

The current distribution of pond slider *Trachemys scripta* (Reptilia: Emydidae) in Croatia

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Abstract. The pond slider *Trachemys scripta* was one of the most commonly exported turtles until the last decade and often released into the wild outside its native range. It was introduced to Europe, Africa, South America and Asia and included on the EU list of 100 World's Worst Invasive Alien Species and the List of invasive alien species of Union concern. The import of the subspecies *Trachemys scripta elegans* into Europe and Croatia has been banned for some time, but the number of specimens recorded in nature is still increasing. In this paper we present 45 new localities where the species was observed in Croatia, which makes a total of 84 known localities. Most of the records, 58%, are in the Continental biogeographical region and the rest in the Mediterranean. It has not yet been recorded for the Alpine biogeographical region. Most records (42%) come from ponds. Three new sightings of females digging nests, laying eggs and sightings of hatchlings were recorded, suggesting successful reproduction of the species. Further surveys of this alien species in Croatia are needed.

Key words: invasive species, terrapin, Emydidae, Reptilia

Izvleček. Razširjenost gizdave želve *Trachemys scripta* (Reptilia: Emydidae) na Hrvaškem – Gizdava želva *Trachemys scripta* je bila v zadnjem desetletju ena izmed najpogostejše izvoženih želv iz Amerike in s strani lastnikov pogosto izpuščena v naravno okolje zunaj njene naravne razširjenosti. Vnesena je bila v Evropo, Afriko, Južno Ameriko in Azijo. Vključena je na Seznam 100 najinvazivnejših tujerodnih vrst sveta in Seznam invazivnih tujerodnih vrst Evropske unije. Uvoz podvrste rdečevratke *Trachemys scripta elegans* je bil v Evropo in Hrvaško prepovedan, vendar se kljub temu število zabeleženih primerkov v naravi povečuje. V prispevku predstavljamo 45 novih lokalitet, kjer je bila vrsta opažena. Skupno je tako za Hrvaško znanih 84 lokalitet o pojavljanju te vrste. Največ najdb (58 %) je iz kontinentalne geografske regije, preostanek pa iz mediteranske. V alpski geografski regiji vrsta še ni bila potrjena. Večina najdb oz. opazovanj (42 %) je z ribnikov. Poročamo tudi o treh novih opažanjih izvaljenih mladičev ter samic, ki kopljejo gnezdo in odlagajo jajca. Potrebne so nadaljnje raziskave o tej tujerodni invazivni vrsti na Hrvaškem.

Ključne besede: invazivne vrste, želve, Emydidae, Reptilia

Introduction

Invasive species threaten biodiversity and related ecosystem services (Kikillus et al. 2010) and can negatively affect native species through predation, competition and transmission of pathogens (Ficetola et al. 2009). One of the most common invasive species also included on the list of 100 of the World's Worst Invasive Alien Species (Lowe et al. 2000) is the pond slider turtle *Trachemys scripta* (Thunberg & Schoepff, 1792). It is native to Eastern, Northern and Central America (Ficetola et al. 2009). The three subspecies of pond sliders *T. scripta scripta* (Schoepff, 1792), *T. scripta elegans* (Wied, 1838) and *T. scripta troostii* (Holbrook, 1836) were probably the most commonly traded reptiles in the world up until the last decade (Ficetola et al. 2012). This species has been farmed in large quantities in the southern USA for the last several decades, partially for the global pet trade and partially as food for Asian markets (van Dijk et al. 2017). Pond sliders were very popular owing to their small size, low price and simple requirements (Teillac-Deschamps et al. 2008). Small turtles bought in the pet shops outgrow their enclosures after several years and are usually released into the wild by their owners (Cadi & Joly 2003). In 1975, turtle trade was banned in the USA due to salmonellosis (Williams 2016), after which the baby turtles were sent to markets in Europe and Asia (Cadi & Joly 2003). An estimated 52 million specimens of *T. s. elegans* were exported from the USA to international markets between 1989 and 1997 (Telecky 2001, Cadi et al. 2004, Scalera 2006). Today, the pond slider is introduced in Europe, Africa, South America and Asia (Cadi et al. 2004). The import of the subspecies *T. s. elegans* has been banned in the European Union from 1997 via the Protection of Species of Wild Fauna and Flora by Regulating Trade (Anonymous 1997) due to their invasive character and impact on native species (Anonymous 2014). In 2016, *T. scripta* was included on the list of invasive alien species that are of concern in the European Union (Anonymous 2016), which means that concrete action at the Union level is required to prevent their introduction, establishment or spread.

Trachemys scripta has been introduced into the Balkan Peninsula probably around the 1970's (Džukić & Kalezić 2004). It is known from several countries in the Balkans, e.g. Slovenia (Krofel et al. 2009, Vamberger et al. 2012), Bosnia and Herzegovina (Jelić & Jelić 2015), Serbia (Scalera 2006, Urošević et al. 2016), Montenegro (Žagar et al. 2013), Bulgaria (Tzankov et al. 2015), and Greece (Scalera 2006, van Dijk et al. 2011). Most records are from urban and peri-urban areas of larger cities (Scalera 2006, Tzankov et al. 2015), while illegal import is still a problem in some areas (Tzankov et al. 2015). Successful reproduction in the wild is known from Slovenia (Vamberger et al. 2012). Today, two subspecies are widely distributed in Croatia: *T. s. elegans* and *T. s. scripta*. According to Jelić & Jelić (2015), 39 recorded sites of *T. scripta* are reported for Croatia. The goal of this paper is to summarize all available knowledge about the current range and reproduction of *T. scripta* subspecies in Croatia.

Materials and methods

To assess the current range of the slider turtle in Croatia, all available knowledge about its occurrence, referring to the period between 1999 and 2017 was gathered, including data from published literature, field surveys, as well as the verified records from the public sent to us by social media. Recent field survey data includes both random findings and targeted surveys for the slider and general amphibians and reptiles inventories carried out through approximately 350 days in the field. Water bodies both in/nearby cities and those further away from urban areas were checked. All data refer to the period between 1999 and 2017. The distribution map based on the dataset was made in ArcMap (v. 10.2.2, ESRI), in the WGS84 coordinate system. Based on unique localities, the tentative habitat preference and the affiliation to a particular biogeographical region were calculated.

Results and discussion

During this survey, *T. scripta* was observed on 44 new localities (Appendix 1), which in addition to the previous knowledge about its distribution (Jelić & Jelić 2015, Schweiger 2015) amounts to a total of 84 localities within Croatia (Figs. 1, 2). In respect to the biogeographical regions, most localities belong to the Continental biogeographical region, i.e. 49 localities (58%), followed by the Mediterranean region, i.e. 35 (42%). No records of this species are known from the Alpine biogeographical region in Croatia. This is probably due to the much lower number of inhabitants per square kilometre (Nejašmić 2000), corresponding to a very limited number of pet shops both now and in the past few decades.

In the Continental biogeographical region, *T. scripta* is present in the lowlands, including lakes, streams and ponds. The highest altitude where it was observed is in a lake 350 meters above sea level. In the Mediterranean biogeographical region, it is present both on the mainland and the Adriatic islands. The highest record concerns the mainland in a pond 475 meters above sea level. While during the first overview of the species distribution in the country (Jelić & Jelić 2015) the species was recorded only on the islands of Krk, Pag and Vir, our records show that it is present also on Veli Brijun, Dugi Otok, Šolta and Korčula. It is hard to say whether these records represent new releases in the last few years or were overlooked during the previous surveys in the country. However, it is probable that the species is present also on other Adriatic islands containing suitable wetland habitats.

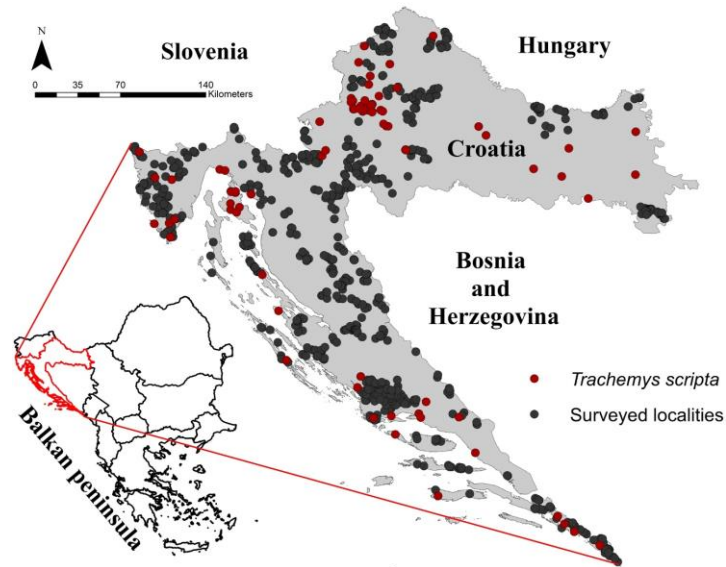


Figure 1. Map with all visited localities and those at which the presence of *Trachemys scripta* was confirmed.
Slika 1. Zemljevid z vsemi obiskanimi lokalitetami in tistimi, na katerih je vrsta *Trachemys scripta* potrjena.

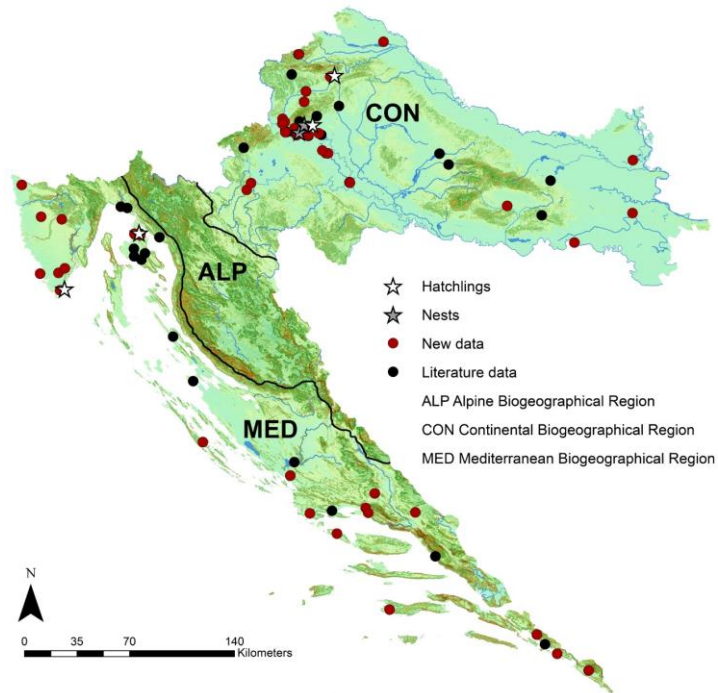


Figure 2. Map with new and previously published localities of *Trachemys scripta* in different biogeographical regions of Croatia.

Slika 2. Zemljevid z novimi in že objavljenimi lokalitetami vrste *Trachemys scripta* v različnih biogeografskih regijah Hrvaške.

Most specimens were observed in ponds, 35 (42%), followed by lakes, 23 (27%), streams, 12 (14%), rivers, 7 (8%), fountains, 5 (6%), and channels 2 (2%). Specimens are often visible in the ponds, floating and basking in the sun, or sometimes even actively swimming towards the observer, expecting to be fed. This corresponds to the data elsewhere from Europe, where *T. scripta* are generally released in freshwater areas, which are frequented by humans, such as public ponds and other natural habitats close to urban areas (Bringsøe 2006). 72% of the localities with pond sliders in Croatia and Bosnia and Herzegovina are 15 km or less away from the cities that have more than 10,000 inhabitants (Jelić & Jelić 2015). *Trachemys scripta* has a total range of about 2–3 km, therefore their presence in the isolated ponds, e.g. more than several kilometres apart, especially in the Mediterranean part of the country, somewhat limits their propagation potential, and the potential for spreading to different habitats (Ryan et al. 2008). On the other hand, specimens released in streams and rivers are most likely to be unnoticed during surveys and are expected to spread and colonize new habitats since their reproduction is predicted to be successful due to similar climate like in Slovenia (Zaninović 2008).

The aquatic habitats in which *T. scripta* was recorded during this study do not necessarily indicate the species' real habitat preference, but they may indicate the habitats on which the individuals can successfully overwinter, due to its adaptability (Cadi & Joly 2004), and as such, they are crucial for further surveys of this species in the country.

Not all *T. scripta* populations are reproductively active. So far, successful reproduction in Europe has been reported from Spain (De Roa & Roig 1997, Martínez-Silvestre 1997, Pleguezuelos 2002, Perez-Santigosa 2008), France (Cadi et al. 2004), Italy (Sindaco et al. 2005), Slovenia (Vamberger et al. 2012, Standfuss et al. 2016) and Austria (Klewein 2014). Egg-laying females and hatchlings were also observed from the Mediterranean region of Turkey (Çiçek & Ayaz 2015).

For Croatia, egg laying was for the first time reported in 2013 from the Continental biogeographical region, specifically from Maksimir Forest Park, Zagreb, while few years later, successful reproduction was confirmed on the same location by monitoring of few nests in nature and recording successful hatching (Jelić et al. 2016). Aside from Maksimir Forest Park, egg laying female was also observed on another location in Zagreb, on the shore of Budek Lake in June 2017 (Dubravko Dender, personal communication).

The first indication of breeding in the Mediterranean biogeographical region was stated in Schweiger (2015) for the island of Krk. The author observed a single one year old hatchling. A couple of years earlier, one female was observed digging a hole (Boris Lauš, pers. obs. in 2012), but the location was never again checked to see if eggs were actually laid. In Medulin, Istria, small hatchlings of *T. s. elegans* were observed in 2015 by the first and second authors in the pond inhabited by more than ten adult specimens. It is most likely that the specimen was hatched in the area. Also, on Dugi Otok Island, near the pond where 6 adult specimens were found, the second author observed one female digging a hole, but no eggs were later found there. While the only evidence of the complete breeding success remains that from the lakes at Maksimir Forest Park (Jelić et al. 2016), it is highly probable that successful breeding can also occur in other parts of Croatia, and in different biogeographical regions. Recently, from a population genetics approach based on 14 highly polymorphic microsatellite loci, the

breeding of this species was confirmed at three localities in two different regions of Slovenia (Standfuss et al. 2016), which are similar to the climate conditions of Croatia.

Bringsøe (2001) suggested that in northern Europe the climate is too cold, while in the Mediterranean region summers are too dry for successful egg development. But the increasing number of the countries, where reproduction was confirmed, indicates that this is not the case (Jelić et al. 2016, Schweiger 2015, Vamberger et al. 2012, Standfuss et al. 2016).

The concerning fact in Croatia is that the number of new localities for this species increased by almost 100% in the last several years. Additionally, in some areas like the pond Sali on Dugi Otok Island or the pond in Medulin (Istria), many adult specimens were observed, and it is possible that they will indeed start to reproduce in the future, if they have not done so already, since this is already known from other Mediterranean regions (Standfuss et al. 2016). Due to the longevity of this species, which may be up to 30 years in the wild (van Dijk et al. 2017), even if for some reason reproduction does not occur, they have still been, and will be, present in the wild for many years. Adults are resistant and can survive long periods in suboptimal areas with low temperature or limited precipitation (Bringsøe 2001). Specimens kept in captivity quickly outgrow their small starter aquariums and become unruly for handling, especially in small apartments in the cities. Consequently, they are still being released into the wild even today. In Croatia, specimens of both *T. s. elegans* and *T. s. scripta* cannot be bought from pet stores any more, but they are available on the internet for sale, especially specimens older than ten years, or people just give them away for free on different internet portals.

In Croatia, two species of native freshwater turtles occur, *Emys orbicularis* (Linnaeus, 1758) and *Mauremys rivulata* (Valenciennes, 1833). Both species are listed in the Red Book of Amphibians and Reptiles of Croatia, *E. orbicularis* as NT (Near threatened) and *M. rivulata* as EN (Endangered) (Jelić et al. 2012). Pond sliders may compete with the native pond turtle *E. orbicularis* for food, egg-laying sites, or basking places (Bury & Wolfheim 1973, Rovero et al. 1999, Lindeman 1999, Cadi & Joly 2003), and can be infested with various pathogens, which have been shown to cause mass mortalities in native species (Iglesias et al. 2015). Some authors consider positive competition with the pond turtle in Europe (Luiselli et al. 1997, Cadi & Joly 2003). The competition with *M. rivulata* has still not been confirmed, but is probably similar as with *E. orbicularis*, given that in southernmost Croatia, for example, all three species are found in the same habitats.

In conclusion, the known distribution of the pond slider in Croatia has been greatly expanded. Additional breeding activities have also been observed. In light of that, it is necessary to continue the survey of this invasive species in Croatia and create a plan for the future removal of this species from the wild.

Acknowledgements

We wish to thank all those that have sent their observations of *T. scripta* in Croatia: Hrvoje Škrln Vučina, Željko Vasilik, Željko Krpan, Stjepan Mekinić, Frano Barišić, Pavao Dragičević, Jure Skejić, Tena Boroš, Paula Dvorski and Berislav Horvatić. We are grateful to Dubravko Dender for information and photographs of the pond slider laying eggs. A part of the data reported in this paper was gathered during the Croatian EU Natura 2000 Integration Project (NIP): Consulting Services for Field research and laboratory processing for collecting new inventory data for taxonomic groups: Actinopterygii and Cephalaspidomorphi, Amphibia and Reptilia, Aves, Chiroptera, Decapoda, Lepidoptera, Odonata, Plecoptera, Trichoptera 2014–2016. We also wish to thank the Croatian Agency for the Environment and Nature for sharing data from their database that enabled us to create this manuscript.

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Appendix 1. List of new records of *Trachemys scripta* in Croatia. T.s.e. – *Trachemys scripta elegans*, T.s.s. – *Trachemys scripta scripta*.

Priloga 1. Seznam novih najdb vrste *Trachemys scripta* na Hrvatskem. T.s.e. – *Trachemys scripta elegans*, T.s.s. – *Trachemys scripta scripta*.

	Locality name	N (WGS84)	E (WGS84)	Dates	Eleva- tion (m)	No. of indivi- duals	Observer	Sub- species
Continental biogeographical region								
1	Rakitje, Rakitje Lake	45.793196	15.829403	28.3.2010	115	1	Muhamed Kovačević, Ivan Špelić	<i>T.s.e.</i>
2	Ivanja Reka, Sava River	45.787931	16.116482	2017	95	1	Hrvoje Škrln Vučina	<i>T.s.e.</i>
3	Zagreb, Bundek park, Bundek Lake*	45.785267	15.984014	1.8.2009, 28.7.2012	111	/	Željko Vasilik, Boris Lauš	<i>T.s.e.</i>
4	Zagreb, Staglišće, stream	45.785002	15.932071	29.6.2008	116	2	Boris Lauš	<i>T.s.e.</i>
5	Zagreb, Savica Lakes*	45.776765	16.026599	13.4.2013, 2017	109	2	Boris Lauš, Damir Plačko	<i>T.s.e.</i>
6	Zagreb, Jarun Lake*	45.776496	15.927268	1.8.2009, 2017	112	/	Boris Lauš, Bojan Šmid	<i>T.s.e.</i>
7	Zagreb, Turopolje, stream	45.685480	16.147839	8.4.2017	106	1	Jure Skejić	<i>T.s.e.</i>
8	Zagreb, Poljana Čička, Odra, Kosnica Stream	45.669200	16.177200	12.4.2017	100	1	Ivona Burić	<i>T.s.e.</i>
9	Zagreb, Turopolje, Sava-Odra Canal	45.668340	16.196176	9.4.2017	100	1	Mladen Zadavec	<i>T.s.e.</i>
10	Nature Park Kopački rit, channel »Conakut«	45.605519	18.801251	6.3.2017	83	1	Katarina Koller Šarić, Hrvoje Domazetović	<i>T.s.s.</i>
11	Sisak, north pond	45.496579	16.381176	17.6.2015	96	/	Željko Vasilik	<i>T.s.e.</i>
12	Sisak, middle pond	45.495000	16.382000	12.4.2015	96	/	Željko Vasilik	<i>T.s.e.</i>
13	Sisak, former brickworks	45.494013	16.379434	29.5.2014	96	1	Željko Vasilik	<i>T.s.e.</i>
14	Sisak, south pond in Ciglarska Graba	45.492534	16.384019	11.4.2017	96	1	Željko Vasilik	<i>T.s.e.</i>
15	Karlovac, Novi centar, pond	45.486971	15.541010	2017	110	100	Željko Krpan	<i>T.s.e.</i>
16	Duga Resa, bridge across the Mrežnica River	45.445734	15.505172	17.6.2008	124	2	Boris Lauš	<i>T.s.e.</i>
17	Požega, fishpond Eminovci	45.347513	17.722460	28.6.2014	152	1	Frano Barišić	unknown
18	Vinkovci, Banja Lake	45.288317	18.785394	20.4.2012	77	1	Pavao Dragičević	<i>T.s.e.</i>
19	Slavonski Brod, Svilaj, pond	45.119985	18.286853	20.8.2015	80	1	Frano Barišić	unknown
20	Rakitje, Rakitje Lake	45.793196	15.829403	28.3.2010	115	1	Muhamed Kovačević, Ivan Špelić	<i>T.s.e.</i>

	Locality name	N (WGS84)	E (WGS84)	Dates	Eleva- tion (m)	No. of indivi- duals	Observer	Sub- species
21	Ivanja Reka, Sava River	45.787931	16.116482	2017	95	1	Hrvoje Škrlin Vučina	<i>T.s.e.</i>
22	Zagreb, Bundek park, Bundek Lake*	45.785267	15.984014	1.8.2009, 28.7.2012	111	/	Željko Vasilik, Boris Lauš	<i>T.s.e.</i>
23	Zagreb, Staglišće, stream	45.785002	15.932071	29.6.2008	116	2	Boris Lauš	<i>T.s.e.</i>
24	Zagreb, Savica Lakes*	45.776765	16.026599	13.4.2013, 2017	109	2	Boris Lauš, Damir Plačko	<i>T.s.e.</i>
25	Zagreb, Jarun Lake*	45.776496	15.927268	1.8.2009, 2017	112	/	Boris Lauš, Bojan Šmid	<i>T.s.e.</i>
26	Zagreb, Turopolje, stream	45.685480	16.147839	8.4.2017	106	1	Jure Skejić	<i>T.s.e.</i>
27	Zagreb, Poljana Čička, Odra, Kosnica Stream	45.669200	16.177200	12.4.2017	100	1	Ivona Burić	<i>T.s.e.</i>
28	Zagreb, Turopolje, Sava-Odra Canal	45.668340	16.196176	9.4.2017	100	1	Mladen Zadravec	<i>T.s.e.</i>
29	Nature Park Kopački rit, channel »Conakut«	45.605519	18.801251	6.3.2017	83	1	Katarina Koller Šarić, Hrvoje Domazetović	<i>T.s.s.</i>
Mediterranean biogeographical region								
30	Sisak, north pond	45.496579	16.381176	17.6.2015	96	/	Željko Vasilik	<i>T.s.e.</i>
31	Istra, Kmeti, south of village St. Lucija, pond	45.443020	13.588106	19.5.2014	50	1	Toni Koren	unknown
32	Istra, Anžiči village, Korneda Pond	45.255762	13.762086	10.7.2014	273	1	Ana Štih	unknown
33	Istra, Pazin, Pazinčica Stream, near the water pump	45.245253	13.937681	10.4.2009	257	1	Toni Koren	unknown
34	Istra, Lobarika, Gornji Radeki, pond	44.923264	13.924587	9.7.2014	136	1	Ana Štih	unknown
35	Istra, Mandalana pond, 1 km west of Cveki	44.952108	13.977462	21.6.2014	84	1	Toni Koren Ana Štih	unknown
36	Istra, Veli Brijun Island, Brijun Pond	44.914626	13.769662	3.5.2014	11	1	Željko Vasilik	<i>T.s.e.</i>
37	Istra, Pula, Medulin, pond	44.818990	13.942461	23.6.2014	9	10	Toni Koren, Ana Štih	<i>T.s.e.</i>
38	Krk Island, Omišalj, Njivice, lake near Njivice	45.170710	14.556338	2.6.2012	15	1	Boris Lauš	<i>T.s.e.</i>
39	Krk Island, two ponds near Mediterranean mussels farm in Čižići	45.161753	14.604901	2009	18	1	Berislav Horvatić, Mario Schweiger	<i>T.s.e.</i>

	Locality name	N (WGS84)	E (WGS84)	Dates	Eleva- tion (m)	No. of indivi- duals	Observer	Sub- species
40	Dugi Otok Island, Sali, Sali Pond	43.929614	15.165853	4.5.2015	43	6	Toni Koren, Ana Štih	<i>T.s.e.</i> , <i>T.s.s.</i>
41	Šibenik, fountain near the »Gospe van Grada« church*	43.734048	15.894212	13.6.2015	15	8	Ivona Burić, Marko Blažić, Katarina Koller	<i>T.s.e.</i>
42	Dicmo, Dicmo Osoje, near St. Jakov church, pond	43.628917	16.592802	17.4.2009	346	1	unknown	<i>T.s.e.</i>
43	Split, Jadro, Jadro River	43.541800	16.519100	20.4.2016	17	1	Stjepan Mekinić	unknown
44	Cista Provo, Crlijivica, pond	43.515190	16.927096	22.6.2014	476	1	Stjepan Mekinić	unknown
45	Stobreč, Žrnovnica, stream	43.513400	16.538600	5.6.2014	5	1	Stjepan Mekinić	unknown
46	Gornji Sevid, pond	43.509144	16.057949	1.5.2015	140	1	Stjepan Mekinić	unknown
47	Šolta Island, Srednje Selo, pond	43.388104	16.281494	19.8.2014, 28.04.2017	97	1	Ivona Burić, Mak Vujanović, Ana Štih	unknown
48	Korčula Island, Gornja Potirna, pond	42.932672	16.712419	9.6.2017	140	1	Ana Štih, Mak Vujanović	<i>T.s.s.</i>
49	Donji Majkovi, pond	42.773538	17.912024	19.8.2016	222	4	Ana Štih, Toni Koren	<i>T.s.e.</i> , <i>T.s.s.</i>
50	Dubrovnik, city park, fountain	42.656262	18.074957	10.10.2017	18	1	Toni Koren	unknown
51	Rožat, Ombla river	42.672073	18.131111	13.08.2015.	0	1	Ana Štih	unknown
52	Konavle, Pridvorje, pond	42.552551	18.327373	27.5.2014	63	1	Toni Koren	<i>T.s.s.</i>

* already published localities (Jelić & Jelić 2015, Schweiger 2015, Štih & Koren 2014)