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New Data on the Spread of *Trachemys scripta* (Thunberg in Schoepff, 1792) (Testudines: Emydidae) and its Subspecies in Serbia

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Abstract: This study presents an overview of localities where the alien pond slider *Trachemys scripta* (Thunberg in Schoepff, 1792) (Emydidiae) and its subspecies, *T. s. elegans* (Wied-Neuwied, 1839)*, T. s. scripta* (Thunberg in Schoepff, 1792) and *T. s. troostii* (Holbrook, 1836), has been introduced in Serbia and shows indication of its possible reproduction in this country. The number of the new reports of these turtles is almost equal to the number of previously published findings. Most introductions as well as the cases of possible reproduction (nest-digging females and hatchlings found) have been concentrated around the large urban hubs – Belgrade and Novi Sad cities, where the largest populations have been detected. Generally, the water bodies in the lowland habitats (less than 100 m a.s.l.) were proven to be much more vulnerable to the introduction of alien turtles – more than 73% of cases of introduction were detected at low altitudes. Previously unreported "substitute" subspecies (*T. s. scripta* and *T. s. troostii*) can hybridise with the red-eared slider (*T. s. elegans*) and possibly increase its invasive potential. We suggest stricter enforcement of the legislation, together with raising public awareness of the problem, eradication of the established populations and building turtle sanctuaries as an ethical and ecologically safe alternative for disposal of unwanted pets.

Key words: invasive species, introductions, reproductive success, red-eared slider, expansion

Introduction

Turtles are considered to be among the most problematic introduced species. That is especially true for the red-eared slider *Trachemys scripta elegans* (Wied-Neuwied, 1839), which is listed as one of the 100 worst invasive species (Scalera 2006). These, once popular pet animals, have been released by owners and are now living in the wild in almost all European countries (Scalera 2006), including Serbia (Scalera 2006, Džukić et al. 2008, Lazarević et al. 2012, Đorđević & Anđelković 2015, Urošević et al. 2016). After the EU posed a ban on import and trade of the red-eared slider via Council Regulation (EC) no. 338/97 on the Protection of Species of Wild Fauna and Flora by

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Regulating Trade (Bringsøe 2006), many so-called "substitute" species and subspecies emerged in the pet trade, among them the yellow-bellied slider *Trachemys scripta scripta* (Thunberg in Schoepff, 1792) and the Cumberland slider *Trachemys scripta troostii* (Holbrook, 1836). Consequently, these turtles also found their way into natural ecosystems (Bringsøe 2006, Alarcos Izquierdo et al. 2010, Valdeón et al. 2010, Pupiņš & Pupiņa 2011, Kleewein 2014, Urošević 2014). In this paper, we present new data on the potential breeding of the red-eared slider in Serbia and report the cases of introduction of two, previously unrecorded, subspecies in this country.

Materials and Methods

The dataset presented in this study includes authors' unpublished field observations gathered in 2013–2017 (24 field entries, 46% of the total entries), field data by other colleagues (see Acknowledgements) and published literature data with additional 28 field entries (Đorđević & Anđelković 2015, Urošević et al. 2016). Some unpublished data confirm known records but there is also a significant amount of previously unreported localities, especially for western Serbia and Vojvodina. During the field trips, subspecies of *Trachemys scripta* were detected by visual observations and identified according to the relevant literature (Bringsøe 2006).

Results

All known findings of *Trachemys scripta* ssp. are shown on the map (Fig. 1). The unpublished data, including confirmation of old findings, are given in Table 1. There are also cases of previously unreported yellow-bellied slider (*T. s. scripta*) for Novi Sad, Inđija, Galovica and Smederevo (Table 1) and Cumberland slider (*T. s. troostii*) for Galovica and Kanjiža (Table 1).

At 12 localities, more than a single individual was observed, while at two of those large populations, more than 40, turtles were reported (Table 1). Possible breeding was observed in Novi Sad (a female digging nest, Đorđević & Anđelković 2015), at Sebeš Canal in Borča (hatchlings found, Đorđević & Anđelković 2015) as well as at Galovica Canal (a female digging nest, this study). Additionally, a captive population in the Belgrade Zoo provided a solid proof of successful breeding in this climate, at least during the warmer years since eggs and hatchlings are vulnerable to colder periods (Đorđević & Anđelković 2015). All cases of possible breeding are also presented on the map (Fig. 1). Most findings of the red-eared slider (73%) and all but one finding of the other subspecies have been recorded in habitats below 100 m a.s.l.

Discussion

Since the last published surveys, the number of reports of red-eared sliders in Serbia has almost doubled. A pattern has begun to emerge. Most findings are accidental introductions of one or few specimens but there are few cases, in the cities of Novi Sad and Belgrade, in which the alien turtles have great population densities (in the Danube River Park in Novi Sad introduced population even outnumbers the population of native European pond turtles). In those cases, breeding behaviour is also reported. Previous studies have linked population density of red-eared sliders with proximity of human settlements (Arvy & Servan 1996, Scalera 2006). The larger water bodies, such as lakes, exhibit the highest percentage of occupied sites compared to small ponds, artificial pools or fountains, due to the

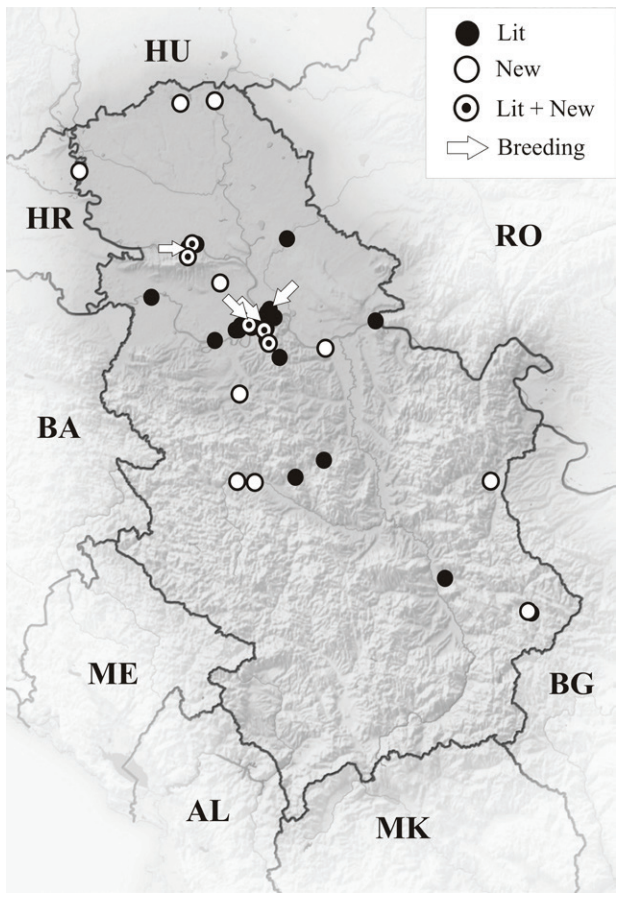

Fig. 1. Map showing the findings of *Trachemys scripta* ssp. in Serbia: published (Lit), reconfirmed (Lit + New), and previously unpublished localities (New). Arrows indicate sites with observed breeding activity or hatchlings.

Table 1. Previously unpublished records of *Trachemys scripta* ssp. in Serbia, with noted subspecies (Sub: E – *T. s. elegans,* S – *T. s. scripta* and T – *T. s. troostii*), locality, altitude (alt, in metres) and geographic coordinates (decimal). Date – full date or year of observation N – as number of observed individuals. Records with breeding evidence are given in boldface. Asterisk (*) denotes reconfirmations of previously published data.

Sub	Locality	alt	Latitude	Longitude	Legator	Date	N
E	Zaječar - r. CrniTimok	125	43.9083	22.2768	M. Popović	08.04.2014.	1
E	Čačak - r. Zapadna Morava	238	43.897	20.3553	D. Petrović	2015	1
E	l. Međuvršje	287.7	43.9115	20.2114	D. Petrović	2015	2
E	Pirot - canal in the fortress	368.5	43.1592	22.5823	I. Medenica	2015	1
E	Surčin - Galovica canal *	69	44.7839	20.3279	G.Pomorišac, A.Golubović	2015	>40
E	Belgrade - "Ada Safari"*	74	44.7833	20.4	D. Ćoso	04.06.2016	1
E	Belgrade - Košutnjak *	82	44.7704	20.4375	A. Urošević, J. Pavlović	13.04.2016	3
E	Belgrade - Košutnjak *	81	44.7699	20.438	A. Urošević, J. Pavlović	21.05.2016	6
E	Belgrade - Košutnjak *	81	44.7699	20.438	D.Ćoso	26.06.2016	5
E	Belgrade - Topčiderski park, lake	82	44.7829	20.4387	A. Urošević	22.05.2016	1
E	Lazarevac - StaraOčaga	98	44.3946	20.2362	S. Avramović	30.05.2016.	2
E	mt. FruškaGora – Popovicalake *	306	45.1836	19.8203	M. Maričić	2016	2
E	Novi Sad - Danube park *	80.8	45.2550	19.8508	M. Maričić	2016	app. 150
E	Palićko lake - nearby pond	100.2	46.0815	19.7524	M. Maričić	12.08.2016.	2
E	Smederevo - Marina	69	44.6682	20.9321	A. Urošević	07.04.2016	3
E	**Surčin - Galovica canal ***	**69**	**44.7791**	**20.3329**	**G. Pomorišac**	**30.05.2016.**	**1**
E	Apatin - canal near the town	80.8	45.6963	18.9276	M. Rajić	2017	3
E	Belgrade - Pariguz lake *	137	44.7062	20.4627	D. Ćoso	02.05.2017.	3
S	Novi Sad - Danube park	81	45.2500	19.8500	D. Ćoso	18.10.2014	1
S	Inđija	116	45.0561	20.0664	A. Surla	23.10.2015.	1
S	Surčin - Galovica canal	70	44.7767	20.3348	G. Pomorišac	25.04.2016.	1
S	Smederevo - Marina	69	44.6682	20.9314	A. Urošević	04.06.2017	1 dead
T	Kanjiža - Tisza bank	78	46.0872	20.0373	D. Grabovac	2013	1
T	Surčin - Galovica canal	70	44.7767	20.3348	G. Pomorišac	03.06.2016.	1

smaller rate of extinction and human preference for releasing turtles into larger water bodies (Di Santo et al. 2017). It seems that the situation in Serbia generally follows this pattern. According to our results, lowland parts of Serbia, which contain the greatest number of large water bodies, proved to be more vulnerable to the introduction of alien turtles. Both modelled and observed distributions of the native European pond turtle *Emys orbicularis* (L., 1758) suggest that its presence is confounded to the lowland and flatland areas of Serbia (Krizmanić et al. 2015, Golubović et al. 2017). The same water bodies probably represent the most suitable habitats for *T. scripta* ssp. In addition, the biggest urban centres in Serbia are situated in lowland areas, thus they are the most suitable for release of unwanted pets. In the Danube River Park in Novi Sad, there were some cases of removal of alien turtles during the cleaning of the pond by the park management but a significant number has still remained at the site (Personal observations by A.S. and M.M.).

This paper presents four cases of possible reproduction of the red-eared slider in Serbia, which is significant since the species is already treated as invasive in the country (Lazarević et al. 2012, Đorđević & Anđelković 2015, Krizmanić et al. 2015, Urošević et al. 2016). Red-eared sliders attain larger body size, have higher fecundity and reach sexual maturity earlier than European turtles (Arvy & Servan 1998). Therefore, they have enhanced competitive potential for feeding, nesting and basking sites, thus could indirectly reduce fitness of the native turtles (Cadi & Joly 2004). Considering their effects on other native fauna, red-eared slid-

ers can exert significant predatory pressure on native amphibian larvae (Polo-Cavia et al. 2010). They are also known vectors of pathogenic strains of bacteria (*Salmonella* sp. and *Arizona* sp.), which can be transmitted to native wildlife and humans (Bringsøe 2006, Scalera 2006). It is well known that the red-eared sliders are capable of surviving during the European winters (Cadi & Joly 2004). The recent molecular study from various localities in Slovenia provided hard evidence that the species is capable of reproducing in the temperate continental climate zone in Europe (Standfuss et al. 2016). Although the release of adults by irresponsible pet owners was, for a long time, considered as the only effective pathway of spreading of alien turtles (Bringsøe 2006, Scalera 2006), establishment of sustainable populations with successful reproduction (Ficetola et al. 2002, Cadi et al. 2004, Pérez-Santigosa et al. 2008, Crescente et al. 2014) and dispersal of locally hatched alien turtles (Standfuss et al. 2016) must also be considered.

This paper also presents new findings of the yellow-bellied slider (four) and the Cumberland slider (two) for Serbia. These subspecies of *T. scripta* are morphologically and ecologically very similar to the red-eared slider (Ernst et al. 1994). All three subspecies can freely hybridise, with hybrid specimens already found in Europe (Valdeón et al. 2010, Kleewein 2014, Standfuss et al. 2016). The possible mixture of subspecies could increase the genetic diversity and possibly enhance the invasive potential of the already problematic red-eared slider.

In Serbia, trade and import of all subspecies of *T. scripta* is prohibited ("official Gazette of the Republic of Serbia" no. 99/2009). However, the ban is still not completely effective and these turtles are widely available on the Serbian market (Urošević et al. 2016). Better implementation of the existing legislation, together with raising public awareness about the problem, is necessary to prevent further release of the pond slider subspecies into the natural ecosystems in Serbia. For prevention of population establishment and expansion, control and eradication measures are suggested, although these are expensive, time consuming and of uncertain outcome (Valdeón et al. 2010, Đorđević & Anđelković 2015). We encourage officials to organise campaigns for collecting unwanted pets and support building and maintenance of turtle sanctuaries, as an ethically acceptable option for releasing of unwanted pets, thus protecting native ecosystems with significant efficiency.

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References

Alarcos Izquierdo G., Flechoso del Cueto F., Rodríguez Pereira A. & Lizana M. 2010. Distribution records of nonnative terrapins in Castilla and León region (Central Spain). Aquatic Invasions 5(3): 303–308.

Arvy C. & Servan J. 1996. Distribution of *Trachemys scripta elegans* in France: a potential competitor for *Emys orbicularis.* In: Fritz U., Joger U., Podloucky R., Servan J. & Buskirk J.R. (Ed.): *Proceedings of the Emys Symposium* Dresden, Germany, 3–6 October 1996. pp. 33–40.

Arvy C. & Servan J. 1998. Imminent competition between *Trachemys scripta* and *Emys orbicularis* in France. Mertensiella 10: 33–40.

Bringsøe H. 2006. NOBANIS – Invasive Alien Species Fact Sheet – *Trachemys scripta*. In Online Database of the North European and Baltic Network on Invasive Alien Species – NOBANIS. Available at: www.nobanis.org. (accessed on 14/07/2014).

Cadi A. & Joly P. 2004. Impact of the introduction of the red-eared slider (*Trachemys scripta elegans*) on survival rates of the European pond turtle (*Emys orbicularis*). Biodiversity and Conservation 13: 2511–2518.

Cadi A., Delmas V., Prieevot- Julliard A. C., Joly P., Pieau C. & Girondot M. 2004. Successful reproduction of the introduced slider turtle (*Trachemys scripta elegans*) in the South of France. Aquatic Conservation: Marine and Freshwater Ecosystems 14: 237–246.

Crescente A., Sperone E., Paolillo G., Bernabo I., Brunelli E. & Tripepi S. 2014. Nesting ecology of the exotic *Trachemys scripta elegans* in an area of Southern Italy (Angitola Lake, Calabria). Amphibia-Reptilia 35: 366–370.

Di Santo M. P., Vignoli L., Carpaneto G. M. & Battisti, C. 2017. Occurrence patterns of alien freshwater turtles in a large urban pond 'Archipelago' (Rome, Italy): Suggesting hypotheses on root causes. Lakes and Reservoirs: Research and Management 22: 56–64

Džukić G., Kalezić M. & Mesaroš G. 2008. Barska kornjača (*Emys orbicularis*, l.) u donjoj Panoniji: prošlost, sadašnjost, budućnost. *Proceedings of the Palić-Hajdukovo symposium, Savetovanje: "Stanje i perspektive populacija barske kornjače u Vojvodini"*. Subotica, Serbia, 10 September 2008. pp. 1–29. (In Serbian).

Đorđević S. & Anđelković M. 2015. Possible reproduction of the red-eared slider, *Trachemys scripta elegans* (Reptilia: Testudines: Emydidae), in Serbia, under natural conditions. Hyla 1: 44–49.

Ernst C. H., Lovich J. E. & Barbour R. W. 1994. Turtles of the United States and Canada. Washington DC: Smithsonian Institution Press. 578p.

Ficetola G. F., Monti A. & Schioppa E. P. 2002. First records of reproduction of *Trachemys scripta* in the Po Delta. Annali del Museo Civico di Storia Naturale 5: 125–128.

Golubović A., Grabovac D. & Popović M. 2017. Actual and potential distribution of the European pond turtle (*Emys orbicularis*) in Serbia and conservation implications. Acta Zoologica Bulgarica 69: 49–56.

Kleewein A. 2014. Natural reproduction of *Trachemys scripta troostii* (Holbrook, 1836) x *Trachemys scripta scripta* (Schoepff, 1792) in Austria. Herpetozoa 26(3/4): 183–185.

Krizmanić I., Urošević A., Simović A., Krstić M., Jović D., Ajtić R., Anđelković M., Slijepčević M., Đorđević S., Golubović A., Žikić V. & Džukić G. 2015. Updated distribution of the European pond turtle *Emys orbicularis* (Linnaeus, 1758) and its conservation issues in Serbia. Archives of Biological Sciences 67(3): 1043–1053.

Lazarević P., Stojanović V., Jelić I., Perić R., Krsteski B., Ajtić R., Sekulić N., Branković S., Sekulić G. & Bjedov V. 2012. Preliminarni spisak invazivnih vrsta u republici Srbiji sa opštim merama kontrole i suzbijanja kao potpora budućim zakonskim aktima. Protection of Nature 62: 5–31. (In Serbian).

Pérez-Santigosa N., Díaz-Paniagua C. & Hidalgo-Vila J. 2008. The reproductive ecology of exotic *Trachemys scripta elegans* in an invaded area of southern Europe. Aquatic Conservation 18: 1302–1310.

Polo-Cavia N., Gonzalo A., López P. & Martín J. 2010. Predator recognition of native but not invasive turtle predators by naïve anuran tadpoles. Animal Behavior 80: 461–466.

Pupiņš M. & Pupiņa A. 2011 First records of 5 allochthonous species and subspecies of Turtles (*Trachemys scripta troostii*, *Mauremys caspica*, *Mauremys rivulata*, *Pelodiscus sinensis*, *Testudo horsfieldii*) and new records of subspecies *Trachemys scripta elegans* in Latvia. Management of Biological Invasions 2: 95–107.

Scalera R. 2006. *Trachemys scripta*. DAISIE (Delivering Alien Invasive Species Inventories for Europe). Available at: http://www.europe-aliens.org (accessed on 23/08/2013).

Standfuss B., Lipovšek G., Fritz U. & Vamberger M. 2016. Threat or fiction: is the pond slider (*Trachemys scripta*) really invasive in Central Europe? A case study from Slovenia. Conservation Genetics 17: 557–563.

Urošević A. 2014. Report of two subspecies of an alien turtle, *Trachemys scripta scripta* and *Trachemys scripta elegans* (Testudines: Emydidae) sharing the same habitat on the island of Zakynthos, Greece. Ecologica Montenegrina 1(4): 268–270.

Urošević A., Tomović Lj., Ajtić R., Simović A. & Džukić G. 2016. Alterations in the reptilian fauna of Serbia: Introduction of exotic and anthropogenic range expansion of native species. Herpetozoa 28(3/4): 115–132.

Valdeón A., Crespo-Diaz A., Egaña-Callejo A. & Alberto Gosá A. 2010. Update of the pond slider *Trachemys scripta* (Schoepff, 1792) records in Navarre (Northern Spain), and presentation of the Aranzadi Turtle Trap forits population control. Aquatic Invasions 5(3): 297–302.

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