Hyla *VOL. 2015., No.2, pp. 29 - 37*
ISSN: 1848-2007

First observations on ecology and distribution of Balkan terrapin, *Mauremys rivulata* (Valenciennes, 1833) in Vlora Bay, Albania

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Abstract

This study aims to provide for the first time information about morphometrics, habitats, population structure and biology of the Balkan Terrapin, *Mauremys rivulata* in the understudied area of Vlora Bay, Albania. Two main different habitats, freshwater channels (several channels in different areas) and ponds or swamps (two ponds in different areas) were monitored from March 2013 to October 2015. A high number of *M. rivulata* were observed basking in or out of the water, while 46 were captured for the first time. All individuals of *M. rivulata* captured were measured (length and width of carapace and plastron), marked (on marginal scutes), photographed and released again in the same habitat. Mean curved carapacial length was 18.1 cm for adult male (n=6), 19.1 cm for adult female (n=17) and 6.2 cm for juvenile (n=23). Sex ratio was 2.8 : 1 (female : male). 50% of all captured *M. rivulata* were juveniles.

Key words: sex ratio, population structure, habitat, distribution, *Mauremys rivulata*, Albania.

INTRODUCTION

Within vertebrates, turtles are among the most endangered species. Approximately 10% of the 317 recent turtle species worldwide belong to the IUCN Red List category "critically endangered" (IUCN, 2010, TURTLE CONSERVATION FUND, 2002). The territory of Albania is inhabited by two species of freshwater turtles: The European Pond Turtle, *Emys orbicularis* (Linnaeus, 1758) (family Emydidae), which is more common and the Balkan Terrapin, *Mauremys rivulata* (Valenciennes, 1833) (family Geoemydidae), which has a limited distribution in Albania (HAXHIU & BUSKIRK, 2009). Regionally, *M. rivulata* is listed as Least Concern (LC) (IUCN, 2004) in view of its wide distribution, tolerance of a degree of habitat modification, while in Albania, because of continuous reduction of ecosystem water surface, it is listed as vulnerable (VU) (Red List of Albanian Fauna, 2013). In Albania it inhabits permanent water bodies limited only to the western lowlands, from the Shkodra field in the north to the Saranda field in the south (HAXHIU, 1998).

Studies on behavior, ecology and conservation of *M. rivulata* (quoted as *Mauremys caspica rivulata* in older reports) are relatively scant (WISCHUF & BUSACK, 2001, RIFAI & AMR, 2004, GÜÇLÜ & TÜRKOZAN, 2010, VAMBERGER ET AL., 2014) when compared with the European Pond turtle *E. orbicularis* (e.g. LEBBORONI & CHELAZZI, 1991, ROVERO & CHELAZZI, 1996, CADI & JOLY, 2003, FICETOLA ET AL., 2004, FICETOLA & BERNARDI, 2006, VAMBERGER & KOS 2011, VAMBERGER ET AL., 2013, KAVIANI & RAHIMIBASHAR, 2015, ZUFFI & FOSCHI, 2015, VELO-ANTON ET AL., 2015).

Studies and publications on *Mauremys rivulata* in Albania are very scarce and they consist of sporadic surveys or accidental observations, mainly on

geographical distribution of the species in Albania (HAXHIU 1981, 1985, 1995, 1997, 1998, HAXHIU & BUSKIRK, 2000, HAXHIU & BUSKIRK 2009). The present study gives crucial information about distribution, habitats and population structure of *Mauremys rivulata* in Albania.

MATERIAL AND METHODS

The study was carried out between March 2013 and October 2015. The study site comprises a small pond covered with dense vegetation with an area of about 0.5 ha in Narta Lagoon, Vlora Bay, called Zverneci pond , a wide area of Orikumi wetland and some freshwater channels (Figure. 1 and Table.1).

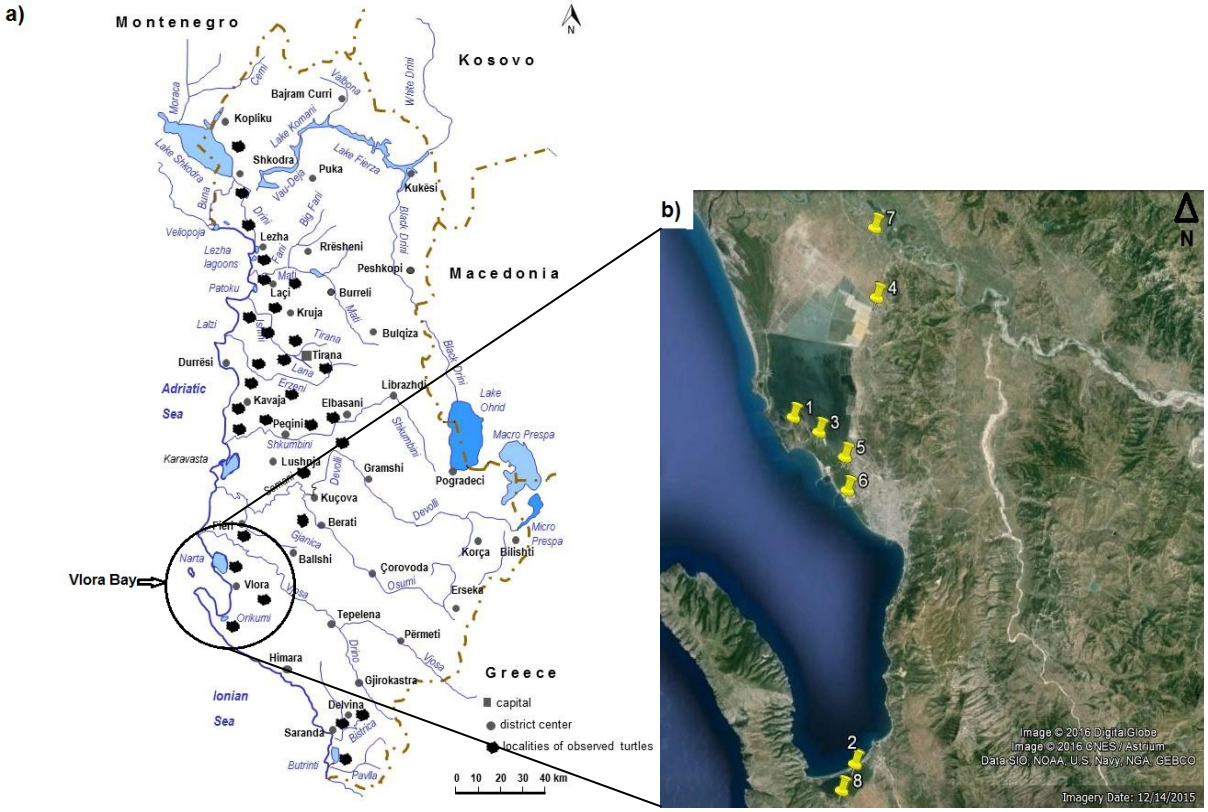

Figure. 1 - (a) Distribution of the Balkan Terrapin in Albania (HAXHIU, 1998); (b) Locations where survey was conducted.

Table 1. A list of visited locations with coordinates (in WGS84 coordinate system) in the Vlora Bay area.

Locations	Coordinates (N)	Coordinates (E)
1. Zverneci pond	40°30'42.06"	19°24'23.46"
2. Orikumi pond	40°19'19.38"	19°27'14.10"
3. Near Zverneci village channel	40°30'12.72"	19°25'34.80"
4. Panaja channel	40°34'37.56"	19°28'15.18"
5. Kavalona Park channel	40°29'23.58"	19°26'46.26"
6. Soda forest channel	40°28'18.18"	19°26'53.52"
7. Novosel – Akerni channel	40°36'54.84"	19°28'9.84"
8. Marmiroi church channel	40°18'27.54"	19°26'37.80"

Dominant plants in the ponds and channels vegetation include *Phragmites australis, Typha angustifolia, Juncus sp., Carex sp.*, *Potamogeton sp.,* some algaes, where the dominant species was *Chara sp.* and other green algae. The habitats, where *M. rivulata* was observed, were inhabited by some other animals like amphibians (*Pelophylax kurtmuelleri*, etc.), three reptile species (*E. orbicularis, Natrix natrix* and *Natrix tesselata*) and some water birds (*Fulica atra*, *Acrocephallus aerondinaceus*, etc.). Turtles were observed (by binoculars or free watching) and were caught during daytime between 08:00 - 12 : 00 and 14:00 – 17:00 h by hand using a simple net. Each captured turtle was individually marked by notching its marginal scutes (CAGLE, 1939, GIBBONS, 1990), measured with a caliper to the nearest 1.0 mm, photographed and released at the capture site. The following measurements were taken: CCL - curved carapace length (curved distance between the nuchal shield and posterior margin of supracaudal), CCW - curved carapace width (curved maximal width of carapace), PL – plastron length (distance between gular and caudal shields), PW -plastron width (maximal width of plastron), Plas-Clo (distance from the end of plastron to the middle of cloaca opening), TTL - total tail length (the distance from the end of plastron to the top of tail). Sex was identified according to male secondary sexual characteristics (RIFAI & AMR, 2004) and captured individuals of *M. rivulata* were classified as male, female and juvenile.

Descriptive statistics of the measurements and rates were calculated using the EXCEL (2010) program. All of the measurement values were summarized to a mean, one standard error (SE) and range. ANOVA Single factor test was applied to examine the differences in morphometrics (CCL, CCW, PL, PW, Plas – clo and TTL) among the sexes.

RESULTS

During the period of study, a total number of 46 individual of the Balkan Terrapin were captured and analyzed, while 104 individuals were just observed from the distance (basking, floating, feeding). From 46 caught animals, five were found dead (two adult female and two juvenile) and two were recaptured (Table. 2).

Table 2. Presence or absence, number of captured and dead individuals of *M. rivulata* in each visited locations in Vlora Bay, Albania.

Habitat type	**Location**	Observed presence of *M. rivulata*	No. of captured individuals	No. of dead individuals
Freshwater ponds with dense vegetation dominated by *Ph.australis.*	1. Zvernec	+	1	0
	2. Orikum	+	2	1
Freshwater channels with vegetation dominated by *Ph. australis*, *Juncus sp*., *Tamarix sp*., ect.	3. Near Zverneci village	-	0	4
	4. Panaja	+	38	0
	5. Kavalona Park	+	2	0
	6. Soda Forest	+	3	0
	7. Novosel - Akerni	-	0	0
	8. Marmiroi church	-	0	0
	TOTAL	**5 (locations)**	**46**	**5**

Figure 2 – Habitats where *M. rivulata* was observed and captured: a) Zverneci pond; b) Orikumi pond; c) Panaja channel covered with *Lemna sp.*; d) Kavalona park channel; e) Soda forest channel (Photo: E. Sacdanaku)

All individuals of *M. rivulata* were observed and captured in the following habitats (Figure 2). We see that the largest number of individuals of *M. rivualata* in the area of Vlora Bay, is observed and captured in two different habitat types (freshwater channel of Panaja and freshwater pond of Zverneci). These habitats are very suitable for turtles, because they are surrounded by dense vegetation dominated by *P. australis*. They were observed mostly basking out of the water, floating and feeding on algaes. In some of the studied areas (Orikumi pond, Soda forest channel and Kavalona park channel) *M. rivulata* was observed in few cases and in others (Marmiroi church channel, the channel near Zverneci

village, Novosel – Akerni channel) we had no record of *M. rivulata* at all, but *E. orbicularis* could be observed.

Based on male secondary characteristics, all caught individuals of *M. rivulata* were classified in male and female (RIFAI & AMR, 2004). The largest individual, which did not show any secondary sexual characteristic had a CCL of 10. 9 cm (109 mm) (Table 4), so animals under CCL 11 cm (110 mm) and others that could not be sexed were considered juveniles. The sex ratio resulted to be 2.8:1 (female : male) (Table. 3). Most abundant in the population of Vlora Bay were juvenile turtles (50.0% of all caught individuals of *M. rivulata*), then females (37%) and males (13%). The largest number of juveniles were caught during April, May, June and September 2015.

Carapace, plastron and tail measurements (cm) are given for 17 female, 6 male and 23 juvenile (Table 4).

Table 3. Capture history of male, female and juvenile individuals of *M. rivulata* from March 2013 to September 2015 in the area of Vlora Bay, Albania

	March 2013	April 2013	April 2015	May 2015	June 2013	June 2015	August 2014	August 2015	September 2013	September 2015	October 2014	Total
♀	1	1	4	1	1	-	1	1	-	7	-	**17**
♂	1	-	1	-	-	-	1	-	-	2	1	**6**
J*	-	-	4	7	-	4	3	-	1	4	-	**23**
Total	**2**	**1**	**9**	**8**	**1**	**4**	**5**	**1**	**1**	**13**	**1**	**46**

*Juvenile individuals

Table 4. Morphometrics of female, male and juvenile *M. rivulata* from Vlora Bay, Albania.

	females (n=17)	males (n=6)	juveniles (n=23)
CCL (cm)	19.1 ± 0.4 (16.8 – 22.9)	18.1 ± 1.5 (12.8 – 21.9)	6.2 ± 0.5 (2.9 – 10.9)
CCW (cm)	15.7 ± 0.3 (13.8 – 18.5)	13.8 ± 1.1 (9.9 – 16.2)	5.2 ± 0.4 (2.9 – 8.9)
PL (cm)	17.1 ± 0.3 (15.0 – 20.0)	14.4 ± 1.6 (10.0 – 17.0)	5.1 ± 0.4 (2.3 – 9.6)
PW (cm)	9.4 ± 0.7 (7.0 – 16.5)	7.7 ± 1.3 (4.9 – 14.0)	2.7 ± 0.2 (1.4 – 4.6)
Plas – Clo (cm)	1.3 ± 0.1 (0.5 – 2.5)	3.2 ± 0.4 (2.0 – 5.0)	0.8 ± 0.1 (0.1 – 1.8)
TTL (cm)	5.7 ± 0.3 (3.0 – 9.0)	6.7 ± 0.5 (5.0 – 8.5)	3.5 ± 0.2 (2.2 – 5.5)

CCL of collected specimens ranged from 2.9 cm to 22.9 cm and within this range the largest animals were females. CCL for juveniles ranged from 2.9 –10.9 cm (mean=6.2 cm), females 16.8–22.9 cm (mean =19.1 cm) and males 12.8–21.9 cm (mean=18.1 cm). In general, males had a longer tail than females. The plas - clo length of females was generally smaller than for males, with an average of 1.3 cm for females, and 3.2 for males. Juveniles had a plas – clo from 0.1 to 1.8 cm (Table 4.).

Analyses of variance showed that the carapacial length between females and males was not significantly different, while carapacial width was significantly different (CCL: $F_{1,\ 21} = 0.94$, $P > 0.05$. CCW: $F_{1,\ 21} = 4.53$, $P < 0.05$). Analyses of variance showed that it was a highly significant difference in the plastron length between females and males, while there was no significant difference in plastron width (PL: $F_{1,\ 20} = 8.60$, $P < 0.01$. PW: $F_{1,\ 19} = 1.22$, $P > 0.05$). There was a highly significant difference in the distance from the end of plastron to the middle of cloaca opening between females and males, while there was not a significant difference in total tail length (Plas - clo: $F_{1,\ 19} = 24.81$, $P < 0.01$. TTL: $F_{1,\ 19} = 2.01$, $P > 0.05$).

DISCUSSION

The Balkan Terrapin was found in a wide range of habitats. It was observed in lentic and lotic habitats, in polluted (Soda forest channel) and unpolluted habitats. The same types of habitats were reported by GASITH & SIDIS (1983) for Palestine, as well as by DISI (1998) and DISI et al. (2001) for Jordan. The distribution of *M. rivulata* in the area of Vlora Bay was unequal (very high in Zverneci pond and Panaja channel and very low in other habitats). To explain why there is such a distribution of *M. rivulata* in the area of Vlora Bay, further detailed studies need to be carried out.

In summer, activities including feeding, swimming, or pursuing a mate were observed during early morning hours or late afternoon, while during midday turtles were mostly basking. The same pattern of activity for *M. rivulata* was reported earlier by WISCHUF & BUSACK (2001).

The carapacial and tail measurements in the present study are in line with previous studies which found that females of the Balkan Terrapin are larger than males (AUER & TAŞKAVAK 2004; RIFAI &AMR 2004; GÜÇLÜ & TÜRKOZAN 2010) and the distance Plas – clo is larger in males than in females (RIFAI &AMR, 2004).

All caught individual of *M. rivulata* under CCL 11 cm (110 mm) and others that could not be sexed were considered juveniles. In GÜÇLÜ & TÜRKOZAN (2010) turtles of less than 81 mm SCL and in RIFAI & AMR (2004) turtles of less than 80 mm SCL were considered too small for sexing and were classified as juveniles. If we consider that we have measured curved carapace length (CCL) and not straight carapace length (SCL) as in RIFAI & AMR (2004) and GÜÇLÜ & TÜRKOZAN (2010), we are almost in line with their result.

The frequency of capture of juveniles, females and males has been determined in the present study, where it was found that juveniles made up half (50.0 %) of the collected sample of turtles. RIFAI & AMR (2004) found that juvenile made up half (50.3%) of the population of *M. rivulata* in Jordan. BURY (1978) stated that juvenile proportions of freshwater turtles in different
populations vary over 0-70 %. He also suggested that juveniles, in general, appear to comprise a variable but low percentage of most populations, in contrast to a high proportion of long-lived mature individuals. Studies on another freshwater turtle, *E. orbicluaris*, in European habitats revealed similar results, with 18.9 % (MAZZOTTI, 1995) and 29% (KELLER et al., 1998) of the studied populations being juveniles. Perhaps biased sampling resulted in the high percentage of juveniles in

the present study. Sampling was mainly done by hand as in RIFAI & AMR (2004), and shallow water was more accessible than deeper water. On the other hand, KELLER et al. (1998) used baited funnel traps to capture animals; those traps where placed in depths of 30–50 cm, which was probably out of the preferred microhabitat zone of juveniles. Thus, perhaps this also contributed to the low apparent percentage of juveniles (29 %) in the population sampled by KELLER et al. (1998).

Female to male ratio was biased toward females with 2.8:1 (female:male). We do not have a balanced sex ratio as in RIFAI & AMR (2004), but our result is similar to that of GÜÇLÜ & TURKOZAN (2008), who found a sex ratio of 3.01:1.17 (female:male). This variation could also be related to environmental temperature, since sex is determined in this species by temperature (TSD) (EWERT & NELSON, 1991, JANZEN & KRENZ, 2004), as in all other known species of Chelonia (ALDERTON, 1997, MOLL & MOLL, 2004). Species with TSD have the potential to produce sex ratios that are greatly skewed toward one sex or the other (PAUGH et al., 2001). In turtles with TSD, males are generally produced at cooler temperatures, ranging between 22.5 °C and 27 °C. Female turtles are produced at warmer temperatures, around 30 °C (EWERT & NELSON, 1991). Our study site in western Albania (Vlora Bay) typically has a Mediterranean climate and experiences high temperatures during the breeding period of *M. rivulata*. It is therefore probable that most of the nests have been producing females and our population, therefore, is skewed toward females.

We found five dead individuals (out of the water), of which four had only the shell (carapace and plastron) very decomposed and one (juvenile) had a hole in the soft carapace (we think attacked by predators). It is hard to determine the cause of death, but we think the major threats to be human activities (especially fishing activities, which are at a high level in the study area) and predators (foxes, dogs, etc.). *M. rivulata* is listed in Appendix II of the Convention of European Wildlife and Natural Habitats of 1979 (HONEGGER, 1981). The species was reported as decreasing and endangered on Cyprus, and decreasing in number in Bulgaria, European Turkey and Anatolia (HONEGGER, 1981). Although this species seems to have great ecological flexibility since it is able to adapt to and even thrive very well in polluted natural and man-made habitats. Data gathered in Albania from 1980-2009 (HAXHIU 1981, 1985, 1995, 1997, 1998, HAXHIU & BUSKIRK, 2000, HAXHIU & BUSKIRK 2009) show that the population of *M. rivulata* has decreased. The main reason of the Albanian population decrease is the continuous reduction of ecosystem water surface. Habitat destruction is also a major threat, where in the last 50 years, thousands of hectares of marshes and lagoons were drained, in order to gain agriculture land. Another reason of the habitat destruction of *M. rivulata* is the unregulated removal of aggregates from the beds of the rivers for the construction industry. This is more common in the western plains river beds where large scale removal of material is causing ecological disasters.

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