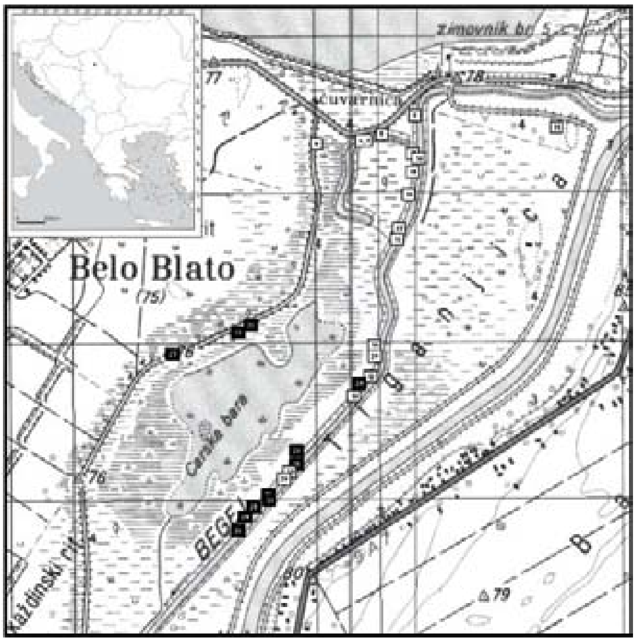

Figure 1. Map of Ass. *Rubo caesii–Aceretum negundi* ass. nova (white relevés' points) and Ass. *Carici otrubae–Fraxinetum pennsylvanicae* ass. nova (black relevés' points) in the study area Carska bara (Vojvodina, Serbia).

Slika 1. Karta Ass. *Rubo caesii–Aceretum negundi* ass. nova (bijelo označena polja) i Ass. *Carici otrubae–Fraxinetum pennsylvanicae* ass. nova (crno označena polja) u području istraživanja Carska bara (Vojvodina, Srbija).

xerothermic steppe flora are present within (Perić, 2010). Regarding the phytogeographical affiliation, the study area belongs to the Pannonian province of the Pannonian-Vlach subregion and the Pontic-Southsiberian floristic-vegetation region (Stevanović et al., 1999). The studied area is located in the wider area of the potential steppe and forest-steppe vegetation (Jovanović et al., 1986). The diversity of the habitats enables high species diversity, hence the variety of rare, endangered or vulnerable animals and plants could be found here. Because of these natural characteristics, Special Nature Reserve Carska bara is recognized as the area of the international importance, so it is included in the list of Ramsar sites, Important bird area (IBA), Important plant area (IPA), Emerald and ASCI area (Hlavati – Širka et al., 2013), which are of the particular importance for the conservation of nature.

Vegetation sampling – *Uzorkovanje vegetacije*

The phytosociological investigation of the selected riparian sites with the high presence of the invasive trees in the area of Carska bara (Vojvodina, Serbia) was conducted in the period 2011 – 2013. Thirty two relevés were made according to Braun – Blanquet (1964) methodology. The size of sampling plots was adjusted to the minimum areal size as proposed by Mueller – Dombois & Ellenberg (1974). It varied from 25 to 200 m^2 for wild growing forest sites, in average of 112.07 m^2. All data were georeferenced using a GPS device eTrex Vista C (Garmin). The plant material was deposited in the Herbarium of the University of Belgrade – BEOU (Theirs, 2014).

Data analysis – *Analiza podataka*

After the transformation of Braun – Blanquet combined alpha-numeric scale into a completely numerical scale as proposed by Van der Maarel (1979), the classification of phytocoenological relevés was done. In addition to our own 32 relevés, four relevés of association *Sambuco nigrae–Aceretum negundo* (from different localities of Austria: Karlhof, Pamhagen, Teichhof, District Neusiedl am See (Exner and Willner, 2004) were also included in the analysis and used for comparison. Relevés were classified using Jaccard (1928) similarity and group average clustering, for further coenological characterization and differentiation. All the analyses were done in PcOrd 6.0 software (Mccune and Mefford, 2011). The names of the newly described associations are harmonized with The International Code of Phytosociological Nomenclature (Weber et al., 2000), while the nomenclature and EUNIS codification of primary vegetation of riparian habitats is compliant with Davies et al. (2004).

In this paper we used the concept of dominant and diagnostic species proposed by Chytrý et al. (2002), Chytrý and Tichý (2003) and Tichý and Chytrý (2006). Fidelity was calculated for two target groups, distinguished in the cluster analysis i.e. those in which two mentioned woody invasive species were highly present. Using the statistical measures of fidelity, we quantified concentrations of species occurrences in groups of classified sites in order to determine diagnostic species (Chytrý et al., 2002). In order to determine dominant species, the coverage index (Ic) was calculated according to Lausi et al. (1982).

Species with Phi-coefficient values higher than 0.40 have been considered diagnostic. Species with cover ≥ 25% in a minimum 5% of the relevés for any association have been accepted as dominant.

Nomenclature of plant taxa, with a few exceptions, follows the Flora Europaea Database (Tutin et al., 2001). All taxa with authors' names quoted in the paper are given in the tables (**Table 1** and **Table 2**).

Table 1. Diagnostic table of new association *Rubo caesii–Aceretum negundi* ass. nova from SNR Carska bara in Serbia. (*holotypus)

Tablica 1. Dijagnostička tablica nove asocijacije *Rubo caesii–Aceretum negundi* ass. nova iz SRP Carska bara u Srbiji. (*holotip)

Life forms	Phytogeographical elements	UTM Grid zone 34T	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR50	DR50	DR51	DR51	Frequency (%)	Cover index according to Lausi et al. (1982) (Ic)	Fidelity index (Φ)
		Altitude (m)	75	75	75	75	75	74	74	74	74	74	74	75	75	75	75	78	75	73	75	76			
		Exposition	SE	SE	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/			
		Slope (°)	3	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
		General cover (%)	90	70	80	95	80	60	40	30	60	30	40	60	80	95	80	100	100	70	60	70			
		Tree layer cover (%)	10	/	80	40	80	50	40	30	60	30	30	20	30	/	80	70	50	70	/	60			
		Shrub layer cover (%)	10	70	20	10	20	60	40	30	5	30	40	10	50	20	50	30	90	40	/	/			
		Herb layer cover (%)	90	70	50	95	20	40	40	30	10	20	40	60	80	95	40	80	70	40	70	5			
		Relevé area (m^2)	25	30	100	25	100	100	50	50	100	50	25	50	50	25	100	100	200	100	100	200			
		Relevé number from cluster	5	6	8	7	9	13	15	16	17	18	14	19	20	21	30	11	22	23	10	12			
		Relevé No.[1]	1	2	3	4	5	6*	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
		Dominant taxa																							
P	ADV	*Acer negundo* L.	2	2	4	2	4	3	2	2	3	2	2	2	4	1	1	4	4	2	3	4	100	66,67	0,40
NP	EAz	*Rubus caesius* L.	2	2	2	1	1	2	1		1	1	1	1	2	3	2		3	+			80	37,22	0,26
		Diagnostic taxa																							
H	KOSM	*Dactylis glomerata* L.	2	3		4	+	r	1			+	2					+	1	+			55	22.22	0.44
P	EAz	*Fraxinus angustifolia* Vahl subsp. *oxycarpa* (Bieb. ex Willd.) Franco & Rocha Afonso						1	2	1	1	2	1				4	1					40	18.33	0.48
		Other taxa																							
G	SE	*Iris pseudacorus* L.				1		+	1	1	1	r		r	+	1	2		2		r		60	17.78	0.10
H	SE	*Symphytum officinale* L.	1		1	+		1	1	1			r	+	1			+	1				55	15.56	-0.08
H	EAz	*Poa trivialis* L.					+	+	r	r	+		r	+	r			2	+	+			55	11.67	0.24
H	HOL	*Urtica dioica* L.						2		2	1	1	1	+		2	1		2			+	50	20.00	-0.06
T	EAz	*Bromus sterilis* L.	+	1				+	r	r	r		r					1	+	+			50	10.00	0.32
P	ADV	*Fraxinus pennsylvanica* Marshall		2	2			2						r			2		+	3			35	16.67	-0.40
H	EAz	*Cirsium arvense* (L.) Scop.	+	+		1		r	r				1		1								35	8.33	0.26
H	EAz	*Arrhenatherum elatius* (L.) Beauv. ex J. & C. Presl						r	r	r			r					1	r	1			35	6.11	0.18
G	MED-SUBMED	*Aristolochia clematitis* L.	+	1		2	+									1				1			30	10.00	-0.08
P	ADV	*Prunus cerasifera* Ehrh.	r			+	r											+	1	2			30	7.78	0.13
H	EAz	*Arctium lappa* L.									+	1							1	+		1	25	7.22	0.36
H	HOL	*Festuca rubra* L.					r	r	r				+						r				25	3.33	0.07
G	KOSM	*Elymus repens* (L.) Gould		2		3	+											3					20	11.67	0.02
G	KOSM	*Phragmites australis* (Cav.) Trin. ex Steudel				1								r	3	2							20	8.89	-0.06
P	ADV	*Gleditsia triacanthos* L.			+						2		2									+	20	7.78	0.02
SH	HOL	*Humulus lupulus* L.												1	2		1					+	20	7.22	-0.19
HydG	EAz	*Carex riparia* Curtis						r	r				2					2					20	6.67	0.10
T	KOSM	*Galium aparine* L.								r						r			2			r	20	4.44	-0.19
T	HOL	*Lapsana communis* L.					r	r	r				r										20	2.22	0.32
H	SE	*Carex hirta* L.					2												r	1			15	5.00	0.04

Life forms	Phytogeographical elements	UTM Grid zone 34T	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR50	DR50	DR51	DR51	Frequency (%)	Cover index according to Lausi et al. (1982) (Ic)	Fidelity index (Φ)
		Altitude (m)	75	75	75	75	75	74	74	74	74	74	74	75	75	75	75	78	75	73	75	76			
		Exposition	SE	SE	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/			
		Slope (°)	3	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
		General cover (%)	90	70	80	95	80	60	40	30	60	30	40	60	80	95	80	100	100	70	60	70			
		Tree layer cover (%)	10	/	80	40	80	50	40	30	60	30	30	20	30	/	80	70	50	70	/	60			
		Shrub layer cover (%)	10	70	20	10	20	60	40	30	5	30	40	10	50	20	50	30	90	40	/	/			
		Herb layer cover (%)	90	70	50	95	20	40	40	30	10	20	40	60	80	95	40	80	70	40	70	5			
		Relevé area (m^2)	25	30	100	25	100	100	50	50	100	50	25	50	50	25	100	100	200	100	100	200			
		Relevé number from cluster	5	6	8	7	9	13	15	16	17	18	14	19	20	21	30	11	22	23	10	12			
		Relevé No.[1]	1	2	3	4	5	6*	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
H	SE	*Scutellaria columnae* All.	1	+	1																		15	4.44	0.27
H	EAz	*Glechoma hederacea* L.								1	1							+					15	4.44	0.04
H	EAz	*Picris hieracioides* L.																1	1	r			15	3.89	0.27
H	EAz	*Polygonum mite* Schrank							1					+	r								15	3.33	0.14
S	EAz	*Solanum dulcamara* L.			r								1							+			15	3.33	-0.43
P	EAz	*Quercus robur* L.				1				r								r					15	2.78	0.14
G	EAz	*Phalaris arundinacea* L.	3	2																			10	6.67	-0.04
H	HOL	*Carex pseudocyperus* L.												r					3				10	4.44	0.07
HydG	ADV	*Acorus calamus* L.			1	1																	10	3.33	0.22
P	ADV	*Morus nigra* L.								1		1											10	3.33	0.22
H	EAz	*Calamagrostis epigejos* (L.) Roth																	2	r			10	3.33	-0.04
H	KOSM	*Calystegia sepium* (L.) R. Br.			1									1									10	3.33	-0.13
T/H	ADV	*Erigeron annuus* (L.) Pers.								1												1	10	3.33	-0.13
H	KOSM	*Carduus acanthoides* L.																	+	1			10	2.78	0.07
H/T	EAz	*Lactuca serriola* L.											+							1			10	2.78	-0.13
H	EAz	*Carex cespitosa* L.																+		+			10	2.22	0.22
T	KOSM	*Solanum nigrum* L.	+		+																		10	2.22	0.22
T	KOSM	*Torilis arvensis* (Hudson) Link																	r	1			10	2.22	0.07
T	KOSM	*Lolium temulentum* L.					+			r													10	1.67	0.22
H	EAz	*Alopecurus pratensis* L.								r										r			10	1.11	0.07
ST	ADV	*Echinocystis lobata* (Michx) Torrey & A. Gray														3							5	3.89	0.15
H/HydG	EAz	*Lycopus europaeus* L.							2														5	2.78	-0.46
NP	SE	*Crataegus monogyna* Jacq.															2						5	2.78	-0.22
H	MED-SUBMED	*Carex divulsa* Stokes																		2			5	2.78	0.15
H	EAz	*Dipsacus laciniatus* L.																2					5	2.78	0.15
G	MED-SUBMED	*Glycyrrhiza glabra* L.				2																	5	2.78	0.15
H	EAz	*Festuca rupicola* Heuffel																	2				5	2.78	-0.03
HydG	KOSM	*Typha latifolia* L.											1										5	1.67	-0.22
T	ADV	*Bidens frondosa* L.											1										5	1.67	-0.22
P	EAz	*Salix alba* L.				1																	5	1.67	-0.13

Life forms	Phytogeographical elements	UTM Grid zone 34T	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR50	DR50	DR51	DR51	Frequency (%)	Cover index according to Lausi et al. (1982) (Ic)	Fidelity index (Φ)
		Altitude (m)	75	75	75	75	75	74	74	74	74	74	74	75	75	75	75	78	75	73	75	76			
		Exposition	SE	SE	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/			
		Slope (°)	3	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0			
		General cover (%)	90	70	80	95	80	60	40	30	60	30	40	60	80	95	80	100	100	70	60	70			
		Tree layer cover (%)	10	/	80	40	80	50	40	30	60	30	30	20	30	/	80	70	50	70	/	60			
		Shrub layer cover (%)	10	70	20	10	20	60	40	30	5	30	40	10	50	20	50	30	90	40	/	/			
		Herb layer cover (%)	90	70	50	95	20	40	40	30	10	20	40	60	80	95	40	80	70	40	70	5			
		Relevé area (m^2)	25	30	100	25	100	100	50	50	100	50	25	50	50	25	100	100	200	100	100	200			
		Relevé number from cluster	5	6	8	7	9	13	15	16	17	18	14	19	20	21	30	11	22	23	10	12			
		Relevé No.[1]	1	2	3	4	5	6*	7	8	9	10	11	12	13	14	15	16	17	18	19	20			
H	SE	*Galium mollugo* L.				1																	5	1.67	-0.03
P	EAz	*Prunus avium* L.				1																	5	1.67	-0.03
G/HydG	KOSM	*Polygonum amphibium* L.			1																		5	1.67	0.15
P	ADV	*Malus domestica* Borkh.																	1				5	1.67	0.15
P	EAz	*Salix fragilis* L.																	1				5	1.67	0.15
H	HOL	*Pastinaca sativa* L.																1					5	1.67	0.15
H	EAz	*Carex otrubae* Podp.																+					5	1.11	-0.52
H	EAz	*Cucubalus baccifer* L.																		+			5	1.11	-0.13
H	EAz	*Ranunculus repens* L.												+									5	1.11	-0.22
H	KOSM	*Cirsium vulgare* (Savi) Ten.								+													5	1.11	-0.13
H/T	KOSM	*Daucus carota* L.																+					5	1.11	-0.03
T	ADV	*Conyza canadensis* (L.) Cronq.																	+				5	1.11	-0.03
ST/T	KOSM	*Fallopia convolvulus* L.																	+				5	1.11	-0.03
H	EAz	*Thalictrum flavum* L.													+								5	1.11	0.15
T/H	ADV	*Lactuca sativa* L.																+					5	1.11	0.15
H	EAz	*Vicia cracca* L.				+																	5	1.11	-0.03
HydG	HOL	*Glyceria maxima* (Hartman) Holmberg												r									5	0.56	-0.46
H	EAz	*Festuca pratensis* Hudson					r																5	0.56	-0.13
H	KOSM	*Agrostis stolonifera* L.									r												5	0.56	-0.03
H	EAz	*Lychnis flos-cuculi* L.		r																			5	0.56	0.15
T	EAz	*Lamium purpureum* L.																				r	5	0.56	0.15
H	MED-SUBMED	*Prunella laciniata* (L.) L.					r																5	0.56	0.15
H	SE	*Aremonia agrimonoides* (L.) DC.									r												5	0.56	0.15
H	KOSM	*Plantago major* L.											r										5	0.56	0.15
H	KOSM	*Rumex crispus* L.					r																5	0.56	-0.03
P	ADV	*Morus alba* L.					r																5	0.56	-0.03

1 Relevés 1 – 20: Serbia, Carska bara: 45° 16' 887" N – 20° 25' 152" E, 45° 16' 863" N – 20° 25' 066" E, 45° 16' 953" N – 20° 25' 318" E, 45° 16' 863" N – 20° 25' 066" E, 45° 16' 852" N – 20° 24' 824" E, 45° 16' 818" N – 20° 25' 310" E, 45° 16' 754" N – 20° 25' 308" E, 45° 16' 672" N – 20° 25' 289" E, 45° 16' 553" N – 20° 25' 241" E, 45° 16' 517" N – 20° 25' 230" E, 45° 16' 800" N – 20° 25' 338" E, 45° 16' 140" N – 20° 25' 120" E, 45° 16' 104" N – 20° 25' 119" E, 45° 15' 695" N – 20° 24' 693" E, 45° 15' 670" N – 20° 24' 668" E, 45° 16' 912" N – 20° 26' 025" E, 45° 14' 529" N – 20° 23' 069" E, 45° 14' 255" N – 20° 22' 819" E, 45° 15' 963" N – 20° 25' 016" E, 45° 16' 029" N – 20° 25' 102" E.

Table 2. Diagnostic table of new association *Carici otrubae–Fraxinetum pennsylvanicae* ass. nova from SNR Carska bara in Serbia. (*holotypus)
Tablica 2. Dijagnostička tablica nove asocijacije *Carici otrubae–Fraxinetum pennsylvanicae* ass. nova iz SRP Carska bara u Srbiji. (*holotip)

Life forms	Phytogeographical elements	UTM Grid zone 34T	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	Frequency (%)	Cover index accor-ding to Lausi et al. (1982) (Ic)	Fidelity index (Φ)
		Altitude (m)	76	78	78	76	75	78	78	78	78	76	76			
		Exposition	/	/	/	/	/	/	/	/	/	SE	SE			
		Slope (°)	0	0	0	0	0	0	0	0	0	5	5			
		General cover (%)	90	90	100	90	80	100	100	100	90	100	100			
		Tree layer cover (%)	90	80	70	60	/	90	70	60	60	10	/			
		Shrub layer cover (%)	10	60	50	70	80	50	40	20	80	100	100			
		Herb layer cover (%)	5	2	90	10	5	10	100	100	5	100	100			
		Relevé area (m^2)	20	200	200	100	100	200	200	200	200	50	50			
		Relevé number from cluster	24	26	29	27	31	36	25	28	35	32	33			
		Relevé No. 2	1	2	3	4	5	6	7	8*	9	10	11			
		Dominant taxa (! also diagnostic)														
P	ADV	*Fraxinus pennsylvanica* Marshall!	4	3	4	3	3	4	3	3	3	4	4	100	82.83	0.63
H	EAz	*Carex otrubae* Podp.!	2	+	1	+		r	1	4	1			73	27.27	0.73
H	SE	*Symphytum officinale* L.	+		3	+			3	+	+	+	+	73	26.26	0.19
		Diagnostic taxa														
S	EAz	*Solanum dulcamara* L.			r		r	r	1	+	r	r	+	73	12.12	0.55
H/HydG	EAz	*Lycopus europaeus* L.	r	+	1			+		r		r	+	64	12.12	0.66
HydG	HOL	*Glyceria maxima (*Hartman) Holmberg		r	r	r	r		1	+			r	64	10.10	0.66
T	EAz	*Polygonum hydropiper* L.						+		r	r			27	4.04	0.45
		Other taxa														
SH	HOL	*Humulus lupulus* L.	r				1	2				3	r	45	17.17	0.26
T	KOSM	*Galium aparine* L.								r	+	+	r	36	6.06	0.13
H	KOSM	*Lythrum salicaria* L.						1				r	r	27	5.05	0.26
H	EAZ	*Poa trivialis* L.	1									1	r	27	7.07	-0.23
H	KOSM	*Sonchus arvensis* L.										2	r	18	6.06	0.37
H	MED-SUBMED	*Althaea officinalis* L.			1								r	18	4.04	0.37
H	KOSM	*Cichorium intybus* L.										r	r	18	2.02	0.37
H	EAz	*Lysimachia vulgaris* L.	r										r	18	2.02	0.24
H	EAz	*Cirsium arvense* (L.) Scop.										2	r	18	6.06	-0.10
H/T	EAz	*Lactuca serriola* L.										+	r	18	3.03	0.08
HydG	KOSM	*Typha latifolia* L.										+	r	18	3.03	0.15
H	EAz	*Epilobium hirsutum* L.											r	9	1.01	0.25
H	EAz	*Epilobium parviflorum* Schreber											r	9	1.01	0.25
T	HOL	*Senecio congestus* (R Br) DC.											r	9	1.01	0.25

Life forms	Phytogeographical elements	UTM Grid zone 34T	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	Frequency (%)	Cover index accor-ding to Lausi et al. (1982) (Ic)	Fidelity index (Φ)
		Altitude (m)	76	78	78	76	75	78	78	78	78	76	76			
		Exposition	/	/	/	/	/	/	/	/	/	SE	SE			
		Slope (°)	0	0	0	0	0	0	0	0	0	5	5			
		General cover (%)	90	90	100	90	80	100	100	100	90	100	100			
		Tree layer cover (%)	90	80	70	60	/	90	70	60	60	10	/			
		Shrub layer cover (%)	10	60	50	70	80	50	40	20	80	100	100			
		Herb layer cover (%)	5	2	90	10	5	10	100	100	5	100	100			
		Relevé area (m^2)	20	200	200	100	100	200	200	200	200	50	50			
		Relevé number from cluster	24	26	29	27	31	36	25	28	35	32	33			
		Relevé No. 2	1	2	3	4	5	6	7	8*	9	10	11			
H	EAz	*Valeriana officinalis* L.											r	9	1.01	0.25
T/H	ADV	*Iris pseudacorus* L.		+	2		r		1	1		r	1	64	18.18	0.11
H	HOL	*Urtica dioica* L.				1	1	2	+			+	1	55	18.18	0.02
P	ADV	*Prunus cerasifera* Ehrh.				+					+		+	27	6.06	0.03
H	EAz	*Cucubalus baccifer* L.										r	+	18	3.03	0.24
H	KOSM	*Calystegia sepium* (L.) R. Br.										r	+	18	3.03	0.08
H	EAz	*Eupatorium cannabinum* L.											+	9	2.02	0.25
H	EAz	*Glechoma hederacea* L.											+	9	2.02	-0.09
P	ADV	*Acer negundo* L.	+	3	2	2	2	1			+	r		73	30.30	-0.34
NP	EAz	*Rubus caesius* L.			+		1			+	1	1		55	15.15	-0.21
G	MED-SUBMED	*Aristolochia clematitis* L.		r		+				+		1		45	10.10	0.17
G	KOSM	*Phragmites australis* (Cav.) Trin. ex Steudel			1	+		r		2				36	11.11	0.23
T	ADV	*Bidens frondosa* L.	+	r	1									27	6.06	0.34
H	HOL	*Galium palustre* L.								+	r			18	3.03	0.37
T/H	ADV	*Erigeron annuus* (L.) Pers.		+								+		18	4.04	0.08
P	ADV	*Gleditsia triacanthos* L.	+						+					18	4.04	-0.02
NP	ADV	*Amorpha fruticosa* L.									3			9	7.07	0.25
H	ADV	*Aster lanceolatus* Willd.							3					9	7.07	0.25
P	ADV	*Celtis occidentalis* L.					1							9	3.03	0.25
NP	HOL	*Rubus idaeus* L.							+					9	2.02	0.25
H	SE	*Epilobium lanceolatum* Sebastiani & Mauri						r						9	1.01	0.25
H	SE	*Ballota nigra* L.										r		9	1.01	0.25
H	EAz	*Leonurus marrubiastrum* L.		r										9	1.01	0.25
H	EAz	*Verbascum lychnitis* L.										r		9	1.01	0.25
G	KOSM	*Cynodon dactylon* (L.) Pers.				r								9	1.01	0.25

Life forms	Phytogeographical elements													Frequency (%)	Cover index accor-ding to Lausi et al. (1982) (Ic)	Fidelity index (Φ)
		UTM Grid zone 34T	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51	DR51			
		Altitude (m)	76	78	78	76	75	78	78	78	78	76	76			
		Exposition	/	/	/	/	/	/	/	/	/	SE	SE			
		Slope (°)	0	0	0	0	0	0	0	0	0	5	5			
		General cover (%)	90	90	100	90	80	100	100	100	90	100	100			
		Tree layer cover (%)	90	80	70	60	/	90	70	60	60	10	/			
		Shrub layer cover (%)	10	60	50	70	80	50	40	20	80	100	100			
		Herb layer cover (%)	5	2	90	10	5	10	100	100	5	100	100			
		Relevé area (m^2)	20	200	200	100	100	200	200	200	200	50	50			
		Relevé number from cluster	24	26	29	27	31	36	25	28	35	32	33			
		Relevé No. 2	1	2	3	4	5	6	7	8*	9	10	11			
T	SE	*Bromus commutatus* Schrader				r								9	1.01	0.25
T	EAz	*Papaver rhoeas* L.				r								9	1.01	0.25
P	EAz	*Salix cinerea* L.								1				9	3.03	0.10
H	SE	*Pimpinella major* (L.) Hudson								+				9	2.02	0.10
T	EAz	*Chenopodium polyspermum* L.		r										9	1.01	0.02
G	KOSM	*Elymus repens* (L.) Gould				+								9	2.02	-0.17
H	HOL	*Festuca rubra* L.				+								9	2.02	-0.21
H	KOSM	*Rumex crispus* L.										r		9	1.01	0.10
H	EAz	*Bromus inermis* Leysser				r								9	1.01	0.10
H	HOL	*Carex pseudocyperus* L.								1				9	3.03	0.02
H	SE	*Carex hirta* L.				2								9	5.05	-0.09

2Relevés 1 – 11: Serbia, Carska bara: 45° 16' 007" N – 20° 25' 041" E, 45° 15' 489" N – 20° 24' 435" E, 45° 15' 535" N – 20° 24' 472" E, 45° 16' 109" N – 20° 24' 111" E, 45° 15' 596" N – 20° 24' 592" E, 45° 15' 617" N – 20° 24' 588" E, 45° 15' 570" N – 20° 24' 516" E, 45° 15' 770" N – 20° 24' 732" E, 45° 15' 721" N – 20° 24' 729" E, 45° 16' 213" N – 20° 24' 500" E, 45° 16' 186" N – 20° 24' 438" E.

RESULTS
REZULTATI

Classification – *Klasifikacija*

Cluster analysis clearly differentiated three groups of relevés (**Figure 2**). Cluster A consists of 20 relevés dominated by *Acer negundo*, while cluster B includes 11 relevés dominated by *Fraxinus pennsylvanica*. The third cluster (C) consists of four relevés and represents the stands of the ass. *Sambuco nigrae–Aceretum negundo* from Austria. Although *Acer negundo* is dominant species in this association, its relevés are separated and allocated from those of cluster A and B. In the relevé 34, *Prunus spinosa* L. is a dominant species, hence this relevé is singled out and has no relevance in characterization of described invasive forest communities.

From a total of 107 taxa that are present in clusters A and B, 50 appears only in cluster A, and 27 only in cluster B, while 30 species are common for both groups. The most common and abundant species in both analyzed groups are: *Acer negundo*, *Rubus caesius* L., *Fraxinus pennsylvanica*, *Urtica dioica* L., *Symphytum officinale* L., *Aristolochia clematitis* L. and *Iris pseudacorus* L.

Based on the results of the cluster analysis and also the analysis of the dominant and diagnostic species, we consider the first two groups (clusters A and B) specific and different enough, to be defined as associations.

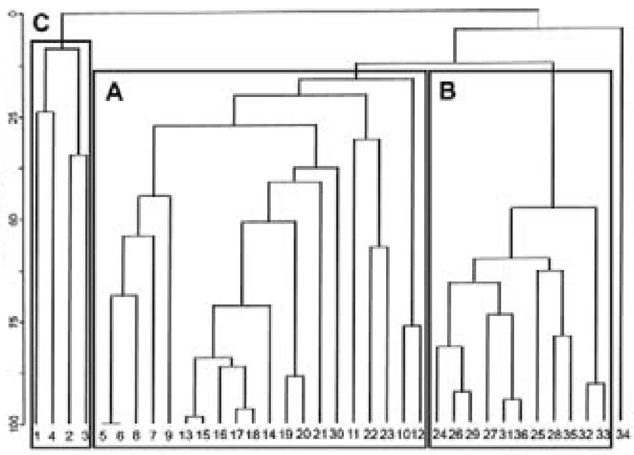

Figure 2. Results of cluster analysis (cluster A – relevés with the dominant species *Acer negundo* L.; cluster B – relevés with the dominant species *Fraxinus pennsylvanica* Marshall; cluster C – relevés of the ass. *Sambuco nigrae–Aceretum negundo* Exner 2004)

Slika 2. Rezultati klaster analize (klaster A – snimci s dominantnom vrstom *Acer negundo* L.; klaster B – snimci s dominantnom vrstom *Fraxinus pennsylvanica* Marshall; klaster C – snimci asocijacije *Sambuco nigrae–Aceretum negundo* Exner 2004)

Syntaxonomical treatment – *Sintaksonomska interpretacija*

Ass. *Rubo caesii–Aceretum negundi* ass. nova hoc loco (Holotypus Table 1, reléve 6, Figure 3)

Dominant species: *Acer negundo* L.$^{(1-4)}$ (Ic = 66.67) and *Rubus caesius* L.$^{(+-3)}$ (Ic = 37.22)

Diagnostic species: *Fraxinus angustifolia* Vahl. subsp. oxycarpa (Bieb ex Willd) Franco & Rocha Afonso (Φ = 0.48), *Dactylis glomerata* L. (Φ = 0.44).

Diagnosis: Ass. *Rubo caesii–Aceretum negundi* is developed on marshy, gley (eugley), hypogley, saline soils, on altitudes between 73 – 78 m on a flat surface, rarely on small slopes (up to 10°). Individuals of the dominant species *Acer negundo* are predominantly present in the canopy layer, up to 15 m high, and also in the shrub and herb layers. Total cover in different stands of this association is 30 – 100 % (average 69.5 %). Total of 80 taxa are present in all 20 relevés, average number of species per relevé is 13. Since the dominant and nominal species *Acer negundo*, is invasive, the association has an invasive character itself. The fact that individuals of this species are present in shrub and herb layers, indicate that this community is in progradation, and the final stage will, most probably, result in the development of the monodominant forest. The other invasive species also present in this association are: *Bidens frondosa* L., *Echinocystis lobata* (Michx) Torrey & A. Gray, *Fraxinus pennsylvanica* and *Gleditsia triacanthos* L.

Ass. *Carici otrubae–Fraxinetum pennsylvanicae* ass. nova hoc loco (Holotypus Table 2, reléve 8, Figure 4)

Dominant species: *Fraxinus pennsylvanica* Marshall$^{(3-4)}$ (Ic = 82.83) and *Carex otrubae* Podp.$^{(r-2)}$ (Ic = 27.27)

Diagnostic species: *Carex otrubae* (Φ = 0.73), *Lycopus europaeus* (Φ = 0.66), *Glyceria maxima* (Hartman) Holmberg

Figure 3. The Ass. *Rubo caesii–Aceretum negundi* ass. nova
Slika 3. Nova asocijacija *Rubo caesii–Aceretum negundi*

Figure 4. The Ass. *Carici otrubae–Fraxinetum pennsylvanicae* ass. nova
Slika 4. Nova asocijacija *Carici otrubae–Fraxinetum pennsylvanicae*

(Φ = 0.66), *Fraxinus pennsylvanica* Marshall (Φ = 0.63), *Solanum dulcamara* (Φ = 0.55), *Polygonum hydropiper* L. (Φ = 0.45).

Diagnosis: Ass. *Carici otrubae–Fraxinetum pennsylvanicae* is developed on marshy, gley (eugley), hypogley, saline soils, on altitudes between 73 - 78 m on a flat surface, up to 5° inclination. Dominant species *Fraxinus pennsylvanica* can reach height up to 10 m in the canopy layer, while younger individuals are present also in the lower layers. Total cover varies from 80 to 100 %, averaging about 95 %. Total of 57 taxa are present in all 11 relevés. The average number of species per stand is 14. Since *Fraxinus pennsylvanica*, the dominant and nominal species is invasive, the association has an invasive character itself. The fact that individuals of the dominant invasive species are present in shrub and herb layers, indicate that this community is in progradation, and the final stage will result in the development of monodominant forest, as well as the first association. The other invasive species present in this association are the following: *Acer negundo*, *Amorpha fruticosa*, *Aster lanceolatus* Willd., *Bidens frondosa*, *Celtis occidentalis* L. and *Gleditsia triacanthos*.

Ecology and synchorology of associations – *Ekologija i sinhorologija asocijacija*

Stands of new associations *Rubo caesii–Aceretum negundi* and *Carici otrubae–Fraxinetum pennsylvanicae* are so far known only from the investigated area, on the former floodplain of Carska bara in northeastern Serbia. There are typical alluvial landforms, both natural and anthropogenically conditioned, due to frequent man interventions. The geological structure is dominated by sediments of Neogene age and pedological structure by alluvial saline soil and gleys, marshy black soil and smonitsa and solonchak's solonetz. Mean annual temperature is 11.6 °C. The coldest month is January with the mean monthly temperature of 0.1 °C, while August is the hottest month with the mean temperature of 22 °C. The mean temperature of winter months is above zero, which is regularly the case in recent years. The average of annual rainfall is 609.8 mm. In the vegetation period (April – October), mean annual amount of precipitation is 68.0 mm in the monthly average. The potential steppe and forest-steppe vegetation (alliances *Festucion rupicolae* Soó 1940, and *Aceri tatarici–Quercion* Zólyomi et Jakucs 1957) are determined by these climatic conditions and geographic location of the wider surrounding area. The potential vegetation in the riparian zone of this area is presented by the azonal vegetation of hygrophile flooded forests of the alliances *Salicion albae* Soó 1940 (EUNIS G1.1) and *Fraxinion angustifoliae* Pedrotti 1970 (EUNIS G1.2) (Davies et al., 2004). However, the natural vegetation has been greatly disturbed, providing the space for the establishment and spread of invasive plant communities.

Syntaxonomical scheme – *Sintaksonomska shema*

Class *Robinietea* Jurko 1963 ex Hadač et Sofron 1980
  Order *Chelidonio–Robinietalia* Jurko ex Hadač et Sofron 1980
    Alliance non defined
      Ass. *Rubo caesii–Aceretum negundi* Batanjski et S. Jovanović ass. nova hoc loco
      Ass. *Carici otrubae–Fraxinetum pennsylvanicae* Batanjski et S. Jovanović ass. nova hoc loco

DISCUSSION
RASPRAVA

According to Stojšić (2010), the most common forest community in the riparian habitats of the investigated area is *Salicetum albae pannonicum* Parabućski (1965) 1972. There are also *Populetum nigro–albae* Slavnić 1952 and the fragmented communities *Fraxino–Quercetum roboris* Rudski (1940) 1949. The native riparian forest vegetation was under strong anthropogenic pressure (before it was protected), which resulted both in occurrence and the spreading of the invasive species, especially woody ones. Negative direction of secondary succession of native forest vegetation, and the substitution of the primary wet meadow habitats in riparian zone continues today. Accordingly, the natural forest communities *Populetum nigro–albae* and *Fraxino–Quercetum roboris* are extensively replaced by new community of invasive species *Fraxinus pennsylvanica*. On the other hand, *Acer negundo* has expanded even more and increasingly occupies the habitats of the native community *Salicetum albae pannonicum* (next to local waters), and some habitats of ass. *Populetum nigro–albae*, forming the stable stands of new invasive community. Similar situation was observed in the middle course of the Vistula river in Poland (Künstler, 1999). However, the substitution of communities is not so strictly divided by habitats, and observed invasive woody species frequently occure together in the analyzed area of Carska bara.

In the light of the anthropogenic interventions and frequent inundation of these habitats, the competitive characteristics of the analyzed invasive species are highlighted, which explain the establishment of their communities. This led to the formation of "novel ecosystems", which are, in this study, formed due to the occurrence of invasive woody plants, that prevent the growth and regeneration of pre-existing plants and thus reduce the potential for system redevelopment (Hobbs et al., 2006; Hobbs et al., 2009). *Acer negundo* occupies the flood plain forests of the willow and poplar in disturbed conditions (due to vegetative growth), which prevents their natural regeneration (Rosario, 1988; Künstler, 1999). Possible limiting factor is the frequency and duration of flooding (Mędrzycki, 2011). In contrast, *Fraxinus pennsylvanica* has tolerance to flooding and is characterized by extremely rapid growth (Gucker, 2005; Kremer et al., 2006), due to which it can successfully suppress the native species from competition, establishing thus the stable community. *Acer negundo* and *Fraxinus pennsylvanica* often cenotically associate with different kinds of willow and poplar in their homeland (Csiszár and Bartha, 2008; Udvardy, 2008). Such situation was observed and analyzed in this reserve. As these communities are similar in composition and structure to those in their native conditions, it should not be surprising that analyzed invasive woody species are not only naturalized, but cenotically stabilized in the study area.

Description and classification of the communities of some woody alien species is done by several authors (Jurko, 1963; Hadač and Sofron, 1980; Zerbe, 2003; Exner and Willner, 2004; Sîrbu and Oprea, 2011), argumenting why non-native species can build communities which can be very stable and rich in characteristic species as native communities. Since many ruderal or segetal communities dominated by non-native plants are identified in the literature as valid, there is no reason why non-indigenous communities of woody plants should not be (Hadač and Sofron, 1980), like in the case of two new communities described in this paper.

The question of the syntaxonomical affiliation of two newly described associations is challenging because these communities have not been described previously. As it was already mentioned, there is only one described association in Europe so far, in which species *Acer negundo* is dominant. It is *Sambuco nigrae-Aceretum negundo* described by Exner and Willner (2004), within potential broad-leaved woodland areas of Austria. It was classified within the class *Robinietea*. Accordingly, we have also classified our two newly described communities in the class *Robinietea*. This class includes anthropogenic tree communities, colonizing disturbed habitats such as deforested lands, selvedges, agricultural and industrial fallows etc. Only two alliances were described within this class. Alliance *Chelidonio–Robinion* Hadač & Sofron 1980 occurs at loamy, mesic, eutrophic soils, or on solidified screes, usually on Southern, Eastern or Western slopes, and the other one *Balloto nigrae–Robinion* Hadač & Sofron 1980, develops at relatively poor sandy, dry soils, mainly in lowlands. Since the newly described invasive woody associations were found in anthropogenically disturbed habitats in the plains, it is reasonable to classify them within the class *Robinietea*. Diagnostic and dominant species of *Robinietea* class are: *Robinia pseudoacacia*, *Chelidonium majus* L., *Sambucus nigra* L., *Poa nemoralis* L. and *Impatiens parviflora* DC. (Hadač and Sofron, 1980; Chytrý and Tichý, 2003). The fact that invasive species is the dominant one (*Robinia pseudoacacia*), suggests that the class *Robinietea* includes communities whose occurrence and establishment are conditioned by anthropogenic activities. In compliance with this standpoint and currently available data on higher syntaxonomic categories, we have classified both new invasive communities within the mentioned class. We agree with Chytrý and Tichý (2003) that *Robinietea* class is insufficiently described in relation to diagnostic species throughout its geographic range. However, the diagnostic species and the habitat types of two newly described communities in this work, suggest that they cannot be classified to neither of the two currently available alliances of *Robinietea* class. For this purpose, the authors consider that an introduction of new syntaxa at the level of alliance or order, including human-caused azonal communities, could be the possible solution.

Another possible solution is further research, which would determine whether some of the communities currently belonging to *Robinietea* class, could be assigned to other higher syntaxa in accordance with native distribution of the dominant species, as considered by Exner and Willner (2004).

Considering the fact that described invasive forest communities represent a major threat to indigenous biodiversity an immediate action plan is necessary for minimizing its negative effects on the autochthonous flora and fragile riparian habitats of Ramsar site and Special Nature Reserve Carska bara. These results are extremely alarming, especially within the internationally important and protected area.

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SAŽETAK

Invazivne vrste, kao drugi faktor rizika ugrožavanja nativne biološke raznolikosti, jedan su od najvećih izazova u očuvanju biološke raznolikosti u Europi prema Europskoj strategiji o invazivnim vrstama. Prijetnje autohtonoj biološkoj raznolikosti i degradacije prirodnih staništa postaju najistaknutije kada invazivne vrste postanu naturalizirane i formiraju stabilne zajednice. To može dovesti do homogenizacije ekosustava i smanjenja autohtone raznolikosti vrsta, a konačni ishod može rezultirati u nastanku novih ekosustava. Veliki broj invazivnih biljaka su drveće. Dvadeset tri strane vrste drveća su identificirane u šumskim ekosustavima Srbije, od kojih je 17 invazivno. Unatoč svim poznatim negativnim utjecajima koje invazivne biljne vrste mogu imati, paradoksalno je što je razina istraživanja invazivnih biljnih zajednica, posebice gdje dominiraju drvenaste vrste, mala. Alarmantno velika prisutnost vrlo invazivnih sjevernoameričkh drvenastih vrsta *Acer negundo* i *Fraxinus pennsylvanica* zabilježena je u zaštićenom močvarnom području Carska Bara. One su uspostavile stabilne šumske zajednice koje su analizirane i opisane u ovome radu. U znanstvenoj literaturi nedostaju podaci o stabiliziranim zajednicama izgrađenim od dve promatrane drvenaste invazivne vrste.

Istraživano područje Carska Bara nalazi se na aluvijalnoj ravnici između rijeka Tise i Begeja, u središnjem Banatu (Vojvodina, Srbija) (**Slika 1**). Zbog svojih prirodnih svojstava, uživa status specijalnog rezervata prirode, ramsarskog područja, važnog područja za ptice (IBA), važnog područja za biljke (IPA), kao i Emerald i ASCI područja.

Fitocenološka istraga odabranih priobalnih šumskih staništa provedena je u razdoblju od 2011. do 2013. godine. Trideset i dva snimka sakupljena su prema Braun-Blanquet metodologiji. Svi podaci su georeferencirani. Osim vlastitih, 4 fitocenološka snimka slične asocijacije iz Austrije uključena su u analizu i korištena za usporedbu. Snimci su klasificirani i grupirani u klaster, za daljnju cenoekološku karakterizaciju i diferencijaciju. Sve analize su rađene u PcOrd 6,0 softveru. Korišten je koncept dominantnih i dijagnostičkih vrsta.

Klaster analizom jasno se izdvajaju tri skupine snimaka (**Slika 2**). Klaster A se sastoji od 20 snimaka u kojima dominira *Acer negundo*, a klaster B uključuje 11 snimaka gdje dominira *Fraxinus pennsylvanica*. Treći klaster (C) od 4 snimka predstvalja posebnu skupinu sastojina ranije opisane zajednice *Sambuco nigrae–Aceretum negundo*, s područja Austrije. Na temelju rezultata svih analiza, smatramo da su prve dvije skupine (klastera A i B) specifične i dovoljno različite, te da se mogu definirati kao nove asocijacije.

Ove nove asocijacije *Rubo caesii–Aceretum negundi* (**Tablica 1**) (**Slika 3**) i *Carici otrubae–Fraxinetum pennsylvanicae* (**Tablica 2**) (**Slika 4**) do sada su poznate samo iz istraživanog područja. Tu je prirodna vegetacija uveliko poremećena i sekundarna sukcesija vegetacije primarnih vlažnih staništa nastavlja se i danas. Prirodne šumske zajednice *Populetum nigro–albae* i *Fraxino–Quercetum roboris* opsežno su zamijenjene novom zajednicom invazivne vrste *Fraxinus pennsylvanica*. S druge strane, *Acer negundo* se proširio i sve više zauzima staništa autohtone zajednice *Salicetum albae*, a negdje i staništa ass. *Populetum nigro–albae*, formirajući stabilne sastojine nove invazivne zajednice. Međutim, zamjena zajednica nije tako strogo podijeljena po tipovima staništima, te se promatrane invazivne vrste često nalaze zajedno.

Definiranje potpune sintaksonomske pripadnosti dvaju novih opisanih zajednica je u ovom trenutku teško, jer one nisu nigdje prethodno opisane. Njihove dijagnostičke vrste i tipovi staništa ukazuju na to da se one ne mogu svrstati niti u jednu od dve trenutno opisane sveze *Robinietea* klase. Kako ove opisane invazivne šumske zajednice predstavljaju veliku opasnost za autohtonu biološku raznolikost, situacija je izuzetno alarmantna s obzirom na činjenicu da je istraživano područje međunarodno važno i zaštićeno.

KLJUČNE RIJEČI: invazivne drvenaste vrste, *Acer negundo*, *Fraxinus pennsylvanica*, šumske zajednice, poplavne zone