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On *Testudo graeca* Linnaeus, 1758 Specimens of Mardin Province

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Abstract: Twenty-four (16♂, 8♀) specimens of the Mediterranean spur-thighed tortoise *Testudo graeca* were examined from Mardin, southeastern Turkey. For morphological comparisons, 15 morphometric characters and 31 ratios developed by combinations of straight carapace length (SCL) and straight carapace width (SCW) were investigated. Males and females were differentiated from one another in terms of straight carapace length/curved carapace length (SCL/CCL), straight carapace length/plastron length (SCL/PL), straight carapace length/abdominal suture length (SCL/AbSL), straight carapace length/anal suture length (SCL/ASL), plastron length/plastron width 1 (PL/PW1), carapace width/straight carapace length (SCW/SCL), carapace width/anal suture length (SCW/ASL), and carapace width/plastron width 1 (SCW/PW1) according to the results of independent t-tests. Females were generally larger than males. The maximum SCL (208.6 mm) was measured in a female. The color of the carapace and plastron was inconsistent and thigh tubercles typically extended in an inwardly curved direction with sharply pointed apices. This character was the most remarkable in distinguishing the Mardin specimens from the pure *ibera* race, which possesses conical thigh tubercles.

Key Words: Reptilia, Testudines, Testudinidae, *Testudo graeca*, tortoise, Mardin, Turkey

Mardin İli *Testudo graeca* Linnaeus, 1758 Örnekleri Hakkında

Özet: Bu çalışmada, Türkiye'nin güneydoğusundaki Mardin ilinden toplam 24 (16♂, 8♀) *Testudo graeca* numunesi incelenmiştir. Morfolojik karşılaştırmalar için 15 morfometrik karakter ve düz karapas boyu ve eninin (SCL ve SCW) diğer karakterlere oranıyla ortaya çıkan 31 oran kullanılmıştır. Populasyonda dişi ve erkeklerin; SCL/CCL (düz karapas boyu/eğri karapas boyu), SCL/PL (düz karapas boyu/plastron uzunluğu), SCL/AbSL (düz karapas boyu/abdominal sütür uzunluğu), SCL/ASL (düz karapas boyu/anal sütür uzunluğu), PL/PW1 (palstron uzunluğu/plastron genişliği 1), CW/SCL (karapas eni/ düz karapas boyu), CW/ASL (karapas eni/anal sütür uzunluğu) ve CW/ PW1 (karapas eni/plastron genişliği 1) karakterleri bakımından t-testi sonuçlarına göre farklılık gösterdiği saptanmıştır. Dişiler genellikle erkeklerden büyüktür. Maksimum düz karapas boyu (SCL) dişi bir bireyden 208.6 mm olarak ölçülmüştür. Karapas ve plastronda renk ve desen değişken olup, kalça tüberkülleri ucu sivri ve içe doğru kıvrıktır. Bu karakter Mardin örneklerini, konik kalça tüberkülüne sahip olan *ibera* alttüründen ayırt edebilen en göze çarpan özelliğidir.

Anahtar Sözcükler: Reptilia, Testudines, Testudinidae, *Testudo graeca*, kara kaplumbağası, Mardin, Türkiye

Introduction

The taxonomic status and distribution range of the Mediterranean spur-thighed tortoise *Testudo graeca* in Turkey is still unclear due to the limited number of studies on this species. Many herpetological studies focusing on specific regions contain a detailed study of other reptiles and amphibians such as lizards, snakes, frogs and salamanders. In other words, Turkish herpetologists have largely ignored the study of land tortoises.

Apart from the disputable status of *Testudo antakyensis*, two species of land tortoise, *Testudo graeca* and *Testudo hermanni*, are recognized to inhabit Turkey. Of these, four subspecies of the more widespread *T. graeca* are recognized: *ibera*, *terrestris*, *anamurensis*, and recently, the poorly known *armeniaca* has been cited from the Ararat region (1). *T. hermanni*, restricted to Thrace, is represented by the eastern race *T. h. boettgeri*. The description of *Testudo antakyensis* is not generally recognized, although the author makes a convincing case

for the existence of a morphologically distinct population in the area around Iskenderun Bay (3). Brinckmeier et al. (2) reported the occurrence of the marginated tortoise, *Testudo marginata*, in the vicinity of the ancient city of Ephesus. Although this record is considered to be a false identification or an introduced specimen by other researchers (3,4) it was included in the Turkish chelonians list by Demirsoy (5). Later, this record was removed from the Turkish chelonians list by Türkozan et al. (6)

Eiselt and Spitzenberger (7) carried out a study on the morphology of Turkish tortoises, when only the subspecies *ibera* and *terrestris* were recognized. This paper remained the seminal contemporary work on the tortoises of Anatolia and Turkish Thrace until the last decade. In recent years, there has been an increasing focus on the taxonomic status of the *Testudo* taxa, and various researchers (3,8) have claimed that the hypotheses of Mertens (9) and Wermuth (10) were invalid and that *T. ibera* is a full and biologically separate species from the North African *graeca*. Nevertheless, we here consider *ibera* to be a subspecies of *graeca* due to the uncompleted revision and lack of common agreement. The more recently described subspecies *T. g. anamurensis* and species *T. antakyensis*, both from coastal southern Turkey, are based upon limited material without significant statistical comparisons. While Weissinger's (11) description enjoys widespread acceptance, the latter is viewed with skepticism among Turkish herpetologists. Neither taxon was included in the most recent book of Turkish herpetofauna (4). Various researchers (3,8) have invalidated the other subspecies, *T. g. terrestris* inhabiting Antakya and its surroundings.

In Turkey, little detailed work on the taxonomic status and ecology of the genus *Testudo* has been carried out. Only Tok (12) discussed the taxonomic status and ecology of *T. graeca ibera* populations from the Reşadiye Peninsula, focusing on a short description of them and their ecology. Taşkavak et al. (13) emphasized the morphologic difference between the Aegean and Mediterranean *Testudo graeca* populations. In a most recent study by Kuyl et al. (14), two main clades of Mediterranean tortoises were identified based on 12S rRNA gene sequences with the application of maximum likelihood and neighbor-joining methods. They recorded that the first clade was composed of the species *T. graeca*, *T. marginata* and *T. kleinmanni* and a second of *T. hermanni*, *T. horsfieldii* and *Indotestudo elongata*.

The present study aims to elucidate the status of a *Testudo graeca* population from southeastern Turkey.

Materials and Methods

A total of 24 (8♀ 16♂) specimens were measured from the Mardin region, southeastern Turkey (Fig. 1). Specimens were obtained from vineyards and other orchards on 29.4. 2001 and 21.05.2001 with an air temperature of 26 °C and 28 °C respectively. The altitude was 500 m. The specimens have been kept alive in a captive breeding farm for further studies. Color and pattern features were recorded while the specimens were alive, although not in keeping with the rigorous standards of Eiselt and Spitzenberger (7). A tape measure, wooden caliper and dial caliper were used for the measurements.

The morphometric features used in this study to compare males and females within the population are as

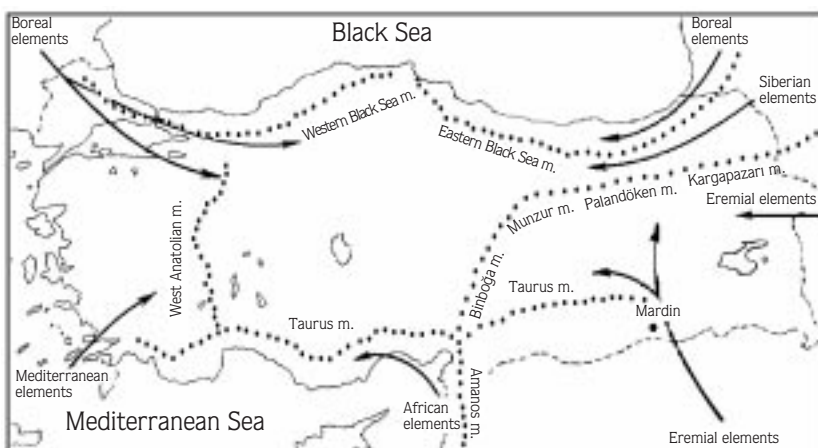


Figure 1. Possible entrance points and barriers to Turkey and zoogeographic position of locality (modified from Demirsoy, 1997).

follows: Straight Carapace Length (SCL): Straight-line measurement from the outermost projection of the nuchal plate to the posterior end of the supracaudalia. Curved Carapace Length (CCL): Curved-line measurement from the anterior to the distal edge of the carapace. Straight Carapace Width (SCW): Straight-line measurement between the lateral margins of the carapace (mid-line). Carapace Height (CH): Vertical measurement between the highest point of the carapace and the lowest point of the plastron. Plastron Length (PL): Straight-line measurement from the outermost projection of the gular to the posterior end of the anal scutes. Plastron Width (PW-1): Straight-line measurement between the lateral margins (from humerals) of the plastron. Plastron Width (PW-2): Straight-line measurement between the lateral margins (at the level of the abdominals) of the plastron. Gular Suture Length (GSL): Length of the gular scute at the mid-seam. Humeral Suture Length (HSL): Length of the humeral scute at the mid-seam. Pectoral Suture Length (PSL): Length of the pectoral scute at the mid-seam. Abdominal Suture Length (AbSL): Length of the abdominal scute at the mid-seam. Femoral Suture Length (FSL): Length of the femoral scute at the mid-seam. Anal Suture Length (ASL): Length of the anal scute at the mid-seam. Nuchal length (NL): Straight-line measurement

from the anterior edge of the nuchal to the posterior end. Nuchal width (NW): The width of the nuchal from the posterior end. Morphometric ratios (SCL/CCL, SCL/CW, SCL/CH, SCL/PL, SCL/GSL, SCL/HSL, SCL/PSL, SCL/ABSL, SCL/FSL, SCL/ASL, SCL/PW-1, SCL/PW-2, SCL/NL, SCL/NW, PL/PW1, PL/PW2, NL/NW, SCW/SCL, SCW/CCL, SCW/CH, SCW/PL, SCW/GSL, SCW/HSL, SCW/PSL, SCW/ABSL, SCW/FSL, SCW/ASL, SCW/PW-1, SCW/PW-2, SCW/NL and SCW/NW) were used to indicate similarities and differences between the sexes. An independent t-test was performed utilizing the above-mentioned 31 ratios to compare males and females within populations. Statistical analyses were carried out using STATISTICA version 5.4.

Results and Discussion

The results of SCL measurements revealed that females were generally larger than males in the Mardin population (Table 1, Fig. 2). However, maximum and minimum SCL were 135 and 239 mm in males respectively. The mean value for this population was 205 mm. Türkozan et al. (15) recorded a maximum SCL of 295 mm in the Mediterranean region. Türkozan et al. (16) gave a maximum SCL of 242 mm in the Aegean region. Accordingly, the Mardin population has a smaller

Table 1. Morphometrics of the adult *Testudo graeca* specimens from Mardin, southeastern Turkey. For abbreviations, see text.

	FEMALE						MALE						OVERALL					
	N	Mean	Min.	Max.	S.D.	S.E.	N	Mean	Min.	Max.	S.D.	S.E.	N	Mean	Min.	Max.	S.D.	S.E.
SCL	8	208.63	155	238	24.38	8.62	16	203.75	135	239	23.49	5.87	24	205.38	135	239	23.37	4.77
CCL	8	264.38	206	295	27.96	9.88	16	267.25	189	302	26.21	6.55	24	266.29	189	302	26.23	5.35
SCW	8	150.5	115	175	17.58	6.22	16	142.88	105	174	15.45	3.86	24	145.42	105	175	16.23	3.31
CH	8	106.13	80	120	12.83	4.54	16	100.5	72	120	10.75	2.69	24	102.38	72	120	11.53	2.35
PL	8	189.63	143	213	21.65	7.66	16	177.13	128	213	18.26	4.56	24	181.29	128	213	19.91	4.06
GSL	8	28.25	20.82	33.45	3.72	1.32	16	27.97	18.91	32.77	3.53	0.88	24	28.06	18.91	33.45	3.52	0.72
HSL	8	27.89	21.8	41.82	6.57	2.32	15	24.76	18.95	29.79	3.24	0.84	23	25.85	18.95	41.82	4.77	0.99
PSL	8	10.65	7.74	15.32	2.55	0.90	15	9.9	4.56	15.46	3.24	0.84	23	10.16	4.56	15.46	2.98	0.62
ABSL	8	65.61	51.62	78.42	8.39	2.97	16	59.99	48.19	71.13	5.55	1.39	24	61.86	48.19	78.42	6.99	1.43
FSL	8	25.36	20.22	31.98	3.72	1.31	16	25.47	20.34	34.7	3.39	0.85	24	25.44	20.22	34.7	3.42	0.70
ASL	8	23.11	15.4	26.76	3.84	1.36	16	19.09	13.45	27.62	4.10	1.03	24	20.43	13.45	27.62	4.38	0.89
PW1	8	89.61	72.21	100.9	9.15	3.24	15	88.03	66.88	101.37	8.11	2.09	23	88.58	66.88	101.37	8.31	1.73
PW2	8	95.31	74.98	104.54	9.30	3.29	16	92.26	65.07	115	10.82	2.70	24	93.27	65.07	115	10.24	2.09
NL	8	17.34	12.99	20.49	2.58	0.91	15	17.36	11.38	21.79	2.76	0.71	23	17.35	11.38	21.79	2.64	0.55
NW	8	8.37	7.21	11.29	1.35	0.48	14	8.33	4.29	15.43	3.34	0.89	22	8.35	4.29	15.43	2.74	0.58

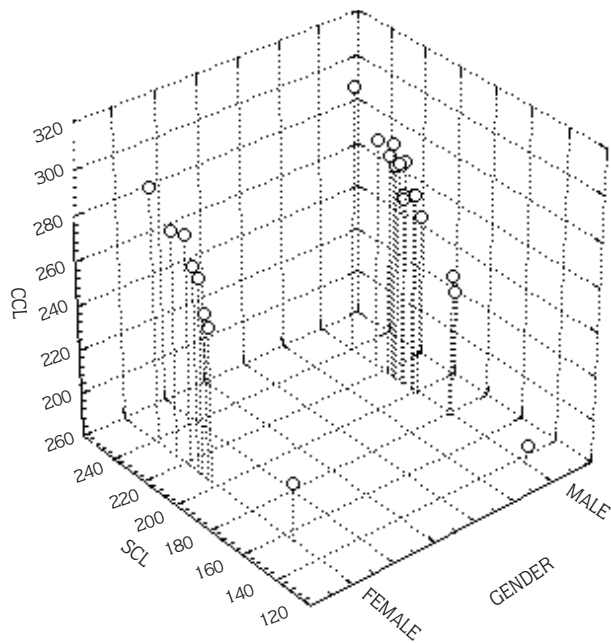


Figure 2. Three-dimensional graph of SCL and CCL measurements of the males and females.

body size in comparison with the Aegean and Mediterranean populations. Beshkov (17) recorded a maximum SCL of 252 mm for *Testudo graeca* in Turkey. However, this record was extended by Türkozan et al. (15) to 295 mm in the Mediterranean region.

Independent t-test performed between various ratios of females and males verified statistically significant difference in eight characters (Table 2). In other words, of the 31 characters examined 26% discriminated statistically between the genders.

In all specimens, the abdominal suture was the longest, whereas the pectoral suture was the shortest. The relative lengths of other sulci exhibited variations (Table 3). Accordingly, six combinations in males, eight combinations in females and 10 combinations in the overall population were recorded. The general plastral formulae created by mean values showed variations between genders as well. In the present study, the intergular seam was the second longest suture. In the Aegean population the interhumeral (16) suture was the second longest suture after the abdominal suture. Boulenger (18) and Başıoğlu and Baran (19) stated that the anal suture is equal to or longer than the abdominal suture for *T. graeca*. However, no specimens were recorded with this combination. Both Loveridge and

Table 2. According to independent t-test, comparison of males and females from Mardin (see text for abbreviations).

	t-value	df	p
SCL/CCL	2.938	19	0.008
SCL/SCW	-1.972	19	0.063
SCL/CH	-1.492	19	0.152
SCL/PL	-3.021	19	0.007
SCL/GSL	0.630	19	0.536
SCL/HSL	-1.173	19	0.255
SCL/PSL	-0.209	19	0.836
SCL/ABSL	-2.568	19	0.019
SCL/FSL	0.524	19	0.606
SCL/ASL	-3.234	19	0.004
SCL/PW1	0.514	19	0.613
SCL/PW2	-0.809	19	0.428
SCL/NL	0.405	19	0.690
SCL/NW	-0.920	19	0.369
PL/PW1	3.443	19	0.003
PL/PW2	1.897	19	0.073
NL/NW	-1.204	19	0.243
SCW/SCL	1.951	19	0.066
SCW/CCL	3.195	19	0.005
SCW/CH	0.039	19	0.969
SCW/PL	-1.085	19	0.292
SCW/GL	1.640	19	0.117
SCW/HL	-0.589	19	0.563
SCW/PSLL	0.161	19	0.873
SCW/ABL	-1.979	19	0.063
SCW/FEL	1.249	19	0.227
SCW/ASL	-3.146	19	0.005
SCW/PW1	2.259	19	0.036
SCW/PW2	1.063	19	0.301
SCW/NL	0.803	19	0.432
SCW/NW	-0.709	19	0.487

Williams (20) and Ernst and Barbour (21) gave a plastral formulation as Abd>(Gul.Hul.Pec.Fen.An: very variable) and Abd>Hum><Gul><An><Pec><Fem for *T. graeca*. Thus, the high variation of this formula pointed out by these researchers was seen in our study as well.

With respect to body ratios, SCL/CH and SCL/SCW were comparable to those in other studies. The SCL/CH values in the present study were subequal to 2 (1.97) in females whereas it was over 2 in males (2.03). This value was recorded to be over 2 in Mediterranean populations (15). The SCL/SCW value in the present study is lower

Plastral formulae	Male	Female	Total
ABSL>GSL>HSL>FSL>ASL>PSL	8 (53.33%)	-	8 (34.78%)
ABSL>GSL>HSL=FSL>ASL>PSL	1 (6.67%)	-	1 (4.35%)
ABSL>FSL>HSL>GSL>ASL>PSL	1 (6.67%)	1 (12.5%)	2 (8.70%)
ABSL>FSL>GSL>HSL>ASL>PSL	1 (6.67%)	1 (12.5%)	2 (8.70%)
ABSL>GSL>FSL>HSL>ASL>PSL	3 (20%)	1 (12.5%)	4 (17.39%)
ABSL>HSL>GSL>FSL>ASL>PSL	1 (6.67%)	1 (12.5%)	2 (8.70%)
ABSL>GSL>HSL>ASL>FSL>PSL	-	1 (12.5%)	1 (4.35%)
ABSL>GSL>ASL>HSL>FSL>PSL	-	1 (12.5%)	1 (4.35%)
ABSL>HSL>GSL>ASL>FSL>PSL	-	1 (12.5%)	1 (4.35%)
ABSL>GSL>FSL>ASL>HSL>PSL	-	1 (12.5%)	1 (4.35%)
Female	ABSL>GSL>HSL>FSL>ASL>PSL		
Male	ABSL>GSL>FSL>HSL>ASL>PSL		
Overall	ABSL>GSL>HSL>FSL>ASL>PSL		

Table 3. Various plastral patterns seen in the males and females of the Mardin population and their percentages (see text for abbreviations).

	AKSEKİ	SELCUK	REŞADIYE	THRACE	ADIYAMAN	MARDİN
SCL/CH	F:2.48 M:2.56 A:2.54	F:2.02 M:1.99 A:2.00	A:2.027	A:1.94	A:1.98	F:1.97 M:2.03 A:2.01
SCL/CW	F:1.44 M:1.47 A:1.46	F:1.37 M:1.39 A:1.38	A:1.414	A:1.33	A:1.40	F:1.39 M:1.43 A:1.41
	Türkozan et. al. (in preparation)	Türkozan et al., 2001	Tok, 1999	Çevik, 1986	Türkozan et al., (in preparation)	Present study

Table 4. Comparison of our results with those given by various authors for relevant localities.
F: Female, M: Male, A: All

than that in Mediterranean and Aegean populations but higher than that in the Thrace population (22) (Table 4). When the mean values of SCL/CH compared statistically, the Thrace ($p = 0.0011$) and Akseki ($p = 0.0000$) populations showed significant differences from the Mardin population. The Thrace ($p = 0.0000$) and Akseki ($p = 0.0050$) populations are separated from the Mardin population in terms of the SCL/SCW ratio as well.

With regard to the morphology of the specimens, the horny scutes of the carapace always have deep, brightly pronounced annual rings (Figs. 3 and 4). The color of the carapace was inconsistent in the specimens examined. The thigh tubercles typically extend in an inwardly curved direction and have sharply pointed apices. These features were also recorded in the Adıyaman population (16). Although some morphological differences were recorded

in the southeastern population, no electrophoretic discrimination was observed between the Aegean and southeastern *Testudo* populations (16).

In conclusion, the morphologic differences in the southeastern population should be carefully examined through the more eastern, western and northern distribution range. Our study area is close to the distribution range of *terrestris* but the morphological features we examined do not conform to the diagnosis of this subspecies given by Başoğlu and Baran (19). According to Davis (23), Turkish Anatolia is divided into two major botanical and zoogeographical parts by the Anatolian diagonal, with different flora and fauna compositions. The Anatolian diagonal comprises a range of mountains with crests 3000-4000 m above sea level. Nilson et al. (24) stated that the vipers of Turkey have

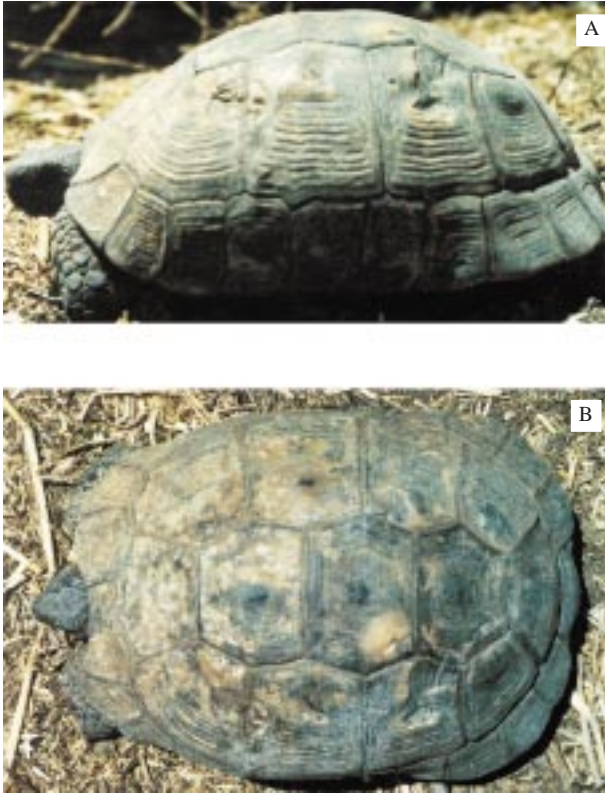


Figure 3. A lateral (A) and dorsal (B) view of an adult female from Mardin.

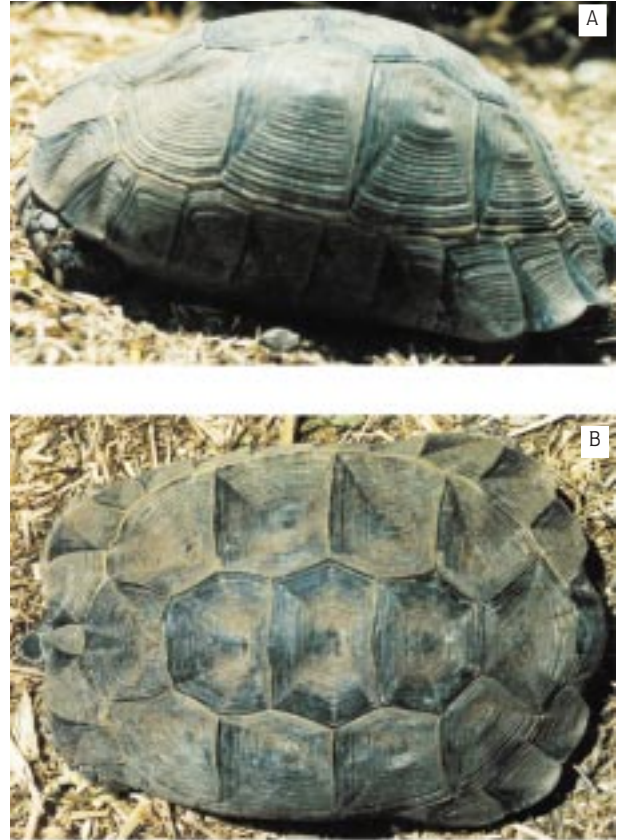


Figure 4. A lateral (A) and dorsal (B) view of an adult male from Mardin.

been affected by this break. Our study area, Mardin, remains in the southeastern part of this break and comprises the entrance point of eremial elements. Başoğlu and Baran (19) described the Mardin region as unknown. By studying other populations we can

determine whether the morphological differences seen here change vertically, gradually or abruptly, and whether they correspond to a change of habitat or other ecological conditions.

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