Turkish Journal of Zoology

Volume 34 | Number 3 Article 13

1-1-2010

Population structure of Mauremys rivulata in western Turkey

ÖZGÜR GÜÇLÜ

OĞUZ TÜRKOZAN

Recommended Citation
GÜÇLÜ, ÖZGÜR and TÜRKOZAN, OĞUZ (2010) "Population structure of Mauremys rivulata in western Turkey," *Turkish Journal of Zoology*: Vol. 34: No. 3, Article 13. https://doi.org/10.3906/zoo-0811-18
Available at: https://journals.tubitak.gov.tr/zoology/vol34/iss3/13

TÜBİTAK

Research Article

Turk J Zool
34 (2010) 385-391
© TÜBİTAK
doi:10.3906/zoo-0811-18

Population structure of *Mauremys rivulata* in western Turkey

Özgür GÜÇLÜ*, Oğuz TÜRKOZAN

Adnan Menderes University, Faculty of Arts and Sciences, Biology Department, 09010 Aydın - TURKEY

Received: 26.11.2008

Abstract: This study aims to provide information about the population structure of *Mauremys rivulata* at the ancient Claros site near Selçuk, in İzmir province. To achieve this goal, a total of 120 turtles (27 males, 70 females, 23 juveniles) were marked and 33 turtles were recaptured between May 2004 and April 2005. Of these recaptured turtles, 20 were female (60.6%), 9 were male (27.3%), and 4 were juveniles (12.1%). The average population size was estimated at 217. This corresponds to 434 individuals/ha. The mean body mass was 189 ± 147.5 g, which corresponds to a mean body mass of 82 kg/ha. The straight-line carapace length (SCL) of the specimens ranged from 55 mm to 181 mm (mean: 105.7 ± 25.8 mm), while the body mass varied between 27 g and 823 g. The sex ratio of marked individuals was 3.01:1.17:1 (female:male:juvenile).

Key words: Geoemydidae, *Mauremys rivulata*, population structure

Türkiye'nin batısındaki *Mauremys rivulata* türünün populasyon yapısı

Özet: Bu çalışma İzmir iline bağlı Selçuk ilçesi yakınlarındaki Klaros antik şehrindeki *Mauremys rivulata*'nın populasyon yapısı hakkında bilgi sağlamayı amaçlamaktadır. Bu amaçla Mayıs 2004 – Nisan 2005 arasında toplam olarak 120 kaplumbağa (27 erkek, 70 dişi, 23 juvenil) markalanmış ve 33 tanesi tekrar yakalanmıştır. Tekrar yakalanan kaplumbağalardan 20 (% 60,6) tanesi dişi, 9 (% 27,3) tanesi erkek ve 4 (% 12,1) tanesi juvenildir. Ortalama populasyon büyüklüğü 217 olarak tahmin edilmiştir. Bu sonuç hektar başına 434 bireye tekabül etmektedir. Ortalama vücut biyoması 189 ± 147,5 g olup hektar başına ortalama biyomas 82 kilogramdır. Hayvanların düz karapas boyu (DKB) 55 mm ile 181 (ortalama 105,7 ± 25,8 mm) mm arasında, ağırlığı ise 27 g ve 823 g arasında değişmektedir. Markalanan hayvanların eşey oranları 3,01:1,17:1 (dişi:erkek:juvenil) şeklindedir.

Anahtar sözcükler: Geoemydidae, *Mauremys rivulata*, populasyon yapısı

Introduction

The study of population structure is one of the most important components of the demographic process. Many studies have been carried out on the population structure of temperate nonmarine chelonians and on the ecological factors affecting them (Mazzotti, 1995; Hailey, 2000; Hailey and Willemsen, 2000; Sauza and Abe, 2000; Auer and

* E-mail: oguclu@adu.edu.tr

Taşkavak, 2004; Marchand and Litvaitis, 2004; Ayaz et al., 2007). Two species of *Mauremys* (Geoemydidae) occur in Turkey (Ayaz et al., 2006; Fritz et al., 2007): *Mauremys caspica* (Gmelin, 1774), ranging from central Anatolia to Iran and Iraq and extending to the Caucasus region; and *Mauremys rivulata* (Valenciennes, 1883), ranging from the Balkans, including Greece, to the Aegean and Mediterranean coastal plains of Turkey, Cyprus, Syria, Lebanon, Jordan, and Israel (Rifai and Amr, 2004; Bonin et al., 2006). In comparison to *Emys orbicularis*, the number of studies on the ecology and behavior of *M. rivulata* is limited (e.g., Gasith and Sidis, 1983; Rovero and Chelazzi, 1996; Cadi and Joly, 2003; Ficetola et al., 2004; Ayaz et al., 2007; Zuffi et al., 2007), but in recent years there has been remarkable interest in the population structure of *Mauremys* (Tok, 1999; Auer and Taşkavak, 2004; Chelazzi et al., 2007; Ayaz and Budak, 2008). Additionally, Rifai and Amr (2004) studied the sex-dependent growth rate of *M. rivulata* in Jordan.

In order to fill information gaps and provide a data set for the conservation management of this species in the future, we aimed to determine the body size, sex ratio, population size, and growth rate of *M. rivulata* in natural conditions in a restricted area of western Turkey.

Study Site

The study was conducted between May 2004 and April 2005 in a flooded area at the ancient Claros site. This site is located 50 km south of the city of İzmir (38°00′N, 27°11′E; altitude: 7 m), and is surrounded by tangerine orchards slightly above the ancient site. The study area consists of several small ponds merging with one another, whose water depth reaches 5 m. These ponds inundate parts of the ancient city. During spring, these small ponds merge and constitute a single big pond.

From the muddy bottom of the pond, there is much emergent vegetation: *Ranunculus trichophyllus*, *Chara* cf. *fragilis*, and *Cladophora* sp. The pond lacks fish, but is rich in amphibians such as *Rana* (*Pelophylax) ridibunda*, *Bufo (Pseudepidalea) viridis*, *Hyla arborea*, and *Triturus karelinii*; water snakes (*Natrix*); and macroinvertebrates (e.g., *Dytiscus*).

Materials and methods

The study was carried out between May 2004 and April 2005. The study site comprises an area of about 0.5 ha. Turtles were caught with a dip net and by hand. Day-long sampling was carried out every month. Most turtles were caught between 0900 and 1500 and then marked and released between 1500 and 1800. Turtles were captured by 2 researchers. Each captured turtle was marked by notching its marginal scutes (Gibbons, 1990a) before release. Sex was determined by secondary sexual characteristics (e.g., plastral concavity, length of tail) (Rifai and Amr, 2004). Turtles of less than 81 mm SCL were considered too small for sexing and were classified as juveniles. All individuals without shell abnormality were measured (SCL and width) with a caliper to the nearest 1 mm and weighed to the nearest 0.1 g with a digital scale. Parameters such as altitude, air and water temperature, and pH were measured.

For estimation of population size, 3 additional capture-recapture sessions were carried out in 2004. The first session was on 4 May for capture and marking and 8 July for recapture, the second session was on 8 July for capture and marking and 16 August for recapture, and the third session was on 16 August for capture and marking and 15 September for recapture. Using the Lincoln index [($n = m \times c/r$) (Mühlenberg, 1993), in which n is the estimated number of individuals in the whole population, m is the number of marked individuals following initial capture, c is the number of individuals in the second capture, and r is the number of recaptured individuals in the second capture], a mean population size was calculated from our 3 capture-recapture sessions.

Marked and recaptured individuals were separated into 2 different groups, May-August and September-April, in order to calculate the mean growth rates. For statistical analysis, the STATISTICA 6.0 program (StatSoft Inc., 2001) was used. Data were examined for confirmation of assumptions of normality (Kolmogorov-Smirnov test) and homogeneity of variance (F_{max} test). All of the measurement values were summarized to a mean and one standard deviation (SD). The correlation analysis test was applied to determine the relationship between the size of captured individuals and water temperature for all samples. Student's t-test was applied to examine the differences in SCL and body mass (BM) among the sexes.

Results

A total of 120 turtles (27 males, 70 females, 23 juveniles) were marked and 33 turtles were recaptured. Of these recaptured turtles, 20 were female (60.6%), 9 were male (27.3%), and 4 were juveniles (12.1%). According to these data, the population size was estimated at 252 for the first session, 222 for the second session, and 177 for the third session, yielding an average of 217 (Table 1). This corresponds to 434 individuals/ha. The mean body mass of 189 ± 147.5 g corresponds to a mean body mass of 82 kg/ha.

The largest and heaviest individuals were females (mean SCL: 120 ± 22.9 mm; mean BM: 257.5 ± 155.1 g). The lengths and body masses of sexable turtles are summarized in Table 2.

The sex ratio of marked individuals was 3.01:1.17:1 (female:male:juvenile). The SCL ranged from 8.1 to 14.0 cm (81.2%) among females and from 8.1 to 10.0 cm (81.5%) among males (Figure 1). Females were larger and heavier than males ($t = 4.81$, $df = 95$, $P < 0.001$ for body mass; $t = 5.48$, $df = 94$, $P < 0.001$ for SCL). In the May-August group, the growth rate was 0-6 mm for males and females and 0.1-11 mm for juveniles. Only 1 male and 1 female turtle did not show any growth during this period. The growth rate among the September-April group was 1 mm in 1 female and 1 juvenile (equivalent to 0.125 mm/month), whereas 1 male grew by 3 mm (equivalent to 0.375 mm/month). The rest of the specimens did not show any growth. The change in body mass ranged from -25 to +9 g in females, from -2 to +3 g in males, and from +3 to +4 g in juveniles in May-August. The change in body mass ranged from +2 to +14 g in females, from -2 to +11 g in males, and from +6 to +13 g in juveniles in September-April.

Table 1. Estimation of population size. First session on 4 May for capture and marking and 8 July for recapture; second session on 8 July for capture and marking and 16 August for recapture; third session on 16 August for capture and marking and 15 September for recapture. n: estimated number of individuals in the whole populations; m: number of marked individuals after first capture; c: number of individuals of second capture; r: number of recaptured (marked) individuals in second capture.

	Session A	Session B	Session C
m	65	88	120
c	31	53	31
r	8	21	21
$n = m \times c/r$	252	222	177
Mean	217		

The monthly pH values and water temperatures are presented in Figure 2. The observed values of both pH and temperature were not statistically different (Mann-Whitney *U* test, $P > 0.05$). However, there was a positive relation between the monthly captured individuals and water temperature ($r = 0.76$; $P < 0.05$) (Figure 3). The mean air temperature measured during our study period was 17.3 ± 7.03 °C (minimum mean: 12.3 ± 6.07 °C; maximum mean: 22.9 ± 7.80 °C), the mean precipitation was 52.4 ± 68.69 mm/m^2, and the mean number of rainy days was 6.9 ± 6.24 days (Turkish State Meteorological Service).

The animals were quite active from May through September. Most of the animals were observed between 0930 and 1400 while foraging, mating, basking, and swimming near the surface of the water. Specimens were caught especially while basking or swimming near the edge of pond. Few animals were observed after 1400. The number of animals observed during the following months was limited due to the

Table 2. Lengths and body masses of sexable turtles (mean, standard deviation, minimum, and maximum).

	Males (n = 27)	Females (n = 70)	Juvenile (n = 23)
Body mass (g)	109.4 (61.0) 66.0-380.0	257.5 (155.1) 80.0-823.0	73.8 (35.6) 27.0-136.0
SCL (cm)	9.4 (13) 7.8-14.2	12.0 (2.3) 8.2-18.1	7.8 (1.4) 5.5-10.0

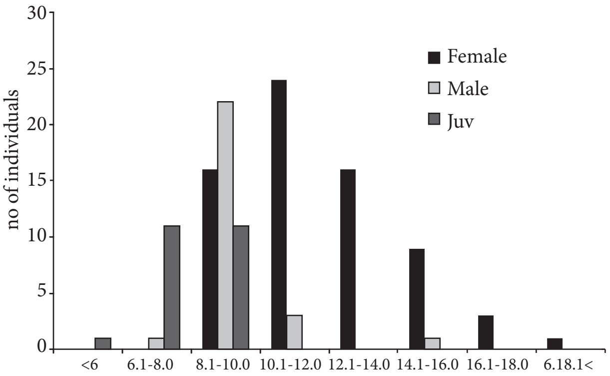

Figure 1. Distribution of SCL (cm) for females, males and juveniles.

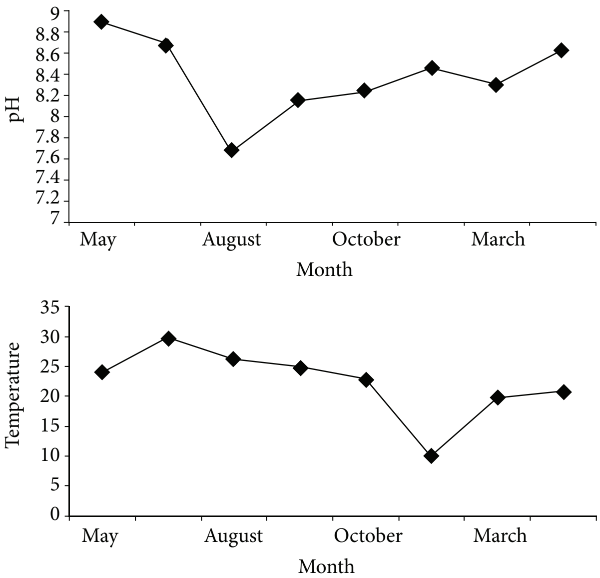

Figure 2. The monthly pH values and water temperature (°C).

increase in water level and decrease in air temperature. However, of 6 individuals captured in November, 2 were captured while mating.

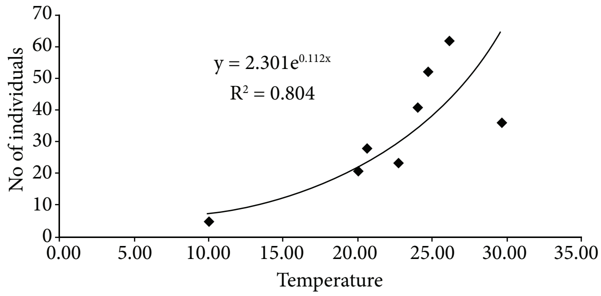

Figure 3. Correlation between the monthly number of captured individuals and water temperature (°C).

Discussion

The population density of *M. rivulata* (434 turtles/ha) at our study site was much higher than in other studies. Auer and Taşkavak (2004) recorded 4970 *M. rivulata*/km^2 (50 turtles/ha). Mazzotti (1995) estimated the population density of *E. orbicularis* at 6.13 individuals/ha. Ayaz et al. (2007) reported 83 *Emys*/ha at Pazarağaç, Turkey. The population density in our study area is at least 5 times larger than those previously recorded values. According to Gasith and Gidis (1984), a maximum of 200,000 *M. rivulata*/km^2 (2000 turtles/ha) has been recorded in polluted habitats of Israel.

Why was the *M. rivulata* population very dense in our study area in comparison to other studies? There may be 2 explanations for this. The first could be the lack of predators in the area. The second could be the area's rich food sources, which prevent competition in the studied population. Most probably, both explanations are true. Turtles older than 1 year are opportunistic omnivores (Sidis and Gasith, 1985). For many omnivorous species, fruit and flowers are particularly common food items because they have energy-rich cells that are easily ruptured so that their energy and nutrients are easily accessible (Schall and Ressel, 1991). Tangerine orchards mainly surrounded our study area and are probably the main source of food. *Chara* cf. *fragilis* is also another potential food source, together with tadpoles. Grazing on *Chara* sp. has also been observed in Jordan (Rifai and Amr, 2004). Therefore, the food availability allows for a dense population in the area. There are, of course, some disadvantages to dense populations, such as an increased risk of illnesses, competition, and stress. The only advantage to such a population could be the dispersal of the population into different habitats because of adverse pressures, as mentioned.

Females outnumbered males in our study area. Females composed 58% of the captured and marked specimens. In contrast, Auer and Taşkavak (2004) reported that males were dominant in their population, explaining this dominancy with the higher activity of males, increasing the possible capture rate during their study period (June-October), which corresponds closely to our study period. This variation could also be related to environmental temperature, since sex is determined in this species by temperature (TSD) (Ewert and Nelson, 1991; Janzen and Krenz, 2004), as in all other known species of *Chelonia* (Alderton, 1997; Moll and 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 and Nelson, 1991). Our study site in western Turkey 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. On the other hand, Gibbons (1990b) listed 4 demographic factors influencing sex ratios in the turtle population. These are "sex ratio of hatchlings," which we discussed above; "differential mortality of sexes"; "differential emigration and migration of sexes"; and "differences in age at maturity of the sexes." It is, therefore, not clear whether the skewed observed sex ratio in favor of one sex may depend only on turtle activity, as reported by Auer and Taşkavak (2004).

In comparison to studies by Auer and Taşkavak (2004) and Rifai and Amr (2004), our juvenile population size (19%) was more than 50% lower. According to Auer and Taşkavak (2004), juveniles composed 42% of all their captures, while juveniles accounted for 50.3% of captures for Rifai and Amr (2004). However, a lower juvenile population (4%) has also been recorded for the European pond turtle, *E. orbicularis*, in Turkey (Ayaz et al., 2008). Keller and Busack (2001) emphasized that a low frequency rate of capture of juveniles is not an extreme condition, most probably resulting from either oblique sampling or low juvenile rates. Our study area is within the vicinity of an ancient city and receives many visitors during the tourism season, mainly between June and September. Archeological excavation in the area has been increasing steadily. Consequently, the available nesting sites have been diminished gradually, which may threaten the survival of the population in the region. Another reason could be the increasing competition and stress among the population because of density. The lower rate of juveniles in this population could be evidence of a population decline in the region.

The mean SCL was 119.5 mm and 93.9 mm in females and males, respectively. Rifai and Amr (2004) recorded the mean SCL as 162.5 mm in females and 114.1 mm in males. Wischuf and Busack (2001) measured the SCL of most of their male specimens as below 110 mm. They concluded that the higher frequency of 'dwarf males' in the population represents the males reaching sexual maturity at 80-100 mm SCL. Our SCL measurements fall within the range previously recorded for the species.

The growth in size was at higher rates among juveniles than adults. Similar conclusions were also noted by Bury (1978) for most freshwater turtles in general and by Rifai and Amr (2004) for *M. rivulata*. Growth in size during the September-April period almost stopped. However, during the same period, except for some females, the turtles interestingly gained weight. This proves the availability of food sources during winter. The weight loss in some females (-16 to -20 g) could be attributed to the existence of eggs. These females were probably gravid at first capture and laid their eggs before recapture. The same type of weight loss was also recorded in the *M. rivulata* of Jordan (Rifai and Amr, 2004). Bury (1978) noted that male freshwater turtles reach sexual maturity earlier than females. He further stated that the growth rate considerably decreases when the turtles reach sexual maturity, and that juveniles grow faster than adults, as males grow faster than females. These results were further confirmed by our study (mean: 5.5 mm for juveniles, 3.0 mm for males, 2.66 mm for females). In another study, Rifai and Amr (2004) presented growth rates ranging from 0 mm to 25.7 mm and from 0 mm to 6.5 mm in juveniles and males, respectively, during a period of 11 months. They recorded female growth ranging between 0 mm and 2 mm during the same period. According to these values, only the juvenile growth rates are greatly different from our values.

However, Bury (1978) noted that the quality of the food in different habitats could be a significant determinative factor for the growth rate. Rifai and Amr (2004), without taking gender into consideration, stated that differences between growth rates could result from different feeding habits based on the habitats of juveniles. A relatively small growth rate could be the result of high population density and food availability. Furthermore, ongoing archeological excavations may also increase the stress on the animals and therefore adversely affect their growth rates.

The positive correlation between the number of captured turtles and water temperature is mainly related to the increasing activity of the turtles associated with heat. However, increasing temperatures during summer lowered the water level and adversely influenced the number of turtles captured.

Acknowledgement

The authors would like to thank Jim Buskirk for his linguistic review of the text.

References

Alderton, D. 1997. Turtles and Tortoises of the World. Blanford Press, London, p. 191.

Auer, M. and Taşkavak, E. 2004. Population structure of syntopic *Emys orbicularis* and *Mauremys rivulata* in western Turkey. Biologia 59, Suppl. 14: 81-84.

Ayaz, D., Turkozan, O., Tosunoğlu, M., Tok, C.V. and Cihan, D. 2006. Morphologic and serologic comparison of two Turkish populations of *Mauremys rivulata* and *Mauremys caspica*. Chelonian Conservation and Biology 5: 10-17.

Ayaz, D., Fritz, U., Tok, C.V., Mermer, A., Tosunoğlu, M., Afsar, M. and Çiçek, K. 2007. Population estimate and body size of European pond turtle (*Emys orbicularis*) from Pazarağaç (Afyonkarahisar/Turkey). Biologia 62: 225-227.

Ayaz, D. and Budak, A. 2008. Distribution and morphology of *Mauremys rivulata* (Valenciennes, 1833) (Reptilia: Testudines: Geoemydidae) in the Lake District and Mediterranean region of Turkey. Turk. J. Zool. 32: 137-145.

Bonin, F., Devaux, B. and Dupré, A. 2006. Turtles of the World. Transl. P.C.H. Pritchard, The Johns Hopkins University Press, Baltimore.

Bury, R.B. 1978. Population ecology of freshwater turtles. In: Turtles: Perspectives and Research (eds. M. Harless, H. Morlock and E. Robert), Krieger Publishing Company, Malabar, Florida, pp. 571-602.

Cadi, A. and Joly, P. 2003. Competition for basking places between the endangered European pond turtle (*Emys orbicularis galloitalica*) and the introduced red-eared slider (*Trachemys scripta elegans*). Canadian Journal of Zoology 81: 1392-1398.

Chelazzi, G., Naziridis, T., Benvenuti, S., Ugolini, A. and Crivelli, A.J. 2007. Use of river-wetland habitats in a declining population of the terrapin (*Mauremys rivulata*) along the Strymon River, northern Greece. Journal of Zoology 271: 154-161.

Ewert, M.A. and Nelson, C.E. 1991. Sex determination in turtles: diverse patterns and some possible adaptive values. Copeia 1991: 50-69.

Ficetola, G.F., Padoa-Schioppa, E., Monti, A., Massa, R., De Bernardi, F. and Bottoni, L. 2004. The importance of aquatic and terrestrial habitat for the European pond turtle (*Emys orbicularis*): implications for conservation planning and management. Canadian Journal of Zoology 82: 1704-1712.

Fritz, U., Ayaz, D., Buschbom, J., Kami, H.G., Mazanaeva, L.F., Aloufi, A.A., Auer, M., Rifai, L., Šilic, T. and Hundsdörfer, A.K. 2007. Go east: phylogeographies of *Mauremys caspica* and *M. rivulata* – discordance of morphology, mitochondrial and nuclear genomic markers and rare hybridization. Journal of Evolutionary Biology 21: 527-540.

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

Gibbons, J.W. 1990a. Turtle studies at SREL: a research perspective. In: Life History and Ecology of the Slider Turtle (ed. J.W. Gibbons), Smithsonian Institution Press, Washington, D.C., pp. 19-44.

Gibbons, J.W. 1990b. Sex ratios and their significance among turtle populations. In: Life History and Ecology of the Slider Turtle (ed. J.W. Gibbons), Smithsonian Institution Press, Washington, D.C., pp. 171-182.

Hailey, A. 2000. Implications of high intrinsic growth rate of a tortoise population for conservation. Animal Conservation 3: 185-189.

Hailey, A. and Willemsen, R.E. 2000. Population density and adult sex ratio of the tortoise *Testudo hermanni* in Greece: evidence for intrinsic population regulation. Journal of Zoology 251: 325-338.

Janzen, F.J. and Krenz, J.G. 2004. Phylogenetics: which was first, GSD or TSD? In: Temperature-Dependent Sex Determination in Vertebrates (eds. N. Valenzuela and V.A. Lance), Smithsonian Institution Press, Washington, D.C., pp. 121-130.

Keller, C. and Busack, S.D. 2001. *Mauremys leprosa* (Schweigger, 1812) – Maurische Bachschildkröte. In: Handbuch der Reptilien und Amphibien Europas: Land- und Sumpfschildkröten (ed. U. Fritz), Aula-Verlag, Wiesbaden/Wiebelsheim, pp. 57-88.

Marchand, M.N. and Litvaitis, J.A. 2004. Effects of habitat features and landscape composition on the population structure of a common aquatic turtle in a region undergoing rapid development. Conservation Biology 18: 758-767.

Mazzotti, S. 1995. Population structure of *Emys orbicularis* in the Bardello (Po Delta, Northern Italy). Amphibia-Reptilia 16: 77-85.

Moll, D. and Moll, E.O. 2004. The Ecology, Exploitation and Conservation of River Turtles. Oxford University Press, New York.

Mühlenberg, M. 1993. Freilandökologie, 3. überarbeitete Auflage. UTB für Wissenschaft 595, Quelle & Meyer, Heidelberg, Wiesbaden.

Paugh, F.H., Andrews, R.M., Cadle, J.E., Crump, M.L., Savitzky, A.H. and Wells, K.D. 2001. Herpetology, 2nd ed. Prentice Hall, New Jersey.

Rifai, L.B. and Amr, Z.S. 2004. Morphometrics and biology of the striped-necked terrapin, *Mauremys rivulata* (Valenciennes, 1833), in Jordan (Reptilia: Testudines: Geoemydidae). Zoologische Abhandlungen 54: 177-197.

Rovero, F. and Chelazzi, G. 1996. Nesting migrations in a population of the European pond turtle *Emys orbicularis* (L.) (Chelonia, Emydidae) from central Italy. Ethology Ecology and Evolution 8: 297-304.

Schall, J.J. and Ressel, S. 1991. Toxic plant compounds and the diet of the predominantly herbivorous whiptail lizard, *Cnemidophorus arubensis*. Copeia 1991:111-119.

Sidis, I. and 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.

Souza, F.L. and Abe, A.S. 2000. Feeding ecology, density and biomass of the freshwater turtle, *Phrynops geoffroanus*, inhabiting a polluted urban river in south-eastern Brazil. Journal of Zoology 252: 437-446.

StatSoft, Inc. 2001. STATISTICA for Windows (data analysis software system), version 6, www.statsoft.com.

Tok, C.V. 1999. The taxonomy and ecology of *Mauremys caspica rivulata* Valenciennes, 1833 (Testudinata: Bataguridae) and *Testudo graeca ibera* Pallas, 1811 (Testudinata: Testudinidae) on Resadiye (Datça) Peninsula. Turkish Journal of Zoology 23: 17-21.

Wischuf, T. and Busack, S.D. 2001. *Mauremys rivulata* (Valenciennes in Bory de Saint-Vincent et al., 1833) – Ostmediterrane Bachschildkröte. In: Handbuch der Reptilien und Amphibien Europas: Land und Sumpfschildkröten (ed. U. Fritz), Aula Verlag, Wiesbaden/Wiebelsheim, pp. 89-110.

Zuffi, M.A.L., Celani, A., Foschi, E. and Tripepi, S. 2007. Geographical patterns of reproductive plasticity in the European pond turtle, *Emys orbicularis*. Journal of Zoology 271: 218-224.