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An investigation on some biological and reproduction characteristics of *Eriphia verrucosa* (Forskål, 1775) in the South Black Sea (Turkey)

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Abstract: In this study, a total of 1360 specimens of *Eriphia verrucosa* were collected from the South Black Sea region of Turkey between February 2012 and January 2013 to determine their biological and reproductive characteristics. The overall sex ratio of all individuals was calculated as 1:0.42 (M/F). The mean carapace width was determined as 6.76, 5.57, and 5.62 cm for males, nonovigerous, and ovigerous females, respectively. The minimum and maximum weight was recorded as 4.07 and 301.4 g for both sexes. The highest correlation between morphological characteristics was determined for carapace length and crab weight in nonovigerous females (R^2 = 0.973; N = 317). The percentage of ovigerous females was 6.25% and they were observed only between May 2012 and August 2012. The mean fecundity was calculated as 89,129 ± 8005 eggs. The egg diameter ranged from 499.0 to 701.7 µm with a mean value of 546.36 ± 18.62 µm for stage I, 606.92 ± 15.92 µm for stage II, and 570.96 ± 9.22 µm for stage III.

Key Words: *Eriphia verrucosa*, reproduction, crab, Black Sea

1. Introduction

Crustaceans have an important share in world fisheries production (Kaya et al., 2009). Production of shrimps, crabs, and lobsters accounts for a significant amount of this class (Zariquiey, 1968) with rates of 58.38%, 26.58%, and 5.22%, respectively (FAO, 2011). Although there are 5 economically consumed crab species in Turkey, statistical data are recorded only for the two of them (*Eriphia verrucosa* Forskål, 1775 and *Callinectes sapidus* Rathbun, 1896) by the relevant organization (TÜİK, 2014).

E. verrucosa, sometimes called the warty crab or yellow crab, is a species found in the Black Sea, Mediterranean Sea, and Eastern Atlantic Ocean from Brittany to Mauritania and the Azores (Manning and Holthuis, 1981; Bakır et al., 2014). The species occurs among stones and seaweeds along rocky coastlines in shallow waters down to depths of 15 m (Rossi and Parisi, 1973). *E. verrucosa* migrates to shallower waters of less than 1 m and begins to reproduce in May or June (Dumitrache and Konsulova, 2009). It is reported that *E. verrucosa* feeds on bivalves, gastropods, hermit crabs, mollusks, and polychaetes (Rossi and Parisi, 1973). In the Black Sea, *E. verrucosa* is known to be the only native species capable of breaking the shells of an invasive snail, *Rapana venosa* (Valenciennes, 1846), but it is unlikely that it will present an effective biological control for the invader (Micu and Todorova, 2007).

On the other hand, *E. verrucosa* is threatened by eutrophication and pollution in the Black Sea. Despite being an abundant species in the Black Sea previously, *E. verrucosa* has shown a decreasing trend since the 1980s and is now listed as an endangered species in the Ukrainian Red Data Book (Dumitrache and Konsulova, 2009).

Unlike other Mediterranean countries, *E. verrucosa* is rarely utilized by Turkish people in the Mediterranean due to lack of awareness for consumption (Holthuis, 1961; Altinelataman and Dinçer, 2007; Doğan et al., 2007; Kaya et al., 2009). Existing studies are focused on faunistic aspects of the species (Holthuis, 1961; Dolgopolskaya, 1969; Kocataş, 1981; Ateş, 1997; Gönlügür, 2003; Kocataş and Katağan, 2003). Some studies have focused on determinations of length–weight relationships and meat composition of warty crab in Turkey (Erkan et al., 2008, 2010; Kaya et al., 2009; Ulaş and Aydın, 2011). However, there is no information about the biological characteristics of this species in the South Black Sea Region and this study aims to fill this gap.

2. Materials and methods

A total of 1360 specimens were collected from the South Black Sea region from Sinop to Ordu, Turkey (Figure 1). The specimens were collected from February 2012 to January 2013. All individuals were captured by diving at

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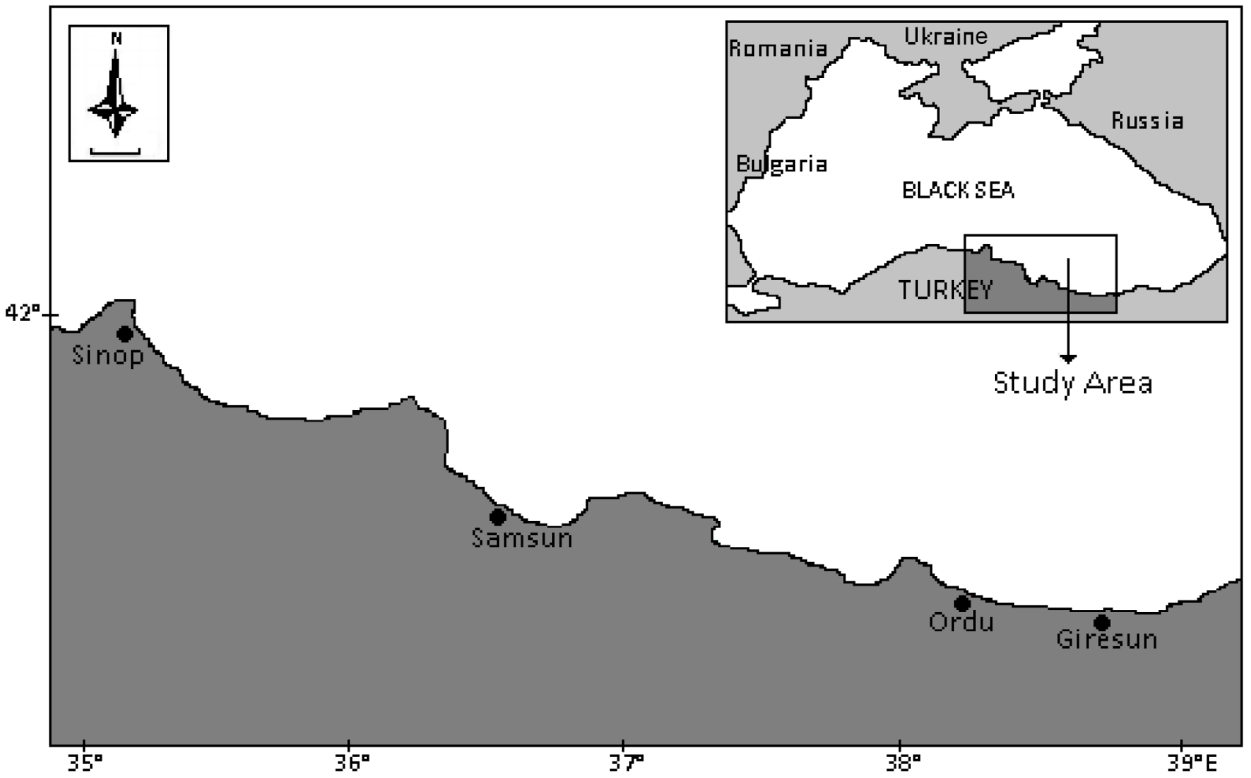

Figure 1. Map of the study area.

depths ranging from 0 to 20 m by trammel nets (16–24 mm) and baits. The specimens were transferred to the laboratory in a cooling box.

The individuals were weighed with a digital scale with an accuracy of 0.01 g and measured for their carapace width with a precision of 0.01 cm. Sex distinction was made by interpreting typical characteristic forms of the abdomen (triangular in males and circular in females) and the appearance of the first 2 pairs of pleopods (modified to gonopods in males) (Wenner, 1989).

Length–weight relationships were determined for all individuals using the equation $W = aL^b$, where W is weight (g), L is CW (carapace width; cm) and a and b are the coefficients of the functional regression between W and L (Ricker, 1973).

Fulton's condition factor (C) was calculated using $C = (W / CW^3) \times 100$, where CW is carapace width (cm) and W is the body weight (g) (Le Cren, 1951; Bagenal, 1968; Sparre and Venema, 1992).

Spawning season was estimated based on observations of monthly samples for whether they carried eggs or not (Düzgüneş et al., 1998). For determination of reproduction characteristics, eggs were weighed on a balance with a sensitivity of 0.001 g. Subsamples of ovigerous female were used for determination of reproduction period and egg developmental stages. The gonadosomatic index was calculated using the formula GSI = 100 × (GW / W), where GW is gonad weight and W is crab weight. Three basic embryonic stages were used for egg development according to Gonzalez-Gurriaran (1985) and Abello (1986):

Stage I: Recently extruded eggs; light yellow in color, embryonic pigmentation is not visible under the binocular magnifying glass.

Stage II: Incipient pigmentation of the embryo eye; egg mass is brownish in color.

Stage III: The embryo is well-developed with well-formed eyes and other pigmentation; before hatching eggs are dark in coloration.

Fecundity and egg size were evaluated from 31 ovigerous females. Number of eggs was estimated based on the gravimetric method. The egg number was determined using the following formula (Jones et al., 1990; Prager et al., 1990): $F = n \times (W_0 / X)$, where F represents the number of eggs, X stands for subsample weight (g), W_0 denotes the weight of the ovary (g), and n represents the number of eggs in the sample. After 40 or 50 eggs were gently removed from each ovigerous female for egg diameter inspection, diameter was measured with a calibrated ocular microscope with a micrometric scale at 0.01 mm sensitivity (Oh and Hartnoll, 2004). Relative fecundity was calculated as $F = (F / W) \times 100$. Fecundity

(F)–carapace width (CW) and fecundity (F)–body weight (W) relationships were determined from the equation of $F = a \times X^b$, where F is fecundity, X is carapace width or weight, "a" is a constant, and "b" is an exponent (Parsons, 1988; Gunderson, 1993).

The observed differences were evaluated statically using SPSS 22.0 and Student's t-test (Sokal and Rohlf, 1969; Düzgüneş et al., 1983). The sex ratio of crabs was analyzed using the chi-square test (χ^2).

3. Results

A total of 1360 specimens were measured in the study period. The sex ratio of the samples was 1:0.42 (M/F), which was significantly different from the expected ratio of 1:1 ($\chi^2 = 237.3$; df = 1; $P < 0.05$). However, it was determined that only 6.25% of females were ovigerous (Figure 2).

The CW ranged from 3.0 to 9.0 cm (mean: 6.76 ± 0.03 cm) in males, from 3.45 to 8.3 cm (mean: 5.57 ± 0.05 cm) in nonovigerous females, and 3.55 to 7.85 cm (mean: 5.62 ± 0.1 cm) in ovigerous females. The mean body weight of males, nonovigerous females, and ovigerous females was found as 129.35 ± 1.59 g, 66.13 ± 175 g, and 77.04 ± 3.63 g, respectively (Table 1). The mean CW and W were significantly different between males and females (t-test; $P < 0.05$).

The CW frequency distribution of the individuals is given in Figure 3. The highest number of crabs was observed in June whereas it was lowest in March (Table 2). The monthly variations in mean CW were significantly different (t-test; $P < 0.05$).

The CW–W and CL–W relationships were determined for the sexes (Figure 4). Values of b varied between 2.773 and 3.027. The highest correlation was determined between CL and W for female individuals ($R^2 = 0.973$; N = 317) (Figure 4). Deviations of b values from 3 were statistically significant (t-test; $P < 0.05$).

The mean C values were calculated as 39.72 for males and 37.31 for all females. The highest monthly C value was in March for males (40.6) and in July for females (39.06) (Figure 5). The mean C values of males and females were significantly different (t-test; $P < 0.05$).

Ovigerous females (N = 85) were observed only between May 2012 and August 2012 with the highest proportion in June (15.46%) (Figure 6A). Gonadosomatic index values declined from 16.24% in May to 8.31% in August and then ovigerous females were not observed. The spawning period occurred between May and August (Figure 6B).

CW of ovigerous females ranged between 4.45 and 7.18 cm. The fecundity of 31 ovigerous females ranged from 15,228 to 224,165 eggs/ind. with a mean value of 89,129 ± 8005 eggs/ind. The egg diameter ranged from 499.0 to 701.7 μm. The mean egg diameter was determined as 546.36 ± 18.62 μm for stage I eggs, 606.92 ± 15.92 μm for stage II eggs, and 570.96 ± 9.22 μm for stage III eggs (Table 3).

The relationship between F and CW was $F = 81.521CW^{2.650}$ ($R^2 = 0.357$), while between F and W it was $F = 556.23W^{1.163}$ ($R^2 = 0.368$) (Figure 7).

4. Discussion

The overall sex ratio of all individuals was calculated as 1:0.42 (M/F) with a significant deviation from the expected 1:1 ratio. The difference may result from its migration and water temperature. Males seem to be dominant compared with females according to the results of the present study. A similar sex ratio (1:0.43) was also reported for *E. verrucosa* from Karaburun by Erkan et al. (2008). Frequency distribution of CW of *E. verrucosa* suggests that the number of male individuals increases with increments of CW classes.

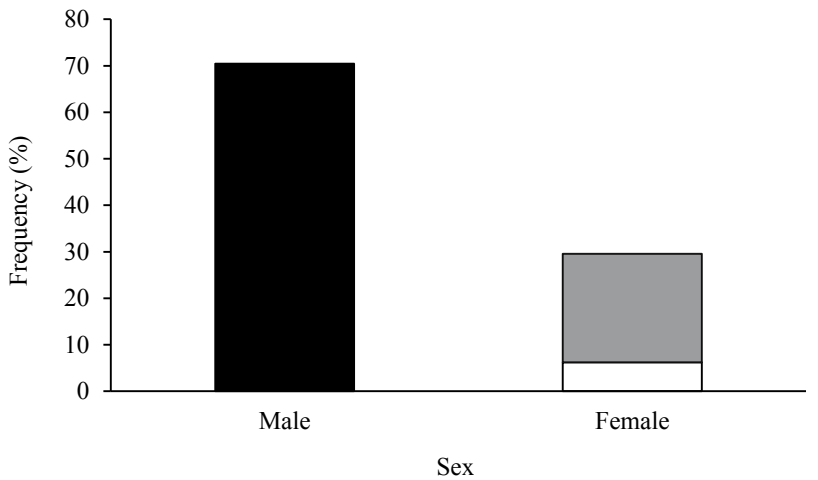

Figure 2. Sex ratio of males (black; N = 958), females (gray; N = 317), and ovigerous females (white; N = 85) of *E. verrucosa* from the study area.

Table 1. Mean, standard error, and range of warty crab (CL: carapace length; CW: carapace width; W: crab weight).

		CL (cm)	CW (cm)	W (g)
Males (958)	Mean	4.92	6.76	129.35
	Std. error	0.02	0.03	1.59
	Min.	2	3	4.07
	Max.	6.75	9	301.4
Nonovigerous females (317)	Mean	3.98	5.57	66.13
	Std. error	0.04	0.05	1.75
	Min.	2.45	3.45	16.33
	Max.	6.05	8.3	216
Ovigerous (85)	Mean	4.05	5.62	77.04
	Std. error	0.07	0.1	3.63
	Min.	2.55	3.55	19.15
	Max.	5.85	7.85	162.28
Total (1360)	Mean	4.64	6.40	111.26
	Std. error	0.02	0.03	1.43
	Min.	2	3	4.07
	Max.	6.75	9	301.4

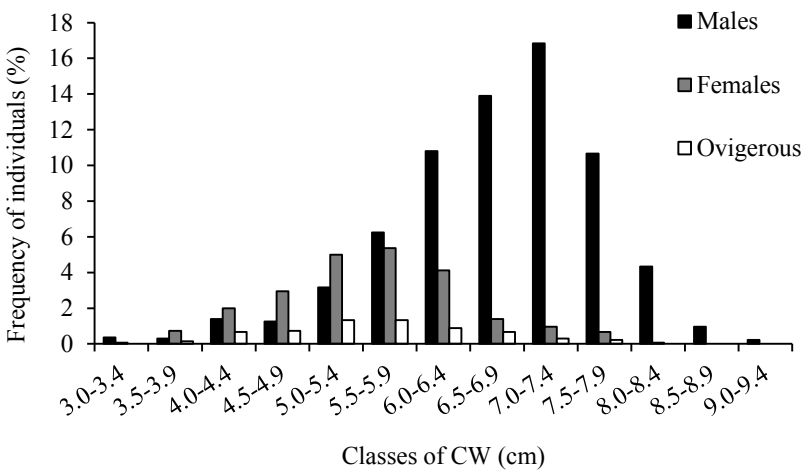

Figure 3. Carapace width (CW) frequency distribution of male (black), nonovigerous females (gray), and ovigerous females (white) of *E. verrucosa* collected from the study area between February 2012 and January 2013.

In this study, mean CL was determined as 4.92 cm for males and 3.98 cm for nonovigerous female crabs. Ulaş and Aydın (2011) reported the mean CL as 8.2 cm for males and 6.8 cm for female crabs collected from the Aegean Sea. The minimum recorded crab weight in the present study was 4.07 g, which was remarkably lower than the value of 74.6 g for *E. verrucosa* from the Aegean Sea (Ulaş and Aydın, 2011). Erkan et al. (2008) reported that the minimum and maximum CWs were 7.10 and 9.3 cm for male and 5.8 and 8 cm for female *E. verrucosa* specimens collected

Table 2. Monthly variations in carapace width of *E. verrucosa* collected from the study area (NF: nonovigerous females ;OF: ovigerous females).

		Month												
		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Total
N	Males	5	4	93	66	511	80	49	50	37	41	15	7	958
	NF	4	1	22	32	69	32	70	37	35	12	1	2	317
	OF	-	-	-	8	49	21	7	-	-	-	-	-	85
	Total	9	5	115	106	629	133	126	87	72	53	16	9	1360
Range (cm)	Males	4.75–7.25	6.8–7.3	4.9–8.55	4.9–8.2	3.0–9.0	3.15–8.7	3.85–8.4	4.2–9.0	5.2–8.4	5.4–8.85	4.8–7.5	5.0–6.6	3.0–9.0
	NF	4.05–6.0	-	4.45–7.95	3.65–7.1	3.8–8.3	3.45–7.3	4.05–7.15	4.2–7.5	4.8–7.3	3.6–6.2	-	4.3–4.9	3.45–8.3
	OF	-	-	-	4.9–6.65	4.0–7.85	3.55–6.52	4.4–6.5	-	-	-	-	-	3.55–7.85
	Total	4.05–7.25	6.3–7.3	4.45–8.55	3.65–8.2	3–9	3.15–8.7	3.85–8.4	4.2–9	4.8–8.4	3.6–8.85	4.3–7.5	4.3–6.6	3.0–9.0
Mean (cm)	Males	6.17	7.13	6.83	7	6.92	5.78	6.43	6.69	6.85	6.91	6.26	5.91	6.76
	NF	5.1	6.3	5.83	5.48	5.97	4.78	5.47	5.65	5.66	5.26	4.3	4.6	5.57
	OF	-	-	-	5.76	5.84	5.13	5.31	-	-	-	-	-	5.62
	Total	5.7	6.96	6.64	6.45	6.73	5.43	5.83	6.25	6.27	6.54	6.14	5.62	6.40
Std. error (cm)	Males	0.56	0.11	0.08	0.09	0.04	0.14	0.11	0.14	0.12	0.13	0.17	0.19	0.03
	NF	0.4	-	0.16	0.15	0.13	0.17	0.08	0.13	0.1	0.24	-	0.3	0.05
	OF	-	-	-	0.22	0.14	0.17	0.29	-	-	-	-	-	0.1
	Total	0.39	0.19	0.08	0.1	0.04	0.1	0.08	0.11	0.1	0.15	0.2	0.25	0.03

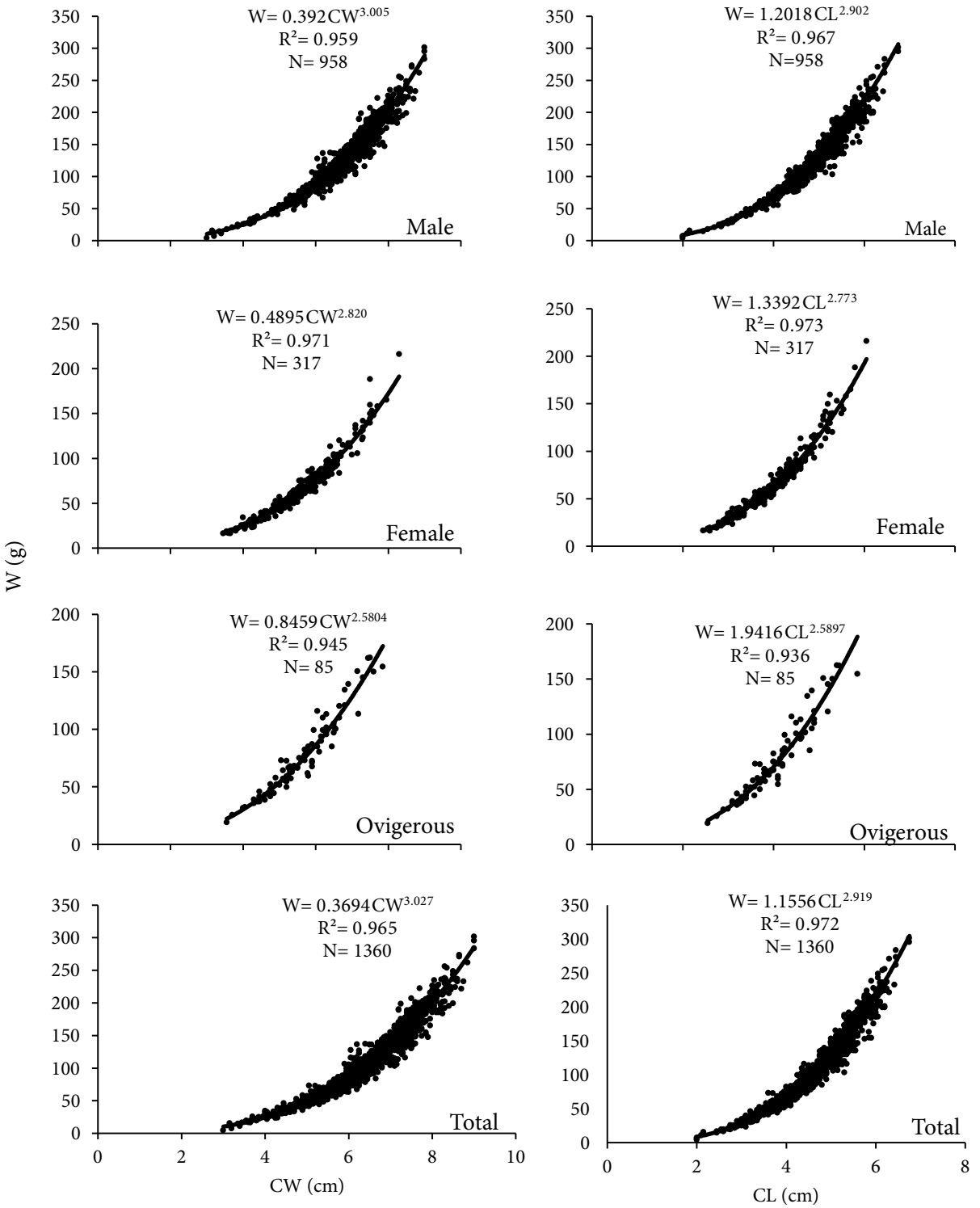

Figure 4. Nonlinear regressions between carapace width (CW) and carapace length (CL) and crab weight (W) for *E. verrucosa* from the study area.

from Karaburun, Black Sea. These differences between the studies could be due to the variations of sampling methods and sampling regions.

The highest correlation was determined between CL and W for females (R^2 = 0.973; N = 317). The CL–crab W relationships were determined as $W = 1.2018CL^{2.902}$

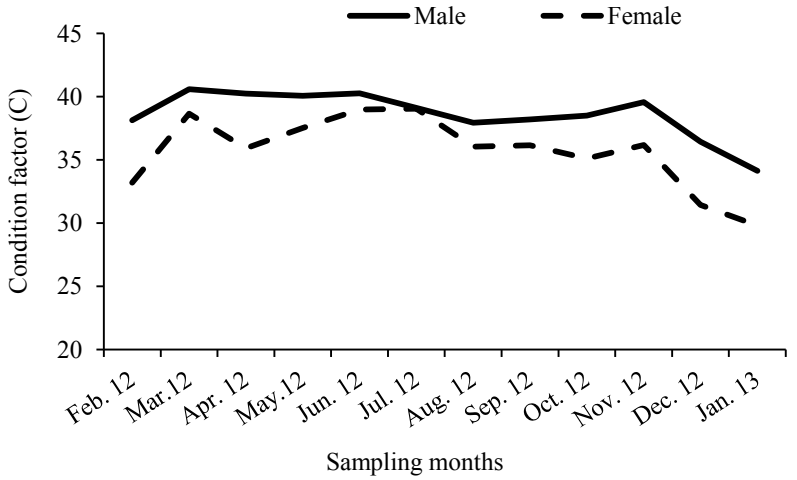

Figure 5. Monthly condition factor graph of the male (line) and female (dashed line) crabs.

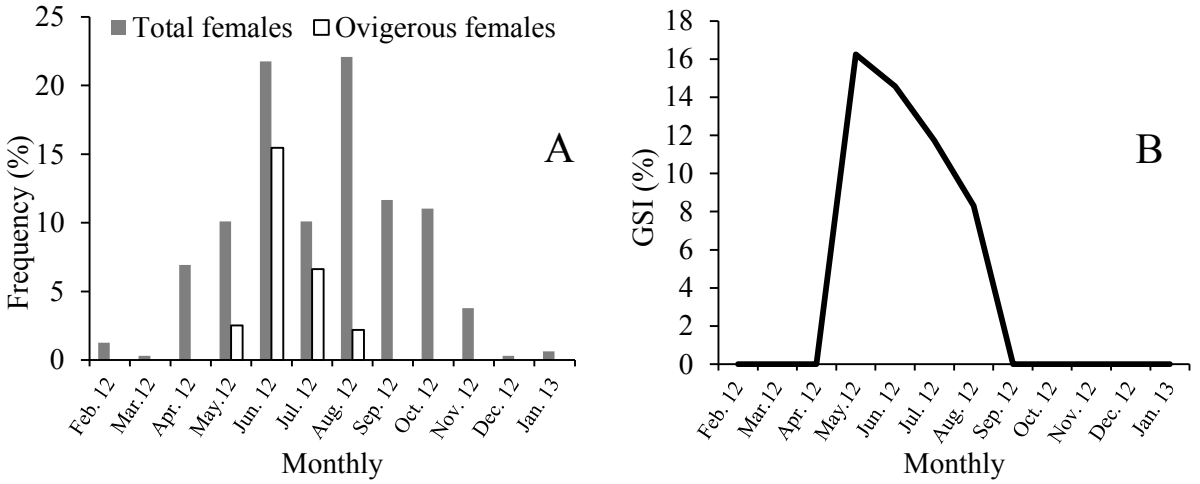

Figure 6. Monthly variations in number of female (gray) and ovigerous females (white) (A), and monthly changes of gonadosomatic index values (B) of *E. verrucosa*.

($R^2 = 0.9674$) for males and $W = 1.3392\ CL^{2.773}$ ($R^2 = 0.973$) for females. The CL–crab W relationships were reported as $W = 8.86\ CL^{0.4073}$ for males and $W = 15.02\ CL^{0.3228}$ for females by Ulaş and Aydın (2011) in the Aegean Sea for *E. verrucosa*. Compared with our findings, weaker correlation coefficients ($R^2 = 0.88$ and $R^2 = 0.63$ for males and females, respectively) were obtained by Ulaş and Aydın (2011). These discrepancies may have resulted from differences in study locations, water temperature, and salinity, as well as food availability.

Ovigerous females were observed only between May and August. The decrease in gonadosomatic index between May (16.24%) and August (8.31%) suggests that spawning takes place between these months. The number of eggs showed variations between developmental stages. Fecundity of 31 ovigerous females was calculated for stage I, stage II, and stage III as 111,054, 99,738, and 64,787 eggs/ind., respectively. A lower number of eggs was found in the more advanced embryonic stages for all sizes.

The F–CW and F–W relationships were determined as $F = 815.21CW^{2.651}$ and $F = 556.23W^{1.163}$, respectively. There were low correlations between fecundity with CW ($R^2 = 0.357$) and crab W ($R^2 = 0.368$) in this species, but they still suggest that fecundity increases with the size of crabs. This variation may result from environmental factors such as predation pressure or difficult weather conditions. Due to predators and weather conditions eggs can break off from the abdomen with time.

Mean egg diameter was 546.36 ± 18.62 μm for stage I, 606.92 ± 15.92 μm for stage II, and 570.96 ± 9.22 μm for

Table 3. Morphometric parameters, fecundity, and egg diameter of developing embryos (from stage I to III) of *E. verrucosa*.

	Stage	Number	Range	Average ± SE
Carapace width (cm)	I (yellow)	8	4.8–7.18	5.74 ± 0.32
Body weight (g)			44.66–113.32	71.32 ± 8.99
Egg diameter (μm)			499.0–663.2	546.36 ± 18.62
Egg number			64,772–165,242	111,054 ± 13,556
Carapace width (cm)	II (orange)	11	4.45–6.65	5.66 ± 0.21
Body weight (g)			45.89–110.0	77.64 ± 6.69
Egg diameter (μm)			541.6–701.7	606.92 ± 15.92
Egg number			15,229–224,165	99,738 ± 17,439
Carapace width (cm)	III (black)	12	4.7–6.52	5.56 ± 0.16
Body weight (g)			44.56–101.32	70.93 ± 4.64
Egg diameter (μm)			518.8–614.1	554.4 ± 8.41
Egg number			33,620–94,669	64,787 ± 5261
Carapace width (cm)	Total	31	4.45–7.18	5.65 ± 0.12
Body weight (g)			44.56–113.32	73.41 ± 3.68
Egg diameter (μm)			499.0–701.7	570.96 ± 9.22
Egg number			15,228–224,165	89,129 ± 8005

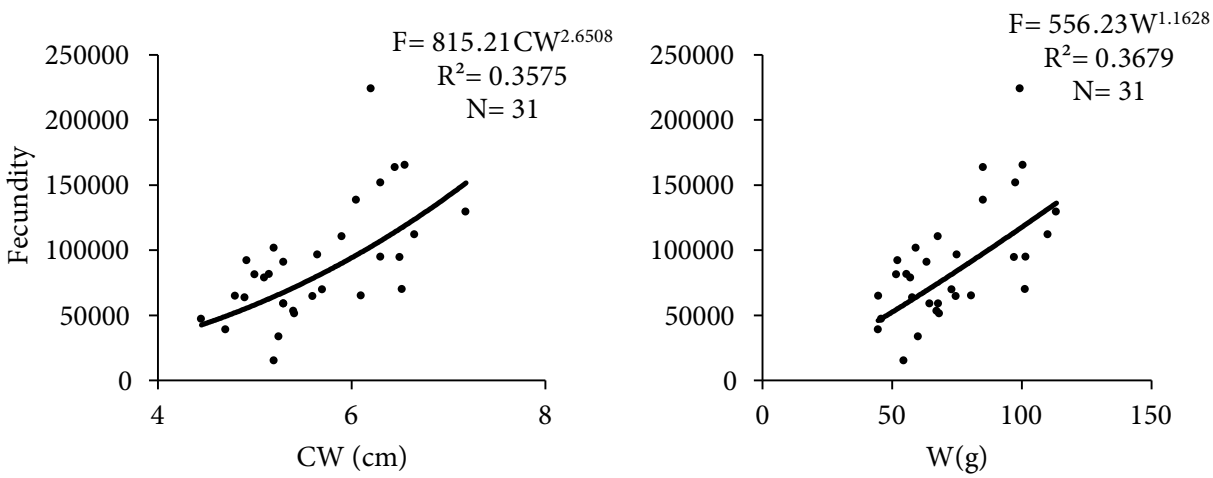

Figure 7. Fecundity–carapace width and fecundity–crab weight relationship of *E. verrucosa* (CW = carapace width; W = crab weight).

stage III eggs. Absence of a clear decreasing or increasing pattern in egg size with development stages may be a result of the limited number of ovigerous females available (N = 31).

During field work, young individuals were observed among the marine plants in November and December. This behavior could be a form of hiding for protection from predators. Various broken Mollusca shells (up to 3 cm), especially from *R. venosa*, were also observed around the crabs' living area, consistent with the findings of a previous study (Micu and Todorova, 2007).

Briefly, it is impossible for us to compare our present results with the literature due to the absence of prior studies in the Black Sea. The findings of this study, however, will

provide a starting point for future studies in the Black Sea on the fundamental biological characteristics of *E. verrucosa*.

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References

Abello P (1986). Analisi de les poblacions de crustacis decapodes demersales al litoral çatala: aspectes biologic sdelbraquiür *Liocarcinus depurator*. PhD, University of Barcelona, Barcelona, Spain (in Catalan).

Altinelataman C, Dinçer T (2007). Proximate composition and the freshness quality in refrigerator storage of the Warty Crab (*Eriphia verrucosa*, Forskål, 1775) meat. Arch Lebensmittelhyg 58: 132-135.

Ateş S (1997). A study on the decapod crustacean fauna of the coast of Gerze-Hamsaroz (Sinop). MSc, Ondokuz Mayıs University, Samsun, Turkey (in Turkish with English abstract).

Bagenal T (1968). Methods for Assessment of Fish Production in Fresh Waters. Oxford, UK: Blackwell Scientific.

Bakır AK, Katağan T, Aker HV, Özcan T, Sezgin M, Ateş AS, Koçak C, Kırkım F (2014). The marine arthropods of Turkey. Turk J Zool 38: 765-831.

Doğan A, Dağlı E, Özcan T, Bakır K, Ergen Z, Önen M, Katağan T (2007). Commercially important invertebrates inhabiting the Turkish seas. Turkish Journal of Aquatic Life 3-5: 36-44 (in Turkish with English abstract).

Dolgopolskaya MA (1969). Determination key of the fauna Black and Azov Seas, Vol. 2. Kiev, Ukraine: Kievskaya Liyana Fabrika.

Dumitrache C, Konsulova T (2009). *Eriphia verrucosa* Forskål, 1755. Black Sea Red Data Book. Nairobi, Kenya: United Nations Environment Programme.

Düzgüneş O, Kesici T, Gürbüz F (1983). İstatistik Metodları I. Ankara, Turkey: Ankara University Faculty of Agriculture Press (in Turkish).

Düzgüneş E, Selimoğlu AŞ, Mutlu C, Şahin C, Aydın M (1998). A preliminary study on the crab species existing on Trabzon coasts. In: The Proceeding of the First International Symposium on Fisheries and Ecology; Trabzon, Turkey.

Erkan M, Balkıs H, Kurun A, Tunalı Y (2008). Seasonal variations in the ovary and testis of *Eriphia verrucosa* (Forskål, 1775) from Karaburun, South Western Black Sea. Pak J Zool 40: 217-221.

Erkan M, Tunalı Y, Ekinci S, Kara S (2010). Histology of the androgenic gland in *Eriphia verrucosa* (Forskål, 1775) (Decapoda, Brachyura). Turk J Zool 34: 79-84.

FAO (2011). Yearbook of Fishery Statistics: Catch and Landing 2010. Rome, Italy: FAO.

Gonzalez-Gurriaran E (1985). Reproduccion de la necora *Macropipus puber* (Decapoda, Brachyura), y ciclo reproductivo en la Ria de Arousa. Bolerin del Instituto Espanol de Oceanografia 2: 10-32 (in Spanish).

Gönlügür G (2003). The qualitative and quantitative investigations on some facies of the upper-infralittoral zone of the Western Black Sea (Sinop) shores. PhD, Ege University, İzmir, Turkey.

Gunderson DR (1993). Surveys of Fisheries Resources. New York, NY, USA: John Wiley & Sons.

Holthuis LB (1961). Report on a collection of Crustacea, Decapoda and Stomatopoda from Turkey and the Balkans. Zoologische Verhandelingen 47: 1-67.

Jones CM, McConaugha JR, Geer PJ, Prager MH (1990). Estimation of spawning stocks size of blue crab, *Callinectes sapidus*, in Chesapeake Bay, 1986-1987. B Mar Sci 46: 159-169.

Kaya Y, Turan H, Erdem ME (2009). Determination of nutritional quality of warty crab (*Eriphia verrucosa* Forskål, 1775). J Anim Vet Adv 8: 120-124.

Kocataş A (1981). Liste préliminaire et répartition des Crustacés Décapodes des eaux Turques. Rapp Comm Int Mer Medit 27: 161-162 (in French).

Kocataş A, Katağan T (2003). The Decapod Crustacean fauna of the Turkish Seas. Zool Middle East 29: 63-74.

Le Cren ED (1951). The length-weight relationships and seasonal cycle in gonad weight and condition in perch (*Perca fluviatilis*). J Anim Ecol 20: 210-219.

Manning RB, Holthuis LB (1981). West African brachyuran crabs (Crustacea: Decapoda). Smithsonian Contributions in Zoology 306: 1-379.

Micu D, Todorova V (2007). Biodiversity of the Western Black Sea. Mar BEF Newsletter 7: 26-28.

Oh CW, Hartnoll RG (2004). Reproductive biology of the common shrimps *Crangon crangon* (Decapoda: Crangonidae) in the central Irish Sea. Mar Biol 144: 303-316.

Parsons R (1988). Statistical Analysis: A Decision-Making Approach. New York, NY, USA: Harper and Row Publishers.

Prager MH, McConaugha JR, Jones CM, Geer PJ (1990). Fecundity of blue crab *Callinectes sapidus*, in Chesapeake Bay: biological, statistical and management consideration. B Mar Sci 46: 170-179.

Ricker WE (1973). Linear regressions in fishery research. J Fish Res Board Can 30: 409-434.

Rossi AC, Parisi V (1973). Experimental studies of predation by the crab *Eriphia verrucosa* on both snail and hermit crabs occupants of conspecific gastropod shells. B Zool 40: 117-135.

Sokal RR, Rohlf FJ (1969). Introduction to Biostatistics. New York, NY, USA: W.H. Freeman and Company.

Sparre P, Venema SC (1992). Introduction to Tropical Fish Stock Assessment, Part I. FAO Fisheries Technical Paper 306/1. Rome, Italy: FAO.

TÜİK (2014). Fishery Statistics 2011. Ankara, Turkey: Turkish Statistical Institute.

Ulaş A, Aydın C (2011). Length-weight relationships of *Eriphia verrucosa* Forskål, 1775 from the Aegean Sea. J Anim Vet Adv 10: 1061-1062.

Wenner EL (1989). Incidence of insemination in female blue crabs, *Callinectes sapidus*. J Crustacean Biol 9: 587-594.

Zariquiey AR (1968). Crustaceos Decapods ibericos. Invest Pesq 32: 1-510 (in Spanish).