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Reynoutria sachalinensis: a new invasive species to the flora of Serbia and its distribution in SE Europe

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ABSTRACT: During an extensive field mapping of *Reynoutria* taxa that was carried out in Serbia and Montenegro in the period 2006–2012, an interesting specimen was collected in the vicinity of the Special Nature Reserve and Ramsar site "Carska bara" (Vojvodina, Serbia). The recorded plant was identified as giant knotweed *Reynoutria sachalinensis* (F. Schmidt) Nakai, and it is the first certain record of this invasive species for Serbia. The species covered an area of 1748 m² on the bank of the canal connected to the river Begej, forming six separate compact stands on the edge of poplar-willow forest, wet grasslands and near agricultural fields, just 3 km from the northern border of Ramsar site "Carska bara". This finding indicates a range extension of *R. sachalinensis* in the Balkan Peninsula. All distribution data of *Reynoutria sachalinensis* in Serbia and SE Europe are presented and critically analyzed.

Key words: Invasive species, first record, range extension, *Reynoutria sachalinensis,* Serbia, Balkan Peninsula

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INTRODUCTION

Reynoutria sachalinensis (= *Polygonum sachalinensis* F. Schmidt, *Fallopia sachalinensis* (F. Schmidt) Ronse Decr., *Pleuropterus sachalinensis* (F. Schmidt) H. Gross, *Tiniaria sachalinensis* (F. Schmidt) Janch.) is a species native to eastern Asia. It is distributed from the southern part of Sakhalin Island, the southern Kuril Islands, the Japanese islands of Hokkaido and Honshu to Korea (Sukopp & Starfinger 1995).

R. sachalinensis was first introduced into Europe in 1855, then in 1861 and later in 1864. It was transferred from Sakhalin to St. Petersburg Botanic Garden from where it was distributed as an ornamental plant to European botanical gardens (Bailey & Conolly 2000). However, this species has escaped to the wild. Giant knotweed was first recorded in the wild in Germany and the Czech Republic in 1869 and in Great Britain in 1896 (Sukopp & Starfinger 1995).

The presence and spreading of invasive alien *Reynoutria* taxa in the central part of the Balkan Peninsula, especially in Serbia, have not been systematically investigated. The first indication that *R. japonica* Houtt. and *R. sachalinensis* (F. Schmidt) Nakai were naturalized in the Balkans was published in Jalas and Suominen (1979). In the Flora of Serbia, Slavnić (1972) did not give any information concerning its presence. The first records on the naturalization of alien *Reynoutria* taxa in Serbia were published in Jovanović (1994) for *R. japonica* and in Glavendekić (2008) for *R.* × *bohemica* Chrtek and Chrtková.

Nevertheless, during recent years, massive and fast spreading of these aggressive taxa has been observed even outside the urban areas, i.e., close to the roads, on

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riverbanks, on agricultural land, etc. Nowadays, the most frequent *Reynoutria* taxa in the Central Balkans, especially in Serbia and Montenegro are *Reynoutria japonica var. japonica* and the hybrid *R.* × *bohemica* (Jovanović *et al.* 2009).

During extensive field mapping in 2006-2012 of *Reynoutria* taxa that was carried out in Serbia and Montenegro, an interesting specimen was collected in the vicinity of Special Nature Reserve "Carska bara" (Vojvodina, Serbia) which was declared as a Ramsar site in 1996. The newly-recorded plant was identified as giant knotweed *Reynoutria sachalinensis* (F. Schmidt) Nakai, and it is the first certain record for this invasive species for Serbia.

The aim of this paper is to present distribution data of *R. sachalinensis* in Serbia and other parts of the Balkan Peninsula. All distribution data are critically analyzed.

MATERIAL AND METHODS

The research was based on personal field study, on herbarium specimens and on literature data. Field mapping was done by the method of GPS positioning with a hand-held GPS Garmin eTrex Vista® HCx. The general distributions of species are presented on a UTM grid square 50 x 50 km based on the Universal Transverse Mercator (UTM) projection. Latitudes and longitudes are given in the World Geodetic System 84 (WGS84). Phytosociological characteristics of sites with *R. sachalinensis* were studied according to the Braun-Blanquet approach (Braun-Blanquet 1928).

The identification was based on Bailey and Wisskirchen (2006) and Bailey *et al.* (2009). Herbarium specimens collected in the field were deposited in the Herbarium of Institute of Botany and Botanical Garden, Faculty of Biology, University of Belgrade (BEOU).

Voucher specimens:

Serbia, Vojvodina (Banat), Ečka, Lukino selo, 45.3155 N, 20.4269 E, 75 m, 11.7.2010, *Hlavati-Širka, V. 16619* (BEOU)

Serbia, Vojvodina (Banat), Ečka, Lukino selo, 45.31534 N, 20.42665 E, 76 m, 08.10.2012, *Jovanović, S., Lakušić, D., Šinžar-Sekulić, J. 37565* (BEOU)

Study Area:

The investigated sites were located just near the Special Nature Reserve „Carska bara" in the western part of the central Banat (Serbia, Vojvodina), in the territory of the municipality of Zrenjanin (**Fig. 1-2, Tab. 1**). The site, a remnant of the once-flooded area in the lower Begej River, is a mosaic of fishponds, swamp, marsh, forest, meadow, and steppe intersected by river, canals, and embankments. Vegetation mainly consists of salt-tolerant communities, a rich aquatic flowering plant community, and steppe vegetation. Its ornithofauna is of great importance for the Special Nature Reserve. Of the 250 recorded bird species, 140 species nest at the site and 100 pass through on migration. Notably, all eight European heron species and *Anser anser* nest at the site. 140 species of nesting birds are globally endangered species from the World and European Red Lists, such as White-headed Duck (*Oxyura leucocephala*), Lesser White-fronted Goose (*Anser erythropus*), Pygmy Cormorant (*Phalacrocorax pygmaeus*), Dalmatian Pelican (*Pelecanus crispus*), White-tailed Eagle (*Heliaeetus albicilla*), Corn Crake (*Crex crex*), as well as species endangered in the Pannonian plain (Budakov et al. 1998). The diversity of biotopes gives rise to high species diversity at the site and includes various rare, endangered, or vulnerable fish, birds, plants, amphibians, reptiles and mammals. Because of these natural characteristics, Special Nature Reserve „Carska bara" is recognized as an area of international importance, so it is included in the list of Ramsar sites, Important bird area (IBA), Important plant area (IPA) and Emerald sites.

RESULTS

Reynoutria sachalinensis was recorded only in the area of the village Lukino selo, near Ečka in Vojvodina, on the bank of the canal connected to the river Begej, at 75 m a.s.l. The species covered an area of 1748 m², forming six separate compact stands. Four stands were located on sublocality Staro Selo, and the remaining two on sublocality Prevodnica (**Fig. 1**, **Tab. 1**). All stands were recorded on the edge of poplar-willow forest (*Populetea albae Br.-Bl.* 1962), wet grasslands (*Molinio-Arrhenatheretea* R.Tx. 1937) and near agricultural fields, just 3 km from the northern border of the Ramsar site and Special Nature Reserve "Carska bara".

A review of the literature data revealed that this species had not previously been recorded for the flora of Serbia (Jovanović 1994, Jovanović *et al.* 2009; Vasić 2006; Glavendekić 2008). Therefore, this finding is the first record of giant knotweed *R. sachalinensis* in Serbia and represents a species range extension on the Balkan Peninsula (**Fig. 2, Tab. 2**).

In the area of the village Lukino selo, near Ečka *R. sachalinensis* builds two types of associations. The first type are monodominant communities in which *R. sachalinensis* completely covers the entire surface of the soil, while the second type are low *Robinia pseudoacacia* stands in which *R. sachalinensis* forms a dense tall herb layer.

A relevé from the community dominated by *R. sachalinensis* - relevé area: 25 m², aspect: SW, slope: 30-60°; coverage: 100 %: ***Reynoutria sachalinensis* 5**, *Hordeum*

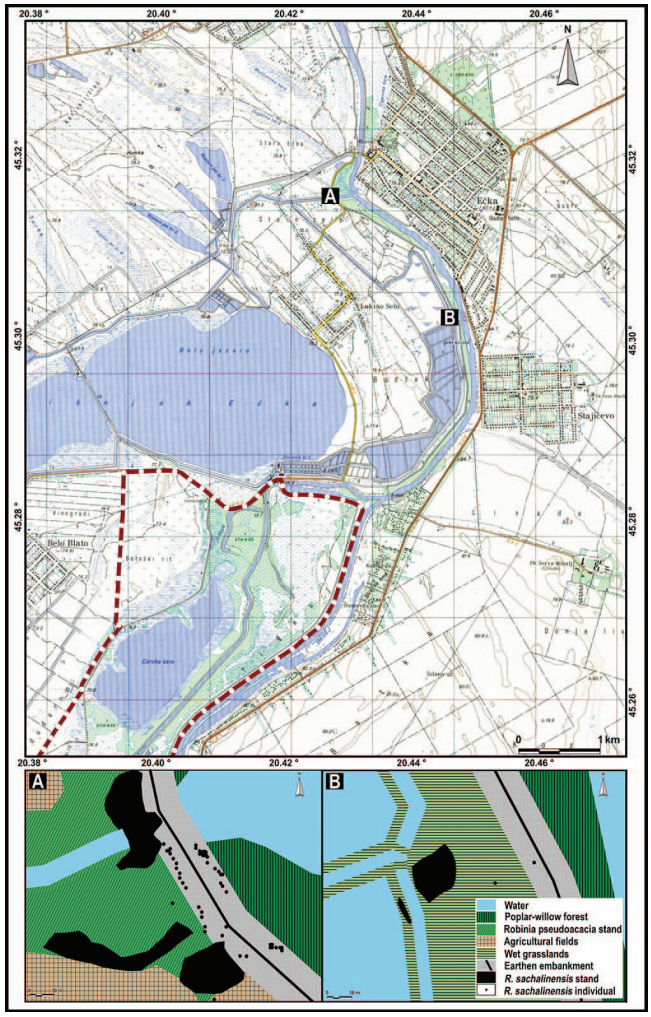

Fig. 1. Distribution of *Reynoutria sachalinensis* in the vicinity of Ečka in Vojvodina (Serbia).
A - Staro Selo, **B** - Prevodnica, **Red line** - Ramsar site and Special Nature Reserve "Carska bara"

murinum 2, *Lolium perenne* 2, *Polygonum aviculare* 1, *Anthriscus sylvestris* 1, *Bromus sp.* 1, *Cichorium intybus* 1, *Convolvulus arvensis* 1, *Calystegia sepium* 1, *Urtica dioica* +, *Rubus caesius* +, *Chenopodium album* +, *Taraxacum officinale* +, *Amaranthus retroflexus* +, *Cornus sanguinea* +, *Crategus monogyna* +, *Bryonia sp.* +, *Sambucus ebulus* r, *Sorghum halepense* r, *Verbena officinalis* r, *Datura stramonium* r.

A relevé from the community dominated by *Robinia pseudoacacia* - relevé area: 25 m^2, slope: 0°; coverage: 100 %: Tree layer**:** *Robinia pseudoacacia* 3, *Acer negundo* 1, Shrub layer**:** *Amorpha fruticosa* 1, *Prunus spinosa* 1, *Crategus monogyna* 1, *Cornus sanguinea* +, *Populus alba* +, Herb layer: ***Reynoutria sachalinensis* 4,** *Polygonum aviculare* 1, *Anthriscus sylvestris* 1, *Urtica dioica* +, *Rubus caesius* +, *Chenopodium album* +, *Taraxacum officinale* +.

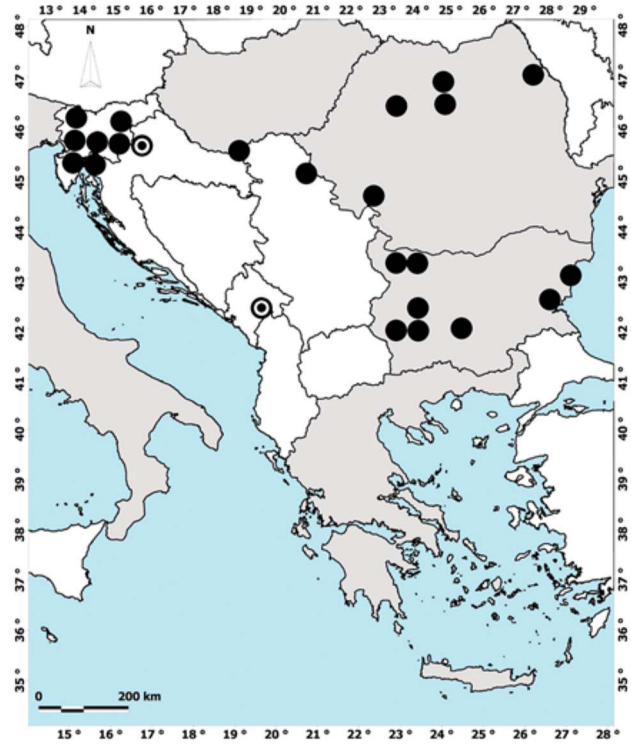

Fig. 2.Distribution of *Reynoutria sachalinensis* in SE Europe.
Grey areas - state where the species is present according to DAISIE (2008); **White areas** - state where the species is not registered according to DAISIE (2008); ● - UTM squares 50 x 50 km; ⦿ - erroneous identification

DISCUSSION

In the Balkan Peninsula, giant knotweed has been recorded in Bulgaria (Jalas & Suominen 1979), Slovenia (Jalas & Suominen 1979; Strgulc-Krajšek & Jogan 2011), Croatia (Nikolić 2012) and Montenegro (Šilić 2006). However, data for Montenegro (Kolašin, Botanical garden "Dulovine") are erroneous, and refer to *R.* × *bohemica* (Jovanović *et al.* 2009). Revision of herbarium material from Croatia (ZA, ZAHO, CNHM) indicates that the available specimens of *R. sachalinensis* were incorrectly identified (ZA-16277, Zagreb, Mlinovi; ZA-16276, Zagreb, Trg Športova; ZA-16275, Zagreb, near the road that connects Moskovska and Zagorska street), and related to the taxon *R.* × *bohemica.* Data from Bulgaria also require serious revision, and probably refer to *R.* × *bohemica.* Special attention should be given to these issues in further research in SE Europe.

No additional data regarding the invasive alien species *R. sachaliensis* are available for Bosnia and Herzegovina, Albania, Macedonia and Montenegro (DAISIE 2008). Data for some other countries in the Balkans are incomplete, e.g., Greece is mentioned as region where the

Table 1. Georeferenced data of the distribution of *Reynoutria sachalinensis* in the village Lukino selo, near Ečka in Vojvodina.

Stand	Locality	Area (m^2)	N lat	E long	Alt (m a.s.l.)	Date
1	Ečka, Lukino selo, Staro selo	569	45.31576	20.42662	77	08.10.2102
2	Ečka, Lukino selo, Staro selo	422	45.31534	20.42665	76	08.10.2102
3	Ečka, Lukino selo, Staro selo	350	45.31534	20.42697	75	08.10.2102
4	Ečka, Lukino selo, Staro selo	6	45.31568	20.42696	77	08.10.2102
5	Ečka, Lukino selo, Prevodnica	378	45.30202	20.44664	75	08.10.2102
6	Ečka, Lukino selo, Prevodnica	23	45.30155	20.44611	75	08.10.2102
Total		**1,748**				

Table 2. Georeferenced data of the distribution of *Reynoutria sachalinensis* in SE Europe.
MGRS - UTM MGRSNAME, **Long** - longitude, **Lat** - latitude**, Alt** - altitude**, Acc** - accuracy, **Date** - Date of occurrence, **BEOU** - Herbarium of University of Belgrade, *erroneous identification

Locality	MGRS	Long	Lat	Alt	Acc	Date	Source
Bulgaria	34TFM3	23.12	42.208		50 km		JALAS, SUOMINEN 1979
Bulgaria	34TFP4	23.167	43.557		50 km		JALAS, SUOMINEN 1979
Bulgaria	34TGM1	23.717	42.195		50 km		JALAS, SUOMINEN 1979
Bulgaria	34TGN2	23.725	42.645		50 km		JALAS, SUOMINEN 1979
Bulgaria	34TGP2	23.744	43.545		50 km		JALAS, SUOMINEN 1979
Bulgaria	35TLG1	24.88	42.208		50 km		JALAS, SUOMINEN 1979
Bulgaria	35TNH2	27.305	42.677		50 km		JALAS, SUOMINEN 1979
Bulgaria	35TNH3	27.922	43.124		50 km		JALAS, SUOMINEN 1979
Croatia: Beli Manastir,	34TCR1	18.606	45.767	94	1 km	2007	PURGER, CSIKY 2008
Croatia: Beli Manastir, Popovac	34TCR1	18.665	45.804	89	1 km	2007	PURGER, CSIKY 2008
Croatia: Beli Manastir, Karanac	34TCR1	18.686	45.756	106	1 km	2007	PURGER, CSIKY 2008
Croatia: Beli Manastir, Branjina	34TCR1	18.693	45.824	87	1 km	2007	PURGER, CSIKY 2008
Croatia: Beli Manastir, Kamenac	34TCR1	18.706	45.768	112	1 km	2007	PURGER, CSIKY 2008
Croatia: Beli Manastir, Podolje	34TCR1	18.728	45.816	102	1 km	2007	PURGER, CSIKY 2008
Croatia: Beli Manastir, Kneževi Vinogradi	34TCR1	18.735	45.749	85	1 km	2007	PURGER, CSIKY 2008
Croatia: Beli Manastir, Kotlina	34TCR1	18.738	45.789	110	1 km	2007	PURGER, CSIKY 2008
Croatia: Beli Manastir, Gajić	34TCR1	18.773	45.839	84	1 km	2007	PURGER, CSIKY 2008
Croatia: Beli Manastir, Suza	34TCR1	18.776	45.782	92	1 km	2007	PURGER, CSIKY 2008
Croatia: Beli Manastir, Draž	34TCR1	18.79	45.837	83	1 km	2007	PURGER, CSIKY 2008
Croatia: Beli Manastir, Zmajevac	34TCR1	18.807	45.799	85	1 km	2007	PURGER, CSIKY 2008
Croatia: Beli Manastir, Batina	34TCR1	18.852	45.851	84	1 km	2007	PURGER, CSIKY 2008

Locality	MGRS	Long	Lat	Alt	Acc	Date	Source
Croatia: Čabar	33TVL4	14.646	45.596	514	1 km	2010	STRGULC-KRAJŠEK, JOGAN. 2011
Croatia: Karlovac, Grič	33TWL1	15.442	45.77	789	1 km	2007	NIKOLIĆ 2012
Croatia: Klana,	33TVL4	14.376	45.447	566	1 km	1997	NIKOLIĆ 2012
Croatia: Rijeka, Kastav	33TVL2	14.349	45.372	351	1 km	1997	NIKOLIĆ 2012
Croatia: Rijeka, Viškovo	33TVL4	14.385	45.378	337	1 km	1997	NIKOLIĆ 2012
Croatia: Rijeka, Grobnik	33TVL4	14.46	45.37	447	1 km	1997	NIKOLIĆ 2012
Croatia: Rijeka, Kostrena	33TVL4	14.5	45.306	96	10 km	1997	NIKOLIĆ 2012
Croatia: Rijeka, Bakar	33TVL4	14.535	45.307	7	1 km	1997	NIKOLIĆ 2012
Croatia: Rijeka, Kraljevica	33TVL4	14.569	45.274	16	1 km	1997	NIKOLIĆ 2012
*Croatia: Zagreb, Trg Športova	33TWL3	15.951	45.809	119	1 km	1971	NIKOLIĆ 2012
*Croatia: Zagreb, Mlinovi	33TWL3	15.964	45.848	231	1 km	1973	NIKOLIĆ 2012
*Croatia: Zagreb, near the road that connects Moskovska and Zagorska street	33TWL3	15.56	45.48	200	1 km	1971	NIKOLIĆ 2012
*Montenegro: Kolašin, Botanical Garden Dulovine	34TCN4	19.528	42.819	1007	1 km	2006	ŠILIĆ 2006
Romania: Beica de Sus	35TLM1	24.821	46.739	397	1 km	1997	OPREA 2005
Romania: Caşva	35TLM1	24.877	46.781	431	1 km	1997	OPREA 2005
Romania: Cluj-Napoca, bank of Someş River, escaped from Botanical Garden	34TFS3	23.6	46.777	333	10 km	1947	OPREA 2005
Romania: Eşelniţa, valley	34TFQ1	22.365	44.702	85	10 km	2002	OPREA 2005
Romania: Gălăoaia	35TLN2	24.93	46.974	519	1 km	1998	OPREA 2005
Romania: Gurghiu	35TLM1	24.855	46.775	414	1 km	1997	OPREA 2005
Romania: Iaşi, naturalized in Botanical Garden	35TNN2	27.551	47.186	99	1 km	2008	OPREA 2005
Romania: Ibăneşti-Pădure	35TLM1	24.976	46.76	540	1 km	1997	OPREA 2005
Romania: Solovăstru	35TLM1	24.77	46.774	396	1 km	1997	OPREA 2005
Serbia: Zrenjanin, Ečka	34TDR4	20.42696	45.31568	72	50 m	2010	BEOU- 16619
Serbia: Zrenjanin, Ečka	34TDR4	20.44664	45.30202	72	50 m	2012	BEOU- 37565
Slovenia: Celje, Medlog, grassy mound near the Styrian highway	33TWM2	15.228	46.248	242	1 km	2010	STRGULC-KRAJŠEK, JOGAN. 2011
Slovenia: Celje, Polule	33TWM2	15.249	46.215	313	1 km	2010	STRGULC-KRAJŠEK, JOGAN. 2011
Slovenia: Celje	33TWM2	15.26	46.231	242	10 km	1935	STRGULC-KRAJŠEK, JOGAN. 2011
Slovenia: Celje, Kidričeva str., near gas station	33TWM2	15.283	46.235	235	1 km	1989	STRGULC-KRAJŠEK, JOGAN. 2011

Locality	MGRS	Long	Lat	Alt	Acc	Date	Source
Slovenia: Jesenice, Planina pod Golico	33TVM2	14.051	46.466	957	1 km	1990	STRGULC-KRAJŠEK, JOGAN. 2011
Slovenia: Kočevje, Rinža river	33TVL3	14.862	45.64	467	1 km	2010	STRGULC-KRAJŠEK, JOGAN. 2011
Slovenia: Ljubljana, Botanical Garden	33TVL3	14.514	46.04	294	1 km	1988	STRGULC-KRAJŠEK, JOGAN. 2011
Slovenia: Ljubljana, Ig	33TVL3	14.527	45.959	297	1 km	2009	STRGULC-KRAJŠEK, JOGAN. 2011
Slovenia: Postojna, Planina near Planinsko polje	33TVL1	14.251	45.83	462	1 km	1981	STRGULC-KRAJŠEK, JOGAN. 2011

Fig. 3 *Reynoutria sachalinensis* in the vicinity of Ečka in Vojvodina (Serbia).

giant knotweed is "less commonly cultivated or escaping" (Snogerup & Snogerup 1997; DAISIE 2008) and "alien of unknown naturalisation status" (Arianoutsou *et al.* 2010), but exact location data are not available.

Despite a significant research effort over a large sampling area in Serbia and Montenegro, we did not find any other giant knotweed population. The closest published record of giant knotweed is Zmajevac in Croatia about 140 km (linear distance) (Purger & Csiky 2008) and Eşelniţei in Romania (Oprea 2005) about 167 km (linear distance).

Giant knotweed is less invasive than *R.* × *bohemica* and *R. japonica* but it can spread rapidly through the riparian zone as flood waters transport vegetative fragments downstream (Pyšek & Prach 1994; Bímová *et al.* 2003). It is well known that giant knotweed is capable of forming large monospecific stands spontaneously on riverbanks, causing serious deterioration of the biodiversity, negatively affecting plant and invertebrate assemblages in riparian habitats (Pyšek & Prach 1994; Marigo & Pautou 1998; Kappes *et al.* 2007; Gerber *et al.* 2008). Its invasion has the potential to cause long-term changes in the structure and functioning of riparian forests and adjacent aquatic habitats (Hejda *et al.* 2009; Urgenson *et al.* 2009). It produces novel secondary compounds which may contribute to allelopathic or antimicrobial effects (Weston *et al.* 2005). Hence, it can lead to community reorganization by displacing native species and depletion of diversity in Ramsar site and Special Nature Reserve "Carska bara" because of the effect on ecosystem structure and function. Therefore, there is a real possibility of its spreading in the protected zone, because this population is located on the bank of the canal connected to the river Begej that flows through the Ramsar site and Special Nature Reserve "Carska bara".

Due to these findings, an immediate action plan is necessary to minimize its effects on the autochthonous flora and fauna of the Ramsar site and Special Nature Reserve. Since the invasion in Serbia was detected at an early stage, the most efficient means to stop its expansion would be to conduct eradication measures to prevent the spread. Vegetative spread can be controlled by purely mechanical disturbance of underground biomass, digging

of the soil surface up to 50 cm in depth (Bímová et al. 2001).

In addition, an action plan should include the sensitizing of the local population to the problem of inadequate disposing of giant knotweed remains from private gardens. Several nearby areas in the vicinity of the Ramsar site and Special Nature Reserve "Carska bara", should be chosen to detect its possible spread. A monitoring program should be implemented to detect early infestation to control and eliminate invasives before any biodiversity loss.

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REZIME

Reynoutria sachalinensis: nova invazivna vrsta za floru Srbije i njeno rasprostranjenje u JI Evropi

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Tokom ekstenzivnog terenskog kartiranja vrsta iz roda *Reynoutria* koja su izvedena na području Srbije i Crne Gore u periodu od 2006. do 2012. godine, pronađen je jedan interesantan primerak u blizini Specijalnog rezervata prirode i Ramsarskog područja "Carska bara" (Vojvodina, Srbija). Prikupljena individua je identifikovana kao vrsta *Reynoutria sachalinensis* (F. Schmidt) Nakai i predstavlja prvi siguran nalaz ove invazivne biljke za Srbiju. *R. sachalinensis* se razvija na obali kanala povezanog sa rekom Begej, na lokalitetu koji je samo 3 km udaljen od severne granice Ramsarskog područja "Carska bara". Vrsta zauzima površinu od 1748 m², obrazujući šest odvojenih kompaktnih sastojina na rubovima vrbovo-topolovih šuma, vlažnih livada i poljoprivrednih površina. Navedeni nalaz ukazuje na širenje areala vrste *R. sachalinensis* na Balkanskom poluostrvu. U radu su prikazani i kritički analizirani svi podaci o rasprostranjenju *R. sachalinensis* u Srbiji i JI Evropi.

Ključne reči: Invazivne vrste, prvi nalaz, širenje areala, *Reynoutria sachalinensis,* Srbija, Balkansko poluostrvo