Research Article

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Spatial Distribution of *Emys orbicularis* (L., 1758) and *Mauremys rivulata* (Valenciennes, 1833) in the Lower Veleka River, Bulgaria: First Observations

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To Andro and Niki, true friends

Abstract: The Veleka River in SE Bulgaria is amongst the northernmost localities of coexistence of *Emys orbicularis* and *Mauremys rivulata,* the two native freshwater turtles. This linear structure provides a rare opportunity to study whether the species separate across a seemingly similar habitat. In 2010–2014, we sampled by boat 5.5 km of the river near its mouth. We collected 64 localities with observations of single or multiple individuals of *E. orbicularis* and 86 of *M. rivulata.* Although both species co-inhabited large portions of the study site, they displayed a tendency to occur more frequently in different parts. *Emys orbicularis* was predominantly found in the lower to middle portions of the study site (interquartile range, IQR of the distance to the bridge: 467–1,867 m), while *M. rivulata* was mostly observed in the middle to upper sections (IQR: 1,287–2,820 m). The medians of the calculated distances in the two species are significantly different (Mann–Whitney U test: $U = 1{,}664.00$, $Z = -4.13$, $p < 0.001$; *E. orbicularis:* median = 1,234.94 m, range = 3,335.98 m; *M. rivulata:* median = 1,911.09 m, range = 4,122.04 m). These preliminary results need to be supplemented with further studies to aid in our understanding of the species' biology and their successful conservation.

Key words: niche partitioning, habitat preference, lotic habitats, Testudines

Introduction

Two species of freshwater turtles are native to Bulgaria: the widespread European Pond Turtle *Emys orbicularis* (Linnaeus, 1758) and the Balkan Terrapin *Mauremys rivulata* (Valenciennes, 1833), which is limited to certain southern regions (Stojanov et al. 2011). In most areas where they occur together, the species seem to be present in unequal numbers (Fritz 2001, 2003, Wischuf & Busack 2001, Auer & Taskavak 2004, Bayrakci et al. 2015). For some syntopic populations competitive relationships between both species were reported (Ayaz & Çiçek 2011). In some regions where both species co-occur, the population of *E. orbicularis* is suppressed; Bayrakci et al. (2015) have attributed this tendency to the extreme tolerance of the Balkan Terrapin to waters of degraded quality (see also Gasith & Sidis 1983, 1984, Sidis & Gasith 1985).

However, few comparisons exist for locations where both species occur in Bulgaria. The Veleka River provides a suitable site to determine whether the two species spatially separate within a lotic habitat. It is a medium to large size river, situated in south-eastern Bulgaria. Although close to the northernmost localities of sympatry of both native Bulgarian freshwater turtles (Stojanov et al. 2011), it is still well within the potential environmental niche for *M. rivulata* (Kornilev et al. 2017).

Materials and Methods

Study site

Before flowing into the Black Sea just north of Sinemorets Village, Bulgaria, the 147 km long Veleka River is slow-flowing, roughly 30–50 m wide and up to 8–10 m deep. At its mouth, there is a 0.8 km sand bank which is a popular beachgoer destination. There, the river is considered a liman (estuary), roughly 2,700 m in length. A gradual transition occurs from "Black Sea river limans (R16)" to "Large Black Sea rivers (R10)", without a clearly defined border. R10 is about 8,000 m in length (G. Gyuzelev, pers. comm.). At certain times, a temporary influx of salt water can be observed but the surface layer generally remains fresh water.

The study site falls within four largely overlapping protected territories: the Natura 2000 SPA and SCI sites "Strandzha", the Strandzha Natural Park, as well as the "Mouth of the Veleka River" Protected Site. It is an important locality for freshwater turtles, included in the National Biodiversity Monitoring System.

The Sinemorets – Sozopol road crosses the river via a bridge at 1,250 m river distance from the sea. We excluded this section from sampling due to limited observations during preliminary sampling. Still, turtles may occasionally reach the beach at times: in 2015, during a sampling of a shallow, 0.25 ha pool of stagnant water situated at the heavily visited beach about 100 m from the river, we captured three *E. orbicularis* (not included in this study).

A boat ramp is present at the base of the road bridge. The only boats allowed by law (Ordinances for the protected site) are by organized tourist groups (up to four slow-moving motorboats at the same time) during 15 June – 15 September, coinciding with the turtles' active season. However, in reality, law enforcement is limited, thus fishing and recreational boats may easily go upstream, either from the boat ramp or from the sea shore.

Data collection

On multiple occasions between 2010 and 2014, we collected coordinates of the locations along the river at which we observed individual or multiple turtles. We sampled roughly 5.5 km of the river upstream of the bridge; the use of boats further upstream is difficult. Observations were predominantly on individuals basking aerially or upon surface vegetation. We did not differentiate among age or sex classes. We used hand-held GPS units (error: ±10 m; Garmin, Olathe, Kansas, USA). Observations were made by 2–3 observers from 1–2 paddle boats, respectively. When using one boat, we zig-zagged to check both river banks; otherwise, observers in each boat were responsible for one side of the river, to avoid double-counting.

Analysis

To evaluate whether there is spatial separation of the observations between the two species, we measured the shortest distance between each observation and a fixed point close to the mouth of the river (the bridge). Although the distance underestimates the real "river" distance, most of the study site is relatively linear. We performed Mann–Whitney U test (species as groups, distance as variable), with $\alpha = 0.05$, using Statistica v. 10.0 (StatSoft, Inc., Tulsa, OK).

Results

Overall, we collected 64 localities with observations of single or multiple individuals of *E. orbicularis* and 86 of *M. rivulata.* Although both native species co-inhabited large portions of the study site, they displayed a tendency to occur more frequently in different parts of the river (Fig. 1). *Emys orbicularis* was predominantly found in the lower to middle portions of the study site (interquartile range, IQR of the distance to the bridge: 467–1,867 m), while *M. rivulata* was mostly observed in the middle to upper sections (IQR: 1,287–2,820 m) (Fig. 2). The medians of the calculated distances in the two species are significantly different (Mann–Whitney U test: $U = 1664.00$, $Z = -4.13$, $p < 0.001$; *E. orbicularis:* median = 1,234.94 m, range = 3,335.98 m; *M. rivulata:* median = 1,911.09 m, range = 4,122.04 m). Although the minimum distances were similar (75 m for *E. orbicularis* and 98 m for *M. rivulata*), the maximums were different (3,411 m vs 4,220 m). When considering the maximum "river" distances, *E. orbicularis* was observed at 4,000 m upstream of the bridge, and *M. rivulata* – at 5,150 m.

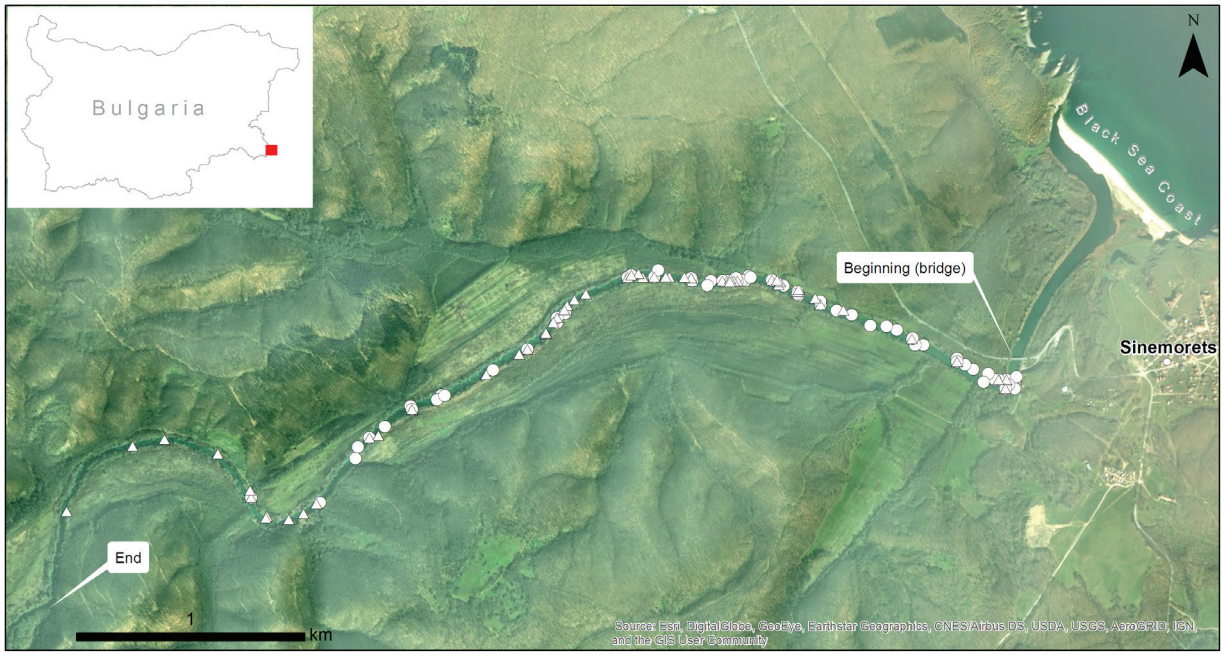

Fig. 1. Distribution of localities of *Emys orbicularis* (circles) and *Mauremys rivulata* (triangles) along the lower Veleka River, southern Bulgaria (shown on overview map)

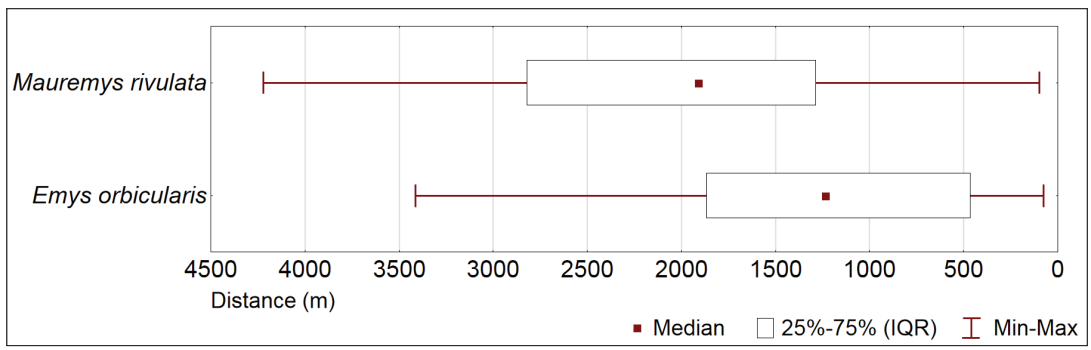

Fig. 2. Boxplot of the distances of observations of *Emys orbicularis* and *Mauremys rivulata* to the beginning of the study site at the Veleka River

Discussion

The skewed distribution of the two turtle species within the studied lotic habitat was likely shaped by a complex set of biotic and abiotic factors. At this point, further studies are needed to evaluate the underlying reasons for the observed results.

We hypothesize that the distribution of the two turtle species was shaped by yet to be identified differences in macro-habitat characteristics. Amongst these, sunlight availability is likely key, as it impacts both aerial and aquatic basking (*sensu* Moll & Legler 1971), especially at the water surface layer. Maintenance of elevated body temperature is a key requirement for most semi-aquatic turtles' biology. However, at the upstream portion of the study site, opportunities for aerial and aquatic basking seem to be limited. Upstream from the study site, the river is narrow, shaded by multiple large, overhanging trees, likely cooling the water; the surface warms up slowly while flowing through the study site, with the warmest temperatures close to the sea. In addition, around the upstream end of the field site direct sunlight also decreased: in this section the river flows in a S–N direction, and is likely shaded for part of the day by a small hill (c. 100 m a.s.l.) situated to the east. Although *M. rivulata* is a species with a more southern distribution, we speculate that it may handle better the more limited open spaces occurring upstream. Observations from the Eastern Rhodopes provide limited support for this hypothesis – there, *M. rivulata* greatly outnumbers *E. orbicularis* in the smaller, drying-up rivulets (see Kornilev et al. 2017).

Besides the potential for "typical" interspecific competition (e.g. for available food and basking sites), tolerance to human-caused disturbance also has to be considered. The river is under strong anthropogenic pressure from various human activities: people likely cause disturbance through their presence; boaters may remove fallen logs suitable for basking to increase their own access; fishermen may (intentionally or unintentionally) kill turtles, which swallow baited hooks. Although found throughout, these impacts are likely stronger in the lower river portion (1–3 km). Whether *E. orbicularis* is more tolerant of disturbance, explaining its higher prevalence downstream, is yet unknown. However, the turtles' behavioural responses to disturbance might not adequately reflect the true physiological impact (see Kornilev 2008 for a discussion).

The minor differences in water salinity are unlikely to influence species distribution, as the salinity near the liman is only c. 0.9‰, but quickly drops to 0.1‰ above the bridge (G. Gyuzelev, pers. comm.). Furthermore, the surface water should remain mostly fresh even during influxes of sea water.

It remains to be determined whether the allochthonous Pond Slider (*Trachemys scripta*), frequently released intentionally at the mouth of the Veleka (Tzankov et al. 2015), impacts both native species within the study site. Negative effects have been substantiated for *E. orbicularis* (e.g. Avery & Servan 1998, Cadi & Joly 1999, 2004, Bringsøe 2001) and *M. leprosa* (Polo-Cavia et al. 2012), and would likely apply to *M. rivulata* as well. However, we never observed high numbers of *T. scripta*; possibly, the river's seasonal catastrophic flooding displaces and potentially kills the sliders, while the native species have evolved to survive these events.

Although our results suggest differential distribution of the two species within the lower Veleka River, the causes that shaped this must be examined further, both to increase our biological knowledge of the species and to improve our abilities for their long-term conservation.

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References

Auer M. & Taskavak E. 2004. Population structures of syntopic *Emys orbicularis* and *Mauremys rivulata* in western Turkey. Biologia 59 (14): 81–84.

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

Ayaz D. & Çiçek K. 2011. Data on the population structure of the European Pond Turtle, *Emys orbicularis* (Linnaeus, 1758) in Lake Sülüklü (western Anatolia, Turkey) (Testudines: Emydidae). Herpetozoa 24 (12): 33–41.

Bayrakci Y., Ayaz D. & Çiçek K. 2015. Data on the populations of syntopic turtles *Emys orbicularis* (L., 1758) and *Mauremys rivulata* (Valenciennes, 1883) from Great Menderes delta. (Western Anatolia, Turkey). Russian Journal of Herpetology 22 (2): 79–83.

Bringsøe H. 2001. *Trachemys scripta* (Schoepff, 1792) – Buchstaben-Schmuckschildkröte. In: Fritz, U. (Hrsg.) Handbuch der Reptilien und Amphibien Europas, Band 3/IIIA: Schildkröten (Testudines) I. Wiebelsheim (Aula), pp. 525–583.

Cadi A. & Joly P. 1999. The introduction of the Slider Turtle (*Trachemys scripta elegans*) in Europe: competition for basking sites with the European Pond Turtle (*Emys orbicularis*). Chelonii 2: 95–100.

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.

Fritz U. 2001. *Emys orbicularis* (Linnaeus, 1758) – Europäische Sumpfschildkröte. In: Fritz, U. (ed.) Handbuch der Reptilien und Amphibien Europas, Band 3/IIIA: Schildkröten I. Wiebelsheim: Aula, pp. 343–515.

Fritz U. 2003. Die Europäische Sumpfschildkröte. Bielefeld: Laurenti. 224 p.

Gasith A. & Sidis I. 1983. The distribution and nature of the habitat of the Caspian Terrapin *Mauremys caspica rivulata* (Testudines: Emydinae) in Israel. Israel Journal of Zoology 32: 91–102.

Gasith A. & Sidis I. 1984. Polluted water bodies, the main habitat of the Caspian Terrapin (*Mauremys caspica rivulata*) in Israel. Copeia 1984: 216–219.

Kornilev Y. V. 2008. Behavioral ecology and effects of disturbance on the Suwannee Cooter (*Pseudemys concinna suwanniensis)* in a blackwater spring-fed river. M.S. Thesis, Gainesville: University of Florida. 117 p.

Kornilev Y., Popgeorgiev G., Naumov B., Stoyanov A. & Tzankov N. 2017. Updated distribution and ecological requirements of the native freshwater turtles in Bulgaria. Acta Zoologica Bulgarica, Supplement 10: 65–76 + i-xvii.

Moll E. O. & Legler J. M. 1971. The life history of a Neotropical Slider Turtle, *Pseudemys scripta* (Schoepff), in Panama. Bulletin of the Los Angeles City Museum of Natural History and Science 11: 1–102.

Polo-Cavia N., López J. & Martín P. 2012. Feeding status and basking requirements of freshwater turtles in an invasion context. Physiology & Behavior 105: 1208–1213.

Sidis I. & Gasith A. 1985. Food habits of the Caspian Terrapin (*Mauremys caspica rivulata*) in unpolluted and polluted habitats in Israel. Journal of Herpetology 19: 108–115.

Stojanov A., Tzankov N. & Naumov B. 2011. Die Amphibien und Reptilien Bulgariens. Frankfurt am Main: Chimaira. 588 p.

Tzankov N. D., Popgeorgiev G. S., Kornilev Y. V., Natchev N., Stoyanov A., Naumov B. & Ivanchev I. 2015. First survey on the invasive Pond Slider (*Trachemys scripta*) in Bulgaria: Historic development and current situation. Hyla – Herpetological Bulletin 2015 (1): 18–27.

Wischuf T. & Busack S. 2001. *Mauremys rivulata* (Valenciennes in Bory de Saint-Vincent et al., 1833) – Ostmediterrane Bachschildkröte. In: Fritz, U. (ed.) Handbuch der Reptilien und Amphibien Europas, Band 3/IIIA: Schildkröten I. Wiebelsheim: Aula, pp. 125–178.

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