

First survey on the invasive Pond slider (*Trachemys scripta*) in Bulgaria: historic development and current situation

Prvo istraživanje invazivne crvenouhe kornjače (*Trachemys scripta*) u Bugarskoj: povijesni razvoj i trenutno stanje

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Abstract

Pond sliders (*Trachemys scripta*) have become a popular pet in Bulgaria since 1990. Through the years a number of released specimens were observed in the wild. Although the negative effects on native turtles have been studied extensively elsewhere, no specific studies (besides brief reports) have addressed the invasion of *T. scripta* in Bulgaria. The present study is based on over 25 years of field monitoring and represents the first source of detailed information on the distribution of the Pond slider in Bulgaria. A total of 293 UTM (10×10 km) squares with habitats suitable for freshwater turtles were surveyed. We collected 64 records for 173 individuals, from 19 UTM squares. From all observed individuals, only two were from the nominate subspecies – the rest belong to *T. s. elegans*. In our study only one subadult was observed. To date no successful hatching has been recorded, although successful overwinterings have been registered. We discuss various mitigation measures that must be rapidly initiated to limit future release of Pond sliders and to remove the non-native specimens from the Bulgarian ecosystems. Actions are demanded especially to avoid the potential epizootic events caused by parasites with highly lethal effect on native species. Such outbreaks might potentially have greater impact on the native pond turtle species than various forms of competition with *T. scripta*.

Key words: Bulgaria, Red-eared slider, pet trade, freshwater turtle communities, invasion, monitoring

Sažetak

Crvenouha kornjača (*Trachemys scripta*) postala je popularni ljubimac u Bugarskoj od 1990. Kroz godine sve veći broj jedinki zabilježen je i u divljini. Iako su negativni učinci na izvornim kornjače su opsežno studirao negdje

drugdje, nema posebne studije (osim kratkih izvješća) obratili invaziju *T. scripta* u Bugarskoj. Ova studija se temelji na više od 25 godina praćenja na terenu i predstavlja prvi izvor detaljne informacije o raspodjeli Pond klizača u Bugarskoj. Ukupno 293 UTM (10 × 10 km) kvadrata sa staništa pogodna za slatkovodne kornjače ispitano. Prikupili smo 64 zapisa za 173 osoba, od 19 UTM kvadrata. Od svih promatranih osoba, samo dvije su od nominirati podvrste - ostatak pripada *T. Š. elegans*. U našem istraživanju je uočeno samo jednoga djeteta. Do danas nije uspješno leženja zabilježena, iako su registrirani uspješni overwinterings. Mi smo razgovarali o raznim mjere ublažavanja koje se moraju brzo pokrenut ograničiti buduće izdanje Ribnjak klizača i za uklanjanje ne-izvornih uzoraka s bugarskim ekosustava. Akcije su zahtijevali posebno da se izbjegne potencijalne epidemiološko događaja uzrokovanih parazitima s vrlo smrtonosnim učinkom na autohtonim vrstama. Takve pojave potencijalno mogu imati veći utjecaj na autohtone vrste kornjača jezerce od raznih oblika natjecanja s *T. scripta*.

Ključne riječi: Bugarska, crvenouha kornjača, trgovina kućnim ljubimcima, slatkovodne kornjače, invazija, monitoring

Introduction

In Europe, the local turtle communities consist of one or maximum two of the total four freshwater species. On the Balkans these are the European pond turtle *Emys orbicularis* (Linnaeus, 1758) and the Balkan pond turtle *Mauremys rivulata* (Valenciennes, 1833). The upper Pliocene period was relatively rich in large freshwater turtle communities that existed in Europe (cf. Młynarski 1976). Thereafter, because of processes that were related to climate oscillations in the Pleistocene period, the species richness dropped significantly to the present levels.

However, since the 1980s, due to their high popularity in the pet trade, Pond sliders have been exported all over the world, and are currently distributed in the wild and in urban areas in nearly all European countries (review in Bringsøe 2006). Negative effects of released Pond sliders *Trachemys scripta* (Thunberg in Schoepff, 1792) on European freshwater ecosystems and especially on native freshwater turtles have previously been documented

(e.g. Avery and Servan 1998, Bringsøe 2001, Cadi and Joly 1999, 2004).

The species has been reported to reproduce successfully in various European countries, mostly in the southwestern part of the continent – Italy (Ferri and Soccini 2003, Ficetola et al. 2003, Sperone et al. 2010), Spain (Martinez-Silvestre 1997, De Roa and Roig 1997, Bertolero and Canicio 2000, Capalleras and Carretero 2000, Pleguezuelos 2004), and France (Cadi et al. 2004, Girondot et al. 2012). Sporadic observations are published for other Europe countries: Austria (Gemel et al. 2005, Gutleb and Happ 2002, Kleewein 2014), Switzerland (Wütrich 2004), Slovenia (Vamberger et al. 2012). The reproductive performance of *T. scripta* in Southwestern Europe was stated to show similar or even higher values than in native areas (Perez-Santigosa et al. 2008).

In Bulgaria, Pond sliders were sold in high numbers (though specific quantities are unknown) since the 1990s and subsequently many specimens have been released in the wild by their owners. However, published data on the species distribution

and its ecological impact in Bulgaria are generally missing. A brief review (with limited specific localities) was published in Stojanov et al. (2011), where faunistic data were summarized and the authors made the assessment that the Pond slider has established itself in the wild. Locally, the species was mentioned for Vitosha Mountain (Tzankov et al. 2014). Thus, the present study is the first attempt to summarize and present the current distribution and status of this invasive freshwater turtle.

Material and methods

The dataset of Pond slider occurrence was compiled from all available authors' observations after 1990, with additional localities provided by colleagues. The data was collected during specific surveys for native freshwater turtles (*E. orbicularis* and *M. rivulata*) and other freshwater herpetofauna, as well as during incidental observations. Surveys were performed throughout the country on various natural, semi-natural, and urbanized bodies of water,

representing potentially suitable habitats for freshwater turtles.

When possible, exact geographic coordinates of each identified Pond slider were marked in situ using handheld GPS units (accuracy ± 5 m; Garmin, Olathe, Kansas, USA). In few cases, locations were identified via publicly available, high-resolution geographically referenced satellite imagery from 2001–2014 (Google Earth 7; Google, Mountain View, California, USA).

The dataset of slider presence/absence (but otherwise presence of native species) were summarized and plotted on the national 10×10 km UTM grid.

Results

Pond sliders were regularly encountered in Bulgaria from 1996. A total of 293 10×10 km UTM squares with habitats suitable for freshwater turtles were surveyed. We collected a total of 64 records for 173 individuals, from 19 UTM squares (6.4% of sampled UTMs; Fig. 1).

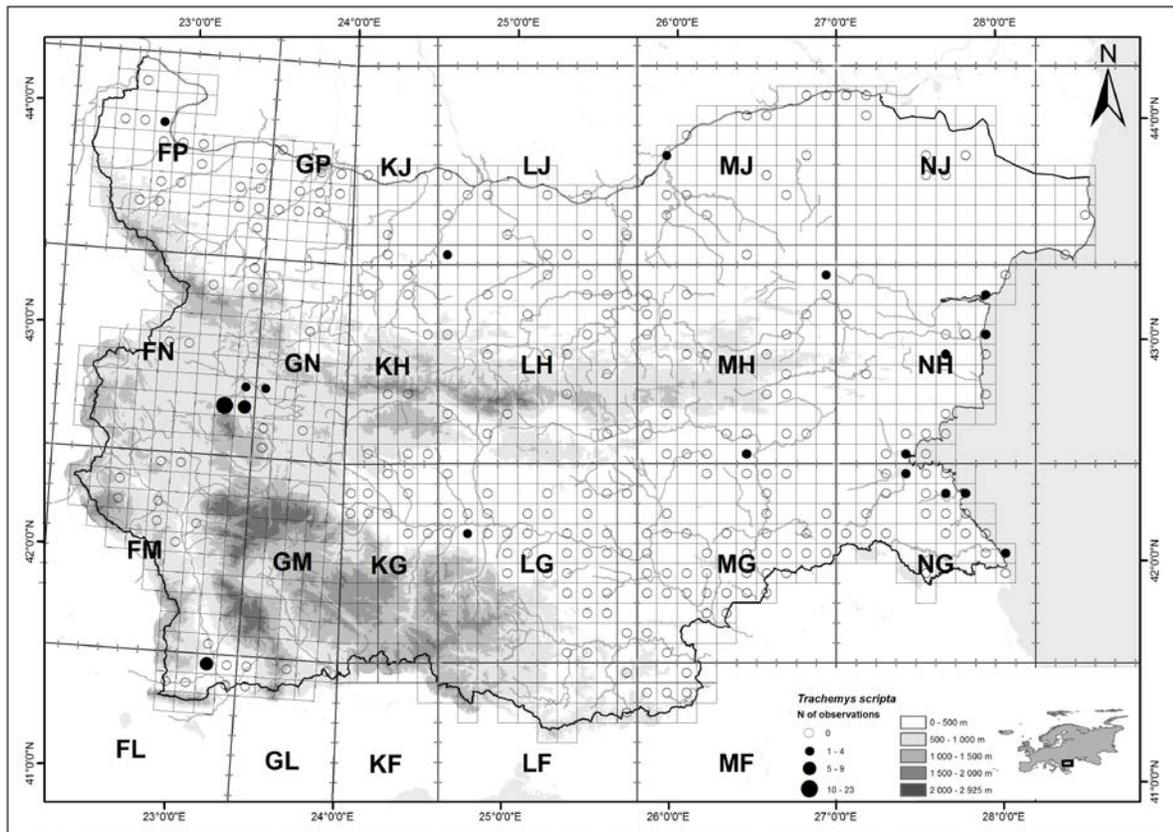


Figure 1. Distribution and relative abundance of observations of *Trachemys scripta* in Bulgaria (1990–2015) on a 10×10 km UTM grid.

Slika 1. Distribucija i relativna abundanca opažanja *Trachemys scripta* u Bugarskoj (1990-2015) na 10x10 km UTM mreži.

Nearly all observed specimens were adults (or at least full-grown) except one sub-adult observed in an artificial pond in South Park in Sofia city. No male specimens were encountered in the field. In most of the localities, the sliders were presented by a single specimen (63% of the localities).

In all of the presented locations, the subspecies *T. scripta elegans* (Wied, 1838) was observed, except in one case where two individuals of *T. scripta scripta* were observed once in the Stomopolou lagoon near the town of Primorsko (UTM NG68).

With distribution from the sea level up to 1200 m a.s.l. (Dendrarium locality, Vitosha Mt., FN82; topographically misrepresented as 1300 m a.s.l. in Stojanov et al. 2011), the identified area of *T. scripta* completely overlaps that of the native pond turtles.

Localities were mostly concentrated in urban or peri-urban zones of the big cities, i.e. Sofia (FN82, FN92), Plovdiv (LG16), Burgas (NH30), Yambol (MH50), Ruse (MJ15), Pleven (LJ00) and Vidin (FP46), where turtles were encountered in artificial ponds, canals, and slow flowing rivers (Table 1). Sliders have also been found in natural habitats

outside settlements, e.g. at Managed Reserve “Veliyov Vir” (NG58) and in natural habitats, commonly visited by people such as the mouths and lower sections of the rivers Kamchiya (NH76),

Ropotamo (NG68) and Veleka (NG85). In certain “hot-spots”, Pond sliders were observed multiple times over the years.

Table 1. Localities and habitats of the observed adult *Trachemys scripta elegans* in Bulgaria (1996-2014).

Tablica 1. Lokacije i staništa opaženih odraslih jedinki *Trachemys scripta elegans* u Bugarskoj (1996-2014).

UTM	Easting	Northing	Locality	Habitat	Count	Date
FL89	23.263	41.459	Rupite	channel	1–12	1996–2014
FL89	23.263	41.461	Rupite	channel	1	2008
FL89	23.264	41.459	Rupite	channel	1	2014
FN82	23.228	42.628	Dendrariuma Vitosha Mtn	artificial pond	1	2006–2008
FN82	23.307	42.668	South Park 1, Sofia	artificial pond	1–12 [^]	1997–2014
FN82	23.308	42.659	South Park 2, Sofia	artificial pond	1–5	1996–2009
FN92	23.342	42.685	Boris' Garden, Sofia	artificial pond	1–3	2005–2012
FN92	23.400	42.663	district Druzha, Sofia	artificial pond	3–8	2006–2009
FN92	23.420	42.689	Sofia, eastern suburbs	artificial pond	1	2014
FN93	23.399	42.768	Negovan	artificial pond	5	2012–2013
FP46	22.858	43.946	Vidin	river	1	2011
GN03	23.469	42.705	Dolni Bogrov	artificial pond	1	late 1990s
LG16	24.746	42.154	Plovdiv, Maritsa River	river	1	2012
LG16	24.750	42.155	Plovdiv, Maritsa River	river	1	2004
MH50	26.492	42.487	Yambol	river	1	2002
MH99	26.965	43.288	near Shumen	artificial pond	2	2014
MJ15	25.941	43.837	Ruse	river	1	2004
NG39	27.423	42.450	Mandra Dam	terrestrial habitat	1	2014
NG58	27.710	42.300	Man. Reserve “Velyov Vir”	natural lake	1	2005
NG58	27.726	42.330	Ropotamo River	river	1	2012
NG58	27.728	42.303	Ropotamo River	river	1	2012–2013
NG68	27.730	42.315	Ropotamo River	river	1	2005
NG68	27.752	42.285	Lake Stomopolou	natural lake	2*	2014
NG85	27.969	42.065	Veleka River	river	1	2005–2012
NH30	27.444	42.507	Burgas Lake	natural lake	1	2014
NH30	27.469	42.519	Atanasovsko Lake	channel (freshwater)	1	2013
NH55	27.673	42.948	Krivini	river	1	2013

NH76	27.886	43.022	Kamchiya River	river	1	2008
NH78	27.873	43.195	Varna Lake	natural pond	1	2000

^ – denotes one subadult individual; * – only observation of two individuals of *T. s. scripta*

Veleka River and Rupite are amongst the non-urban localities with frequent observations of the Pond slider.

The downstream of the Veleka River (UTM square NG85) was the subject of regular monitoring of the population of the native freshwater turtles (*E. orbicularis*, *M. rivulata*) since 2005. Both autochthonous taxa inhabit syntopically this section. Sliders were observed only in the lowermost part close to the river mouth. This section is with the highest human presence and most probably the sliders are released there. The lower section of the river is characterised by rapid water level fluctuations of ± 2 meters and changes in salinity (from freshwater to brackish) due to buildup/breakage of a sandbar at the mouth. In these extreme conditions, the released sliders seem to be in a disadvantage compared to the native pond turtles and even though they are highly adaptive, in this case local conditions likely regulate and contain the invasion.

At the Rupite locality (UTM square FL89) sliders were encountered regularly and in large numbers since 1996. The hot mineral water sources there provide suitable conditions. This place is a highly popular tourist destination not only at the local level and visitors flow is permanent throughout the year. The locality is obviously regarded as a very suitable place for Pond slider and individuals are likely released constantly.

Historically, a large number of sliders were released by citizens in an artificial pond within the Sofia Zoo. In this basin, the species has overwintered

successfully for many years. By 2010 the concentration of individuals increased to several hundred and even began to have an impact on the waterfowl. In 2010/2011, the pond froze permanently for a prolonged period forming a thick layer of ice that likely led to depletion of oxygen in the water or complete freezing of the water column. After the thaw, seemingly the whole population in the pond was observed dead. Stoyanov (2015) reports a similar die-off in an artificial pond in 2005.

Notably, no breeding was detected in Bulgaria to date. It must be pointed out that in semi-natural conditions (such as in Sofia Zoo) sliders have been repeatedly observed to lay eggs, but no successful hatching or juveniles have been documented, although the reasons for the failure are unknown.

Discussion

In Europe, Bulgaria being no exception, mostly one (rarely two) freshwater turtle species inhabit particular water bodies, thus lowering the evolutionary drivers for increased competitiveness over other freshwater turtles. In opposite to the European water turtles, in the core area of the Pond slider's native distribution it commonly co-occurs with various other freshwater turtles, and commonly dominates by numbers in local communities. The Pond slider is highly competitive in interspecific encounters, both in its native range, as well as in the range of invasion. Some taxa with similar requirement such as *Chrysemys picta* (Schneider,

1783) seem to avoid slider presence and are rare when living in syntopy (Gibbons 1990). Pond sliders have been demonstrated to possess a set of advantages that allow them to displace the native species (vs. *M. leprosa*: better thermoregulatory abilities, Polo-Cavia et al. 2012; competitive behavior for food resources, Polo-Cavia et al. 2010; vs. *E. orbicularis*: competition for basking sites and impact on survival rates, Cadi and Joly 1999, 2004). Pond sliders potentially have a long-term impact on local communities, living up to 30 years (estimated by Gibbons and Semlitsch 1982). They reach sexual maturity at 5–7 years of age and at 110–160 mm plastron length (Gibbons and Greene 1990), thus allowing for a relatively quick population growth. Their relatively low age of maturity and higher fecundity [within the native range see Cagle (1946); in Europe see Perez-Santigosa et al. (2008)] obviously can be recognised as an advantage over the local native species. The sliders are highly mobile and are capable of moving to other suitable habitats in a vast range – up to 9 km in natural conditions (Gibbons et al. 1990). Thus, these turtles can populate a large network of waterbodies quickly. The Pond sliders are opportunistic animals; their diet is rather flexible and includes mostly abundant aquatic vegetation and invertebrates in their native range (Parmenter and Avery 1990). Studies in Europe detected overlap of the food spectrums of *T. scripta* and the native species, but sliders showed the widest diet of all investigated species (Pérez-Santigosa et al. 2011).

Sliders host a large set of helminth parasites (Esch et al. 1990) and transmissible pathogens (Bringsøe 2006, Hidalgo-Vila et al. 2008, 2009). Therefore these animals could be a risk factor for local aquatic and

semi-aquatic communities and environments. Highly alarming results were recently obtained in Spain, where an epizootic event caused by blood fluke trematodes with North American origin was documented, with lethal effect over a native meta-population of *E. orbicularis* (Iglesias et al. 2015).

Legislative history and impacts

On 22 December 1997 the European Council implemented an import ban of *T. s. elegans* into the European Union (Regulation (EC) No. 338/97). Subsequently, this led to mass importation of the nominate subspecies *T. s. scripta*. Quite recently both subspecies of sliders (*scripta* and *elegans*) were banned for import in EU (Regulation No 578/2013, followed by Regulation 888/2014). Internal regulations do not exist for controlling sliders already within the EU, including their sale/re-sale, release to and removal from the wild.

Although, Bulgaria entered the EU in 2007, at present (2015) hatchling *T. scripta* spp. are still imported (mainly from the Czech Republic, with unknown origin) and are sold in numerous pet shops. For example, an illegal import of 600 hatchlings of *T. s. elegans* (declared as aquarium fish) were confiscated at Sofia airport customs in 2014. The shipment was from Singapore, where a breeding centre likely exists.

Quite recently, individual registration of pet herpetofauna became mandatory at the Regional Inspectorates of Environment and Water, the responsible executive bodies. However, there is no working mechanism to enforce registration and then follow it up, e.g. monitoring of what happens with the sold turtles. According to our observations and unpublished data, in most cases, the turtles are kept until maturity.

It seems that the visitors treat the sliders with sympathy and are convinced that they naturally occur in Bulgarian wetlands. This attitude promotes a sort of intentional, but misunderstood and incorrect attitude for “release back into the wild” of unwanted pet turtles. Some owners release the adult animal in a nearby water basin – so turtles may appear in urban fountains, ponds, flooded foundations of buildings and puddles; unfortunately, multiple turtles end up in peri-urban and natural habitats. Other owners submit turtles to zoos, where they are collected in large numbers (see above). It is unclear what happens to turtles when the capacity of the zoo is filled. Recently, owners have been able to return adult turtles back to the pet shops, which are then sold at the same price as hatchlings.

Possible measures to limit the number and distribution range of Pond sliders in Bulgaria

Competent authorities (such as the Regional Inspectorates of Environment and Water and the National Agency for Fisheries and Aqua-culture) should increase their efforts to limit the trade with *T. scripta* and ban the releases of sliders in the wild (e.g. by organizing campaigns for collecting unwanted pets). Working protocols to follow up on the registered individuals must be implemented. Another urgent measures package is related to the trapping, collecting and removing the Pond sliders from the wild. Proper devices for capture could be funnel traps of various designs, commonly used to sample freshwater turtle populations with very good results (see Plummer 1979, Kennett 1992, Gibbons 1990, Thomas et al. 2008). Additionally, basking traps were efficient for exotic turtle trapping in Spain (Pérez-Santigosa et al. 2006).

Implemented measures and experience from countries facing comparable high risks must be urgently applied to Bulgaria – as Alarcos et al. (2010) pointed out, passive monitoring has limited effectiveness and future eradication becomes either nearly impossible or very costly.

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