

Morphological comparison
of *Emys orbicularis* (LINNAEUS, 1758)
from European Turkey and eastern Bulgaria
(Testudines: Emydidae)

Morphologischer Vergleich von *Emys orbicularis* (LINNAEUS, 1758)
aus der Europäischen Türkei und dem östlichen Bulgarien
(Testudines: Emydidae)

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KURZFASSUNG

Bei 20 Exemplaren der Europäischen Sumpfschildkröte *Emys orbicularis* (LINNAEUS, 1758) aus Türkisch Thracien (10 ♂♂, 10 ♀♀) wurden morphometrische Merkmale und Färbungsmerkmale mit denen von ostbulgarischen Sumpfschildkröten (28 ♂♂, 42 ♀♀) verglichen. Die durchschnittliche Carapaxlänge (CL) thrakischer Schildkröten betrug bei Männchen 131,5 mm und bei Weibchen 141,0 mm, während bei den bulgarischen Schildkröten die entsprechenden Durchschnittswerte bei 119,4 und 129,1 mm lagen. Das jeweils größte thrakische Männchen und Weibchen maß 155,2 mm bzw. 164,2 mm CL; das größte bulgarische Männchen hatte 146,0 mm und das größte Weibchen 157,7 mm CL. Ein unabhängiger *t*-Test zeigte, daß sich thrakische und bulgarische Schildkröten bei einem (Männchen) bzw. bei vier Merkmalsverhältnissen (Weibchen) signifikant voneinander unterscheiden. Färbung und Zeichnung der meisten bulgarischen und thrakischen Schildkröten ähnelt jener der Unterart *E. o. orbicularis*, allerdings sind bulgarische und thrakische Exemplare deutlich kleiner; einige Merkmalsverhältnisse sind intermediär zwischen der nominotypischen Unterart und *E. o. hellenica* (VALENCIENNES, 1832). Dieser Befund stimmt mit der vorgeschlagenen Zuordnung zur Unterart *E. o. colchica* FRITZ, 1994 überein. In dieser nominellen Unterart könnten allerdings lediglich Populationen zusammengefaßt werden, die zu kleinwüchsig sind, um *E. o. orbicularis* zugeordnet werden zu können.

ABSTRACT

Twenty specimens (10 ♂♂, 10 ♀♀) of the European Pond Turtle *Emys orbicularis* (LINNAEUS, 1758), from Turkish Thrace were studied concerning morphometrics and colour-pattern and compared with those of specimens from eastern Bulgaria (28 ♂♂, 42 ♀♀). The mean carapace length (CL) of the Thracian turtles was 131.5 mm in males and 141.0 mm in females, while in the Bulgarian turtles the means were 119.4 mm and 129.1 mm, respectively. Size records for Thracian males and females were 155.2 mm and 164.2 mm CL respectively, while the largest Bulgarian male and female measured 146.0 mm and 157.7 mm, respectively. An independent *t*-test revealed significant morphometric differences as to one character ratio in males and four in females when Bulgarian and Thracian turtles were compared. Overall, most Bulgarian and Thracian turtles resemble *E. o. orbicularis* in colouration and pattern, however, they are significantly smaller and some character ratios are intermediate between the nominotypical subspecies and *E. o. hellenica* (VALENCIENNES, 1832). This corresponds with their tentative allocation to *E. o. colchica* FRITZ, 1994; however, this nominal subspecies could represent merely an assemblage of populations comprising turtles being too small for assigning to the nominotypical subspecies.

KEY WORDS

Reptilia: Testudines: Emydidae: *Emys orbicularis*, morphology, Turkish Thrace, Bulgaria

INTRODUCTION

Emys orbicularis (LINNAEUS, 1758), one of the two Palaearctic members (*Emys orbicularis* and *E. trinacris* FRITZ et al., 2005) of Emydidae, is distributed from North Africa over most of Europe south of

Scandinavia and Asia Minor to the Caspian and Aral Seas (FRITZ 2001, 2003). In spite of its pattern and colouration variations (SCHREIBER 1912; ARNOLD & BURTON 1978) and its wide range, until recently the Euro-

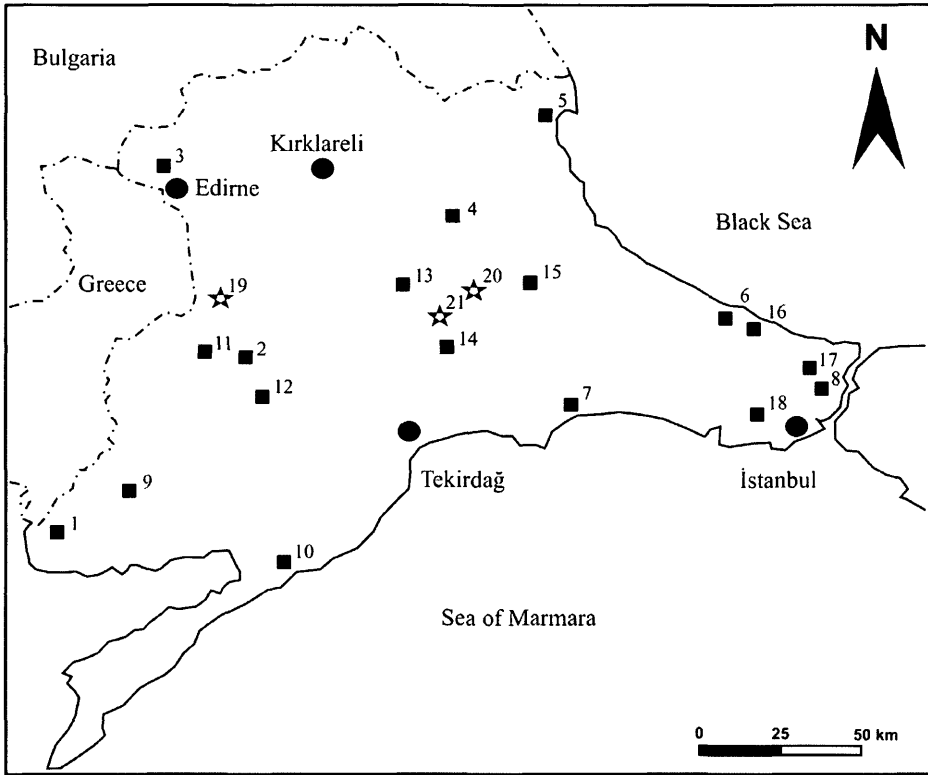


Fig. 1: Record localities of *Emys orbicularis* (LINNAEUS, 1758) in Turkish Thrace. Data from the literature (1-18; squares) and the localities where the now studied specimens were caught (19-21; asterisks).

Abb. 1: Fundorte von *Emys orbicularis* (LINNAEUS, 1758) in Türkisch Thrakien. Daten aus der Literatur (1-18, Quadrate) und Fundorte, an denen die jetzt untersuchten Schildkröten gefangen wurden (19-21; Sterne).

- 1 - İpsala (Edirne) (BAŞOĞLU & HELLMICH 1959), 2 - Mandra (Tekirdağ) (BAŞOĞLU & HELLMICH 1959), 3 - Edirne, (BAŞOĞLU & HELLMICH 1959), 4 - West of Vize (Kırklareli) (BAŞOĞLU & HELLMICH 1959), 5 - İğneada (Kırklareli) (BAŞOĞLU & HELLMICH 1959), 6 - Karaburun (İstanbul) (BAŞOĞLU & HELLMICH 1959), 7 - Silivri (İstanbul) (BAŞOĞLU & HELLMICH 1959), 8 - Belgrat Forest (İstanbul) (BAŞOĞLU & HELLMICH 1959), 9 - Paşa Köyü, İpsala (Edirne) (ÇEVİK 1982), 10 - Kavak Village, Gelibolu (Edirne) (ÇEVİK 1982), 11 - Uzunköprü (Edirne) (ÇEVİK 1982), 12 - Kutlugün Village, Hayrabolu (Tekirdağ) (ÇEVİK 1982), 13 - Turgutbey Village, Lüleburgaz (Kırklareli), (ÇEVİK 1982), 14 - Büyük Karıştıran (Kırklareli) (ÇEVİK 1982), 15 - Saray (Tekirdağ) (ÇEVİK 1982), 16 - Kısırmandra Village (İstanbul) (ÇEVİK 1982), 17 - Göktürk (İstanbul) (ÇEVİK 1982), 18 - Altınşehir (İstanbul) (ÇEVİK 1982), 19 - Yeniköy (Uzunköprü, Edirne) (present study), 20 - Emirali (Kırklareli) (present study), 21 - Evrensekiz (Lüleburgaz, Kırklareli) (present study).

pean Pond Turtle was accepted as a monotypic species (e.g., WERMUTH & MERTENS 1961; ERNST & BARBOUR 1989). However, recent research demonstrated that it is one of the most fragmented and structured Western Palearctic reptile species with many sub-species described. Sicilian pond turtles were recently shown to represent a distinct species (LENK et al. 1999; FRITZ 2001, 2003; JESU et al. 2004; FRITZ et al. 2005).

Emys orbicularis is distributed almost all over Turkey (EISELT & SPITZENBERGER 1967; BASOGLU & BARAN 1977; FRITZ 1989; BARAN & ATATÜR 1998; TAŞKAVAK & REIMANN 1998; FRITZ 2001, 2003). However, until recently, for most regions few detailed data were available. Therefore, the taxonomic status of many Turkish populations is still badly known (FRITZ et al. 1998; FRITZ 2001, 2003). A preliminary investiga-

Table 1: Measurements of *Emys orbicularis* (LINNAEUS, 1758) from Turkish Thrace and eastern Bulgaria. Character abbreviations as listed in 'Materials and Methods'. n - sample size; mean - arithmetic mean value; range - minimum and maximum values; SD - standard deviation of the mean.

Tab. 1: Meßwerte von *Emys orbicularis* (LINNAEUS, 1758) aus Türkisch Thrakien und Ost-Bulgarien. Merkmalsabkürzungen sind unter 'Materials and Methods' erklärt. n - Stichprobengröße; Mittelwert - arithmetisches Mittel; Spannweite - Minimum- und Maximumwerte; SD - Standardabweichung des Mittelwertes.

Character Merkmal	Bulgarian Males / Männchen aus Bulgarien				Thracian Males / Männchen aus Thrakien			
	n	Mean Mittelwert	Range Spannweite	SD	n	Mean Mittelwert	Range Spannweite	SD
CL	28	119.4	105.4-146.0	9.2	10	131.5	119.1-155.2	12.4
CW	27	93.2	83.2-105.2	5.9	10	103.9	93.1-122.2	8.6
SH	28	44.8	37.0-55.0	3.9	10	48.5	42.1-58.2	4.9
PL	28	107.1	91.8-136.9	9.0	10	119.2	107.2-137.1	10.1
HW	25	22.3	19.3-25.1	1.3	10	23.9	21.2-28.5	2.4
HL	25	30.6	26.8-32.9	1.6	10	31.4	27.9-35.4	2.4
PW_I	28	55.1	46.7-67.0	4.0	10	61.1	55.6-71.2	4.6
PW_II	26	62.9	54.7-77.0	5.0	10	71.2	65.3-87.9	7.0
GuL	26	19.1	12.1-23.9	2.6	10	22.1	19.2-28.3	2.6
HuL	27	9.1	6.0-11.7	1.1	10	9.2	7.3-10.9	1.3
PeL	28	17.9	13.0-25.0	2.4	10	19.1	13.5-24.1	3.5
AbL	28	15.8	11.0-19.0	1.5	10	18.4	16.3-21.0	1.6
FeL	28	12.8	8.1-18.3	2.3	10	13.9	11.3-19.7	2.4
AnL	28	28.4	23.0-37.1	2.8	10	31.7	28.0-36.6	2.9

Character Merkmal	Bulgarian Females / Weibchen aus Bulgarien				Thracian Females / Weibchen aus Thrakien			
	n	Mean Mittelwert	Range Spannweite	SD	n	Mean Mittelwert	Range Spannweite	SD
CL	42	129.1	96.7-157.7	16.7	10	141.0	110.1-164.2	16.4
CW	42	99.2	76.0-122.0	11.2	10	110.1	85.2-127.1	11.5
SH	40	53.6	35.9-70.5	7.9	10	56.0	43.3-67.1	7.2
PL	42	123.6	87.6-150.8	17.2	10	136.6	101.1-154.1	16.2
HW	38	23.3	18.7-29.0	2.4	10	24.6	20.3-27.7	2.0
HL	38	31.4	23.7-38.0	3.5	10	32.1	26.0-37.3	3.0
PW_I	40	62.9	46.1-77.8	7.9	10	69.0	50.8-80.9	8.0
PW_II	40	71.3	51.7-87.9	9.0	10	80.9	58.4-92.9	10.3
GuL	42	22.0	15.0-29.0	3.5	10	25.2	19.1-31.0	3.2
HuL	42	11.0	6.1-15.2	2.4	10	11.4	7.6-15.3	2.7
PeL	42	21.8	12.0-27.8	3.8	10	23.7	17.8-29.7	3.6
AbL	42	18.8	12.2-24.5	3.3	10	21.9	16.4-27.0	3.1
FeL	42	13.7	8.0-22.0	3.0	10	15.5	10.2-20.2	3.1
AnL	42	34.0	24.6-46.5	4.9	10	38.1	28.8-38.1	5.2

tion, mainly using museum specimens, revealed a diverse morphological differentiation within Turkey (FRITZ et al. 1998). In their small size and coloration pond turtles from the Marmara and Aegean regions and down to the eastern Mediterranean region resemble *E. o. hellenica* (VALENCIENNES, 1832). In the Black Sea and eastern Anatolian regions, pond turtles are larger in size and distinctly darker in colour (*E. o. colchica* FRITZ, 1994), while from the high plateaus west of Ereğli (Konya) a distinctive, light-brownish coloured subspecies (*E. o. luteofusca* FRITZ, 1989) was described. A further subspecies, *E. o. eiselti* FRITZ et al., 1998,

small and dark-coloured, is endemic in the vicinity of Gaziantep. Little is known from the European part of Turkey (Trakya = Thrace) that constitutes a crossroads of European and Asiatic faunal elements. Only a single study by ÇEVİK (1982) provides anecdotal data on pond turtles from there.

In this study, *E. orbicularis* specimens from three localities in Turkish Thrace were studied morphologically and compared with turtles from neighbouring Bulgaria (Black Sea region and southeastern Bulgaria) from where – in contrast to other geographically neighbouring regions – comparative specimens were available in sufficient numbers.

MATERIALS AND METHODS

Pond turtles were collected from three different localities in Turkish Thrace in 2004 (asterisks in Fig. 1). A total of 20 specimens (10 ♂♂, 10 ♀♀) were caught. Turtles were captured by hand, using a dip net. Colouration and pattern characteristics of each turtle were recorded as outlined in FRITZ (1995). Specimens were released after measuring and sexing. A total of 70 museum specimens (28 ♂♂, 42 ♀♀), collected by various investigators in neighbouring Bulgaria, served for comparison with our Thracian material; for calculation of character ratios and indices only specimens (20 ♂♂, 34 ♀♀) with complete data sets were used (see appendix).

Measurements (all straight line) were taken with a calliper to the nearest 0.1 mm as follows: Maximum carapacial length (CL); maximum carapacial width (CW); maximum shell height (CH); maximum plastral length (PL); head length (HL); head width (HW); intergular length (GuL); interhumeral length (HuL); interpectoral length (PeL);

interabdominal length (AbL); interfemoral length (FeL); interanal length (AnL). Only adult specimens were measured to avoid an influence of possible allometric growth.

Morphometric ratios and indices (CL/CW, CL/SH, CL/HW, CL/HL, PL/GuL*10, PL/HuL*10, PL/PeL*10, PL/AbL*10, PL/FeL*10, PL/AnL*10) were calculated to reveal similarities and differences between the Bulgarian and Thracian samples. As a clear sexual dimorphism is known to occur in European pond turtles (FRITZ 2001), data were processed for each sex separately. Before performing statistical analyses, logarithmic transformations of the raw data and the Arctan transformations of the ratios were computed. Data distribution was examined using the Kolmogorov-Smirnov test for normality. Later, independent *t*-tests were performed utilizing the above mentioned 10 characters to compare the samples. The significance level for all statistics was set at $\alpha = 0.05$. Statistical analyses were carried out with SPSS® 11.0 for Windows®.

RESULTS AND DISCUSSION

Size and measurements. Basic measurements for the specimens from Bulgaria and Thrace are presented in Table 1. In both sexes Thracian turtles reach a slightly larger size than Bulgarian specimens. The size records for Thracian males and females were 155.2 mm and 164.2 mm CL respectively, while the largest Bulgarian male and female measured 146.0 mm and 157.7 mm, respectively. CL data clearly show that, the turtles are small-sized and fall within the range of many southern subspecies of *E. orbicularis*; they do not resemble the nominotypical subspecies with a record size of 230 mm in females (FRITZ 2001, 2003). Looking at the *Emys* populations of Turkey, a complicated pattern of size variation emerges. Some populations from the Central Anatolian Plateau are large-sized, with maximum shell lengths of approximately 200 mm, whereas other Central Anatolian populations and populations along the Aegean and Mediterranean

coasts have only small to medium-sized shells (AYAZ 1998, 2003; FRITZ 2001, 2003; TAŞKAVAK & AYAZ 2006). An unverified size record for a Turkish pond turtle was published by SCHWEIGER (1994), who claims that specimens from Bünyan (35 km ENE Kayseri) may reach 240 mm carapacial length. CRUCITTI et al. (1990) reported 206 mm carapacial length for a specimen from Karamukbataklığı (Afyonkarahisar). However, this value was measured over the curvature of the shell, so that the straight line carapacial length most probably ranged between 175 and 190 mm (FRITZ 2003). A female from Kovada Lake measured 181 mm (AYAZ 2003) and another female from Seydişehir 176 mm (FRITZ et al. 1998).

Character ratios. When independent *t*-tests were performed for ratios and indices (Tab. 2), the Thracian males were differentiated by one (CL/HL) and the females by four (CL/SH, CL/HL, PL/GuL*10, PL/AbL*10) character ratios from the respec-

Table 2: Descriptive statistics of morphological ratios and indices of *Emys orbicularis* (LINNAEUS, 1758) from Turkish Thrace and east Bulgaria. Character abbreviations as listed in Materials and Methods. n - sample size; mean - arithmetic mean value; range - minimum and maximum values; SD - standard deviation of the mean.

Tab. 2: Deskriptive Statistiken gestaltsbeschreibender Quotienten und Indizes von *Emys orbicularis* (LINNAEUS, 1758) aus Türkisch Thrakien und Ost-Bulgarien. Merkmalsabkürzungen sind unter 'Materials and Methods' erklärt. n - Stichprobengröße; Mittelwert - arithmetisches Mittel; Spannweite - Minimum- und Maximumwerte; SD - Standardabweichung des Mittelwertes.

Ratio, Index Quotient, Index	Bulgarian Males / Männchen aus Bulgarien				Thracian Males / Männchen aus Thrakien			
	n	mean Mittelwert	range Spannweite	SD	n	mean Mittelwert	range Spannweite	SD
CL/CW	20	1.28	1.18-1.39	0.04	10	1.27	1.20-1.31	0.04
CL/SH	20	2.67	2.49-2.85	0.10	10	2.72	2.52-2.85	0.12
CL/HW	20	5.38	4.85-5.82	0.26	10	5.52	5.05-5.92	0.28
CL/HL	20	3.89	3.53-4.61	0.25	10	4.19	3.74-4.58	0.22
PL/GuL*10	20	56.29	49.31-76.28	5.93	10	54.11	48.53-58.44	3.34
PL/HuL*10	20	120.91	96.33-179.17	18.88	10	131.23	103.13-162.52	19.39
PL/PeL*10	20	59.77	51.97-67.38	5.09	10	63.93	52.58-81.39	9.24
PL/AbL*10	20	68.58	62.52-84.29	5.01	10	65.09	54.41-78.02	6.88
PL/FeL*10	20	83.02	69.44-117.17	83.02	10	87.14	67.46-98.94	11.67
PL/AnL*10	20	37.83	33.90-41.33	1.95	10	37.62	34.51-41.36	2.08
Ratio, Index Quotient, Index	Bulgarian Females / Weibchen aus Bulgarien				Thracian Females / Weibchen aus Thrakien			
	n	mean Mittelwert	range Spannweite	SD	n	mean Mittelwert	range Spannweite	SD
CL/CW	34	1.30	1.21-1.44	0.05	10	1.28	1.17-1.35	0.05
CL/SH	34	2.42	2.15-2.75	0.14	10	2.53	2.25-2.72	0.14
CL/HW	34	5.54	4.96-6.05	0.25	10	5.72	5.05-6.23	0.34
CL/HL	34	4.12	3.68-4.49	0.20	10	4.39	3.92-4.80	0.30
PL/GuL*10	34	57.10	50.00-66.41	3.52	10	54.33	49.65-61.55	3.50
PL/HuL*10	34	115.52	87.12-200.82	24.74	10	124.84	94.43-167.14	26.23
PL/PeL*10	34	57.68	48.81-79.58	6.03	10	58.05	51.28-68.21	4.50
PL/AbL*10	34	66.73	56.94-78.44	5.31	10	62.75	53.41-73.53	5.81
PL/FeL*10	34	93.67	68.54-118.37	12.61	10	89.81	71.39-105.26	11.36
PL/AnL*10	34	36.04	32.26-43.77	2.38	10	35.99	33.60-39.60	1.99

Table 3: Comparison of 10 characters of the 2 samples (Turkish Thrace and east Bulgaria) of *Emys orbicularis* (LINNAEUS, 1758) according to independent *t*-tests (significant differences between samples in bold italics). *t* - *t*-test values; d.f. - degrees of freedom; *P* - probability values. Character abbreviations as listed in Materials and Methods.

Tab. 3: Vergleich von 10 Merkmalen der beiden Stichproben (Türkisch Thrakien und Ost-Bulgarien) von *Emys orbicularis* (LINNAEUS, 1758) mittels *t*-Test für unabhängige Stichproben (signifikante Unterschiede zwischen den Samples in kursiver Fettschrift). *t* - *t*-Test Werte; *df*. - Freiheitsgrade; *P* - Wahrscheinlichkeitswerte. Merkmalsabkürzungen sind unter 'Materials and Methods' erklärt.

Ratio, Index Quotient, Index	Males / Männchen			Females / Weibchen		
	<i>t</i>	<i>df</i>	<i>P</i>	<i>t</i>	<i>df</i>	<i>P</i>
CL/CW	-1.02	28	0.315	-0.90	42	0.375
CL/SH	1.04	28	0.308	2.18	42	0.035
CL/HW	1.33	28	0.196	1.72	42	0.093
CL/HL	3.23	28	0.003	3.02	42	0.004
PL/GuL*10	-1.07	28	0.296	-2.28	42	0.028
PL/HuL*10	1.52	28	0.141	1.10	42	0.277
PL/PeL*10	1.37	28	0.182	0.33	42	0.747
PL/AbL*10	-1.83	28	0.079	-2.18	42	0.035
PL/FeL*10	0.92	28	0.367	-8.82	42	0.417
PL/AnL*10	-0.29	28	0.778	-0.003	42	0.998

Table 4: Patterns of colouration of *Emys orbicularis* (LINNAEUS, 1758) from Turkish Thrace. Phenotypic categories according to FRITZ (1995).

Tab. 4: Färbungstypen bei *Emys orbicularis* (LINNAEUS, 1758) aus Türkisch Thrakien. Phänotypische Kategorien nach FRITZ (1995).

Body Part Körperteil	Phenotypic category Phänotypische Kategorie	Bulgaria / Bulgarien		Thrace / Thrakien	
		Males Männchen (n = 28)	Females Weibchen (n = 42)	Males Männchen (n = 10)	Females Weibchen (n = 10)
Carapace / Carapax-	orbicularis type	26 (93%)	38 (90%)	9 (90%)	7 (70%)
	Intermediate / dazwischenliegend	-	-	1 (10%)	3 (30%)
	maculosa type	2 (7%)	4 (10%)	-	-
Plastron	Less than 1/3 dark / weniger als 1/3 dunkel	10 (36%)	15 (35%)	-	5 (50%)
	1/3 - 2/3 dark / 1/3 - 2/3 dunkel	11 (39%)	20 (48%)	5 (50%)	4(40%)
	More than 2/3 dark / mehr als 2/3 dunkel	7 (25%)	7 (17%)	5 (50%)	1 (10%)
Top of Head / Kopf- oberseite	Dotted / gefleckt	2 (7%)	17 (41%)	1 (10%)	3 (30%)
	Intermediate / dazwischenliegend	10 (36%)	9 (21%)	-	1 (10%)
	reticulate / retikuliert	16 (57%)	16 (38%)	9 (90%)	6 (60%)
Throat / Kehle	Predominantly yellow / vorwiegend gelb	5 (18%)	12 (29%)	3 (30%)	7 (70%)
	Predominantly black / vorwiegend schwarz	23 (82%)	30 (71%)	7 (70%)	3 (30%)
Iris	Brownish-reddish / bräunlich-rötlich	?	?	10 (100%)	-
	Yellowish-whitish / gelblich-weißlich	?	?	-	10 (100%)

tive sex of the Bulgarian sample (Tab. 3). In both males and females the Bulgarian sample was significantly different from the Turkish regarding the ratio CL/HL corresponding to the relatively longer head in the Bulgarian males and females (Tab. 2). Also other studies suggested that head length is a powerful tool for discriminating different subspecies and populations of pond turtles (e.g., FRITZ 1989; SCHULZE & FRITZ 2003).

Females of the two samples also differed with respect to the indices PL/GuL*10 and PL/AbL*10 in that the means were larger in the Thracian specimens (Tab. 2), i.e., the suture lengths between gular and abdominal plates were longer relative to the plastral length. Another character differentiating females from the Bulgarian and Thracian samples is the CL/SH ratio. Shell height was smaller with regard to carapace length in the Thracian females, which on the average have flatter shells than the east Bulgarian specimens. The comparison of our PL/GuL*10 indices and the CL/SH ratios with those published by FRITZ (1994, 1995) reveals that eastern Bulgarian and Turkish Thracian specimens are intermediate between *E. o. orbicularis* and *E. o. hellenica* (with Turkish Thracian turtles being closer to *E. o. hellenica* and eastern Bulgarian ones closer to the nominotypical subspecies).

Colouration (Tab. 4). The predominant type of carapacial colouration in both samples was the dark, black colour type with a radiating pattern of streaks or dots (so-called orbicularis colouration type; Fig. 2). All six specimens from one of the Bulgarian localities, Svilengrad, make a clear exception in that they have a very light brownish carapacial colouration (so-called maculosa colouration type), suggestive of considerable population-specific variation as also known in the closely related species *E. trinacris* (FRITZ et al. 2006). Plastron colouration was highly variable, with a clear tendency towards darker colouration in males. In some specimens, radiating distal blotches were present (Fig. 3; see also ÇEVİK 1982). Uniform dark plastrons as described from some localities in Asiatic Turkey (FRITZ et al. 1998; TAŞKAVAK & REIMANN 1998) were not observed in the Thracian turtles, but in some Bulgarian specimens. This difference could be due to different sample size and differences in the age structure of both samples however. It is known that the shell of turtles darkens increasingly with increasing age (FRITZ 2001, 2003).

The pattern of the top side of the head shows no clear sexual dimorphism in both samples. This resembles the character state of *E. o. orbicularis*, while in the Balkan sub-



Fig. 2: Carapace colouration of *Emys orbicularis* (LINNAEUS, 1758) (Male from Yeniköy, no. 19 in figure 1).
Abb. 2: Carapaxfärbung von *Emys orbicularis* (LINNAEUS, 1758) (Männchen von Yeniköy, 19 in Abb. 1).



Fig. 3: Plastron colouration of *Emys orbicularis* (LINNAEUS, 1758) (Female from Yeniköy, no. 19 in figure 1).
Abb. 3: Plaстрalfärbung von *Emys orbicularis* (LINNAEUS, 1758) (Weibchen von Yeniköy, 19 in Abb. 1).

species *E. o. hellenica* a clear dimorphism occurs with males displaying a reticulate and females a dotted pattern.

The colour of the iris was brownish-red in all Thracian males, yellowish-whitish in the females; iris colouration could not be determined in the preserved Bulgarian turtles (Tab. 4). However, according to FRITZ & OBST (1995) and FRITZ (2001, 2003), pond turtle males from the Bulgarian Black Sea coast have a reddish iris colouration. In the males of the populations inhabiting the western and southern parts of Anatolia, yellowish to whitish iris colouration is characteristic; in other Turkish regions, brownish to reddish iris colourations prevail like in the nominotypical subspecies (AYAZ 1998, 2003; FRITZ 2001, 2003; TAŞKAVAK & AYAZ 2006). A brownish-red iris is also known to occur in males from Bulgaria (FRITZ 1992).

In conclusion, most east Bulgarian and Turkish Thracian turtles resemble *E. o. orbicularis* in colouration and pattern, while they are significantly smaller and some character ratios are intermediate between

the nominotypical subspecies and *E. o. hellenica*. These findings are in line with data from other regions of the southeastern Balkan Peninsula. Originally, FRITZ (1992) and FRITZ & OBST (1995) suggested that European Pond Turtles from those regions represent intergrades between both subspecies. However, mitochondrial haplotypes of pond turtles from the southeastern Balkans do not support this hypothesis (LENK et al. 1999; FRITZ et al. 2007). According to these data, the southeastern Balkans region is inhabited by turtles harbouring haplotypes similar to, but distinct from the nominotypical subspecies. Therefore, FRITZ (2001, 2003) tentatively assigned pond turtles from the southeastern Balkans to the subspecies *E. o. colchica*. Further research on individuals from other regions of this form's range is needed to reveal whether *E. o. colchica* represents a distinct evolutionary lineage or merely an assemblage of populations comprising turtles being too small for assigning to the nominotypical subspecies.

ACKNOWLEDGEMENTS

We are indebted to The Scientific and Technological Research Council of Turkey (TÜBİTAK) for financial support through Project No. TBAG-2402 (103T189). Dr. J. CABOT-NIEVES (EBD), Dr. F. GLAW

and Dr. U. GRUBER (ZSM), Dr. G. KÖHLER (SMF), Dr. E. KRAMER (NMB), Dr. J. MORAVEC (NMP), and Dr. G. R. ZUG (USNM) allowed access to museum specimens in their care. (For museum acronyms see appendix).

REFERENCES

- ARNOLD, E. N. & BURTON, J. A. (1978): A field guide to the reptiles and amphibians of Britain and Europe.- London (Collins), 272 pp.
- AYAZ, D. (1998): Ege Bölgesi *Emys orbicularis* (Testudinata: Emydidae) ve *Mauremys rivulata* (Testudinata: Bataguridae) türlerinin taksonomisi ve biyolojisi üzerine araştırmalar. MSc Thesis, Ege University, 108 pp [In Turkish with English summary].
- AYAZ, D. (2003): Gölle Bölgesi ve Doğu Akdeniz Bölgesi *Emys orbicularis* (Testudinata: Emydidae) ve *Mauremys rivulata* (Testudinata: Bataguridae) türlerinin sistematik durumu, morfolojisi, dağılışı, üreme ve beslenme biyolojisi üzerine araştırmalar. Ph. D. Thesis, Ege University, 239 pp [In Turkish with English summary].
- BARAN, İ. & ATATÜR, M. K. (1998): Türkiye Herpetofaunası. Ankara (T.C. Çevre Bakanlığı Yayınları), 214 pp.
- BAŞOĞLU, M. & BARAN, İ. (1977): Türkiye Sürüngenleri. Kısım I. Kaplumbağa ve Kertenkeleler. (The Reptiles of Turkey. Part I. The Turtles and Lizards).- Bornova-İzmir (İlker Matbaası), 414 pp.
- BAŞOĞLU, M. & HELLMICH, W. (1959): Auf herpetologischer Forschungsfahrt in Ost-Anatolien.- Auar.- Terrar.-Z., Stuttgart; 12: 118-121, 149-152.
- CRUCITTI, P. & CAMPESE, A. & MALORI, M. (1990): Popolazioni sintopiche di *Emys orbicularis* e *Mauremys caspica* nella Tracia, Grecia Orientale.- Boll. Mus. reg. Sci. nat., Torino; 8: 187-196.
- ÇEVİK, İ. E. (1982): Trakya kaplumbağa ve kertenkelelerinin taksonomik araştırılması.- Ph. D. Thesis, Ege University, 85 pp [In Turkish with English summary].
- EISELT, J. & SPITZENBERGER, F. (1967): Ergebnisse zoologischer Sammelreisen in der Türkei. Testudines.- Ann. Naturhist. Mus., Wien; 70: 357-378, 1 pl.
- ERNST, C. H. & BARBOUR, R. W. (1989): Turtles of the world. Washington, D. C. London (Smithsonian Institution Press), 388 pp.
- FRITZ, U. (1989): Zur innerartlichen Variabilität von *Emys orbicularis* (LINNAEUS, 1758). I. Eine neue Unterart der Europäischen Sumpfschildkröte aus Kleinasien, *Emys orbicularis luteofusca* subsp. nov.- Salamandra, Bonn; 25 (3/4): 143-168.

- FRITZ, U. (1992): Zur innerartlichen Variabilität von *Emys orbicularis* (LINNAEUS, 1758). 2. Variabilität in Osteuropa und Redefinition von *Emys orbicularis orbicularis* (LINNAEUS, 1758) und *Emys orbicularis hellenica* (VALENCIENNES, 1832).- Zool. Abh. Staatl. Mus. Tierkunde, Dresden; 47(5): 37-77.
- FRITZ, U. (1993): Weitere Mitteilung zur innerartlichen Variabilität, Chorologie und Zoogeographie von *Emys orbicularis* (LINNAEUS, 1758) in Kleinasien.- Herpetozoa, Wien, 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. Staatl. Mus. Tierkunde, Dresden; 48 (4): 53-93.
- FRITZ, U. (1995): Zur innerartlichen Variabilität von *Emys orbicularis* (LINNAEUS, 1758). 5a. Taxonomie in Mittel- und Westeuropa, auf Korsika, Sardinien, der Apenninen-Halbinsel und Sizilien und Unterartengruppen von *E. orbicularis*.- Zool. Abh. Mus. Tierkunde, Dresden; 48 (13): 185-242.
- FRITZ, U. (2001): *Emys orbicularis* (LINNAEUS, 1758) – Europäische Sumpfschildkröte; pp 343-515. In: FRITZ, U. (ed.): Handbuch der Reptilien und Amphibien Europas, Band 3/IIIA: Schildkröten I. Wiebelsheim (Aula).
- FRITZ, U. (2003): Die Europäische Sumpfschildkröte. Bielefeld (Laurenti), 224 pp.
- FRITZ, U. & BARAN, I. & BUDAK, A. & AMTHAUER, E. (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 Turkey.- Mertensiella, Rheinbach; 10: 103-121.
- FRITZ, U. & D'ANGELO, S. & PENNISI, M. G. & LO VALVO, M. (2006): Variation of Sicilian pond turtles, *Emys trinacris* – What makes a species cryptic? Amphibia-Reptilia, Leiden; 27: 513-529.
- FRITZ, U. & FATTIZZO, T. & GUICKING, D. & TRIPEPI, S. & PENNISI, M. G. & LENK, P. & JOGER, U. & WINK, M. (2005): A new cryptic species of pond turtle from southern Italy, the hottest spot in the range of the genus *Emys*.- Zoologica Scripta, Oslo, 34: 351-371.
- FRITZ, U. & GUICKING, D. & KAMI, H. & ARAKELYAN, M. & AUER, M. & AYAZ, D. & AYRES FERNÁNDEZ, D. & BAKIEV, A. G. & CELANI, A. & DŽUKIĆ, G. & FAHD, S. & HAVAŠ, P. & JOGER, U. & KHABIBULLIN, V. F. & MAZANAIEVA, L. F. & ŠIROKÝ, P. & TRIPEPI, S. & VALDEÓN VÉLEZ, A. & VELO ANTÓN, G. & WINK, M. (2007 in press): Mitochondrial phylogeography of European pond turtles (*Emys orbicularis*, *Emys trinacris*) – an update.- Amphibia-Reptilia, Leiden, 28.
- FRITZ, U. & OBST, F. J. (1995): Morphologische Variabilität in den Intergradationszonen von *Emys orbicularis orbicularis* und *E. o. hellenica*.- Salamandra, Bonn; 31 (3): 157-180.
- JESU, R. & PIOMBO, R. & SALVIDIO, S. & LAMGNI, L. & ORTALE, S. & GENTA, P. (2004): Un nuovo taxon di testuggine palustre endemico della Liguria occidentale: *Emys orbicularis ingauna* n. ssp.- Ann. Mus. Civ. Stor. natur. "G. Doria", Genova; 96: 133-192.
- LENK, P. & FRITZ, U. & JOGER, U. & WINK, M. (1999): Mitochondrial phylogeography of the European pond turtle, *Emys orbicularis* (LINNAEUS, 1758).- Molecular Ecology, Oxford; 8: 1911-1922.
- SCHREIBER, E. (1912): Herpetologia europaea. Stuttgart (G. Fischer), 960 pp.
- SCHULZE, A. & FRITZ, U. (2003): Morphological variation in Tyrrhenian *Emys orbicularis* revisited.- Amphibia-Reptilia, Leiden; 24: 230-234.
- SCHWEIGER, M. (1994): Ergänzende Bemerkungen zur Verbreitung von *Mauremys caspica* (GMELIN, 1774) in Kleinasien.- Herpetozoa, Wien; 7 (1/2): 67-70.
- TAŞKAVAK, E. & AYAZ, D. (2006): Some investigations on the taxonomic status of *Emys orbicularis* from the Aegean and Central Anatolian regions of Turkey.- Pakistan J. Biol. Sci., Faisalabad, 9 (4): 574-581.
- TAŞKAVAK, E. & REIMANN, M. (1998): The present status of *Emys orbicularis* (LINNAEUS, 1758) in southern Central Anatolia.- Mertensiella, Rheinbach; 10: 267-278.
- WERMUTH, H. & MERTENS, R. (1961): Schildkröten, Krokodile, Brückenechsen.- Jena (Fischer), XXVI, 422 pp.

APPENDIX

Museum specimens of Bulgarian *Emys orbicularis* (LINNAEUS, 1758) examined. Specimens yielding complete sets of measurements used for statistical calculations are asterisked. Acronyms: EBD - Estación Biológica de Doñana, Sevilla; MTD - Museum für Tierkunde, Dresden; NMB - Naturhistorisches Museum, Basel; NMP - Národní Muzeum, Praha; SMF - Senckenberg Museum, Frankfurt am Main; USNM - United States National Museum, Smithsonian Institution, Washington, D.C., ZSM - Zoologische Staatssammlung, München.

Males: EBD (ex MTD) unknown catalogue number*, Akhtopol, Bulgaria, 17 May 1970, leg. J. CIHAR; MTD 4367*, 4371*, 4372, 4377, 4379*, 4380, 4389*, 4392, 4394*,

5030*, 5032*, 5034-5035*, 7177-7179*, 7180, Karazite/Primorsko, Bulgaria, 1971 and 1972, leg. OBST and HAMPEL; MTD 22281, Sosopol, Bulgaria, 1978, leg. L. GEISSLER and A. NÖLLERT; NMP 7113*, 34233*, Akhtopol, Bulgaria; NMP 9477*, Topolovgrad, Bulgaria, 4 March 1972, leg. Z. ROČEK; NMP 9478-9479*, Ropotamo River, Bulgaria, 9 Aug. 1972, leg. Z. ROČEK; SMF 60049*, Varna, Bulgaria, Nov. 1957, leg. O. E. STRECK; USNM (ex MTD) unknown catalogue number*, Akhtopol, Bulgaria, 17 May 1970, leg. J. CIHAR; ZSM 99/1934:1*, ZSM 99/1934:2, Svilengrad, Bulgaria, Aug. 1931, leg. F. FUSS.

Females: MTD 4365-4366*, 4368-4369, Karazite/Primorsko, Bulgaria, 1971, leg. OBST and HAMPEL; MTD 22282*, Sosopol, Bulgaria, 1978, leg. L. GEISSLER and A. NÖLLERT; MTD 4369-4370*, 4373-4374*, 4376*, 4378, 4383, 4385-5388*, 4391*, 4395*, 5023, 5024-5025*, 5026, 5027-5028*, 5029, 5031*, 5033*, 5036*, 7182-7183*, 8800, Primorsko, Bulgaria, May 1972, leg. OBST and HAMPEL; NMB 19367*, Albena, Bulgaria, early 1971, leg. J. FRITZSCHE; NMP 7114-7116*, 7117, 7118*, Akhtopol, Bulgaria; NMP P6j-59/89a-b*, Uzun Kum, Bulgaria (near Alazda Monastery, N Varna); ZSM 99/1934:3-5*, Svilengrad, Bulgaria, early Aug. 1931, leg. F. FUSS.

SUBMITTED: January 09, 2007

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Jahr/Year: 2007

Band/Volume: [20_1_2](#)

Autor(en)/Author(s): Ayaz Dincer, Fritz Uwe, Atatür Mehmet Kutsay

Artikel/Article: [Morphological comparison of *Emys orbicularis* \(Linnaeus, 1758\) from European Turkey and eastern Bulgaria \(Testudines: Emydidae\)](#)
[Morphologischer Vergleich von *Emys orbicularis* \(Linnaeus, 1758\) aus der Europäischen Türkei und dem östlichen Bulgarien \(Testudines: Emydidae\) 11-20](#)