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ASTERETUM LANCEOLATI - XENOSPONTANEOUS COMMUNITY ON WET AND RIPARIAN HABITATS

Abstract: Invasive species *Aster lanceolatus* grows on moist habitats on the whole territory of Serbia. In Belgrade, this species is recorded with a higher degree of presence at a number of localities. With the aim to investigate the community in which this species is dominant, the wide area of Serbia was researched, and 8 localities on the territory of Belgrade were chosen for the analysis of the community. Floristic structure of the community was determined by the standard Braun-Blanquet method (1964), phytogeographical analysis was performed according to Gajić (1980, 1984), and determination of life forms according to Raunkier (Ellenberg, Mueller-Dombois, 1967). pH soil analysis and electric conductivity (EC) were performed at all investigated localities. It was established that the community dominates the moist habitats of Belgrade. It is composed of 104 species and among them *Aster lanceolatus* Willd., *Cichorium intybus* L., *Agropyrum repens* (L.) Beauv., *Calystegia sepium* (L.) R. Br., *Cirsium arvense* (L.) Scop., *Symphytum officinale* L. and *Rumex obtusifolius* L. are the most frequent. In relation to life forms, the community has hemicriptophytes character, and in relation to phytogeography Euroasian and Middle Europaean floral elements are dominant, with a high presence of cosmopolitan and adventive floral elements. On the locialities Veliko Ratno ostrvo (island) and Makiš, EC values point to the fact that the amount of nutrient in the soil is higher than at other localities.

Key words: Invasive community, *Aster lanceolatus*, Belgrade

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***ASTERETUM LANCEOLATI* - КСЕНОСПОНТАНА ЗАЈЕДНИЦА НА ВЛАЖНИМ И ПРИОБАЛНИМ СТАНИШТИМА**

Извод: Инвазивна врста *Aster lanceolatus* расте на влажним стаништима на целој територији Србије. У Београду је висок степен присуства ове врсте забележен на неколико локалитета. Са циљем да се истражи заједница у којој доминира ова врста, истражена је шира територија Србије, а на територији Београда је за анализу ове заједнице издвојено 8 локалитета. Флористичка структура заједнице је утврђена методом Braun-Blanquet (1964), фитогеографска анализа је урађена методом према Gajiću (1980, 1984), а утврђивање биолошких облика према Raunkier-у (Ellenberg, Mueller-Dombois, 1967). На свим истраживаним локалитетима је урађена анализа *pH* вредности земљишта као и електричне проводљивости (*EC*). Утврђено је да ова заједница доминира влажним стаништима Београда. Састоји се од 104 врсте међу којима су најучесталије *Aster lanceolatus* Willd., *Cichorium intybus* L., *Agropyrum repens* (L.) Beauv., *Calystegia sepium* (L.) R. Br., *Cirsium arvense* (L.) Scop., *Symphytum officinale* L. i *Rumex obtusifolius* L. Што се тиче биолошких облика, заједницу одликује хемикриптофитски карактер, а са фитогеографског аспекта доминантни су евроазијски и средњеевропски флорални елементи уз изражено присуство космополитских и адвентивних флоралних елемената. На локалитетима Велико Ратно острво и Макиш вредности *EC* указују на чињеницу да је количина хранљивих материја већа него на другим локалитетима.

Кључне речи: инвазивна заједница, *Aster lanceolatus*, Београд

1. INTRODUCTION

Aster lanceolatus L. is one of the widespread invasive species in Serbia. Usually, it grows in moist habitats along the rivers, and its expansion is conditioned by the dynamics of water course as by morphological characteristics of underground shoots, flowering and fruiting period etc. (Obratov-Petković *et al*., 2009). Riparian landscapes are important corridors for plant dispersal (Van der Pijl, 1982, Johansson *et al*., 1996). Riparian habitats play a central role in the process of invasion and naturalisation of alien plants (Pyšek, Prach, 1993). The largest number of alien plant species which have naturalised in the natural vegetation of central Europe are found in floodplain vegetation (Lohmeyer, Sukopp, 1992, 2001, Pyšek *et al*., 2002). Many species which are over propagated in natural vegetation, were first spotted in flooded areas. Twelve of the thirteen most frequent invaders of central Europe can be found in floodplains (Lohmeyer, Sukopp, 1992). Cities and settlements are usually located near large rivers, therefore the urban, suburban and rural settlements have been recognized as centers of the invasive species expansion (Sukopp, 1976, Kowarik, 1992, 1999, Müller, 1995, 1997, Pyšek, Pyšek, 1991, Pyšek, 1998).

The adventive species form xenospontaneous communities in the area, spread within natural and seminatural communities, or appear episodically. The newcomers have become established in aquatic communities (*Elodea canadensis* Michx.), in rushes

(*Acorus calamus* L., *Bidens frondosa* L.), and in riparian shrubberies (e.g., *Bidens frondosa*, *Helianthus tubesosus* L., *Impatiens parviflora* DC., *Solidago gigantea* Aiton) (Więclaw, 2008).

Aster lanceolatus forms its own plant community classified as *Calystegio-Asteretum lanceolati* (Stachnowicz, Nagengast 2010). This vegetation type originated from a natural tall-herb community (most probably *Urtico-Convolvuletum sepium*) which had been overgrown by *Aster lanceolatum*. Such a type of plant communities, whose species combination originated from the expansion of alien taxa within initially natural vegetation, is classified as a xenospontaneous community, whereas kenophytes which form their own self-dominated vegetation types are also called post-neophytes (Faliński, 1969). Thus, *Aster lanceolatus* may be treated as a locally potentially expansive species (Stachnowicz, 2010). Several alien species are present along the shore, many of which seem to be potentially invasive, e.g. *Acer negundo*, *Aster lanceolatus*, *Echinocystis lobata*, *Padus serotina*, *Parthenocissus inserta*, *Robinia pseudacacia* and *Rudbeckia laciniata*. Most of these species are also known as invasive kenophytes from other areas of Poland (Tokarska-Guzik, 2005). 21 of 27 kenophytes have already demonstrated their local neophytism (Table 2) and at least three of them have the status of post-neophytes (Faliński, 1969) as they have already formed their own, xenospontaneous plant communities.

The community dominated by *Aster lanceolatus* L. in Serbia was for the first time distinguished in Ada Ciganlija (Radulović, 1982). During this period, in this locality intensive care was not carried out, as it is now, but fragments of this community have been preserved until today. The species was not spread in a number of anthropogenically degraded habitats. In 1994 (Jovanović, 1994) and in 1996 (Cvejić *et al*., 1991), in the area of Belgrade *Aster lanceolatus* was a sporadic species with number and sociality which were not exceeding +2. Lately, the species has spread not only in the Belgrade area, but also in the entire territory of Serbia with a clearly separate community to wetlands and lower altitudes. The fact is that in ecosystems which are at high altitudes and where the river dynamics and human effects are weaker, less neophytes are found with lower abundance than in river valleys (Müller, Okuda, 1998).

The community *Asteretum lanceolati* consists of 107 species, and according to Lohmeyer and Sukopp (1992) about 50 invasive plants grow in the annual vegetation (*Bidentetea-communities*) or in the communities dominated by *Polygonum lapathifolium*, *Xanthium strumarium* and species from genera *Chenopodium* and *Amaranthus*. Perennial vegetation types (excluding woody vegetation) contain more than 50 naturalised species. In the inundation area of big rivers, such as the localities that were studied, the communities are rich with *Convolvulus sepium* as the dominant species. Apart from this species, *Helianthus tuberosus*, *Solidago gigantea*, *S. canadensis*, *Aster salignus* and *Brassica nigra* are present in high abundance (Okuda, 1996).

Several case studies in the world have shown that invasive vascular species can change the nature of the ecosystem. If shrubby invasive species are concerned, they are

densely spaced, well positioned in respect of nutrition and water supply, so that the native species characteristic for the particular ecosystem and habitat lose the ability to expand their population. Therefore, the succession of natural ecosystem does not lead to the progression of natural communities, but such communities are characterized by a regressive succession dominated by invasive species, and most often new types of communities arise.

Climate change leads to the extension of the growing season and reduces winter and low temperatures, which is particularly important for the spread of the species *Aster lanceolatus*. Flowering of this species is connected with the fall and late fall period (the flowering period is from the end of August to early November).

The aim of the paper was to establish the localities where the *Asteretum lanceolati* community occurs on the territory of Serbia and Belgrade, to analyze soil and electric conductivity of the soil, to describe the floristic structure of the community, to performe life form analysis and phytogeographical analysis.

2. MATERIAL AND METHODS

The field studies were carried out in 2008 and 2009 in the wider region of Serbia and Belgrade, in the following locations: the Jadar river valley, Western, Southern and Great Morava, Čelarevo, Bačka Palanka, Požega, Vrnjačka Banja and Kraljevo. From literature data, according to the manual „The habitats of Serbia - mannual with description and basic data" (2005), the *Aster lanceolatus* species were analyzed in the area of the Vlasina`s lake, Aleksandrovac, Bujanovac, Vranjska banja, Seličevica, Leskovačko polje, Živkovo (near Jablanica river), northern Banat, Bačka, Sremska Posavina, Begeč, Kać, Novi Sad, Glozan and Kosovska Mirovica.

The following localities were processed as representative: Ada Ciganlija, Ada Međica, Pančevački rit, Makiš, part of New Belgrade along Sava river, Veliko Ratno ostrvo (island), Kumodraški potok (creek) and Topčiderska reka (river).

Determination of plant species was carried out by standard floristic methods. The relevant literature was used for plant identification: Javorka and Csapody (1934), Josifović (1970-1977), Tutin *et al*., (eds.) (1964-1980), Sarić and Diklić (1986) and Sarić (1992) and Online data base of Flora Europaea (http://rbg- web2.rbge.org.uk/FE/fe.html).

The floristic structure of the community was determined by the standard Braun-Blanquet method (1964). The phytogeographical analysis was performed according to Gajić (1980, 1984). System of Raunkier was used for the classification of life forms (Ellenberg, Mueller-Dombois, 1967).

Data on community edificator representation were produced on the basis of previous research on the representation of *Aster lanceolatus* on these sites, and these are shown to form „CPS SKEW" Schwarze Liste und Watch List gebietsfremde Invasive Pflanzen,

on line (2009), as amended and adapted to conditions in Belgrade and its surroundings (Obratov-Petković *et al*., 2009).

The samples for soil analysis were taken from each locality. Soil samples for the *pH* and electrical conductivity (*EC*) tests are taken from the 0-15 *cm* depth. The *pH* is determined on a 1:5 air dried soil (<2 *mm*): deionised water suspensions using a pH meter MA 5730 ISKRA standardized against known buffer solutions (ISO 10390, 1994). The *EC* was determined from the same suspensions using Milwaukee Sharp C66 Waterproof *EC* Conductivity Tester calibrated with Milwaukee 1413 *µs/cm* calibration solution.

3. RESULTS

Floristic structure of the community, the life forms and chorological spectrum are shown in Table 1.

The community consists of 107 plant species. *Aster lanceolatus*, an invasive plant is the edificator of the community. In the Kumodraški potok (creek), it is represented with the highest presence degree, where the number of individuals per division is 2700 (Obratov-Petković *et al*., 2009).

There are 16 species in the tree layer, of which 8 are invasive: *Acer negundo*, *A. saccharinum*, *Ulmus laevis*, *Robinia pseudacacia*, *Ailanthus altissima*, *Fraxinus pennsilvanica*, *F. americana*, *Acer negundo* while *Morus nigra* and *M. alba* are adventive species. The most dominant invasive, woody species were recorded on Ada Ciganlija, the part of New Belgrade along the Sava river, Makiš and the left bank of the Danube river, while other woody invasive species were found in a single record.

There are 8 species in the shrub layer, of which 2 are invasive: *Amorpha fruticosa* and *Reynoutria japonica*. *Amorpha fruticosa* is represented in all the investigated sites, and the number and sociality of this species ranges from mark + in Kumodraški stream to 2.2 and 1.3 at sites Ada Ciganlija, the left bank of the Danube and Ada Međica. *Reynoutria japonica* was recorded only at the site Topčiderska reka (river) with mark 4.4. From other species with a higher degree of presence *Urtica dioica* and *Rubus caesius* are in almost all localities.

There are 83 species in the floor of the ground flora, of which 9 are invasive or potential invasive plant species. *Aster lanceolatus* is the edificator of the community and the most frequent species. It forms dense populations, mostly in Veliko Ratno ostrvo (island) and Makiš. In other localities the populations are also dense, and the values of their number and the sociality are not lower than 3.3. All other species, characteristic for the community are under-represented. It is the same case with invasive species *Cichorium intybus* which is described in all localities, but with the mark +. *Agropyrum repens* is not present at all localities, and it is the most frequent on the part of New Belgrade along the Sava River, Makiš and the Kumodraški potok (creek). *Cyrsium arvense*, *Symphytum officinale*, *Rumex obtusifolius*, *Artemisia vulgaris*, *Erigeron annuus* and *Amaranthus*

Table 1. Floristic structure of the community *Asteretum lanceolati*
Табела 1. Флористичка структура заједнице *Asteretum lanceolati*

Locality **Локалитет**	**Ада Циг.**	**Ада Међ.**	**Велико ратно острво**	**Савски део Новог Београда**	**Макиш**	**Лева обала Дунава**	**Кумод. поток**	**Топч. река**	**Degree presence** **Степен присус.**	**Жив. форма** **Life form**	**Флорни елемети** **Floral elements**
Надм. вис. / Elevation	73 *m*	71 *m*	70 *m*	73 *m*	98 *m*	79 *m*	186 *m*	148 *m*			
Експозиција / Exposition	NE	NE	NE	NE	NE	NW	NE	NE			
Земљиште *pH*	7.79bc	8.33a	7.57cd	8.23ab	7.79bc	7.21e	7.16de	7.82bc			
Soil *EC* [$mS \cdot cm^{-1}$]	0.18ab	0.096b	0.20a	0.11ab	0.22a	0.14ab	0.12ab	0.16ab			
Покровност / Coverage	80%	50%	70%	60%	90%	80%	70%	60%			
Спрат дрвећа / Tree layer											
Acer negundo L.	+			+	2.2	+			II	p	adv (sam)
Carpinus betulus L.			2.2			1.1			II	p	Se.
Quercus robur L.						3.3			I	p	Subse.
Alnus glutinosa (L.) Gaertn.		2.2							I	p	Subse.
Fraxinus excelsior L.		+							I	p	Subse.
Populus nigra L.								+	I	p	Subse.
Salix alba L.						+			I	p	Subevr.
Acer saccharinum L.		1.1							I	p	adv (sam)
Betula pendula Roth	1.1								I	p	Subj.sib.
Fraxinus americana L.		+							I	p	adv (sam)
Robinia pseudoaccacia L.						+			I	p	adv (sam)
Morus alba L.		+							I	p	Adv.
M. nigra L.		+							I	p	Adv.
Ailanthus altissima (Mill.) Swingle	+								I	p	adv (i.az)

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Locality **Локалитет**	**Ада Циг.**	**Ада Међ.**	**Велико ратно острво**	**Савски део Новог Београда**	**Макиш**	**Лева обала Дунава**	**Кумод. поток**	**Топч. река**	**Degree presence** **Степен присус.**	**Жив. форма** **Life form**	**Флорни елемети** **Floral elements**
Fraxinus pennsylvanica Marshall					+				I	p	Adv.
Спрат жбуња / Shrub layer											
Amorpha fruticosa L.	2.2	1.3	1.2	1.1	1.3	2.2	+	+.1	V	np	Adv.
Urtica dioica L.	+.1	+	1.1	+.1	+.1	+.1	1.1	1.1	V	h	Evr.
Rubus caesius L.	2.2	2.2	2.3	3.3	1.1	1.1		1.1	V	np	Subj.sib.
Vitis silvestris Gmel.	2.2	2.3				1.2			II	pl	Subeuks.
Calystegia sepium (L.) R. Br.						1.1		1.1	II	g	Evr.
Reynoutria japonica Houtt.								4.4	I	h	adv (i.az)
Sambucus ebulus L.			2.2						I	g	Subpont.-subm.
Sambucus nigra L.					+				I	np	Subse.
Clematis integrifolia L.					+				I	h	Pont.-ca.
Спрат приземне флоре / Ground layer											
Aster lanceolatus Willd.	4.4	4.4	4.5	3.3	4.5	4.4	4.4	3.3	V	h	adv (sam)
Cichorium intybus L.	+	+	+	+	+	+	+	+	V	h	Subevr.
Agropyrum repens (L.) Beauv.		2.2	+	3.3	3.3	1.1	3.3		IV	g	Evr.
Calystegia sepium (L.) R. Br.	+		+			1.1	1.1	1.1	IV	g	Evr.
Cirsium arvense (L.) Scop.	+			+		+	+	+.1	IV	g	Subevr.
Symphytum officinale L.	+	+	+				+	+	IV	h	Subse.
Rumex obtusifolius L.	2.1		+		1.3		1.1		III	h	Subse.

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Locality Локалитет	**Ада Циг.**	**Ада Међ.**	**Велико ратно острво**	**Савски део Новог Београда**	**Макиш**	**Лева обала Дунава**	**Кумод. поток**	**Топч. река**	**Degree presence Степен присус.**	**Жив. форма Life form**	**Флорни елемети Floral elements**
Populus alba L.		+	+1.			+.1		+.1	III	p	Subj.sib.
Artemisia vulgaris L.	+		+			1.1	1.1		III	h	Cirk.
Erigeron annuus (L.) Pers.	2.2	+	+			+			III	th	Adv.
Populus alba L.		+	+1.			+.1		+.1	III	p	Subj.sib.
Convolvulus arvensis L.			+		+	+	1.1		III	g	Kosm.
Bidens tripartitus L.	+	+.1			+			+	III	t	Subse.
Achillea millefolium L.	+				+		+	+	III	h	Evr.
Hordeum murinum L.	+		+			+	+		III	t	Subm.
Dactylis glomerata L.				3.3		+		1.1	II	h	Subevr.
Lotus corniculatus L.	+		+			+			II	h	Subevroaz.
Trifolium repens L.	+		+			+			II	h	Subevr.
Trifolium pratense L.	+		+			+			II	h	Subm.
Euphorbia palustris L.		+			+	+			II	h	Evr.
Geranium robertianum L.	+				+			+	II	th	Subcirk.
Agrostis stolonifera L.			3.4	+.2					II	h	Subevr.
Ulmus laevis Pall.		2.2			3.3				II	p	Subse.
Poa trivialis L.			+		3.3				II	h	Subevr.
Roripa silvestris (L.) Bess.	+.1		2.2						II	h	Subevr.
Polygonum lapathifolium L.			+					2.2	II	g	Subcirk.
Conyza canadensis (L.) Cronquist	2.1	+							II	th	Adv.

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Locality **Локалитет**	**Ада Циг.**	**Ада Међ.**	**Велико ратно острво**	**Савски део Новог Београда**	**Макиш**	**Лева обала Дунава**	**Кумод. поток**	**Топч. река**	**Degree presence** **Степен присус.**	**Жив. форма** **Life form**	**Флорни елемети** **Floral elements**
Glechoma hederacea L.	+.1		1.3						II	h	Evr.
Lysimachia vulgaris L.	1.1		1.2						II	zc	Evr.
Amaranthus retroflexus L.				1.1			1.1		II	t	Adv.
Lythrum salicaria L.						1.1	1.1		II	h	Pont.-ca-subm.
Hedera helix L.	1.1	1.1							II	pl	Subatl.-subm.
Chenopodium album L.						1.1	+.1		II	t	Kosm.
Aristolochia clematitis L.	+	1.1							II	g	Subm.
Galium aparine L.	1.1		+						II	t	Evr.
Vicia cracca L.	+.1						+		II	h	Evr.
Echinocystis lobata (Michx.) Torr. & A.Gray			+		+				II	t	adv (sam)
Ranunculus repens L.	+		+						II	h	Evr.
Stachys palustris L.	+		+						II	g	Cirk.
Capsella bursa-pastoris (L.) Medik.						+		+	II	th	Kosm.
Mentha arvesis L.						+	+		II	g	Cirk.
Carex distans L.	+					+			II	h	Evr.
Consolida regalis Gray						+	+		II	t	Subse.
Lapsana communis L.						+		+	II	th	Subse.

Table 1. Floristic structure of the community *Asteretum lanceolati*
Табела 1. Флористичка структура заједнице *Asteretum lanceolati*

Locality Локалитет	**Ада Циг.**	**Ада Међ.**	**Велико ратно острво**	**Савски део Новог Београда**	**Макиш**	**Лева обала Дунава**	**Кумод. поток**	**Топч. река**	**Degree presence Степен присус.**	**Жив. форма Life form**	**Флорни елемети Floral elements**
Lactuca serriola L.	+						+		II	th	Subpont.-subca-subm.
Humulus lupulus L.	+						+		II	h	Subj.-sib.
Silene alba (Mill.) E.H.L.Krause	+						+		II	th	Subevr.
Chelidonium majus L.	3.3								II	h	Evr.
Stellaria media (L.) Vill.	2.2								I	th	Kosm.
Equisetum telmateia Ehrh.							2.2		I	g	Cirk.
Mentha longifolia (L.) Huds.							1.1		I	g	Subse.
Festuca arundinacea Schreb.	1.1								I	h	Subevr.
Polygonum aviculare L.							1.1		I	t	Kosm.
Salvia verticillata L.							1.1		I	h	Subpont.-subm.
Galium mollugo L.							1.1		I	h	Subse.
Polygonum aviculare L.							1.1		I	t	Kosm.
Phalaris arundinacea L.			+.3						I	g	evr-sam (bor-temp)
Iris graminea L.			+.3						I	g	Subse.
Xanthium strumarium L., var. *italicum*	+.2								I	t	Adv.
Alliaria petiolata (M.Bieb.) Cavara & Grande	+.1								I	h	Subse.

Table 1. Floristic structure of the community *Asteretum lanceolati*
Табела 1. Флористичка структура заједнице *Asteretum lanceolati*

Locality **Локалитет**	**Ада Циг.**	**Ада Међ.**	**Велико ратно острво**	**Савски део Новог Београда**	**Макиш**	**Лева обала Дунава**	**Кумод. поток**	**Топч. река**	**Degree presence** **Степен присус.**	**Жив. форма** **Life form**	**Флорни елемети** **Floral elements**
Salix fragilis L.								+.1	I	p	Subse.
Silene vulgaris (Moench) Garcke							+.1		I	h	Subevr.
Solidago gigantea Aiton							+.1		I	h	Adv.
Plantago major L.	+.1								I	h	Evr.
Plantago lanceolata L.	+.1								I	h	Evr.
Symphytum tuberosum L.						+			I	g	Pont.-subm.
Potentilla reptans L.						+			I	h	Evr.
Melilotus alba Medik.						+			I	th	Subse.
Lolium perenne L.						+			I	h	Subse.
Cynodon dactylon (L.) Pers.						+			I	g	Kosm.
Salix triandra L.				+					I	p	Evr.
Euphorbia cyparissias L.	+								I	h	Evr.
Ballota nigra L.	+								I	g	Subpont.
Poa pratensis L.	+								I	h	Subcirk.
Arctium lappa L.	+								I	h	Evr.
Tussilago farfara L.					+				I	g	Subevr.
Holcus lanatus L.					+				I	h	Evr.
Galium cruciata (L.) Scop.						+			I	g	Subse.
Bromus sterilis L.			+						I	t	Subevr.

Table 1. Floristic structure of the community *Asteretum lanceolati*
Табела 1. Флористичка структура заједнице *Asteretum lanceolati*

Locality Локалитет	**Ада Циг.**	**Ада Мeђ.**	**Велико ратно острво**	**Савски део Новог Београда**	**Макиш**	**Лева обала Дунава**	**Кумод. поток**	**Топч. река**	**Degree presence Степен присус.**	**Жив. форма Life form**	**Флорни елемети Floral elements**
Linaria vulgaris Mill.							+		I	h	Subse.
Papaver rhoeas L.							+		I	th	Subevr.
Roripa amphibia (L.) Bess.							+		I	h	Subevr.

retroflexus are in this group. The other species of this community are generally those in anthropogenically degraded habitats. Figure 1 shows the percentage ratio of invasive plants and other plants in *Asteretum lanceolati* community. Of the total number of plant species 16% accounts for the invasive plant species.

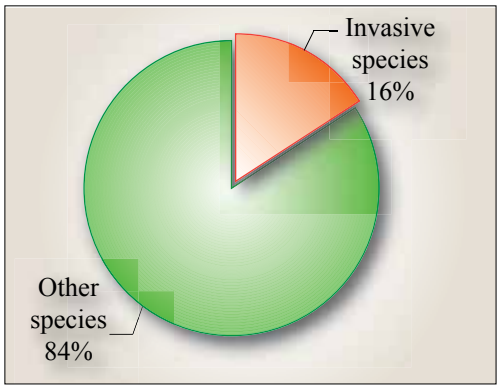

Figure 1. Percentage ratio of invasive and other plant species in investigated localities

Графикон 1. Однос инвазивних и осталих биљних врста на истраживаним локацијама у процентима

The analysis of the life forms (Fig. 2) in the flora of the investigated area shows the domination of hemicriptophytes (H), because the community is composed of herbaceous plants, also a high percentage of plants are the phanerophytes (P). The percentage of chamaephytes (Ch) and therophyta (T) are almost the same because these species are mostly found in open habitats. A very important percentage of geophytes (G) is recorded in the community (19, almost a half), which shows a very mesophilic character of the phytocenoses.

Chorological spectrum of the community showed the domination of the Eurasian (Evr) and Middle European floristic elements (Se) (Fig. 3), and a small number of Pontic-Central Asian (Pont-ca) and sub-Mediterranean floral elements (Subm). Therefore, the presence of circumpolar (Cirk), cosmopolitan (Kosm) and adventive (Adv) floral elements is marked in the community.

Based on analysis, Dale *et al*., (1965), Chmielewski and Semple (1985) concluded that *Aster lanceolatus* occurs on soil that contains almost no organic matter, with a *pH* of 4.6-7.8, and that soil texture does not affect the distribution of species.

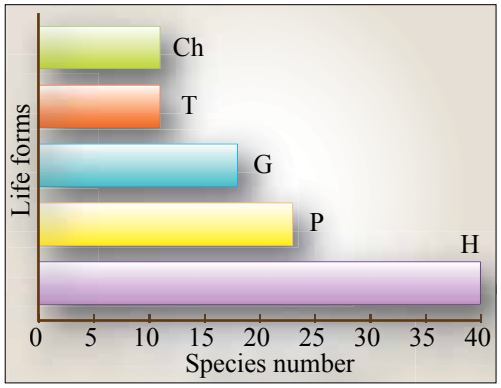

Figure 2. Spectrum of life forms of the community *Asteretum lanceolati*

Графикон 2. Спектар животних форми заједнице *Asteretum lanceolati*

The analysis of variance and multiple ranges of attained results for the *pH* value of the soil at 8 sites indicate that there are significant differences. Locality Ada Međica is singled out into a particular homogeneous group (*pH*=8,33) with the occurrence of a single overlap value from the site of the part of New Belgrade along the Sava

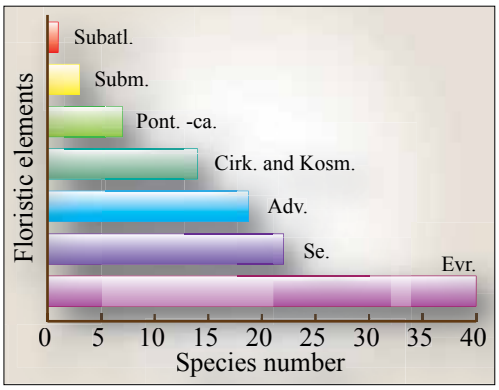

Figure 3. Chorological spectrum of the community *Asteretum lanceolati*

Графикон 3. Хоролошки спектар заједнице *Asteretum lanceolati*

River. In relation to other localities the difference is at a statistically significant level. Differences of the measured *pH* of soil at the localities Ada Ciganlija, Makiš, Kumodraški potok (creek), and Topčiderska reka (river) are not at a statistically significant level.

EC values at the sites VRO Island and Makiš indicate that the amount of nutrients in the soil is higher than in other sites. Coverage of the site type, density and size of plants is also confirmed by the results obtained from these measurements. The lowest *EC* values are mesured in the soil sample from the locality Ada Međica and these are singled out into a particular homogeneous group. There are no significant differences at other localities.

4. DISSCUSION

Invasive species are acknowledged as a major threat to the conservation of global biodiversity (Sala *et al*., 2000, McNeely *et al*., 2001, Cronk, Fuller, 2001, Sukopp, 2002, Cox, 2004). Climate change, agriculture, forestry, trade and passenger traffic, enlarging of recreational areas and unplanned building promote accidental spread of species across their natural boundaries (Jäger, 1988, Kowarik, 2003).

According to literature data (Müller and Okuda, 1998), a North American invasive plant and the edificator of the community - Aster lanceolatus is often a coenobiont in communities in the inundation of big rivers and it is best adapted to seasonal inundation and poor soil aeration. Also, the habitats of the communities are abandoned farmland and plantations, the land along roads, fences, canals, railroads, meadows, ponds, lakes and borders of forests, wetlands (Jones, 1978, Semple *et al*., 1996), and they are characterized by high concentrations of nitrogen compounds in the soil (nitrates and nitrites). The community has rarest representation at dry habitats, along motorway or edges of abandoned fields (Chmielewski, Semple, 1985). Aster lanceolatus is well adapted and tolerant to a wide scale of physiographic and other environmental conditions. It appears in seven of the nine major physiographic regions in Northern America (Hunt, 1974). As the edificator of the community *Aster lanceolatus* dominates the abovementioned habitats, regardless of the extensive production of clones. On the territory of California *Aster lanceolatus* is located in several communities, mainly in the oak belt and shrub formations in wetlands and bog (http://www.cnplx.info/nplx).

On the 8 investigated localities the analysis of variance and multiple ranges of attained results for the *pH* value of the soil indicate that there are significant differences. Locality Ada Međica is singled out as a particular homogeneous group with the occurrence of a single overlap value from the site of the part of New Belgrade along the Sava River. The characteristic of these two localities is their isolation. Ada Međica is under the influence of strong anthropopressure with the rudiments of the native flora, and the part of New Belgrade along the Sava River is the most urban part. Veliko Ratno ostrvo (island) and Makiš show the highest values in relation to electrical conductivity (*EC*) in the soil. At these sites there is very dense population of *Aster lanceolatus*.

In relation to life forms, terophytes and phanerophytes are much more present among the neophytes than in native ecosystems, while hemicryptophytes hydrophytes are less present. In the community *Asteretum lanceolati* more phanerophytes (23%) are represented than usual in the communities that develop in open habitats.

Investigation of communities with *Aster lanceolatus* and other invasive plants in Czech Republic (Pyšek *et al*., 1995) has shown that nutrient- rich and warmer sites appear to be more susceptible to invasions as the invaders often require such conditions. This is confirmed by the studies of the *EC*. On Veliko Ratno ostrvo (island) and Makiš, the *EC* values indicate that the amounts of nutrients in the soil are higher than at other localities. At these two localities the abundance of characteristic species of the community is the greatest.

The edificator of the community is not adapted to the conditions of shadow, which can easily be concluded by its presence in Ada Ciganlija and the left bank of the Danube river on one side and Makiš, on the other. It occurs sporadically in shade habitats. In such habitats inflorescence and the number of heads of flowers are considerably reduced.

Analysis of the communities in which *Aster lanceolatus* is a coenobiont shows that there is a special relationship between the basic communities and native vegetation and other invasive species (Rejmánek, 1989). Nevertheless, a very important question is whether some communities are more invasive than others (Williamson, 1996) and consequently, whether some regions are more susceptible to invasion by other invasive species (Lonsdale, 1999). Variability in available resources (habitat) is described as the most important mechanism which could explain the invasive nature of the ecosystems (Davis *et al*., 2000, Davis, Pelsor, 2001). Potential effects of global warming on the dynamics of the spread of invasive species are also labeled as significant (Mooney, Hobbs, 2000, Richardson *et al*., 2000).

5. CONCLUSION

The *Asteretum lanceolati* community is a new type of invasive community in wet and degraded habitats. It occurs mainly under human impact in the area of rivers and depends on the dynamics of the river bed. The community is composed of 104 species, and

Aster lanceolatus, *Cichorium intybus*, *Agropyrum repens*, *Cyrsium arvense*, *Symphytum officinale*, *Rumex obtusifolius*, *Artemisia vulgaris*, *Erigeron annuus* and *Amaranthus retroflexus* form the characteristic set. The other species of the community are those that are on anthropogenically degraded habitats. From the total number of plant species, 16% are invasive plants. The edificator of the community and the species of the characteristic set are characterized by the expressed number and sociality. In relation to life forms, the communities have chemocriptophytes character, and in relation to phytogeography Euroasian and Middle Europaean floral elements are dominant, with a high presence of cosmopolitan and adventive floral elements.

The analysis of variance and multiple range of attained results for the *pH* value of the soil at 8 sites indicates that there are significant differences: locality Ada Međica is singled out into a particular homogeneous group with the occurrence of a single overlap value from the site of the part of New Belgrade along the Sava River. In relation to all other sites the difference is at a statistically significant level. Differences in the measured values of *pH* in other localities are not at a statistically significant level.

EC values at the sites VRO Island and Makiš indicate that the amount of nutrients in the soil is higher than in other sites. The coverage of the site type, density and size of plants are also confirmed by the results obtained from these measurements.

Degradation and devastation of the habitat and climate changes often lead to the spread of invasive species and their communities. The invasiveness degree of the community is in direct correlation with the degradation of habitats.

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ASTERETUM LANCEOLATI - КСЕНОСПОНТАНА ЗАЈЕДНИЦА НА ВЛАЖНИМ И ПРИОБАЛНИМ СТАНИШТИМА

Резиме

Aster lanceolatus је једна од најинвазивнијих зељастих биљних врста у Србији. Обично се налази на влажним и приобалним стаништима дуж водотока, а њено ширење је условљено како динамиком речног корита тако и морфолошким прилагођеностима као што су веома развијен систем ризома, време цветања (касна јесен), плодоношења и сл. У Србији је забележена на већем броју локалитета, а као репрезентативни за приказ и анализу заједнице изабрани су локалитети у Београду у којима врста апсолутно доминира: Ада Циганлија, Ада међица, лева обала Дунава (Панчевачки рит), Макиш, савски део Новог Београда, Велико ратно истрво, Кумодрашки поток и Топчидерска река.

Опсежна флористичка истраживања на овим локалитетима вршена су у току 2008. и 2009. године. Подаци који су неопходни за одређивање структуре заједнице анализирани су на основу „CPS SKEW" Schwarze Liste und Watch List gebietsfremde Invasive Pflanzen, on line (2009), модификовани за услове Београда. У исто време испитивана је и електрична проводљивост земљишта и pH земљишта.

Утврђено је да се заједница састоји од 107 биљних врста, од којих се едификатор заједнице *Aster lanceolatus* доминантна врста на свим локалитетима. Осим ове инвазивне врсте у састав заједнице улазе још око 20 инвазивних врста и неофита као што су: *Cichorium intybus*, *Agropyrum repens*, *Cyrsium arvense*, *Symphytum officinale*, *Rumex obtusifolius*, *Artemisia vulgaris*, *Erigeron annuus*, *Amaranthus retroflexus*, *Acer negundo*, *A. saccharinum*, *Ulmus laevis*, *Robinia pseudacacia*, *Ailanthus altissima*, *Fraxinus pennsilvanica*, *F. americana*, *Acer negundo*, *Amorpha fruticosa*, *Reynoutria japonica*, итд.

Анализа животних форми показала је доминацију хемикриптофита, а заступљеност хамефита и терофита је готово иста с обзиром да се углавном ради о деградираним стаништима под изразитом антропопресијом.

Анализом хоролошког спектра заједнице утврђена је доминациа евроазијских средњеевропских флорних елемената. Учешће циркумполарних, космополитских и адвентивних елемената је врло високо.

Анализа варијансе и мултипле анализе pH земљишта показала је да постоје сигнификантне разлике између локалитета, при чему се издвајају Ада Међица и савски део Новог Београда, а остали локалитети нису показали диференцијацију на статистичом нивоу.

Електрична проводљивост земљишта је, према истраживањима, изражена на локалитетима Велико Ратно острви и Макиш, што указије на већу концентрацију хранљивих материја у земљишту у односу на остале локалитете, што је у корелацију са бројношћу врста на наведеним локалитетима. Најмања вредност за електричну проводљивост земљишта констатована је на локалитету Ада Међица где је и бројност врста најмања.