

Distribution and Morphology of *Mauremys rivulata* (Valenciennes, 1833) (Reptilia: Testudines: Geoemydidae) in the Lake District and Mediterranean Region of Turkey

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Abstract: Morphometric measurements and color-pattern features of 62 samples of *Mauremys rivulata* from the Lake District (Göller Bölgesi) and the Mediterranean Region of Turkey were compared. Between populations, males apparently differed in 10 characters and females in 12 characters (independent t-test), but coefficient of difference (CD) values for these characters were not significant, and sexes were combined into a single group and compared with Aegean *M. rivulata* with respect to morphometric features. The greatest straight carapace length (SCL) observed in a male and female Aegean specimen was 215.0 mm and 214.0 mm, respectively. This paper also provides the first record of *M. rivulata* in Lake Eğirdir of the Lake District. *Mauremys rivulata* specimens were captured in Sakçagözü-Kömürler (Gaziantep) on the easternmost border of the study site, whereas no *M. capica* specimens were encountered in the area.

Key Words: Testudines, Geoemydidae, *Mauremys rivulata*, morphology, distribution, Turkey

Göller Bölgesi ve Akdeniz Bölgesi'nde *Mauremys rivulata* (V., 1833)'nin Morfolojisi ve Dağılışı (Reptilia: Testudines: Geoemydidae)

Özet: Göller Bölgesi ve Akdeniz Bölgesi'nden 62 *M. rivulata* örneği morfolojik ölçümler ve renk-desen özellikleri bakımından karşılaştırılmıştır. Renk-desen ve morfolojik ölçümler bakımından önemli farklılıklar tespit edilemediğinden birleştirilmiş ve Ege Bölgesi *M. rivulata* popülasyonu ile morfolojik olarak karşılaştırılmıştır. Independent t-testine göre erkekler 10, dişiler 12 karakter bakımından ayrılmıştır. İstatistiksel olarak önemli bulunan bu karakterler için CD (Farklılık Katsayısı) değerleri hesaplandığında hiç bir karakter için CD değeri önemli çıkmamıştır. Erkekler ve dişilerde en büyük düz karapas boyu (SCL) Ege Bölgesi örneklerinden ölçülmüştür, sırasıyla 215.0 mm ve 214.0 mm. Göller Bölgesi'nde Eğirdir Gölü'nde *M. rivulata*'nın yaşadığı ilk kez tespit edilmiştir. Çalışma alanının en doğu sınırını oluşturan Sakçagözü-Kömürler (Gaziantep)'de *M. rivulata* yakalanmış, *M. capica* bulunamamıştır.

Anahtar Sözcükler: Testudines, Geoemydidae, *Mauremys rivulata*, morfoloji, dağılışı, Türkiye

Introduction

Three species of hard-shelled freshwater turtles are found in European and Anatolian Turkey: *Mauremys rivulata*, *Mauremys caspica*, and *Emys orbicularis*. Until recently, *M. rivulata* and *M. caspica* were considered subspecies of *M. caspica* (Başoğlu and Baran, 1977; Ernst and Barbour, 1989); however, Fritz and Freytag (1993), Wischuf and Fritz (1996), and Fritz and Wischuf (1997) studied *Mauremys* populations of the Near and Middle East and clarified its specific status based on color-pattern

and distribution characteristics. In addition, some investigations of the serology and molecular phylogeny of *Mauremys* support the specific status of both taxa (Barth et al., 2004; Ayaz et al., 2006). The distribution of *M. rivulata* includes Europe, the former Yugoslavia, Greece, many Aegean Islands, including Crete and Cyprus, Bulgaria to western and southern Turkey, the coastal strip of Syria, Lebanon to Israel, and Jordan (Fritz and Wischuf, 1997; Wischuf and Busack, 2001; Rifai and Amr, 2004).

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Mauremys rivulata is a well-known species in Turkey. Fritz and Wischuf (1995) stated that *M. rivulata* inhabits areas dominated by a warm Mediterranean climate, whereas *M. caspica* is confined to a continental steppe climate. Furthermore, they concluded that there was no evidence of the presence of *M. rivulata* in the continental high plateau of Central Anatolia. The Anatolian distribution map of *M. caspica* and *M. rivulata* was dealt with in detail by Eiselt and Spitzenberger (1967). This map was reproduced, including a few new records, by Başıoğlu and Baran (1977) and served as a basis for studies undertaken by Busack and Ernst (1980), Fritz and Freytag (1993), and Fritz and Wischuf (1995, 1997). An updated distribution map of both species in Turkey was also presented by Ayaz et al. (2006).

Information on the morphology and distribution of *M. rivulata* in Turkey varies considerably. Studies of Turkish Thracian turtles by Çevik (1982), and the turtles of Reşadiye Peninsula by Tok (1999) provided only a rough idea of these regions. Taşkavak et al. (1997) revealed statistically significant morphological differences between the 2 populations of *M. rivulata* in Anatolia.

This present study examined the morphology and distribution of *M. rivulata* from the Lake District and Mediterranean Region of Turkey, and compared the morphometric characteristics of individuals from these regions with specimens from the Aegean Region.

Material and Methods

Field studies in 20 fresh and brackish water systems, including the Lake District and Mediterranean Region, were undertaken between April 2001 and July 2002. Except for 2 (1 ♂, 1 ♀) specimens previously captured by other researchers, 62 (27 ♂♂, 26 ♀♀ and 9 Juvenile) *Mauremys rivulata* specimens were collected from 12 localities (Figure 1). Of these, 58 specimens were released after the required measurements had been taken. The 4 remaining (3 ♂♂, 1 ♀) specimens were preserved in the museum of the Zoology Department of Ege University (ZDEU).

Material: ZDEU. 59/2000. 1 ♂, 1 ♀, Kocçaliler (Bucak/Burdur); ZDEU. 35/2002. 3 ♂♂, 1 ♀, Kapisuyu (Samandağ/Hatay). Released specimens: 4 ♂♂, 5 juv., Kapisuyu (Samandağ/Hatay); 2 ♀♀, Karasu (Islahiye/Gaziantep); 1 ♂, 1 ♀, 1 juv., Botaş (Yumurtalık/Adana); 1 ♂, 1 ♀, between Sakçagözü and Kömürler (Gaziantep); 4 ♂♂, 1 ♀, 1 juv., Hassa (Hatay); 1 ♂, 1 ♀, Bahçe (Osmaniye); 1 ♀, İskenderun (Centrum/Hatay); 3 ♂♂, 2 ♀♀, Lake Eğirdir (Isparta); 1 ♂, 2 ♀♀, Tekebaşı Village (Samandağ/Hatay); 5 ♂♂, 6 ♀♀, 2 juv., Manavgat (Antalya) and 4 ♂♂, 6 ♀♀, Akseki (Antalya).

All measurements were taken with calipers and are straight lines to the nearest 0.1 mm (see detailed definitions and figures in Fritz, 1995). Specimens with a maximum straight line carapace length (SCL) < 10 cm

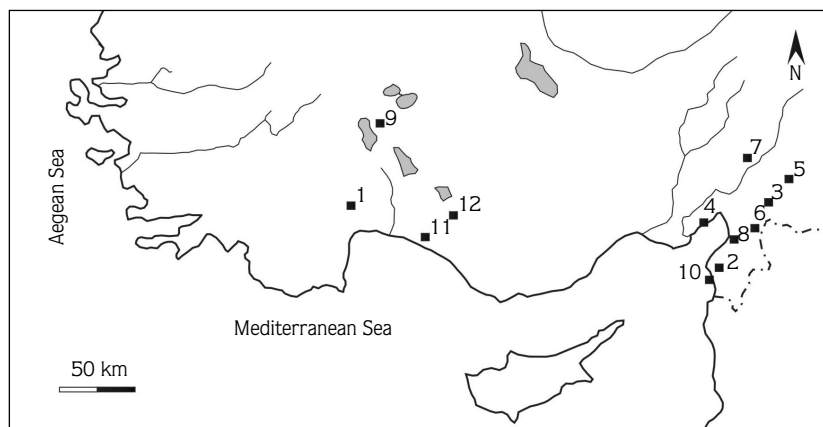


Figure 1. Study sites. 1) Kocçaliler (Bucak/Burdur), 2) Kapisuyu (Samandağ/Hatay), 3) Karasu (Islahiye/Gaziantep), 4) Botaş (Yumurtalık/Adana), 5) Sakçagözü-Kömürler (Gaziantep), 6) Hassa (Hatay), 7) Bahçe (Osmaniye), 8) İskenderun (Centrum/Hatay), 9) Lake Eğirdir (Isparta), 10) Tekebaşı village (Samandağ/Hatay), 11) Manavgat (Antalya), and 12) Akseki (Antalya).

were considered juveniles (Winden and Bogaerts, 1992). Each specimen's color and pattern characteristics, in addition to locality elevation, air and water temperature, pH, and habitat type, were recorded in the field.

The 15 morphometric measurements taken were as follows: SCL, curved carapace length (CCL), maximum carapace width (CW), maximum carapace height (CH), midline plastron length (PL), plastron width from humeral (PW-I), plastron width from abdominal (PW-II), gular suture length (GuL), humeral suture length (HuL), pectoral suture length (PeL), abdominal suture length (AbL), femoral suture length (FeL), anal suture length (AnL), nuchal length (NuL), and nuchal width (NuW).

In all, 27 ratios were used to investigate differences between the Aegean and Mediterranean populations (SCL: CW, SCL: CH, SCL: PL, SCL: PW-I, SCL: PW-II, SCL: CCL, SCL: GuL, SCL: HuL, SCL: PeL, SCL: AbL, SCL: FeL, SCL: AnL, SCL: NuL, SCL: NuW, CW: CH, CW: PL, CW: PW-I, CW: PW-II, CW: CCL, CW: GuL, CW: HuL, CW: PeL, CW: AbL, CW: FeL, CW: AnL, CW: NuL, CW: NuW). Ratios were used due to the uncertainty concerning age groups and whether growth was isometric. Sexual dimorphism has

been extensively described in turtles (Gibbons and Lovich, 1990) and data were processed separately for each sex. First, independent t-tests were performed utilizing the 27 ratios to compare male and female specimens (separately) from the Aegean Region with those from the Mediterranean. Afterwards, the coefficient of difference [$CD = (\text{mean}_1 - \text{mean}_2) / (\text{SD}_1 + \text{SD}_2)$] was calculated for the characters exhibiting differences (Mayr, 1969). Differences were considered significant when the CD value was ≥ 1.28 . Statistical analyses were carried out using SPSS v.10.0. Our *Mauremys rivulata* specimens were compared with the Aegean population studied by Ayaz (1998).

Results and Discussion

Distribution and Habitat

In Turkey, *Mauremys rivulata* largely inhabits Thrace, as well as western and southern Anatolia (Başoğlu and Baran, 1977; Baran and Atatür, 1998). Types of habitat, specimens (captured or observed), certain physical characteristics, and ecological parameters of the water systems studied are given in Table 1.

Table 1. The examined localities and habitat types of *M. rivulata*, with some ecological parameters (+: captured or observed, -: not observed).

Localities	Habitat type	Water (°C)	Air (°C)	pH	<i>Mauremys rivulata</i>	Date	Altitude (m)
Lake Akşehir (Konya)	Lake	27	37	7.8	-	13.7.2001	950
Lake Beyşehir (Konya)	Lake	28	44	7.1	-	3.7.2001	1080
Lake Çavuşçu (Konya)	Lake	23	26	6.8	-	2.7.2001	1010
Lake Eber (Afyonkarahisar)	Lake	19.5	23	6.3	-	2.7.2001	860
Lake Eğirdir (İsparta)	Creek	20	24	7.2	+	4.7.2001	880
Lake Kovada (İsparta)	Lake	20	28	7.2	-	4.7.2001	870
Çakırköy Village (Afyonkarahisar)	Canal	14	17	7.7	-	16.5.2001	1005
Yağmapınar (Karapınar/Konya)	Spring pool	19.5	26	7.6	-	12.6.2001	1020
Pazarağaç (Çay/Afyonkarahisar)	Marshes	21	25	6.4	-	16.5.2001	925
Kapısuyu Village (Hatay)	creek	20	32	7.1	+	4.9.2001	Sea Level
Tekebaşı Village (Hatay)	creek	21	33	6.9	+	5.9.2001	Sea Level
Between Sakçağözü-Kömürlü (Gaziantep)	creek	28	36	6.9	+	9.6.2001	450
Karasu (Gaziantep)	stream	29	34	6.7	+	10.6.2001	460
Hassa (Hatay)	stream	27	35	7.4	+	10.6.2001	460
Bahçe (Osmaniye)	stream	28	36	7.2	+	10.6.2001	460
İskenderun (Centrum/Hatay)	stream	27	33	7.5	+	2.7.2002	Sea Level
Botaş (Yumurtalık/Adana)	creek	28	37	7.1	+	12.6.2001	Sea Level
Huzurkent (Tarsus/Mersin)	creek	29	38	6.9	+	3.7.2002	Sea Level
Lake Akyayan (Adana)	Lake	27	34	7.4	+	10.6.2001	Sea Level
Lake Akyatan (Adana)	Lake	28	35	7.5	+	10.6.2001	Sea Level

In Turkey's Lake District, *Mauremys rivulata* samples were caught only in a creek flowing into Lake Eğirdir from the south; these specimens represent new records. Specimens were collected by hand from shallow parts of the creek that supported dense vegetation (*Phragmites australis*, *Typha angustifolia*, and *Juncus* sp. were the dominant plant species). Frogs (*Rana ridibunda*) and snakes (*Natrix natrix*) were also observed in the area.

Eiselt and Spitzenberger (1967), and Fritz and Freytag (1993) determined the Euphrates and Ceyhan rivers to be the exact borderlines between the ranges of *Mauremys rivulata* and *M. caspica*. Earlier reports of sympatry between these species near Ankara (Boulenger, 1926; Bird 1936; Bodenheimer, 1944) turned out to be wrong or doubtful (Fritz and Wischuf 1995). Taşkavak (1992) stated that in Gölbaşı, Adıyaman County, the Ceyhan River and a tributary of the Euphrates, Göksu River, *M. caspica* and *M. rivulata* are within 5 km of each other. He recorded specimens from Ceyhan as *M. rivulata*, while those from Göksu were identified as *M. caspica*. According to Taşkavak (1992), the easternmost border of the range of *M. rivulata* in Anatolia coincides with Afrin and Karasu creeks, which flow into the Asi River. In the present study *M. rivulata* was captured between the towns of Kömürler and Sakçagözü (Gaziantep), forming the easternmost border of our study area where no *M. caspica* were recorded.

Werner (1902) reported *M. caspica* from Porsuk Creek, a tributary of the Sakarya River (Eskişehir), but Eiselt and Spitzenberger (1967) thought this occurrence could, according to general distribution patterns, be *M. rivulata*. The record was later treated as doubtful in published distribution maps (Başoğlu and Baran, 1977; Fritz and Freytag, 1993). Ayaz (1998) captured 3 specimens of *M. rivulata* from Şaphane (Kütahya), about 70 km west of Porsuk Creek.

Morphology

Morphometrics: Morphometric measurements obtained from adult specimens are shown in Table 2. The longest SCL for both males and females was measured in Aegean specimens (215 mm and 214 mm, respectively), while the shortest was in Mediterranean samples (101 mm for both males and females). Frequency analyses performed for SCL values revealed that Aegean males and Mediterranean females demonstrated the longest SCLs (Figure 2).

Werner (1902) reported an SCL of 180 mm for a *Mauremys rivulata* from Lake Balıklı (Bursa) as the largest measurement ever recorded from Anatolia. Siebenrock (1913) did not agree with Werner (1902) and noted that an *M. rivulata* reported from Mersin (Mediterranean Region) had a carapace length of 194 mm. According to Siebenrock (1913), the longest *M. rivulata* specimens, with carapace lengths measuring up to 220 mm (Wischuf and Busack, 2001), were found in Syria and Nahr el Deheb (northwest Syria). Siebenrock (1913) attributed the difference in carapace length between specimens from Lake Balıklı, Mersin, and Eastern Anatolia to geographic variation. These data suggest that size decreases gradually from east to west, since specimens from Dalmatia are relatively smaller (Siebenrock, 1913).

Our findings with respect to maximum SCL contradict Siebenrock's (1913) data. This is in line with observations of SCL for *Mauremys rivulata* from Thrace (196.5 mm) reported by Çevik (1982) and from Datça (172 mm) by Tok (1999). Taşkavak et al. (1997) compared *M. rivulata* populations in Nurdağı (Gaziantep) and İzmir, and in contrast to Siebenrock's (1913) data, Nurdağı (Gaziantep) specimens were smaller than western specimens. In conclusion, there is no gradual size reduction from east to west, suggesting that a geographically correlated size decrease is a misconception based on biased sampling. Larger mean values were measured in males from the Aegean Region and in females from the Mediterranean Region, but female measurements were similar to one another in each population.

Separate t-tests were applied to males and females of both groups to compare 27 ratios. Population differences were apparent in males with regard to 10 ratios (37.04%), and females with regard to 12 ratios (44.44%) (Table 3). CD values calculated for characters exhibiting differences indicated that none of the CD values attained the significant value of 1.28.

SCL: CW and SCL: CH ratios were comparable to those given in other studies. The Aegean population was similar to that in Thrace (Çevik, 1982) with regard to SCL: CW ratio. The Mediterranean population, however, demonstrated values closer to the Nurdağı, Gaziantep population (Taşkavak et al., 1997). As reported in a number of other studies (Çevik, 1982; Tok, 1999; Taşkavak et al., 1997) Aegean and Mediterranean

Table 2. The summarized statistical analyses of morphometric measurements of the adult *M. rivulata* specimens from the Aegean and Mediterranean regions. (n = sample size, SD = standard deviation).

	Aegean Region											
	Males				Females				Overall			
	n	Range	Mean	SD	n	Range	Mean	SD	n	Range	Mean	SD
SCL	20	119.0-215.0	169.25	24.76	37	108.0-214.0	157.89	26.57	57	108.0-215.0	161.88	26.30
CCL	20	131.0-241.0	185.90	28.24	37	116.0-236.0	172.95	29.87	57	116.0-241.0	177.49	29.72
CW	20	85.0-145.0	116.35	16.06	37	78.0-146.0	110.73	17.24	57	78.0-146.0	112.70	16.91
CH	20	40.0-71.0	54.05	8.62	37	38.0-82.0	57.46	11.65	57	38.0-82.0	56.26	10.74
PL	20	107.0-184.0	147.10	21.82	37	101.0-201.0	148.16	24.85	57	101.0-201.0	147.79	23.64
PW-I	20	45.0-82.0	63.80	10.47	37	42.0-87.0	63.92	11.31	57	42.0-87.0	63.88	10.93
PW-II	20	51.0-92.0	71.70	10.81	37	45.0-97.0	72.38	12.97	57	45.0-97.0	72.14	12.16
GuL	20	12.0-21.0	17.40	2.58	37	8.0-22.0	17.05	2.92	57	8.0-22.0	17.18	2.79
HuL	20	9.0-16.0	13.00	2.15	37	10.0-19.0	14.00	2.13	57	9.0-19.0	13.65	2.18
PeL	20	16.0-33.0	24.55	4.19	37	17.0-44.0	26.14	5.23	57	16.0-44.0	25.58	4.91
AbL	20	23.0-46.0	34.90	6.39	37	20.0-55.0	35.14	8.97	57	20.0-55.0	35.05	8.10
FeL	20	24.0-37.0	31.75	4.04	37	20.0-40.0	29.76	4.94	57	20.0-40.0	30.46	4.70
AnL	20	10.0-17.0	13.10	1.83	37	12.0-24.0	17.19	2.90	57	10.0-24.0	15.75	3.23
NuL	20	8.0-13.0	11.15	1.53	37	9.0-13.0	10.65	1.06	57	8.0-13.0	10.83	1.26
NuW	20	7.0-12.0	9.60	1.43	37	8.0-14.0	10.22	1.29	57	7.0-14.0	10.00	1.36
Mediterranean Region												
SCL	27	101.0-185.0	137.89	29.70	26	101.0-206.0	160.15	29.29	53	101.0-206.0	148.81	31.30
CCL	27	113.0-216.0	156.07	35.39	26	110.0-232.0	181.27	33.38	53	110.0-232.0	168.43	36.38
CW	27	70.8-130.0	97.30	20.27	26	73.7-141.0	114.49	19.99	53	70.8-141.0	105.73	21.74
CH	27	33.0-63.0	44.52	10.07	26	34.0-79.0	60.54	12.82	53	33.0-79.0	52.38	13.97
PL	27	86.2-164.0	121.10	27.99	26	85.8-195.0	151.31	29.01	53	85.8-195.0	135.92	32.08
PW-I	27	38.7-71.2	52.63	11.13	25	38.1-84.8	64.71	13.04	52	38.1-84.8	58.44	13.43
PW-II	27	42.3-81.2	60.56	13.73	26	44.4-97.0	76.43	15.12	53	42.3-97.0	68.34	16.38
GuL	27	10.3-22.2	14.95	3.84	26	9.5-24.1	18.14	3.82	53	9.6-24.1	16.52	4.12
HuL	27	5.6-14.8	10.06	2.71	26	7.7-17.0	12.85	2.42	53	5.6-17.0	11.43	2.91
PeL	27	12.6-26.7	18.14	4.54	25	13.2-34.9	25.02	4.73	52	12.6-34.9	21.45	5.75
AbL	27	17.9-40.1	27.85	7.34	25	17.0-49.8	35.58	9.63	52	17.0-49.8	31.57	9.29
FeL	27	18.5-37.6	25.86	5.98	26	17.7-37.5	30.08	5.74	53	17.7-37.6	27.93	6.18
AnL	27	8.1-15.7	11.06	2.01	26	9.5-25.5	16.97	3.65	53	8.1-25.5	13.96	4.16
NuL	27	6.4-12.0	8.63	1.68	26	6.7-14.0	9.92	1.52	53	6.4-14.0	9.26	1.72
NuW	27	6.7-11.3	8.63	1.17	26	6.7-13.0	9.32	1.59	53	6.7-13.0	8.97	1.42

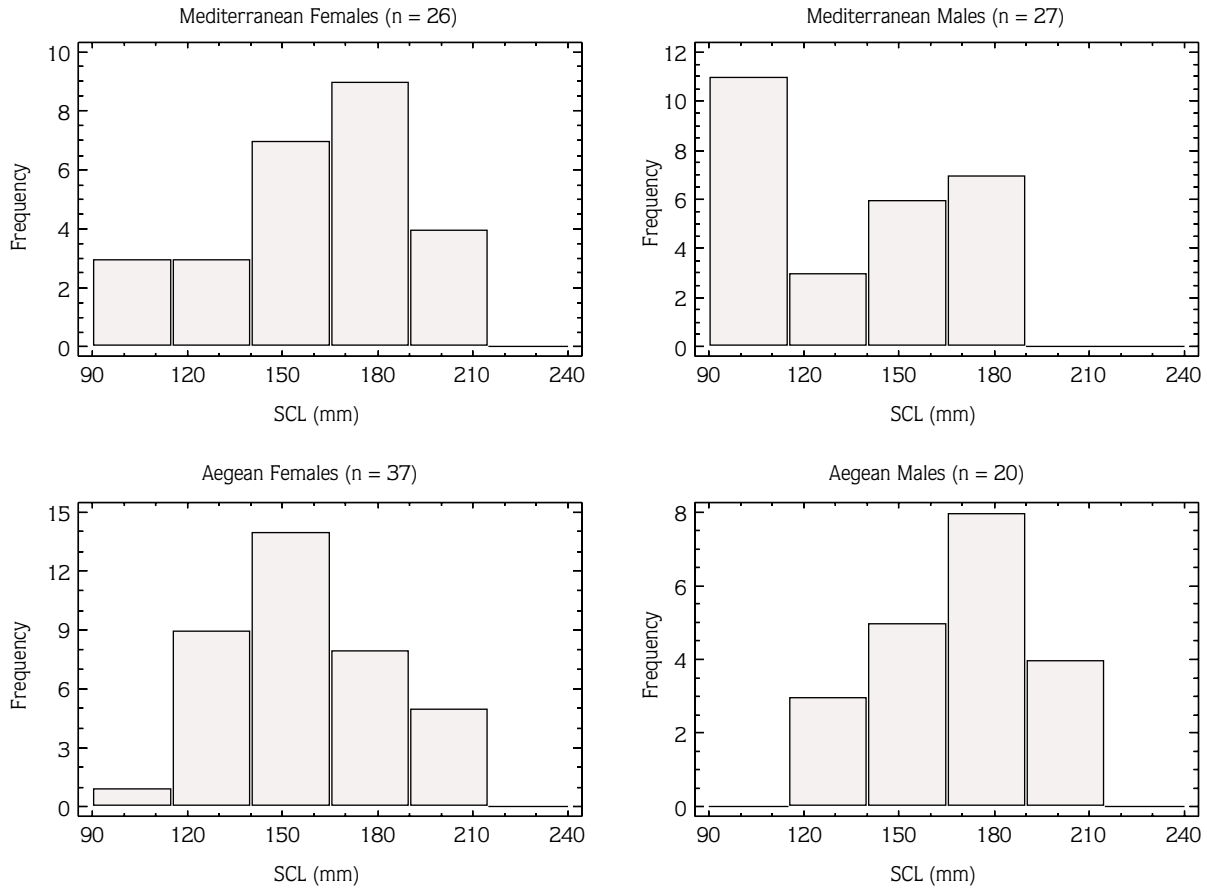


Figure 2. Frequency distribution of SCL in the Aegean and Mediterranean regions.

Table 3. Comparison of the 2 populations according to the independent t-test (significant differences between samples in bold).

Ratios	Males			Females		
	t-value	df	P	t-value	df	P
SCL: CW	-2.826	45	0.007	-3.189	61	0.002
SCL: CH	-1.267	45	0.212	-2.403	61	0.019
SCL: PW-II	-2.592	45	0.013	-4.242	61	0.000
SCL: CCL	-6.212	45	0.000	-7.813	61	0.000
SCL: HuL	1.553	45	0.127	2.328	61	0.023
SCL: PeL	3.450	45	0.001	2.034	60	0.046
SCL: NuL	1.792	45	0.080	2.218	61	0.030
SCL: NuW	-2.854	45	0.007	2.341	61	0.023
CW: PW-II	-0.833	45	0.409	-2.079	61	0.042
CW: HuL	2.197	45	0.033	2.886	61	0.005
CW: PeL	4.076	45	0.000	2.858	60	0.006
CW: AbL	2.422	45	0.000	0.586	60	0.560
CW: NuL	3.067	45	0.004	3.054	61	0.003
CW: NuW	-2.394	45	0.021	2.859	61	0.006

Table 4. Plastral formulae of Mediterranean (27 ♂♂, 26 ♀♀) and Aegean (20 ♂♂, 37 ♀♀) *M. rivulata*, presented as sample size, percentage for males; sample size, percentage for females.

Plastral Formulae	Mediterranean	Aegean
AbL>FeL>PeL>GuL>AnL>HuL	13, 48.2; 15, 56	8, 40; 9, 24.3
FeL>AbL>PeL>GuL>AnL>HuL	6, 22.2; 3, 12	-
AbL>FeL>PeL>GuL>HuL>AnL	5, 18.5; 2, 8	4, 20; -
AbL>FeL>GuL>PeL>AnL>HuL	2, 7.4; -	-
FeL>AbL>PeL>HuL>GuL>AnL	1, 3.7; -	-
AbL>FeL>PeL>AnL>HuL>GuL	-; 2, 8	-; 1, 2.7
FeL>AbL>PeL>AnL>GuL>HuL	-; 1, 4	-
AbL>PeL>FeL>AnL>GuL>HuL	-; 1, 4	-
FeL>PeL>AbL>AnL>GuL>HuL	-; 1, 4	-
AbL>FeL>PeL>AnL>GuL>HuL	-; 1, 4	-; 12, 32.4
AbL>FeL>PeL>GuL>AnL=HuL	-	4, 20; -
FeL>AbL>PeL>GuL>HuL>AnL	-	2, 10; 1, 2.7
FeL>AbL>PeL>GuL>HuL=AnL	-	1, 5; -
AbL>FeL>PeL>AnL=GuL>HuL	-	1, 5; 3, 8.1
AbL>FeL>PeL>GuL=AnL=HuL	-	-; 2, 5.4
AbL>FeL=PeL>AnL>GuL>HuL	-	-; 2, 5.4
AbL=FeL>PeL>AnL>GuL>HuL	-	-; 1, 2.7
AbL>FeL>PeL>HuL>GuL>AnL	-	-; 1, 2.7
FeL>AbL=PeL>GuL>HuL>AnL	-	-; 1, 2.7
AbL>FeL>PeL>AnL>GuL=HuL	-	-; 1, 2.7
AbL>PeL>FeL>GuL>AnL>HuL	-	-; 1, 2.7
FeL>AbL>PeL>HuL>AnL=GuL	-	-; 1, 2.7
AbL=FeL>PeL>GuL>AnL>HuL	-	-; 1, 2.7

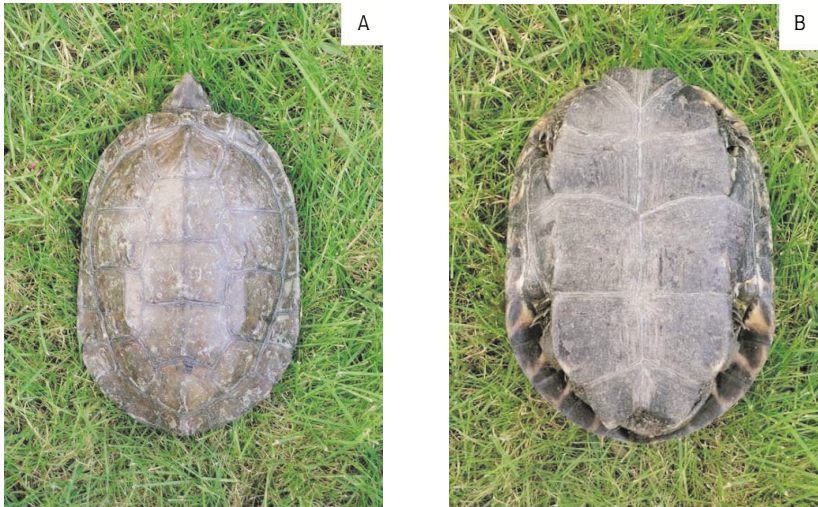


Figure 3. Dorsal (A) and ventral (B) view of an *M. rivulata* specimen (♀, Bahçe, Osmaniye).

populations exhibited similar SCL:CH ratios, and population CD values were not different.

When plastral formulae were constructed according to suture length of horny plastron shields of Aegean and Mediterranean specimens, considerably high variation was observed (Table 4). Ernst and Barbour (1989) gave the plastral formulae for male and female specimens of *Mauremys rivulata* in order of decreasing length at the midline: AbL-FeL-PeL-GuL-AnL-HuL. The formula provided was encountered in 28 specimens (51.92%) in the Aegean Region and in 17 (29.83%) in the Mediterranean Region. The general formula formed by evaluating Aegean and Mediterranean populations in groups of males and females, as well as a combined group of males and females, resembled the formula presented by Ernst and Barbour (1989), except for females from the Mediterranean Region.

Color and Pattern: Basic carapace color varied from light or dark olive green to various shades of brown (Figure 3A). Dark brown or black coloration was

observed in the plastron (Figure 3B), but dark coloration was more distinctive in sub-adult and juvenile specimens. The cream-colored edges of the brown or black plastral shields in adults were hardly noticeable in sub-adults and juveniles. In old specimens, however, this light color widens toward the ventro-median line. With respect to these characteristics, our data are in agreement with the literature (Tok, 1999; Fritz and Wischuf, 1997).

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