

Data on the population structure of the European Pond Turtle, *Emys orbicularis* (LINNAEUS, 1758) in Lake Sülüklü (western Anatolia, Turkey) (Testudines: Emydidae)

Daten zur Populationsstruktur der Europäischen Sumpfschildkröte *Emys orbicularis* (LINNAEUS, 1758) im See Sülüklü (Westanatolien, Türkei)
(Testudines: Emydidae)

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KURZFASSUNG

Die Autoren untersuchten die Population der Europäischen Sumpfschildkröte, *Emys orbicularis* (LINNAEUS, 1758) des Sülüklü-Sees (Manisa, Türkei) in der Zeit von April bis September 2010. Auf Grundlage der durchgeführten Abschätzungen betrug der Anteil der Jungtiere an der Population 6,8 %, der Männchen 39,1 % und der Weibchen 54,1 %. Bei Anwendung des Jolly-Seber Algorithmus berechnete sich die Populationsgröße mit 205 Exemplaren (Standardfehler = 19,5, Spannweite = 167-243), die Überlebensrate mit 0,82 und die Fangwahrscheinlichkeit mit 0,31. Das Geschlechterverhältnis der adulten Schildkröten war signifikant zugunsten der Weibchen verschoben (Männchen:Weibchen = 0,7, $P \leq 0,009$). Die mittlere Carapaxlänge (Stockmaß, SCL), Plastronlänge (PL) und Körpermasse (BM) betragen bei adulten Männchen ($n = 52$) SCL = 132,2±1,19 mm, PL = 120,3±0,98 mm, BM = 407,4±94,01 g und bei adulten Weibchen ($n = 72$) SCL = 147,8±1,44 mm, PL = 144,4±1,39, BM = 707,4±132,11 g. Darüber hinaus werden die Faktoren besprochen, welche die lokale Schildkrötenpopulation in ihrem Bestand gefährden.

ABSTRACT

The authors monitored the population of the European Pond Turtle, *Emys orbicularis* (LINNAEUS, 1758) in Lake Sülüklü (Manisa, Turkey) from April to September 2010. According to these estimations, 6.8% of the population were juveniles, 39.1% males and 54.1% females. Using Jolly-Seber's formula, the population size was calculated as 205 (Standard Error = 19.5, range = 167-243), survival rate as 0.82, and capture probability as 0.31. The adult sex ratio was significantly skewed in favor of females (males:females = 0.7, $P \leq 0.009$). Mean straight carapace length (SCL), plastron length (PL), and body mass (BM) of adult turtles were for males ($n = 52$) SCL = 132.2±1.19 mm, PL = 120.3±0.98 mm, and BM = 407.4±94.01 g, and for females ($n = 72$) SCL = 147.8±1.44 mm, PL = 144.4±1.39, and BM = 707.4±132.11 g. The factors threatening the local population were discussed.

KEY WORDS

Reptilia: Testudines: Emydidae: European Pond Turtle, *Emys orbicularis*, population structure, population dynamics, population size, body size, ecology, conservation, western Anatolia, Turkey

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" (TURTLE CONSERVATION FUND 2002; IUCN 2010). The threatened European Pond Turtle, *Emys orbicularis* (LINNAEUS, 1758), one of two Palearctic representatives of the family Emydidae, is one of the most widely distributed water turtle species ranging from

Northwestern Africa in the west to the former Aral Sea in the east, and from the Moscow region in the north to the Turkish-Syrian border in the south (FRITZ 2001, 2003). The populations of the European Pond Turtle are threatened due to many factors, primarily destruction and disappearance of habitats (VAN DIJK et al. 2000; GIBBONS et al. 2000; TURTLE CONSERVATION FUND 2002). Although the species is considered within the scope of the species re-

quiring conservation in the Bern Convention and in ANNEX II of the European Habitat and Species Directives, it is included in the category of “near threatened” in the Red List of IUCN (TORTOISE & FRESHWATER TURTLE SPECIALIST GROUP 1996).

The European populations of the species are threatened by destruction (especially swamps) and disappearance of their habitats, industrial and agrochemical contamination, destruction of eggs due to cultivation of the soil, and the occupation of the habitat of the species by foreign freshwater turtles (SERVAN 1995). Thus, some populations have disappeared (VELO-ANTÓN et al. 2008). The populations in Italy (GARIBOLDI & ZUFFI 1994; CHELAZZI et al. 2000), France (CHEYLAN 1998; GAY & LEBRAUD 1998), Poland (MITRUS 2000), Germany (HANKA & JOGER 1998; SCHNEEWEISS 1998; SCHNEE-

WEISS & FRITZ 2000), former Soviet Union (SNIESHKUS 1998; SHCHERBAK 1998; KOTENKO 2004). Turkish populations are endangered, particularly due to habitat destruction (ATATÜR 1995; TAŞKAVAK & REIMANN 1998; AYAZ et al. 2007, 2008a).

Information on Anatolian populations is largely based on accidental observations scattered in systematic studies, and a few ecological studies, mainly on population size (AUER 2002; AUER & TAŞKAVAK 2004; AYAZ et al. 2007, 2008a) which are inadequate to evaluate a population’s threat status.

The present study aims to provide information on the population structure and size of the Lake Sülüklü population of *E. orbicularis*, its sex ratio, and body sizes, thereby contributing to the scarcely known ecology of the Anatolian populations of the species.

MATERIALS AND METHODS

Lake Sülüklü, the study site, is located on the northeastern slope of Mt. Spil [38.565035°N, 27.532617°E, 612 m a.s.l.] and it is surrounded by a pine forest (*Pinus brutia*). The surface area of the lake is nearly 1.58 ha and its depth 2-4 m. Dominant plants in the lake vegetation include *Typha angustifolia*, *Phragmites australis*, *Juncus* sp., *Carex* sp. and *Potamogeton* sp. The lake is nourished by ground waters, snow melt and rain. The water level drops drastically, especially in summer (July and August), because of a decrease in spring water influx and monthly rainfall. Four amphibians - *Bufo viridis* LAURENTI, 1768, *Pelophylax bedriagae* (CAMERANO, 1882), *Lissotriton vulgaris* (LINNAEUS, 1758), *Triturus karelinii* (STRAUCH, 1870), and three reptilian species - *E. orbicularis*, *Mauremys rivulata* (VALENCIENNES, 1833) and *Natrix natrix* (LINNAEUS, 1758) inhabit the Lake.

The lake was sampled ten times between April 23 and September 9, 2010. During the study period, the air temperature was 23-27°C, water temperature was 23-26°C, and the weather was clear. The mean monthly air temperature (1975-2009) of Manisa ranged from 15.2 to 28.3 (Fig. 1).

Turtles were caught during daytime between 08.00-11.00 h and 15.00-18.00 h

by net and hand. In addition, fish traps were set at six points early in the morning and checked four times between 08.00 h and 18.00 h.

During the study, 133 (52 males, 72 females, and 9 juveniles) European Pond Turtles were marked; 79 of these individuals were recaptured (Table 1). Each captured turtle was individually marked by notching its marginal scutes (GIBBONS 1990). Then, the individuals were released, each to its place of capture. Individuals’ straight carapace length (SCL) and plastron length (PL) were measured to the nearest 0.1 mm using a caliper, and body mass was recorded to the nearest 0.1 g using digital scales. Sex was determined from secondary sex characteristics (ZUFFI & GARIBOLDI 1995). The smallest turtle showing secondary sex characteristics was a male that had a SCL of 112.0 mm; smaller specimens were considered juveniles.

In the calculation of population size and related parameters, the POPAN model, a parameterized Jolly-Seber model, developed by SCHWARZ & ARNASON (1996) was applied and processed using the MARK (COOCH & WHITE 2010) program. The suitable models were specified according to the lowest value of Akaike’s Information Cri-

teria (AICc) (BURNHAM & ANDERSON 2002; COOCH & WHITE 2010). The approximate population density (d) was calculated applying the formula $d = N/a$ in which the mean population size (N) is divided by the area of

the lake (a). A χ^2 test was used to compare the sex ratios, whereas a t -test was used to compare the sexes. All statistical analyses were performed using SPSS ver. 10.0 with alpha set at 0.05.

RESULTS AND DISCUSSION

Body size and mass.- The average straight carapace lengths were 88.4 ± 1.08 (81.0-96.0) mm for juveniles, 132.2 ± 1.19 (112.0-147.0) mm for males and 147.8 ± 1.44 (111.0-170.0) mm for females. The average plastron length was determined as 84.4 ± 1.12 (76.0-92.0) mm in juveniles, 120.3 ± 0.98 (103.0-132.0) mm in males and 144.4 ± 1.39 (108.0-164.0) mm in females. The average body mass was 152.5 ± 62.08 (108.6-196.4) g for juveniles, 407.4 ± 94.01 (244.0-505.0) g for males and 707.4 ± 132.11 (400.0-860.8) g for females. Females were larger than males (t -test, for SCL: $t = 3.43$, $P \leq 0.001$; for PL: $t = 5.56$, $P \leq 0.000$; for BM: $t = 5.04$, $P \leq 0.000$).

In *E. orbicularis*, body sizes vary depending on latitude and environmental factors (FRITZ 2001, 2003), with the populations in the south of the range area of the species tending to be smaller (FRITZ 1998; KELLER et al. 1998). Anatolian populations of European Pond Turtles exhibit a considerable morphological variation (FRITZ et al. 1998). Based on the results of recent genetic studies (FRITZ et al. 2009), which are considerably different from earlier views (FRITZ 2003), the Lake Sülüklü population might be assigned to the nominate subspecies. AYAZ et al. (2008b) reported the SCL of individuals from various parts of Turkey ranging from 89 to 169 mm in males ($n = 396$) and from 90 to 183 mm in females ($n = 354$). Some populations from the Central Anatolian Plateau are large, with maximum shell lengths of approximately 200 mm (FRITZ 2001, 2003), whereas other Central Anatolian populations and populations along the Aegean and Mediterranean coasts have only small to medium-sized shells (AYAZ 2003; AYAZ et al. 2008b; FRITZ 2001, 2003; TAŞKAVAK & AYAZ 2006). The Lake Sülüklü population must be categorized as medium-sized and similar to the Aegean and Mediterranean populations (Fig. 2).

Breeding ecology and sampling success.- 13 to 27 individuals were captured on each sampling day (Table 1). In *E. orbicularis* breeding occurs from March to May, depending on latitude (ERNST & BARBOUR 1989). In the Lake Sülüklü population, mating started early in April and continued until May. The number of individuals captured was highest during this time (Table 1).

During the study, 212 individuals (83 males, 120 females, and 9 juveniles) were captured. Of these individuals, 133 (52 males, 72 females, and 9 juveniles) were initially captured and marked, and 79 out of the marked individuals were recaptured at least once.

Ratio of juveniles.- Of the population in Lake Sülüklü, 6.8% were juveniles, 39.1% were males and 54.1% were females. The rate of juveniles was rather low, and it is highly probable that it does not reflect the real value. Generally, juvenile European Pond Turtles prefer small, shallow water bodies with dense vegetation, where they can easily find food, shelter and protection from predators, and live a more cryptic life than adults (e.g., ZUFFI 2000; MOSIMANN & CADI 2004). In other studies on the species, the rate of juveniles ranged from 1.9% to 55% (SERVAN 1998; KELLER 1997; BRAITMAYER et al. 1998; AUER & TAŞKAVAK 2004; CADI et al. 2004; AYAZ et al. 2007, 2008a).

Sex ratio in adults.- The sex ratio observed throughout the study (males: females) was generally female-biased (Table 2). A male-biased sex ratio was only observed during the sampling on June 17. When the whole study period was considered, the sex ratio was found as 0.7 ($\chi^2 = 6.74$, $P \leq 0.09$) and it was female-biased. Balanced (TAŞKAVAK & AYAZ 2006), male-biased (FRITZ 2001, 2003; AUER & TAŞKAVAK 2004; CADI et al. 2004; CORDERO RIVERA & AYRES FERNÁNDES 2004; MOSI-

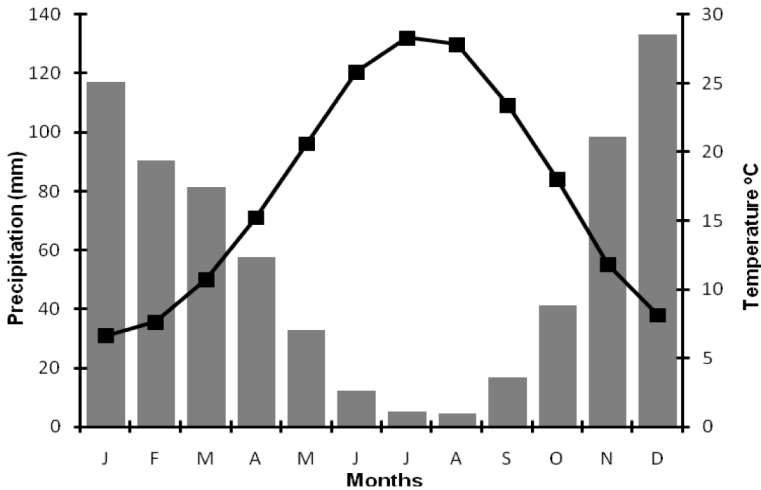


Fig. 1: Climate diagram (1975-2009) of Manisa, Turkey. Bars show mean monthly precipitation (mm), the line represents the mean monthly temperature (°C). (Source: TURKISH STATE METEOROLOGICAL SERVICE 2011).

Abb. 1: Klimadiagramm (1975-2009) von Manisa, Türkei. Balken stellen die monatlichen Niederschläge (mm) dar, die Linie zeigt den Verlauf der mittlere Monatstemperatur (°C). (Quelle: TURKISH STATE METEOROLOGICAL SERVICE 2011).

MANN & CADI 2004; AYAZ et al. 2007, 2008a) and female-biased (GIRONDOT & PIEAU 1993; MAZZOTTI 1995; MASCORT 1998; SERVAN 1998; SNIESHKUS 1998; PARDE et al. 2000) sex ratios were observed in different European Pond Turtle populations.

Survival rate, biomass, population density.- For estimating the survival rate, the $\{\Phi(\cdot)p(t)\}$ model was applied to the obtained data, since this model in which the survival rate does not vary during the year $\Phi(\cdot)$ and capture probability varies among the samplings $p(t)$, had the lowest AICc (579.23) value. According to this model, super-population size was calculated as 205 (SE = 19.5, range = 167-243). The survival rate ranged from 0.23 to 1 during the year, and its mean value was found as 0.82 (SE = 0.04, range = 0.73-0.89). Capture probability ranged from 0.08 to 1 during the year, and its mean value was calculated as 0.31 (SE = 1.64, mean = 0.07-0.40). Probability of entry was detected as 0.10 (SE = 0.31, mean = 0.00-0.67). The population density in the lake was calculated as 130 individuals/ha and the biomass as 71.4 kg/ha. In *Emys orbicularis*, the survival rate was observed to be 0.80-1.00 in Poland

(MITRUS & ZEMANEK 2004) and 0.80 in Lake Yayla (Western Anatolia) (AYAZ et al. 2008a). Besides, annual survival rate of some freshwater turtles is also very high (e.g. IVERSON 1991; CONGDON et al. 1993, 2000).

In the Ukraine, there are more than 112 individuals per hectare in some populations of the species, and this figure ranges from 38-380 in some populations at low elevations (KOTENKO 2004). It was observed that the European Pond Turtle populations had different densities in the Volga Delta, Tigach River (BOZHANSKY & ORLOVA 1998), in some lakes in the Stravropol Region (75-125 turtles/ha, TERTYSHNIKOV & VYSOTIN 1987), Azerbaijan (70-80 turtles/ha, ALEKPEROV 1978), Dagestan (1-30 turtles/ha, MAZANAIEVA & ORLOVA 2004), Geneva (Switzerland) (64 turtles/ha, MOSIMANN & CADI 2004), and Po Delta Region (northern Italy) (6 turtles/ha, MAZZOTTI 1995). In the Anatolian populations, the population density was 225 turtles/ha in Çukurköy (Western Anatolia) (AUER & TAŞKAVAK 2004), 83 turtles/ha in Pazaragaç (Central Anatolia) (AYAZ et al. 2007), and 81 turtles/ha in Lake Yayla (Western



Fig. 2: Adult female *Emys orbicularis* (LINNAEUS, 1758) from Lake Sülüklü, western Anatolia, Turkey.
Abb. 2: Adultes Weibchen von *Emys orbicularis* (LINNAEUS, 1758) vom Sülüklü-See, Westanatolien, Türkei.



Fig. 3: Reedy habitat of *Emys orbicularis* (LINNAEUS, 1758) at Lake Sülüklü, western Anatolia, Turkey.
Abb. 3: Schilfbestandener Lebensraum von *Emys orbicularis* (LINNAEUS, 1758) am Sülüklü-See, Westanatolien, Türkei.

Table 1: Capture history of *Emys orbicularis* (LINNAEUS, 1758) in Lake Sülüklü. n – total number of animals caught, u – number of animals caught once, m – number of recaptures.

Tab. 1: Ergebnis der Fang-Wiederfangversuche an *Emys orbicularis* (LINNAEUS, 1758) im Sülüklü-See. n – Gesamtzahl gefangener Individuen, u – Anzahl einmal gefangener Individuen, m – Anzahl der Wiederfänge.

	23 April	4 May	10 May	21 May	17 June	2 July	4 August	18 August	27 August	9 September	Total
n	24	27	26	19	20	24	13	22	22	15	212
u	24	26	20	11	14	11	5	8	9	5	133
m	0	1	6	8	6	13	8	14	13	10	79

Anatolia) (AYAZ et al. 2008a). In Anatolia, the population density of *E. orbicularis* is associated with habitat quality, competition with *M. rivulata* and *Mauremys caspica* (GMELIN, 1774), and environmental factors. According to our observations, density is generally high in the Central Anatolian, Western and Central Black Sea populations and low in the Coastal Aegean, Mediterranean and Southeastern populations.

Threats to the Lake Sülüklü population of *Emys*. – The water of Lake Sülüklü (Fig. 3) is used for irrigation of the surrounding cherry gardens. In addition, lake water is contaminated when the agricultural pesticides used in the gardens are diluted. The second important pressure on the *Emys* population in Lake Sülüklü is fishing by amateur fishermen. The European Pond Turtle is attracted by the bait and caught by the fishing lines thrown into the lake to catch the introduced *Cyprinus carpio*. Damage to turtles caught by nets was observed in four individuals (3% of the population). During the study, two marked

individuals were killed by amateur fishermen. The third factor is damage to eggs. Some egg-laying sites are situated in adjacent gardens. Since agricultural activity is high particularly in April-June at these sites, the eggs laid here are destroyed. In Turkey, the major factors endangering the European Pond Turtle are the draining of wetlands for agriculture (e.g., former Amik Lake), illegal collecting and trade, the coating of main waterways with concrete (and thus separating nesting from feeding areas), urbanization due to tourism, and the application of agrochemicals (ATATÜR 1995; AYAZ et al. 2007, 2008a). Unfortunately, there is lack of information about the ecology of the Anatolian populations of the European Pond Turtle (e.g., population structure and dynamics, and breeding). Within the scope of another project to be launched in April 2011, the authors will monitor *Emys* populations of the Mediterranean Region for three years. Based on these results, a model action plan for the sustainability of the Anatolian *Emys* populations shall be developed.

Table 2: The sex ratio among the *Emys orbicularis* (LINNAEUS, 1758) specimens captured in Lake Sülüklü including the significance of the deviation from a balanced sex ratio (χ^2 test). M - males, F - females, J - juveniles.

Tab. 2: Geschlechterverhältnis der Exemplare von *Emys orbicularis* (LINNAEUS, 1758), die im Sülüklü-See gefangen wurden und Signifikanz der Abweichung vom ausgeglichenen Geschlechterverhältnis (χ^2 Test). M - Männchen, F - Weibchen, J - Juvenile.

		23 April	4 May	10 May	21 May	17 June	2 July	4 August	18 August	27 August	9 September	Total
M		9	10	9	9	10	10	5	7	8	6	83
F		15	16	16	10	9	13	6	14	13	8	120
J		0	1	1	0	1	1	2	1	1	1	9
M:F		0.6	0.6	0.6	0.9	1.1	0.8	0.8	0.5	0.6	0.8	0.7
M versus F	χ^2 $P \leq$	1.50 0.220	1.38 0.239	1.48 0.223	0.53 0.818	0.53 0.818	0.39 0.532	0.09 0.763	2.33 0.126	1.19 0.275	0.29 0.593	6.74 0.09

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DATE OF SUBMISSION: February 9, 2011

Corresponding editor: Heinz Grillitsch

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