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Morphometric Measurements of the Euphrates Soft-shelled Turtle, *Rafetus euphraticus*, in the Central Marshes, Iraq

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Abstract

The Euphrates soft-shell turtle *Rafetus euphraticus* is classified as endangered on the IUCN Red List and is thought to have recently undergone large population declines. Species information in Iraq is limited to a few rapid surveys with little detailed information on its breeding and distribution. Turtles have been recorded inside the water by setting nets in certain areas in the Central Marshes. Morphometric measurements were recorded in Euphrates soft-shelled turtles *Rafetus euphraticus*, sampled in the Central Marshes. According to nine morphometric ratios, the populations of *R. euphraticus* in the Central Marshes are smaller in size than previous specimens that have been recorded in neighboring countries. The carapaces length (CL) rang for current study was 70 to 560 mm, whereas it was 187 to 680 mm according to a previous study. The carapaces width (CW) rang for the current study was 63 to 420 mm, while in a previous study it was recorded to be 152 to 465 mm.

Keywords: *Rafetus euphraticus*, Euphrates softshell turtle, Central Marshes, Morphometric measurements and Morphology

القياسات المورفومترية لترسة الفرات ملساء الصدفة *euphraticus Rafetus* في الأهوار الوسطى في العراق

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الخلاصة

تم تصنيف ترسة الفرات ملساء الصدفة *Rafetus euphraticus* على أنها مهددة بخطر الانقراض ضمن القائمة الحمراء للاتحاد الدولي لحفظ الطبيعة، ويُعتقد أنها تعرضت لانخفاض كبير في أعدادها مؤخرًا. تقتصر معلومات الأنواع في العراق على عدد قليل من المسوحات السريعة مع القليل من المعلومات التفصيلية عن التربية والتوزيع. تم تسجيل ترسة الفرات داخل المياه عن طريق وضع الشباك في مناطق معينة بالأهوار الوسطى. تم تسجيل القياسات المورفومترية لترسة الفرات ملساء الصدفة *Rafetus euphraticus*، التي تم أخذ عينات منها في الأهوار الوسطى. وفقًا لتسع نسب مورفومترية ، فإن *R. euphraticus* في الأهوار الوسطى اصغر في الحجم من العينات السابقة التي تم تسجيلها في البلدان المجاورة. تراوح طول الدروع CL للدراسة الحالية من 70 إلى 560 ملم ، بينما تراوح فيدراسة سابقة من 187 إلى 680 ملم. تراوح عرض الدروع CW للدراسة الحالية من 63 إلى 420 ملم ، بينما تراوح فيدراسة سابقة من 152 إلى 465 ملم.

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1. Introduction

Rafetus euphraticus (Daudin, 1801) known as the Euphrates soft-shell turtle, is an enigmatic and highly aquatic trionychidae distributed in Euphrates and Tigris rivers and their tributaries in Iraq, Syria, Turkey and Iran [1]. The Euphrates soft-shell turtle *R. euphraticus* is listed on The International Union for Conservation of Nature Red List of Threatened Species (IUCN Red list) as endangered species and is thought to have recently undergone a large population decline in Iraq [2]. Although Iraq is expected to hold the biggest number of appropriate places for the Euphrates soft-shell turtle [3], there is a gap in information inside Iraq on this species [4]. The first published observations in Iraq (after anecdotal records in the 1960s) were in 1992 from the Euphrates River [5]. The species was subsequently recorded in Iraq from 2005 onwards during KBA (Key Biodiversity Area) surveys in nineteen sites all over Iraq, two in the Kurdistan area and Mosel [4], eight in the central portion of Iraq and nine in the south [3]. However, these surveys were rapid and, therefore, more intensive surveys at finer spatial scales are needed to obtain a more accurate understanding of the species distribution and conservation status [2].

The Central Marsh in southern Iraq is the focus of the present research because it's been recognized as a potential stronghold for the species due to its ecological suitability [3]. As a result of the Tigris-Euphrates river complexity, the Central Marsh is one of the three main wetlands in Iraq followed by Al-Hammar and Hawizeh marshes. The Central Marsh formerly covered around 300,000 hectares but was almost totally drained following the 1991 uprising sevents in Iraq and has since been reflooded in 2003 – 2004 [6]. While the Central Marsh is Iraq's first national park officially recognized as Mesopotamian National Park in July 2013 [7].

1.1 Description of Euphrates Soft-shell Turtle (*Rafetus euphraticus*)

The Euphrates soft-shelled turtle is large in comparison to other near eastern freshwater turtles, with adult individuals ranging in length from 32 to 68 cm [8]. The olive-green leathery skin that covers the carapace distinguishes the species. The adult has a flattened and compressed dorsum (Figure 1). The maximum carapace length (leathery shell) of a Tigris specimen at the biology department of Ege University was 680 mm [9]. While the maximum bony carapace length was given as 282 mm by Meylan [10] and the biggest specimen in the collection of Pritchard measured 292 mm, and the maximum bony disc length was recorded to reach 351 mm [11]. Hatchlings' straight total carapace length has been reported as being 43.3 mm. (Gramentz) [11] and ranging between 39.3 to 43.5 mm (Ghaffari *et al.*) [1]. There are no observable differences between males and females in terms of absolute or relative body measurements in specimens from the Euphrates, Tigris and their tributaries.



Figure 1: A Photo of the Euphrates soft-shell turtle *Rafetus euphraticus* in the Central Marshes.

The carapace is strong and meaty in the front and smooth and free of tubercles on the sides. From the above, it is simple to see the bony disc's contour and sutures. Minor vertebral depression can be seen in certain specimens (typically big adults). The carapace's ground color is consistently olive-green, with sporadic, diffused black blotches and a few irregular cream-colored patches, mainly on the lateral borders. On the head, larger and more numerous patches can be seen. Occasionally, rather than the normal olive-green, the whole dorsum's ground coloring is consistently dark brown, and very infrequently, black. Comparing the snout to that of *Trionyx triunguis* and *Pelodiscus sinensis*, it is proportionately shorter and thicker. The lateral septal ridges, also known as the septal papillae, have small longitudinal troughs with sharp edges. The plastron's anterior edge reaches the carapace's anterior edge. The plastron length and overall carapace width are approximately equivalent. Both the hyo- and hypoplastra still have callosities which are the only remaining bone components of the plastron. Despite being a little roughened, these sections lack the vermiculate sculpting found on the bony carapace components [9].

2. Materials and Methods

2.1 The Study Area

The Iraqi marshlands, or Mesopotamian marshlands which are listed as one of the UNESCO World Heritage sites, used to be the largest wetland ecosystem of Southwest Asia [12]. The study area is a vast complex of permanent freshwater wetlands, semi-desert arid lands, and scrublands of the Central Marshes encompasses the geographical zone (31°11'N 46°59'E) extending between ThiQar (Nassiriyah), Mayssan (Emara) and Basra provinces. The total area size of the Central Marshes is 219,700 ha (2197km²) [13].

The surveying plot's 4000 ha (40 km²) research area is located inside the Central Marshes. With an elevation of less than 6 meters, the Central Marshes are located in the Tigris-

Euphrates Alluvial Salt Marsh Eco region. The Tigris and Euphrates rivers provide water for Central Marshes, and these rivers' tributaries create huge wetlands with open freshwater lakes that are mostly covered with *Typha* genus and common reed *phragmites australis* vegetation (Figure 2).

One of the biggest marshes in the province of Thi-Qar is called Al-Chibayish (Central Marshes), which is located south of the Tigris River in the Messan governorate. The Al-Bitera, Al-Majer Al-Kabeer Rivers and Al-Areedh branches are located on the right side of Tigris River. Euphrates River is situated between Sook Al-Sheyukh and Al-Qurnamarshes on the southern side of the Central Marshes. During flood seasons, the Central Marshes' wet area is around 3000 km². The Central Marshes are connected to the Euphrates River by 12 outlets acting as culverts (Al-Soora, Al-Jala'a, Kahala, Al-Badreea, Al-Sana'a, Abu gedaea'a, Alkhenzeeri, Al-Sabagheea, Hadsa, Abu Juelana, Abu Al-Narsee, Abu Sobaat). These outflows also serve as feeders for the marshes when the Euphrates River has a greater water level than the southern portion of the marshes [14].

The complicated feeding system of the Al-Chibayish marshes results from the fact that many outlets in the southern part occasionally serve as feeders from the Euphrates River to the marshes. Additionally, Abu-Ziriq marsh plays a significant role in the marshes' feeding system. Hence, its outlets are also thought of as feeders of the Al-Chibayish marshes. The three sites chosen in this study are shown in Figure 2.



Figure 2: Sampling sites in Al-Chibayish marshes [15].

2.2 Euphrates Soft-shell Turtle Capturing

2.2.1 Hand Capture

This is a very simple method that is used with any species that is not poisonous. Simply sneak on the individual and attempt to grab it with your hands. With slower animals like turtles, it functions well [16].

2.2.2 Netting

This technique is recommended for sampling aquatic reptiles. It can provide an accurate indicator of the presence or absence of species at the most fundamental level and can contribute to estimations of relative abundance and absolute density [16].

The Euphrates soft-shell turtles (*Rafetus euphraticus*) were captured from the Central Marshes by a 200 x 2m seine net of mesh size 10 cm² and fishing net with the same size (Figure 3). According to The Royal Society for The Conservation of Nature [16]. Capturing samples was conducted for 2 to 3 days from each month from October 14, 2021, to September 17, 2022, except the hibernation season (December to February). For all studied sites, the net was installed (Figure 3) at about 5 a.m. and collecting it at approximately 5 p.m.

Fishing nets were used instead of submerged traps because this equipment is not available and the fishing nets provide a good efficiency in our survey.



Figure 3: Photos of the fishing net used for collecting turtle.

2.3 The Morphometric Measurement

For measurement points and morphometric variables, the survey followed the protocol shown in Figure 4 described by Taşkavak [8]. Morphometrics were measured by using a digital Vernier caliper (150 mm). Straight line morphometric measurements (mm) included the length of the carapace from the anterior to distal edge (CL), the maximum width between the carapace margins (CW), the length of the midline from the point of greatest carapace width to the distal edge (PGCW), the length of the plastron from the proximal to the distal end (PL), the maximum width between the lateral margins of the plastron (PW), the length of the rostrum (RL), the length of the snout (SL), the width of the snout (SW), interorbital distance (ID) and head width (HW). Animals that were sexually immature and had a carapace length of less than 250 mm, were classified as subadults, while those with a carapace length of less than 110 mm were classified as juveniles. The weight of the turtles was measured by Digital Lab Weighing Scales (50 Kg).

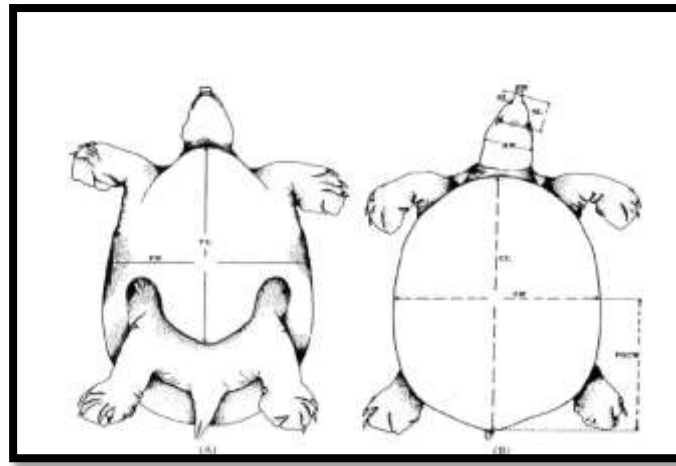


Figure 4: Measurements used in morphological analyses (PL: Plastron length, PW: Plastron width, CL: Carapace length, CW: Carapace width, PGCW: length of midline from the point of greatest carapace width to the distal edge of the carapace, HW: Head width, ID: Interorbital distance, SW: Snout width, SL: Snout length, RL: Rostrum length). A = Ventral; B = Dorsal [8].

Statistical Analysis:

The Statistical Analysis System- SAS (2018) program was used to detect the effect of difference factors in study parameters. T-test was used to compare between means in this study.

3 Results and Discussion

3.1 Morphology of Euphrates Softshell Turtle

The morphological measurement of the 40 specimens we captured during the study are given in Table 1. In mature *R. euphraticus*, the carapace was smooth, peripherally thick and fleshy. In some samples, usually large adults, there was a tiny vertebral depression. The carapace's ground color was consistently olive-green with a few sporadic specks of cream hue, particularly on the lateral margin (Figure 5). On the head, larger and more numerous patches can be seen. On rare occasions, the whole dorsum's ground coloration is consistently brown rather than the typical olive-green. The septal papillae, or lateral septal ridges, feature tiny longitudinal troughs with pointed edges [8] [17].



Figure 5: A photo of *R. euphraticus*, the carapace ground color was consistently olive-green with a few sporadic specks of cream hue, particularly on the lateral margin.

Previous a morphological study was conducted in Turkey on 41 individuals of *R. euphraticus* by Taşkavak [8]. The comparison of the data obtained from 2021- 2022 survey on 40 individuals with previous study is shown in Table 2 (Figure 6):

- The carapaces length (CL) mean for the current study was 367.55mm, while in the previous study it was 418.84 mm.
- The carapaces width (CW) mean for the current study was 279.03 mm, while in the previous study it was 303.12 mm.
- The plastron length (PL) mean for current study was 282.03 mm, while in the previous study it was 306.02 mm.
- The plastron width (PW) mean for the current study was 246.48 mm, while in the previous study it was 298.51 mm.
- The length of midline from the point of greatest carapace width to the distal edge of the carapace (PGCW) mean for current study was 175.35 mm, while in the previous study it was 183.43 mm.
- The rostrum length (RL) mean for the current study was 13.94 mm, while in the previous study it was 13.18 mm.
- The snout length (SL) mean for the current study was 10.78 mm, while in the previous study it was 10.07 mm.
- The snout width (SW) mean for the current study was 28.74 mm, while in the previous study it was 30.88 mm.
- The interorbital distance (ID) mean for the current study was 13.02 mm, while in the previous study it was 10.44 mm.
- The head width (HW) mean for the current study was 55.77 mm, while in the previous study it was 58.81 mm.

According to the comparison between the *R. euphraticus* in Turkey and Iraq as shown in Table 2, it was found that the *R. euphraticus* in Turkey are larger in size than those in Iraq.

This may be due to the temperatures in Turkey being lower than the temperatures in Iraq [18]. According to Bergman's rule, turtles are larger in low-temperature areas than turtles in high-temperature areas [19]. Larger sizes are associated with higher thermal inertia or due to the benefits of smaller sizes that are associated with faster heat gain and loss [19] [20].

The carapaces of adult *R. euphraticus* are flattened and dorsally compressed. The literature provides carapace length measurements that range from 70 mm to 560 mm. Taskavak's biggest specimen was 680 mm in length when the carapace was straight [8]. The largest straight carapace length among Iranian specimens was 520 mm.

Except for the Asian narrow-headed softshell turtle (*Chitra chitra*), sexual size dimorphism has not been proven in old world trionychids [20]. Sexual dimorphism was not apparent, according to the measurements of the 40 distinct morphometric ratios. Our results agree with those of Gramentz and Taskavak [11] [8] respectively, who found no evidence of size sexual dimorphism in the Trionychidae family, despite the fact that there was no statistically significant distinction between males and females.

Table 1: Morphometric measurements (in mm and weight Kg) of 40 captured turtles.

Specimens	CL	CW	PL	PW	PGC W	RL	SL	SW	ID	HW	W
1	380	270	280	250	190	28.55	15.48	11.92	13.62	57.73	6.08
2	350	290	250	180	170	36.06	8.63	9.2	10.73	45.08	2.84
3	480	340	370	310	240	35.53	15.78	12.38	20.84	77.18	9.35
4	370	290	300	260	180	40.4	9.01	9.95	12.47	50.68	5.47
5	500	360	400	330	260	38.66	14.56	10.63	16.44	61.96	11.7
6	420	310	330	300	210	35.4	15.9	10.1	13.7	50.5	5.25
7	310	240	230	210	155	25.02	8.9	7.5	11.5	48.3	2.7
8	380	290	300	280	190	33.8	13.4	9.02	13.3	53.9	5.1
9	450	370	360	330	225	33.15	18.01	15.63	17.82	69.37	7.8
10	190	170	170	130	95	22.15	11.65	9.6	10.55	37.31	1.43
11	72	63	64	60	36	14.95	5.89	6.5	6.3	22.11	2.63
12	230	180	180	150	115	28.52	13.18	10.37	13.12	38.39	1.7
13	410	310	330	280	205	30.1	15.21	13.12	14.95	66.61	6.86
14	380	280	280	260	190	14.34	12.52	12.17	25.17	55.71	5.33
15	240	210	200	190	120	22.1	8.1	10.5	9.36	41.34	2.34
16	70	63	62	59	35	13.55	5.66	6.4	5.01	20.38	2.3
17	90	75	75	70	45	15.2	6.17	7.01	5.35	22.41	2.43
18	460	340	340	310	230	31.28	15.62	11.77	14.22	72.44	9.5
19	430	310	330	290	210	30.5	12.71	15.42	11.41	61.12	7.4
20	560	380	400	330	280	33.14	22.81	11.63	16.46	71.33	11.6
21	360	280	280	160	180	26.52	14.31	10.42	12.66	57.19	5
22	410	280	300	280	205	26.22	14.43	11.17	15.15	61.49	5.7
23	520	380	380	350	260	40.71	18.72	11.51	15.59	69.46	10.4
24	460	360	350	330	230	31.73	16.17	9.45	14.42	65.66	9.1

25	430	420	320	290	215	31.41	15.42	10.22	13.38	61.82	7.2
26	440	330	330	290	220	29.11	17.74	11.16	16.52	63.34	7.7
27	490	320	350	300	245	33.94	21.72	11.61	14.15	69.19	8.5
28	390	290	290	260	195	27.55	14	12.17	12.44	65.31	5.3
29	290	230	220	200	145	23.35	15.79	9.12	8.42	45.62	2.8
30	400	310	310	280	200	30.74	16.37	9.24	14.27	62.14	2.7
31	230	190	180	180	115	22.85	8.64	6.11	8.95	39.76	1.5
32	290	210	220	200	145	21.57	12.37	8.46	11.18	45.63	2.9
33	490	340	360	300	245	32.93	20.34	10.66	14.06	63.75	6.5
34	280	220	220	200	140	17.71	10.44	6.43	11.28	53.62	4.7
35	460	340	340	300	230	38.54	15.34	16.32	11.78	62.12	8.54
36	410	310	300	290	205	28.14	16.51	15.91	11.31	65.33	6.76
37	290	270	300	250	145	21.24	14.25	13.12	13.28	53.14	5.37
38	470	320	360	280	235	31.23	16.34	12.15	13.23	71.34	9.1
39	440	320	330	270	220	35.38	14.33	12.5	14.45	66.17	7.8
40	380	300	290	270	190	36.44	15.17	12.81	12.1	64.91	5.1
Mean	367.55	279.025	282.025	246.475	175.35	28.7428	13.9398	10.784	13.0235	55.771	5.812
SD	118.3	82.4	85.0	74.9	59.4	7.22	4	2.54	3.68	13.93	2.83
Min.	70	63	62	59	35	13.55	5.66	6.11	5.01	20.38	1.43
Max.	560	420	400	350	280	40.71	22.81	16.32	25.17	77.18	11.7

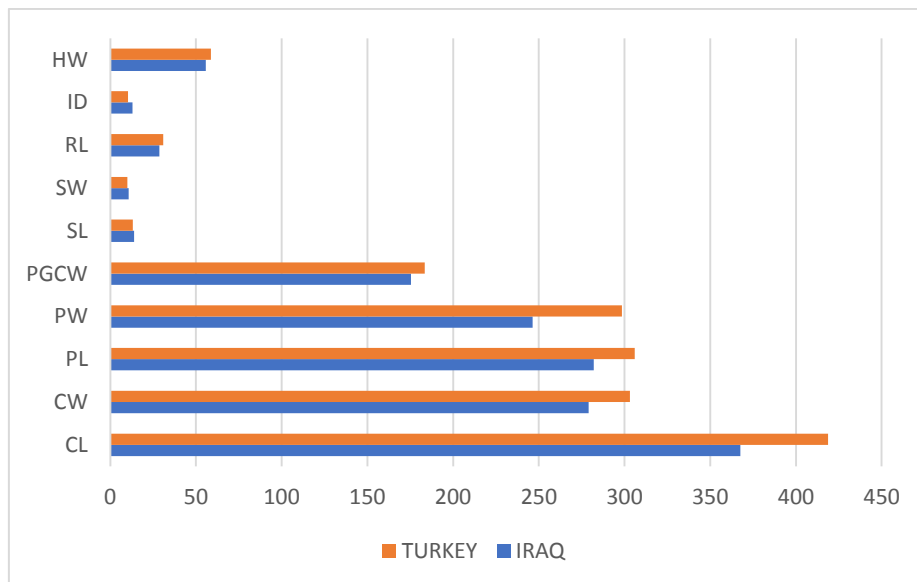


Figure 6: Comparison between Iraq and Turkey samples.

Table 2: Comparison between Iraq and Turkey samples

Morphometric Measurement	Mean \pm SE		T-test
	Iraq	Turkey	
CL	367.55 \pm 14.59	418.84 \pm 22.07	25.53 *
CW	279.03 \pm 11.94	303.12 \pm 15.61	17.65 *
PL	282.03 \pm 11.02	306.02 \pm 14.78	14.93 *
PW	246.48 \pm 17.53	298.51 \pm 15.41	26.81 *
PGCW	175.35 \pm 9.76	183.43 \pm 11.04	7.49 *
SL	13.94 \pm 1.27	13.18 \pm 1.08	1.02 NS
SW	10.78 \pm 0.85	10.07 \pm 1.15	1.18 NS
RL	28.74 \pm 3.45	30.88 \pm 2.81	3.72 NS
ID	13.02 \pm 2.33	10.44 \pm 0.84	4.48 NS
HW	55.77 \pm 3.02	58.81 \pm 3.29	5.79 NS
* ($P \leq 0.05$), NS: Non-Significant.			

Conclusion

According to the comparison between 41 individuals of *R. euphraticus* in Turkey and 40 individuals in Iraq, it was found that the *R. euphraticus* in Turkey have larger size than those in Iraq. This may be due to the temperatures in Turkey being lower than the temperatures in Iraq. According to Bergman's rule, turtles are larger in low-temperature areas than turtles in high-temperature areas.

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