Population structures of syntopic *Emys orbicularis* and *Mauremys rivulata* in western Turkey

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Data on body size, population density, sex ratio, age, and sexual maturity are presented for a syntopic population of *Emys orbicularis* and *Mauremys rivulata* from Çukurköy, western Turkey. 49 *E. orbicularis* and 98 *M. rivulata* were recorded from May to October 2001. This corresponds to an estimated density of 2,250 *E. orbicularis* and 4,970 *M. rivulata* per km² water surface. Mean straight-line carapacial length was 124 mm for adult male (*n* = 13) and 146 mm for adult female *E. orbicularis* (*n* = 9); mean adult body mass was 336 g for males and 565 g for females. Average straight-line carapace length was 146 mm in adult male (*n* = 41) and 168 mm in adult female *M. rivulata* (*n* = 16); the mean weight was 381 g in males and 594 g in females. Sex ratios were 1.4 : 1 in *E. orbicularis* and 2.6 : 1 in *M. rivulata* (male : female). 55% of all captured *E. orbicularis* and 42% of all *M. rivulata* were juveniles. Male *E. orbicularis* could be sexed at 110 mm straight-line carapace length, when exhibiting 7 scute annuli (males). Equivalent data for *M. rivulata* were 86 mm and 3 annuli.

Key words: *Emys orbicularis*, *Mauremys rivulata*, population density, body size, sex ratio, Turkey.

Introduction

Regarding ecology, *Emys orbicularis* (L., 1758) is a well studied species in different parts of its wide distribution range (see reviews in Fritz, 2001, 2003). Distinctly less is known about *Mauremys rivulata* (Valenciennes, 1833), distributed from Dalmatia through the Balkan peninsula and Turkey southward to Israel (Wischuf & Busack, 2001). Studies on the ecology of this species are rare and restricted to Israel (Gasith & Sidis, 1984, 1985). In many parts of its range, *M. rivulata* occurs syntopically with *E. orbicularis* (Fritz, 2001, 2003; Wischuf & Busack, 2001). However, no ecological data are available for mixed populations of both freshwater turtle species. The present study is aimed to provide some basics for a syntopic population in western Turkey.

Material and methods

Investigations were conducted in the high valley of Çukurköy from May to October 2001. The valley is located adjacent to Dumanlı peak at the southern edge of the Yunt mountains, 50 km north of Izmir (38°41’ N, 27°07’ E). The Aegean region has a Mediterranean climate. However, in the study site, located 620 m
a.s.l., the climate is on average 2 °C cooler than in the Aegean lowland. Rainfall occurs mainly from November to May.

The study site comprises an area of 1.5 km². Approximately half of the valley is used as farmland, the other half as pasture. The surrounding slopes consist of pasture as well, covered by Mediterranean thorn-bush vegetation with juniper, kermes oak, and pine. Three types of water bodies were found and investigated in Çukurköy valley: Artificial shallow cattle ponds in the pasture (Fig. 1), water holes (up to 5 m deep) between the fields, and a spring creek at the northwestern edge of the high valley.

The collection method is well known to impact the recorded sex ratio and age distribution in *Emys orbicularis* (KOTENKO, 2000). To minimize this bias, several capture methods were applied. Turtles were caught by net, hand (muddling) or with fishtraps. Sampling for the general investigations was carried out every four weeks during two consecutive days. Traps were checked twice a day. All individuals were measured (straight-line carapace length) with a calliper to the nearest 0.1 mm, and weighed to the nearest 2 g with a spring balance. In addition, all individuals were marked by notching marginal scutes (CAGLE, 1939). However, juveniles with shell lengths below 5 cm were marked instead with nail polish. If possible, the sex was identified according to male secondary sexual characters (e. g. tail shape, concave plastron). When the turtles were too small for sexing, they were classified as juveniles. For age determination, growth rings were counted (SEXTON, 1959) on the first pleural scute of carapace under the premise that one annulus is produced yearly. At the study site, turtle growth is interrupted by a hibernation period of at least three months (TAŞKAVAK, unpubl. data).

For estimation of population size, two additional special capture-recapture sessions were performed. Session A used 9–27 June for capture and marking, and 29 June–18 August for recapture; session B 22 August–1 September and 3 September–5 October, respectively.

The number of recaptured individuals allows a rough estimate of population density according to the Lincoln Index (MÜHLENBERG, 1993):

\[
    n = m * c/r
\]

*n* – estimated number of individuals in the whole population; *m* – number of marked individuals after first capture; *c* – number of individuals of second capture; *r* – number of recaptured (marked) individuals in second capture.

Using the Lincoln Index, a mean population size was calculated from our two capture-recapture sessions.

**Results**

**Habitat**

Turtles of both species and all size classes were found in the pasture ponds (Fig. 1). In early spring, approximately 0.08 km² of the pasture was covered with water from the winter rains. In May 2001 the total water surface, comprising inundated land and ponds was reduced to 0.04 km². By mid-July the pasture ponds fell dry. Individuals of both species migrated to the water holes in the nearby field, or to aestivation sites on land. *Emys orbicularis* and *Mauremys rivulata* were located in the water holes from May to October. Only *M. rivulata* was found in slow flowing parts of the spring creek, connecting the study site with the Izmir lowland habitats.

**Population size and sex ratio**

From May to October 2001, a total of 147 turtles were caught and marked (49 *E. orbicularis*, 98 *M. rivulata*). The sex ratio for *E. orbicularis* was 1.4 : 1 (male : female), and for *M. rivulata* 2.6 : 1 (male : female). Juvenile turtles were abundant (55% of all *E. orbicularis*; 42% of all *M. rivulata*). According to the Lincoln Index the mean population size is 90 for *E. orbicularis* and 197 for *M. rivulata* (Tab. 1). Thus, only approximately 50% of the populations of both species were marked during the study. Our population size estimations correspond to a density of 2,250 *E. orbicularis* and 4,970 *M. rivulata* per km² water surface.

**Body size, sexual maturity and age**

Lengths and body masses of sexable turtles are summarized in Table 2. The smallest *E. orbicularis* with male secondary sex characteristics measured 110 mm straight-line carapacial length and had seven annuli. In *M. rivulata*, male secondary sex characteristics appear with 86 mm carapace length (three annuli). A maximum of 16 annuli could be

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<th>Emys orbicularis</th>
<th>Mauremys rivulata</th>
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<tr>
<td></td>
<td>Session A</td>
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<tr>
<td>m</td>
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<td>Mean</td>
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Table 2. Straight-line carapace lengths (SCL) and body masses of sexable turtles from Çukurköy (average, maximum, minimum).

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<th>Emys orbicularis</th>
<th>Mauremys rivulata</th>
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<tr>
<td></td>
<td>males (n = 13)</td>
<td>females (n = 9)</td>
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<tr>
<td>SCL [mm]</td>
<td>124 (110–138)</td>
<td>146 (134–162)</td>
</tr>
<tr>
<td>Body mass [g]</td>
<td>336 (220–406)</td>
<td>565 (440–680)</td>
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Fig. 2. Juvenile Emys orbicularis from Çukurköy; age one, two, and four years.

counted in an E. orbicularis and in a M. rivulata, suggesting an age of at least 16 years for both individuals. Juvenile E. orbicularis (Fig. 2) generally have a light yellow iris colour. Mature females have a white or yellow iris, mature males a light brownish to red iris. A plastral hinge is already present in E. orbicularis with five annuli (corresponding to a shell length of approx. 100 mm); younger individuals have still rigid, unhinged plastrae.

Discussion

According to recent literature reviews (FRITZ, 2001, 2003), population densities of Emys orbicularis vary considerably, depending on region and study method. In general, population densities are high in South Europe and the centre of the range, while marginal populations in Central and Northeast Europe, North Africa, as well as in southern and eastern Asia Minor are often characterized by low or extremely low individual numbers. The Çukurköy local population belongs with a high density of 2,250 pond turtles/km² to the first category. Little is known about Mauremys rivulata. This species occurs in natural streams and ponds with 1,900–20,000 individuals per km² in Israel; a maximum of 200,000 turtles/km² has been recorded from polluted habitats (GASITH & SIDIS, 1984). According to these data, M. rivulata seems generally less negatively impacted by human activity than E. orbicularis. The mean density reported in this study (4,970 M. rivulata/km²) resembles densities from similar natural habitats in Israel.

In Çukurköy, males dominate in both studied species. However, we cannot exclude that the sex ratio was favoured for males by the applied collection methods. Males were generally more active during our investigations. Thus, the chance to capture a male turtle might have been greater than for a female turtle. A considerable proportion of E. orbicularis and M. rivulata were juveniles, suggesting that both populations are stable. The percentage of young E. orbicularis (55%) even exceeds other flourishing populations from different parts of the range. KELLER (1997) recorded during her long-term investigations in the Doñana reserve (Spain) approximately 20% juveniles and
9% subadults. BRAITMAYER et al. (1998) found 12% juveniles in Menorca. SERVAN (1987, 1998) recorded 30% and 15% juvenile *Emys orbicularis* in two local populations in Central France (Brenne). For *M. rivulata*, no published data are available (WISCHUF & BUSACK, 2001).

In *Emys orbicularis*, there is much size variation, depending on subspecies, latitude, and local environmental conditions (FRITZ, 2001, 2003). The population from Çukurköy matches with its small shell lengths many other populations in the south of the species' range (FRITZ, 2001, 2003). Our values for shell lengths in *M. rivulata* fall within the range reported earlier for the species (BUSACK & ERMST, 1980; GASITH & SIDIS, 1984; TOK, 1999; WISCHUF & BUSACK, 2001).

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**References**


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