

Some Investigations on the Taxonomy of the *Emys orbicularis* (Linnaeus, 1758) (Testudinata: Emydidae) Specimens from Aegean Region of Turkey

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Özet: Türkiye'nin Ege Bölgesi'nden *Emys orbicularis* (Linnaeus, 1758) (Testudinata: Emydidae) örneklerinin taksonomisi üzerine bazı araştırmalar. Bu çalışmada Türkiye'nin Ege Bölgesi'ndeki dokuz farklı lokaliteden toplanan 71 *E. orbicularis* örneği incelenmiştir. Morfolojik karşılaştırma için örneklerin 19 metrik karakteri ve bu metrik karakterlerden geliştirilmiş 35 oran çeşitli populasyonlar arasındaki fark ve benzerlikleri ortaya koymak için incelenmiştir. Farklı populasyonlara arasındaki morfometrik karşılaştırmalara ilaveten, renk ve desen özellikleri ile eşeyssel farklılıklar da dikkate alınmıştır. Sonuç olarak, Ege Denizi kıyılarına yakın yaşayan populasyonların *Emys orbicularis hellenica*'ya benzer olduğu, buna karşın Orta Anadolu'ya yakın populasyonların ise daha çok *Emys orbicularis luteofusca*'ya benzer olduğu görülmüştür.

Anahtar Kelimeler: *Emys orbicularis hellenica*, *Emys orbicularis luteofusca*, taksonomi, Batı Anadolu.

Abstract: In this study, 71 *Emys orbicularis* (Linnaeus, 1758) specimens from nine different localities in the Aegean region of Turkey were examined. For morphological comparison, 19 metric characters of the specimens and 35 ratios developed from these metric characters were investigated to establish the differences and similarities among various populations. In addition to the morphometric comparisons between the different populations, colour and pattern characteristics and sexual dimorphism were also considered. As a result, it is evident that the populations living near the coast of the Aegean Sea are similar to *Emys orbicularis hellenica*, whereas the populations closer to central Anatolia are somewhat similar to *Emys orbicularis luteofusca*.

Key Words: *Emys orbicularis hellenica*, *Emys orbicularis luteofusca*, taxonomy, Western Anatolia.

Introduction

The distribution of *Emys orbicularis* (Linnaeus, 1758) extends from Northwest Africa, through almost all of Central Europe, including the Iberian Peninsula and the Mediterranean islands of Corsica, Sardinia, Sicily, the Balkan Peninsula, and Western Asia (Wermuth and Mertens, 1961; Iverson, 1986; Fritz, 1992; Snieshkus, 1995). In spite of suitable biotopes, the species does not have an uninterrupted distribution in Turkey, nor is it predictably abundant at all suitable habitats (Eiselt and Spitzenberger, 1967; Başoğlu and Baran, 1977). Werner (1902) and Venzmer (1922), who had evaluated the works of other researchers, verified the presence of the species in the following regions: Marmara, Aegean and Mediterranean littoral, and Central Anatolia. The presence of *E. orbicularis* was reported in various papers relevant to Greece and Greek Islands (Broggi, 1978; Ioannides *et al.*, 1994; Bringsoe, 1985). However, Baran (1984) did not record this species in the Turkish islands between Marmaris and Iskenderun, nor between Izmir and Bodrum. Mertens and Wermuth (1960) and Wermuth and Mertens (1961), who gave information on general taxonomy and distribution of turtles, consider *E. orbicularis* to be monotypic. Various researchers have subsequently reported specimens of *E. orbicularis* from different regions of Turkey (Lambert, 1970; Clark and Clark,

1973; Andrén and Nilson, 1976; Kasperek, 1990; Dazsak and Cawthraw, 1991; Baran *et al.*, 1992; Mulder, 1995). A subspecies of *E. orbicularis* from Central Anatolia was described by Fritz (1989) and subsequent studies (Fritz, 1992, 1993, 1994, 1996; Fritz and Obst, 1995; Fritz *et al.*, 1998) indicate that *E. orbicularis* is not monotypic, but rather a highly polytypic species, with thirteen subspecies currently recognised. Of those, four are found in Turkey: *E. orbicularis* cf. *hellenica*, *colchica*, *luteofusca*, and *eiselti* (Fritz *et al.*, 1998). The present study aims to clarify taxonomic status and distribution of the species *E. orbicularis* in the Aegean Region of Western Anatolia.

Materials and Methods

Except for a small number of available specimens previously captured by other researchers, a total of 71 *E. orbicularis* specimens were collected from nine localities of the Aegean Region between April and September 1997. Of these, 15 specimens were released after the required measurements had been taken. The 56 remaining *E. orbicularis* specimens were preserved in the museum of the Zoology Department of Ege University (ZDEU) for future osteological studies. The localities where the specimens were captured are shown in Figure 1.

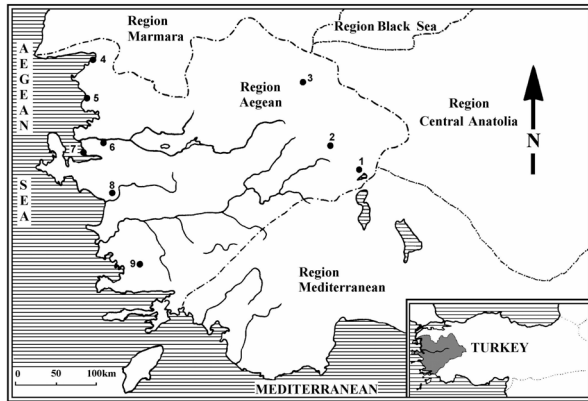


Figure 1. Map of localities where the specimens were collected, and specimens' numbers, collectors, capture dates, catalogue numbers of the *E. orbicularis* specimens. 1)-Yedigöller-Kütahya (3, Y.E. Dinçaslan, 03.08.1997, ZDEU 113/1997), 2)-Karamukbataklığı-Afyon (5, D. Ayaz-U. C. Erişmiş, 10.07.1997, ZDEU 119/1997), 3)-Çakırköy, Merkez-Afyon (30, D. Ayaz-U.C. Erişmiş, 10.07.1997, ZDEU 126/1997), 4)-Üyücek Creek, Burhaniye-Balikesir (1, E. Taşkavak-D. Ayaz, 18.08.1997, ZDEU 118/1997), 5)-Gülkent-Dikili-Izmir (9, E. Taşkavak-D. Ayaz, 19.08.1997, Released to biotope), 6)-Ulukent, Menemen-Izmir (1, D. Ayaz, 22.06.1997, ZDEU 116/1997), 7)-Bird Paradise, Çiğli-Izmir (1, M. Tosunoğlu, 22.06.1997, ZDEU 117/1997), 8)-Pamucak, Selçuk-Izmir (6, D. Ayaz, 23.08.1997, ZDEU 111/1997), 9)-Ekinanbarı Village, Milas-Mugla (15, U. Ayaz, 07.09.1997, ZDEU 115/1997). ZDEU= Zoology Department, Ege University.

Various methods were used to capture turtles. In general, they were caught easily by hand while basking or swimming in very shallow water. In water as deep as 1m, they were caught by a dip-net having a 20 cm hoop diameter. In water deeper than 1 m, most specimens were captured in a baited prawn trap. To prevent the turtles being suffocated, the prawn trap was checked every 2-3 hours after being set. Some turtles were captured with a baited, D-shaped dip-net or with baited fishing lines.

The colour and pattern of the turtles were recorded, and both colour and black and white photographs were taken. Specimens were anaesthetised and killed humanely, and a fixative solution prepared previously with 9 ml 40% formol and 91 ml 70% ethyl alcohol was injected later into the body cavity and extremities.

We utilised the morphometric characters defined by Fritz (1994, 1995) to measure our specimens. Measurements were made to the nearest 0.05 mm with a dial calliper; shell depth measurements were taken with wooden callipers to the nearest 0.1 cm. Animals having a straight-line carapace length greater than 10 cm were considered as adult (Winden and Bogaerts 1992). Discriminant analysis was used to compare the different populations. Growth rings on the shell were also considered here for maturity verification.

Nineteen morphometric measurements taken were as follows: CSL (straight-line maximum carapace length), CCL (curved carapace length), CW (maximum carapace width), CH (maximum carapace height), PL (midline plastron length), GuL (Gular suture length), HumL (Humeral suture length), Pecl (Pectoral suture length), AbdL (Abdominal suture length),

FemL (Femoral suture length), AnL (Anal suture length), PW (Plastron Width-I & II), HW (Head width), HL (Head length-I & II), HH (Head height), NuL (Nuchal length), NuW (Nuchal width).

Thirty-five ratios developed by combinations of two characters were used to investigate differences between the specimens having a straight-line carapace length more than 10 cm, collected from different localities. These ratios were used due to the uncertainty in the specimens' age groups, and because it was not known whether the growth was isometric or not. Samples from places close together were pooled to produce regional samples large enough for analysis, e.g. Afyon (includes Karamukbataklığı and Çakırköy localities) and Izmir (includes Çiğli, Menemen, Burhaniye, Dikili and Selçuk). Thus, four sampling groups, Izmir, Afyon, Mugla and Kütahya, were used for analyses.

Results

The morphometric parameters of four sampling groups are summarised in Table 1 for adult females and males. Specimens from Afyon populations reached a larger size than those from the other three groups. Population size-structure can be discerned most clearly in Afyon specimens, owing to the relatively large sample size (Figure 2). There were also discernible differences in the pectoral scute lengths. In Afyon specimens the pectoral sutures were relatively longer than in the other populations examined (Table 1). The nuchal scute's length was equal to its width in 14 specimens, 47 specimens had a longer nuchal, and four specimens had a nuchal broader than long. Somewhat parallel-sided nuchal scutes were seen in 45 specimens, but not in 20 specimens (six specimens were not considered owing to their deformed shapes).

Plastral formulations of the specimens examined are given in Table 2. According to plastral formulas, not only do differences exist between populations, there is also high variation within each population. For each population, the average plastral formulas are also given in Table 2.

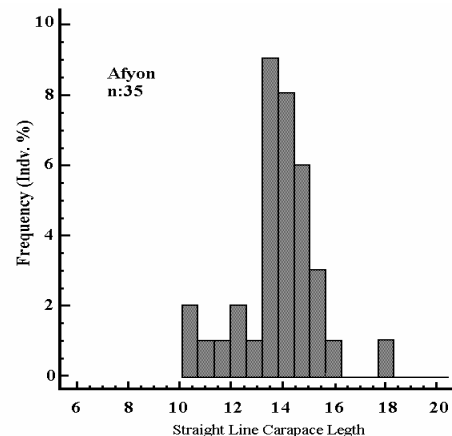


Figure 2. Frequency distribution of straight-line carapace length for overall Afyon specimens.

Table 1. The summarized statistical analyses of morphometric measurements of the adult *E. orbicularis* specimens from Izmir, Afyon (A) and Muğla and Kütahya (B) (see text for abbreviations).

A								
FEMALES					MALES			
GROUP IZMIR								
Characters	N	Mean±SE	Range	SD	N	Mean±SE	Range	SD
CSL	8	11.93±0.39	10.20-13.30	1.11	7	11.46±0.34	10.40-12.60	0.89
CW	8	9.50±0.32	8.00-10.90	0.92	7	9.04±0.26	8.20-9.80	0.68
CH	8	5.00±0.23	4.00-6.10	0.66	7	4.40±0.12	3.80-4.80	0.31
PL	8	11.15±0.40	9.30-12.70	1.14	7	10.37±0.31	9.20-11.20	0.81
GuL	8	2.06±0.08	1.70-2.40	0.22	7	1.86±0.12	1.50-2.30	0.30
HumL	8	0.89±0.07	0.60-1.20	0.20	7	0.86±0.06	0.70-1.20	0.17
PekL	8	1.98±0.11	1.50-2.50	0.31	7	1.79±0.08	1.40-2.00	0.22
AbdL	8	1.88±0.05	1.70-2.10	0.15	7	1.73±0.04	1.60-1.90	0.11
FemL	8	1.23±0.07	0.90-1.50	0.21	7	1.16±0.08	1.00-1.50	0.21
AnL	8	3.14±0.12	2.50-3.60	0.35	7	2.91±0.11	2.50-3.20	0.28
PW-I	8	5.78±0.23	4.80-6.60	0.64	7	5.31±0.17	4.70-5.90	0.45
PW-II	8	6.55±0.26	5.40-7.50	0.74	7	6.13±0.17	5.50-6.60	0.44
HW	8	2.34±0.08	2.00-2.60	0.22	7	2.26±0.05	2.10-2.40	0.13
HL-I	8	1.06±0.02	1.00-1.10	0.05	7	1.04±0.03	1.00-1.20	0.08
HL-II	8	2.84±0.10	2.50-3.40	0.28	7	2.80±0.05	2.60-2.90	0.13
HH	8	1.10±0.03	1.00-1.20	0.09	7	1.06±0.02	1.00-1.10	0.05
NuL	8	0.56±0.04	0.40-0.70	0.12	7	0.60±0.04	0.50-0.70	0.10
NuW	8	0.49±0.04	0.40-0.70	0.11	7	0.43±0.02	0.40-0.50	0.05
CCL	8	13.50±0.43	11.40-15.10	1.22	7	12.87±0.37	11.40-14.20	0.98
GROUP AFYON								
CSL	25	14.01±0.33	10.50-18.00	1.66	10	13.21±0.30	11.70-14.40	0.96
CW	25	11.01±0.23	8.20-12.90	1.16	10	10.38±0.17	9.60-11.10	0.55
CH	25	5.52±0.13	4.10-6.80	0.67	10	4.77±0.15	4.10-5.40	0.48
PL	25	13.31±0.35	9.60-17.50	1.73	10	11.53±0.26	10.20-12.80	0.84
GuL	25	2.34±0.06	1.80-2.90	0.28	10	2.10±0.05	1.90-2.40	0.16
HumL	25	1.14±0.04	0.80-1.60	0.21	10	0.98±0.06	0.60-1.30	0.20
PekL	25	2.31±0.08	1.60-3.40	0.41	10	1.91±0.08	1.50-2.30	0.26
AbdL	25	2.23±0.06	1.60-3.00	0.31	10	1.84±0.07	1.50-2.20	0.23
FemL	25	1.26±0.05	0.90-1.90	0.24	10	1.23±0.05	1.00-1.50	0.17
AnL	25	3.94±0.10	2.90-5.10	0.50	10	3.32±0.07	3.00-3.70	0.23
PW-I	25	7.00±0.15	5.10-8.70	0.76	10	6.26±0.12	5.70-6.90	0.37
PW-II	25	7.94±0.19	5.60-9.70	0.94	10	6.88±0.10	6.40-7.40	0.32
HW	25	2.60±0.05	2.00-3.10	0.25	10	2.55±0.05	2.30-2.80	0.16
HL-I	25	1.18±0.02	1.00-1.30	0.10	10	1.18±0.02	1.10-1.30	0.08
HL-II	25	3.10±0.06	2.40-3.60	0.29	10	3.09±0.05	2.90-3.30	0.14
HH	25	1.24±0.03	0.90-1.60	0.13	10	1.22±0.03	1.10-1.40	0.09
NuL	25	0.63±0.02	0.40-0.90	0.11	10	0.54±0.02	0.40-0.60	0.07
NuW	23	0.43±0.02	0.30-0.60	0.09	10	0.32±0.02	0.20-0.40	0.08
CCL	25	15.58±0.36	11.60-19.90	1.80	10	14.51±0.33	13.10-15.80	1.04
B								
FEMALES					MALES			
GROUP MUĞLA								
Characters	N	Mean±SE	Range	SD	N	Mean±SE	Range	SD
CSL	3	12.30±0.59	11.20-13.20	1.01	3	11.17±0.46	10.40-12.00	0.80
CW	3	9.57±0.28	9.00-9.90	0.49	3	8.93±0.22	8.50-9.20	0.38
CH	3	5.33±0.58	4.30-6.30	1.00	3	4.37±0.23	4.00-4.80	0.40
PL	3	11.43±0.72	10.00-12.30	1.25	3	10.13±0.30	9.70-10.70	0.51
GuL	3	2.03±0.09	1.90-2.20	0.15	3	1.87±0.12	1.70-2.10	0.21
HumL	3	1.10±0.17	0.80-1.40	0.30	3	0.83±0.03	0.80-0.90	0.06
PekL	3	1.83±0.15	1.60-2.10	0.25	3	1.70±0.06	1.60-1.80	0.10
AbdL	3	1.83±0.17	1.50-2.00	0.29	3	1.70±0.06	1.60-1.80	0.10
FemL	3	1.27±0.03	1.20-1.30	0.06	3	1.27±0.12	1.10-1.50	0.21
AnL	3	3.03±0.27	2.50-3.40	0.47	3	2.60±0.15	2.30-2.80	0.26
PW-I	3	5.90±0.35	5.20-6.30	0.61	3	5.20±0.21	4.90-5.60	0.36
PW-II	3	6.77±0.38	6.00-7.20	0.67	3	5.93±0.19	5.70-6.30	0.32
HW	3	2.27±0.07	2.20-2.40	0.12	3	2.30±0.10	2.10-2.40	0.17
HL-I	3	1.17±0.09	1.00-1.30	0.15	3	1.07±0.03	1.00-1.10	0.06
HL-II	3	3.07±0.20	2.70-3.40	0.35	3	2.83±0.12	2.60-3.00	0.21
HH	3	1.03±0.03	1.00-1.10	0.06	3	1.07±0.09	0.90-1.20	0.15
NuL	1	0.40	0.40	-	1	0.50	0.50	-
NuW	1	0.50	0.50	-	1	0.30	0.30	-
CCL	3	13.90±0.57	12.80-14.70	0.98	3	12.73±0.34	12.30-13.40	0.59

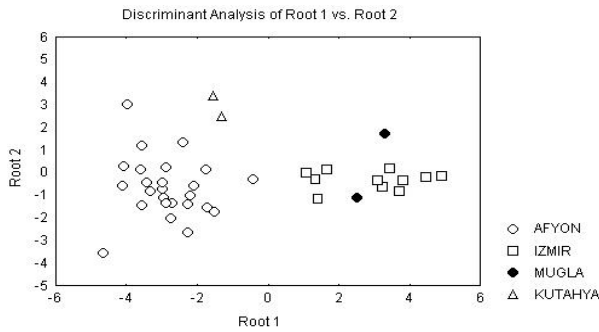


Figure 3. Discriminant analysis of the *E. orbicularis* specimens from four localities for raw morphometric measurements [N: 65; Grouping: 4; Wilks' Lambda: 0.03, Approx. F (42, 143)= 8.32, p< 0.00; Number of variables in the model: 14 (CSL, CW, CH, PL, GuL, AbdL, FemL, AnL, PW-I, PW-II, HW, HL-II, NuL, CCL); Because of zero variance, HumL, PekL, HL-I, HH and NuW were excluded, For abbreviations, see text).

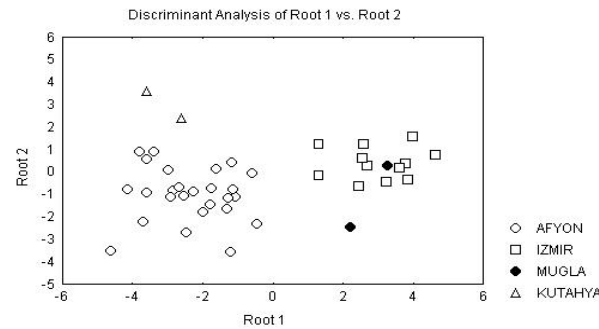


Figure 4. Discriminant analysis of the *E. orbicularis* specimens from four localities for the developed ratios [N: 65; Grouping: 4; Wilks' Lambda: 0.02, Approx. F (54, 131)= 6.56, p< 0.00, Number of variables in the model: 18 (CSL/CW, CSL/CH, CSL/PL, CSL/GuL, CSL/HumL, CSL/PecL, CSL/AbdL, CSL/FemL, CSL/AnL, CSL/PW-I, CSL/PW-II, CSL/HW, CSL/HL-I, CSL/HL-II, CSL/HH, CSL/uL, CSL/NuW, CSL/CCL); For abbreviations, see text).

consistent, there is sexual dimorphism in colour and pattern of the iris as well. Adult females have a whitish to cream-coloured iris crossed by brownish bands. There is not a cross-like mark in males, and colour of the iris is reddish brown.

The plastron colour of females is lighter than that of males. Although the pattern on the head does not reveal a sharp sexual dimorphism, females have yellow blotches dispersing irregularly on a dark background, whereas males have a reticulate pattern.

We meticulously examined colour and pattern of the *E. orbicularis* specimens, which were mostly based on the characteristics given by Fritz and Obst (1995). Variations in the carapace, plastron, head, gular area and iris (in live specimens) are given in Table 3. The specimens were pooled into two main groups for this examination: a)- group Afyon (including the localities of Çakırköy, Karamuk Bataklığı in Afyon and Kütahya) and b)- group Izmir (including the localities of Dikili, Çiğli, Selçuk, Menemen in Izmir, Burhaniye in Balıkesir and Milas in Muğla). Although there are variations of colour and pattern even among the specimens considered within the same population, these characteristics are given in Table 4 for groups of Afyon and Izmir, respectively.

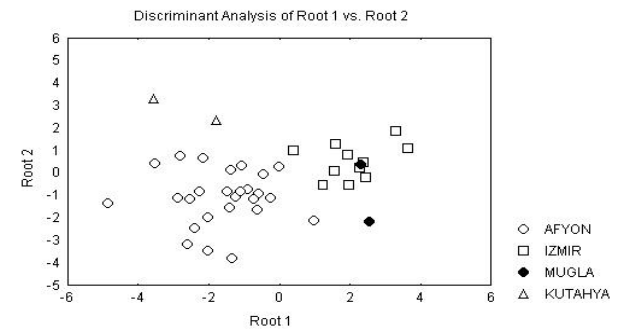


Figure 5. Discriminant analysis of the *E. orbicularis* specimens from four localities for the developed ratios [N: 65; Grouping: 4; Wilks' Lambda: 0.04, Approx. F (48, 137)= 5.91, p< 0.00, Number of variables in the model: 16 (CW/CH, CW/PL, CW/GuL, CW//HumL, CW/PekL, CW/AbdL, CW/FemL, CW/AnL, CW/PW-I, CW/PW-II, CW/HW, CW/HL-I, CW/HH, CW/NuL, CW/NuW, CW/CCL); Because of minimum tolerance less than specified limit (0.01), CW/HL-II was excluded. For abbreviations, see text).

It is observed that the cloacal opening of almost all *E. orbicularis* specimens is nearer to the posterior margin of the plastron in females than in males. Shell height of adult females is greater than adult males, i.e. males are somewhat more flattened than females. The plastron is flat in females, whereas it is slightly concave in males. Although it is not

Table 3. Colour and pattern variations (based on the characteristics given by Fritz & Obst, 1995) considered for carapace, plastron, gular area and iris of the specimens examined.

Characters	Type A	Type B	Type C	Type D
Carapace	Black elements on light coloured background (usually light brownish, olive green coloured or yellowish)	Yellowish coloured radial patterns on blackish background	Yellowish and blackish parts on carapace almost equal	
Plastron	Homogeneously light coloured plastron or dark stains occupying about 1/3 of plastron	The considered dark stains occupy about 2/3 of plastron	The considered dark stains occupy more than 2/3 of plastron	
Head	A vermiculate pattern on head	A denser vermiculate pattern on rostrum direction, reticular appearance	A spotted pattern, dispersing having separately and irregularly on head	
Gular area (Colour)	Dark coloured gular area (homogeneously black or yellow stained black)	Black-yellow gular area (yellowish and blackish parts on gular area are almost equal)	Yellow-black gular area (the more yellowish parts and less blackish parts)	Yellow gular area (homogeneously yellow gular area; Quite old specimens having pale yellow gular area were also considered in this group)

Table 3. continued

Gular area (Pattern)	A marble like pattern	Patternless, i.e., not a marble like appearance	A discernible marble like appearance towards plastron, but less anteriorly	-
Iris	Whitish, light yellow coloured iris	Brownish, reddish coloured iris	-	-

Table 4. Colour and pattern variations employed in carapace, plastron, gular area and iris of the Afyon and Izmir groups.

Character	Type A	Type B	Type C	Type D	Notes
AFYON GROUP					
Carapace	2 specimens	27 specimens	9 specimens	-	Continuous or interrupted radial marks
Plastron	29 specimens	5 specimens	4 specimens	-	In general, light coloured such as yellowish to light olive green. Brownish and blackish stains on light background colour.
Head	6 specimens	30 specimens	2 specimens	-	Various background coloration, from black to brownish and olive green. A relatively light coloured patterns on this background
Gular area Colour	Dark coloured: 2 specimens	Black-yellow: 8 specimens	Yellow-black: 24 specimens	Yellow: 4 specimens	-
Gular Area pattern	8 specimens	4 specimens	26 specimens	-	-
Iris	25 specimens (11 have a cross like dark coloration, and 7 have 2-3 bands)	7 specimens (No cross like appearance, but 2-3 bands)	-	-	-
IZMIR GROUP					
Carapace	1 specimen	31 specimens	Absent	-	Of 15 specimens from Milas, 7 are juveniles and all have type B coloration
Plastron	15 specimens	8 specimens	9 specimens	-	-
Head	16 specimens	5 specimens	11 specimens	-	A darker background coloration than Afyon group
Gular area Colour	Dark coloured: Absent	Black-yellow: 1 specimen	Yellow-black: 8 specimens	Yellow: 23 specimens	-
Gular Area pattern	11 specimens	13 specimens	8 specimens	-	-
Iris	18 specimens, (2 have a cross like dark coloration, and others have 2-3 bands)	10 specimens, (2 have a cross like dark coloration)	-	-	-

Discussion

The plastron formula (An>Abd>Pec>Gul>Fem>Hum) given by Ernst and Barbour (1989) for the species was discordant with all our specimens taken into consideration here. Consequently, regarding high variation even in same locality, we believe that plastron formulae are not very useful in taxonomic discrimination in *E. orbicularis*. Siebenrock (1905) suggested that light-coloured *E. orbicularis* populations in Turkey may be distinct from a taxonomic point of view. Nevertheless, Eiselt and Spitzenberger (1967) stated that pale individuals may occur within generally dark-coloured populations, even though light-coloured *Emys* populations exist.

Fritz (1989) determined that the species exhibits differences in colour pattern in various localities of Turkey. The author described *Emys orbicularis luteofusca* from Konya-Ereğli region, in which the colour of the carapace and soft parts ranged from light yellowish-brown to light olive brown. In the same study, he also stated that specimens from the regions of the Aegean and Marmara are *E. orbicularis* (sensu lato) due to their dark coloration. Fritz (1993) later compared the Aegean and Marmara specimens with European subspecies of *E. orbicularis* by taking colour and pattern characteristics into consideration. With regard the dark coloration of the plastron, the Aegean and Marmara specimens were designated as *E. o. cf. hellenica*. In addition

to colour and pattern characteristics, morphological differences between populations have been noted. Thus, the carapace length of *E. o. luteofusca*, a medium-sized subspecies, reaches at least 17.5 cm in females and 14 cm in males (Fritz 1989), but regarding carapace length, the Aegean and Marmara specimens are smaller than subspecies *luteofusca* (Fritz, 1993).

According to Fritz (1992), the most striking difference between populations was in the proportions of the carapace length and head length. He determined a value of about 5 for the ratio in *E. o. luteofusca*, but an approximate value of 4 for other populations of the species. In the same work, he indicated that specimens located between *E. o. luteofusca* and dark-coloured populations have values ranging from 4 to 5 according to geographical location. Thus, our specimens from Muğla and Izmir were quite similar to *E. o. cf. hellenica* stated by Fritz (1992) for the Aegean and Marmara specimens, due to their small size, their CL/HL ratios being approximately 4, and their generally dark coloration. Considering the length of the carapace, the Kütahya specimens were somewhat similar to those from Afyon. However, turtles from Afyon and Kütahya had characteristics intermediate between *E. o. cf. hellenica* and *E. orbicularis luteofusca* owing to their large carapace length and long femoral suture, their ratio of carapace length and head length being 4.5, and, finally, their relatively light coloration.

Taşkavak and Reimann (1998) determined the existence

of two different populations of *E. orbicularis* at Cihanbeyli and Boğat, in central Anatolia. They stated that specimens from Cihanbeyli were statistically similar to the subspecies *luteofusca* described by Fritz (1989), but different from the Izmir specimens. Additionally, the colour and pattern features of the specimens from Cihanbeyli correspond to those given by Fritz (1989) for *E. o. luteofusca* (Taşkavak and Reimann, 1998). However, the Boğat population (about 90 km from Cihanbeyli) is statistically different from the Cihanbeyli population, having morphometric characteristics of *luteofusca*, but very similar to those from Izmir. We conclude from our analysis of our data that the statistical differences found in both measurements and ratios developed from measurements between the four sampling groups indicate that the coastal and inland populations of *E. orbicularis* are clearly different. Both colour and pattern features and morphometric characteristics of the Izmir and Muğla specimens correspond to those given by Fritz (1992, 1995) and Taşkavak and Reimann (1998). However, multivariate analyses discriminate the Afyon and Kütahya specimens from the Izmir and Muğla specimens. Considering gradual changes in morphological characters found in discriminant analyses, we assume that the Afyon and Kütahya specimens are intermediate forms between *E. o. cf. hellenica* in coastal areas of the Aegean Region and other subspecies living east of Afyon and Kütahya. Which subspecies are seen in the east of Afyon and Kütahya; *E. orbicularis luteofusca* described by Fritz (1989) from Central Anatolia, an isolated population pointed out by Taşkavak and Reimann (1998) from Boğat in Central Anatolia or an unnamed population of *E. orbicularis* (see Figure 1 given by Fritz, 1993) inhabits Mediterranean Region? Consequently, we believe that a better understanding of these questions relevant to distribution of *E. orbicularis* is desirable, for which more specimens are needed from the Afyon and Kütahya localities as well as the Central Anatolia and Mediterranean regions of Turkey.

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References

- Andrén, C., G. Nilson, 1976. Observations on the Herpetofauna of Turkey in 1968-1973. *British Journal of Herpetology*, 5 (7): 575-584.
- Baran, İ., 1984. Taxonomic investigation on the herpetofauna of the Turkish islands between Izmir and Bodrum (in Turkish). *Doğa Bilim Dergisi*, A2, 8 (1): 43-52.
- Baran, İ., İ. Yılmaz, R. Kete, Y. Kumlutaş, H. Durmuş, 1992. The herpetofauna of the Western and Central Black Sea basin (in Turkish). *Doğa Tr. J. of Zool.*, 16: 275-288.
- Başoğlu, M., İ. Baran, 1977. The Reptiles of Turkey, Part I. The Turtles and Lizards, (in Turkish). *E.Ü. Fen Fak. Kitaplar Serisi*, Izmir, 76, 272s. Izmir.
- Bringsoe, H., 1985. A check-list of Peloponnesian Amphibians and Reptiles, including new records from Greece. *Ann. Musei. Goulandris*, 7: 271-318.
- Broggi, M. F., 1978. Herpetologische Beobachtungen auf der Insel Lesbos (Griechenland). *Salamandra*, 14 (4): 161-171.
- Clark, R. J., E. D. Clark, 1973. Collection of Amphibians and Reptiles from Turkey. *Calif. Acad. Sci.*, 104:1-62.
- Dzask, P., S. Cawthraw, 1991. A review of the Reptiles and Amphibians of Turkey, Including a literature survey and species checklist. *Brith. Herpetol. Soc. Bull.*, 36:14-26.
- Eiselt, J., F. Spitzenberger, 1967. Ergebnisse zoologischer sammelreisen in der Türkei: Testudines. *Ann. Naturhistor. Mus.*, 70:357-378.
- Ernst, C. H., R. W. Barbour, 1989. *Turtles of the World*. Smithsonian Institution Press., Washington, D. C., and London, 388p.
- Fritz, U., 1989. Zur innerartlichen Variabilität von *Emys orbicularis* (Linnaeus, 1758), 1. Eine neue Unterart der Europäischen Sumpfschildkröte aus Kleinasien, *Emys orbicularis luteofusca* subsp. nov., *Salamandra*, 25 (3/4): 143-168.
- Fritz, U., 1992. Zur innerartlichen Variabilität von *E. o. orbicularis* (Linnaeus, 1758) 2. Variabilität in Osteuropa und Redefinition von *E. o. orbicularis* (Linnaeus, 1758) und *E. o. hellenica* (Valenciennes, 1832) (Reptilia: Testudines: Emydidae). *Zool. Abh. Staatl. Mus. Tierkd.*, 47(5): 37-77.
- Fritz, U., 1993. Weitere Mitteilung zur innerartlichen Variabilität, Chorologie und Zoogeographie von *Emys orbicularis* (Linnaeus, 1758) in Kleinasien (Testudines: Cryptodira: Emydidae). *Herpetozoa*, 6(1/2): 37-55.
- Fritz, U., 1994. Zur innerartlichen Variabilität von *Emys orbicularis* (Linnaeus, 1758), 4. Variabilität und Zoogeographie im pontokaspischen Gebiet mit Beschreibung von drei neuen Unterarten. *Zool. Abh. Mus. Tierkd.*, 48(4): 53-93.
- Fritz, U., 1995. Zur innerartlichen Variabilität von *Emys orbicularis* (Linnaeus, 1758), 5a. Taxonomie in Mittel-Westeuropa, auf Korsika, Sardinien, der Apenninen-Halbinsel und Sizilien und Unterartengruppen von *E. orbicularis* (Reptilia: Testudines: Emydidae). *Zool. Abh. Staatl. Mus. Tierkd.*, 48(14): 185-242.
- Fritz, U., 1996. Zur innerartlichen Variabilität von *Emys orbicularis* (Linnaeus, 1758), 5b. Intraspezifische Hierarchie und Zoogeographie (Reptilia: Testudines: Emydidae). *Zool. Abh. Staatl. Mus. Tierkd.*, 49(3): 31-71.
- Fritz, U., İ. Baran, A. Budak, E. Amthauer, 1998. Some notes on the morphology of *Emys orbicularis* in Anatolia, especially on *E. o. luteofusca* and *E. o. colchica*, with the description of a new subspecies from southeastern Mertensiella, 10: 103-121.
- Fritz, U., F. J. Obst, 1995. Morphologische Variabilität in den Intergradationszonen von *Emys orbicularis orbicularis* und *E. orbicularis hellenica*. *Salamandra*, 31(3): 157-180.
- Ioannides, Y., M. Dimaki, A. Dimitropoulos, 1994. The Herpetofauna of Samos (Eastern Aegean, Greece), *Ann. Mus. Goulandris*, 9: 445-456.
- Iverson, J. B., 1986. A checklist with distribution maps of the world. First Edition. Privately printed, Paust Printing, 450p. Richmond, Indiana.
- Kasperek, M., 1990. Zur Herpetofauna des Beckens von Köyceğiz, Türkei (Dalyan-Region). *Salamandra*, 26(2/3): 155-164.
- Lambert, M. R. K., 1970. Notes on a collection and observations of Amphibians and Reptiles from South West. Turkey. *Brit. J. Herpetol.*, 4: 129-134.
- Mertens, R., H. Wermuth, 1960. *Die Amphibien und Reptilien Europas*. (Dritte Liste), Verlag Waldemar Kramer, 264 Seite, Frankfurt a. Main.
- Mulder, J., 1995. Herpetological observations in Turkey (1987-1995). *Deinsea*, 51-66.
- Siebenrock, F., 1905. Schildkroten. Ergebnisse einer naturwissenschaftlichen Reise zum Erdschias Dagh (Kleinasien), Ausgeführt von Dr. Arnold Penther und Dr. Emerich Zederbauer. *Ann. Naturhistor. Mus.*, 20: 309-310.
- Snieshkus, E., 1995. Europe pond turtle's (*Emys orbicularis*) reintroductions protect in Lithuania. 222-223, *Int. Congress of Chelonian Conservation*, (Soptom, ed.), 243p. Gonfaron, France.
- Taşkavak, E., M. J. Reimann, 1998. The present status of *Emys orbicularis* (Linnaeus, 1758) in southern Central Anatolia. *Proceeding of the EMYSS Symposium Dresden 96.-Mertensiella*, 10: 267-278.
- Venzmer, G., 1922. Neues Verzeichnis der Amphibien und Reptilien von Kleinasien. *Zool. Jb. Syst.*, 46: 43-60.
- Werner, F., 1902. Die Reptilien und Amphibienfauna von Kleinasien. *SB. Akad. Wiss. Wien, math. -naturw. Kl. Abt. I*, 111, 1057-1121.
- Wermuth, H., R. Mertens, 1961. *Schildkröten, Krokodile, Brückenechsen*. Veb. Gustav Fischer Verlag, Jena, 422 pp.
- Winden, J. V. D., S. Bogaerts, 1992. Herpetofauna of the Göksu Delta, Turkey. Report 311, Department of Animal Ecology Univ. of Nijmegen, 144p. The Netherlands.