Pakistan J. Zool., vol. 45(6), pp. 1615-1622, 2013

Length-Weight Relationship and Reproductive Features of the Mediterranean Green Crab, *Carcinus aestuarii* Nardo, 1847 (Decapoda: Brachyura) in the Eastern Black Sea, Turkey

Mehmet Aydin
Faculty of Marine Sciences, Ordu University, 52400, Fatsa, Ordu, Turkey

Abstract. The length/width-weight relationships and reproductive traits of *Carcinus aestuarii* Nardo, 1847 caught from Ordu, the Eastern Black Sea, Turkey were assessed in this study. A total of 565 specimens were analyzed (286 males and 279 females) and their carapace width (CW) ranged from 1.25 to 8.55 cm in males and from 2.1 to 9.2 cm in females. The carapace length (CL) oscillated from 1.0 to 6.6 cm in males and 1.4 to 7.0 cm in females. Relationships between carapace length and weight, and between carapace width and weight were found as $W=0.574\ CL^{2.95}$ (r=0.97) and $W=0.213\ CW^{3.117}$ (r=0.95), respectively. The overall sex ratio of males to females was 1:1.02. The average number and diameter of eggs were 272 162.8 and 420 µm. The present findings will make an important contribution to the knowledge of growth and reproduction of the species *C. aestuarii* in the Eastern Black Sea.

Key words: Growth, reproduction**,** Mediterranean green crabs, *Carcinus aestuarii*

INTRODUCTION

Carcinus aestuarii Nardo, 1847 belongs to the family *Portunidae* and its original habitat is the estuarine and lagoon waters in the Mediterranean Sea (Mori *et al.*, 1990; Yamada and Hauck, 2001; Chen *et al*., 2004; Ozcan *et al.*, 2009). The species is widely distributed from Atlantic Ocean (Fischer *et al.*, 1987) to the Black Sea and Sea of Azov (Yamada and Hauck, 2001; Bilgin and Çelik, 2004; Chen *et al.*, 2004). *C. aestuarii* populations are resistant to highly variable environmental conditions (Abelló *et al*., 1997). The brachyuran crab genus *Carcinus* consists of two species, *Carcinus maenas* Linnaeus, 1758 and *Carcinus aestuarii* Nardo, 1847. The former is a global invasive marine species with several life history characteristics including a long-lived pelagic larval phase which favor its dispersal and establishment in a wide range of ecosystems (Yamada and Hauck, 2001; Carlton and Cohen, 2003). *C. aestuarii* is also an invasive crab which has been introduced to Japan and South Africa (Yamada and Hauck, 2001; Carlton and Cohen, 2003; Chen *et al*., 2004).

C. aestuarii can be distinguished from other crabs by its fan-shaped carapaces, five sharp teeth at anterio-lateral region behind the eyes and 3 lobs between orbitals (Yamada and Hauck, 2001). Dorsal surface of the carapace is highly flat and granulated and its width is longer than the length. Its colors are dark green and brown, and they have semicircle-shaped bands at both sides of the carapace which are formed by white spots (Bilgin and Çelik, 2004). *C. maenas* and *C. aestuarii*, can generally be distinguished in the field by three diagnostic characteristics: the shape of the copulatory appendages (pleopods) in the male, the shape of the frontal area between the eyes, and the carapace width to length ratio (Yamada and Hauck, 2001).

C. aestuarii individuals reach the sexual maturity within one year. Its feeding type is omnivorous-predator and has a high survival rate. *C. aestuarii* diet varies depending on the existence of local species in intertidal zone (Yamada and Hauck, 2001; Chen *et al.*, 2004, Tepolt *et al.*, 2006). This species interacts with the benthic fauna and may negatively affect the environment they live (Chen *et al.*, 2004). Therefore, from a sustainable ecosystem management perspective, it appears that studying the biology of the crap species which have significant impacts on the epibenthic ecosystems is highly critical.

Some studies have been conducted on this species in Aegean and Mediterranean regions. The studies in the Aegean Sea have dealt with male to female ratio and some morphometric characteristics

* Corresponding author: maydin69@hotmail.com
0030-9923/2013/0006-1615 $ 8.00/0

of the species (Can *et al*. 2004, 2007; Koçak *et al*., 2011). Another study in Homa Lagoon, the Aegean Sea investigated the reproductive features of the species (Ozbek *et al*., 2012). But there is no study about the growth and reproductive characteristics of *C. aestuarii* in the Black Sea. Therefore, this study was planned to reveal the reproductive and growth properties of this species in the Eastern Black Sea.

MATERIALS AND METHODS

This study was carried out in the Eastern Black Sea region from February 2011 to June 2012 including 6 localities situated in the study area (41° 37' 18" N-37° 22' 26" E) and (40° 58' 35" N-38° 02' 58" E)) (Fig. 1). The crabs were collected as discard products from artisanal fishery (gillnets and trammel nets) and by scuba divers. Crabs were wet weighed (W) in the laboratory with a digital scale (0.001g) and the carapace length (CL) and width (CW) were measured with a digital caliper (1 mm). Their sexes were determined and then sex ratio of the population was analyzed using Chi-square test (χ^2).

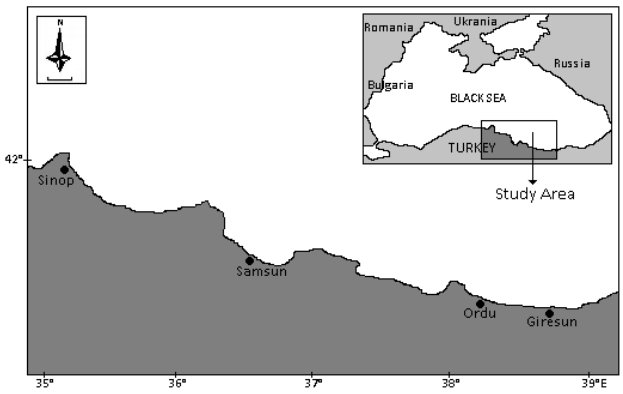

Fig. 1. The map of study area.

The variations in the W with respect to CL were determined by allometric growth equation: $Y = a X^b$ (Quiles *et al.,* 2001). Growth equation was separately calculated for both sexes and using the CL and CW. The parameters *a* and *b* in CL/CW-W relationship were estimated by regression analysis using the method of least square.

Gonad maturation stages were determined by macroscopic observations (Wenner, 1989). In order to obtain the data related to reproductive biology, the pleopod eggs were removed from female and the total weight of eggs were measured by a balance with a sensitivity of 0.0001 g. Then, sub-samples were randomly taken from different areas and weighed. The eggs were counted over a glass slide after dripping 30% glycerin over the samples to separate the eggs. The number of eggs was calculated by gravimetric method via the equation $F=n*(W_0/X)$, where F represents the number of eggs, X stands for sub-sample weight (g), W_0 denotes the weight of ovary and n represents the number of eggs in the sample. Moreover, diameters of randomly selected 50 eyed-egg were measured for each subsample by a stereo microscope with an ocular micrometer (Jones *et al.*, 1990; Prager *et al.*, 1990). The relationships among the variables were identified using the regression analysis. The best appropriate model was selected based on R^2 value (Ulaş and Aydın, 2011). Statistical analysis were carried out using the Excel and SPSS v.19.

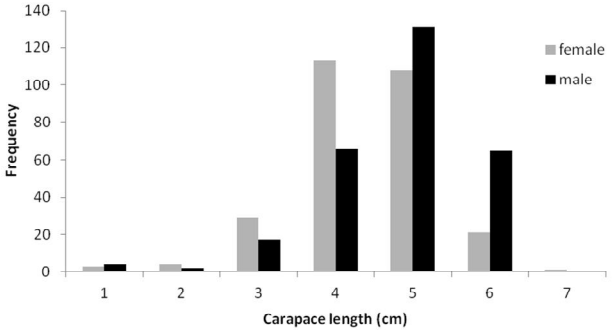

Fig. 2. Size frequency distributions of *C. aestuarii* for male and female

RESULTS

A total of 565 crabs were caught over the study period. Total number of males and females were 286 and 279. The overall ratio of females to males was 1:1.02. The observed sex ratio was not significantly different from the equality. (χ^2=0.0867; d.f. =1; $p < 0.05$).

The distribution of specimens according to sexes is presented in Figure 2. Females were longer than males among the individuals with CL less than

4 cm whereas males were larger than females in specimens with longer carapace.

Basic statistical values related to the biometric measurements belonging to Mediterranean green crab are given in Table I. Minimum W was found in the males with 0.76 g whereas maximum W was 172 g in the females. Minimum and maximum CW for all individuals were 1.25 and 9.2 cm respectively.

Table I.- Mean and standard deviation (SD) for carapace length (CL), carapace width (CW) and weight (W) parameters of each sex of *Carcinus aestuarii* Nardo, 1847 in Ordu (Turkish Black Sea)

Sex	Parameters		
	CL (cm) ± SD	CW(cm) ± SD	W (g) ± SD
Female	4.8 ± 0.8 (1.4 - 7)	6.09 ±1 (2.1 - 9.2)	61.54 ± 29.5 (1.8 - 172)
Male	5.24 ± 0.9 (1 - 6.6)	6.61 ± 1.15 (1.25 - 8.55)	86.9 ± 38.5 (0.76 - 164.4)
Male and Female	5.02 ± 0.9 (1 – 7)	6.35 ± 1.1 (1.25 – 9.2)	74.38 ± 36.6 (0.76 – 172)

Table II.- Parameters of the relationship among weight (W) and carapace length (CL), W and carapace width (CW) and CL and CW of each sex for *Carcinus aestuarii* Nardo, 1847 from Ordu (Turkish Black Sea).

	Male (n=286)	Female (n=279)	Combined (n=565)
$W=a\ CL^b$			
a	0.595	0.628	0.574
b	2.954	2.873	2.954
R^2	0.976	0.955	0.966
P value	P<0.01	P<0.01	P<0.01
$W=a\ CW^b$			
a	0.235	0.218	0.213
b	3.081	3.078	3.117
R^2	0.963	0.942	0.954
P value	P<0.01	P<0.01	P<0.01
CL=b CW+a			
a	0.324	0.279	0.306
b	1.201	1.210	1.205
R^2	0.940	0.996	0.950
P value	P<0.01	P<0.01	P<0.01

*R^2, coefficient of determination.

The relationships of W with CL and CW are exponential, whereas this relationship is linear between CL and CW (Table II). All the relations were highly strong, being higher than 0.94. The b values between CL and W for males, females and all specimens were below 3, while those between CW and W were above 3.

Regression analyses between CW, CL, and W for males, females, and both sexes combined are presented in Figure 3 and 4, which show a high positive linear relationship between these variables. The weight-carapace width relationship indicated positive allometric growth for combined sex and isometric growth for male and female. The correlation coefficient values (CL-W and CW-W) for males were higher (0.976 and 0.963 *vs* 0.955 and 0.942) than females and combined sex (Figs. 3, 4), probably due to the presence of 17 individuals with eggs. A strong relationship (R^2=0.956) was also found between CL and CW for female (Fig. 5).

The CW and CL ratio is given in Table III. The ratio varied between 0.76 and 1.47 without any noticeable difference between the sexes. However, there was a descending trend in the ratio with the increase in length classes.

Table III.- The ratios of carapace width (CW) to carapace length (CL) for various sizes of males(M) and females(F).

Size groups	CW/CL (F+M)(N)	CW/CL (F)(N)	CW/CL (M)(N)
10-20 mm	1.47 (7)	1.49 (3)	1.45 (4)
20-30 mm	1.37 (6)	1.39 (4)	1.35 (2)
30-40 mm	1.28 (46)	1.29 (29)	1.27 (17)
40-50 mm	1.27 (179)	1.27 (113)	1.27 (66)
50-60 mm	1.26 (240)	1.25 (108)	1.27 (131)
60-70mm	1.25 (86)	1.28 (21)	1.24 (65)
70>	0.76 (1)	0.76 (1)	-----

*N, number.

Of 279 females obtained during the study, 18.6 % had eggs and their CLs ranged from 2.65 to 6.9 cm. Fecundity was estimated by counting the mature eggs sub-sampled from 17 berried females (Avg. CW: 6.6±1.5 cm, Min: 3.6 cm Max: 9.1cm). Eyed eggs were taken into account in fecundity estimation and the number of eggs/g gonad and egg batch weight (g) were determined (Table IV). Minimum and maximum egg batch weight were 5.6 and 17.9 g respectively. The average number of eggs was were estimated as 24 016/g gonad.

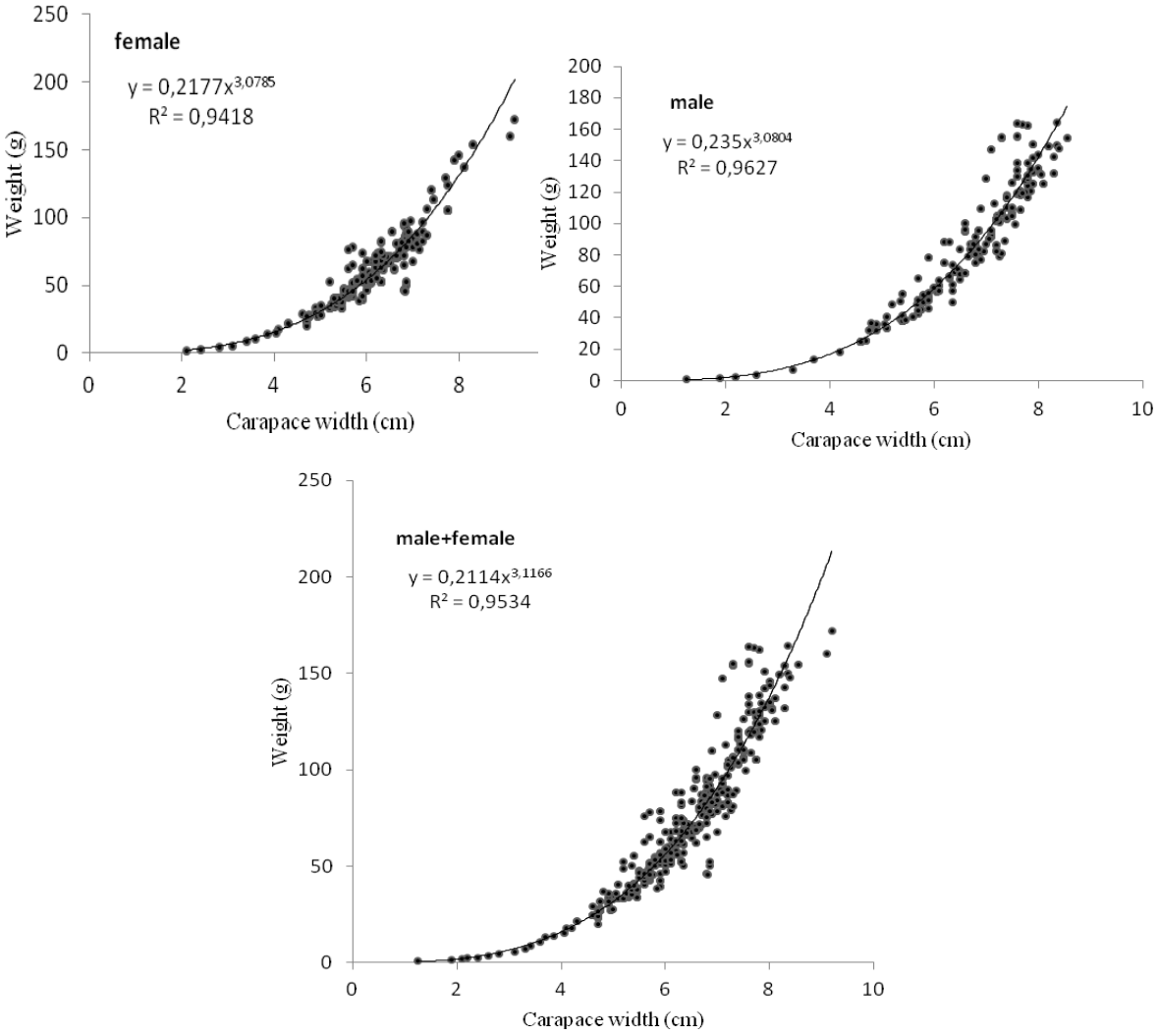

Fig. 3. The relationship between carapace width (CW) and weight (W) for *Carcinus aestuarii* Nardo, 1847 from Ordu (Turkish Black Sea).

There was a positive linear relationship (R^2=0.84) between the number of eyed eggs and CL ($P< 0.05$). A higher number of individuals carrying eyed eggs were observed in May (Fig. 6). There was also a strong positive relationship between CL and egg diameter with an R^2 value of 0.94 (Fig. 7) ($P< 0.05$).

DISCUSSION

` In this study, length-weight relationships and reproductive properties of Mediterranean green crab (*Carcinus aestuarii*) from the Eastern Black Sea coasts (Ordu) of Turkey were determined. In agreement with the findings of Can *et al.* (2004), who studied *C. aestuarii* populations in Cakalburnu lagoon (the Aegean Sea), we determined a sex-ratio of 1:1.02. On the other hand, Ozcan *et al.* (2009) reported that male proportion was higher than females with a sex ratio of 1:5.50 in Homa lagoon (Aegean Sea). The inconsistent results could be due the differences in study locations (*e.g.* a closed lagoon in the latter case vs. costal waters in our study) and sampling methods. Indeed, Ozcan *et al.* (2009) used the passive sampling systems during a period when the males were more active than the females, which could lead to the much higher male ratio. Can *et al.* (2004) recorded that female and male CLs varied between 0.6 and 4.2 and between

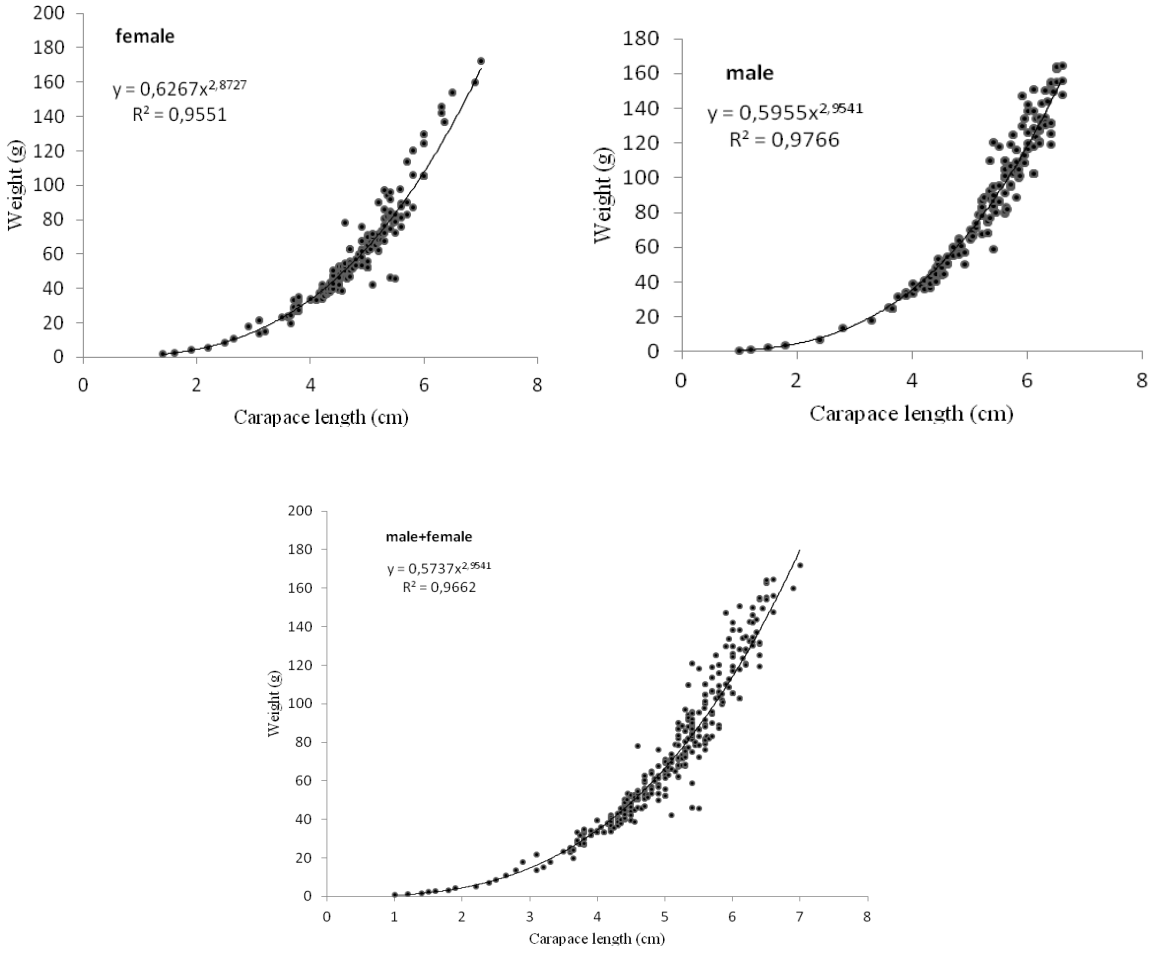

Fig. 4. The relationship between carapace length (CL) and weight (W) for *Carcinus aestuarii* Nardo, 1847 from Ordu (Turkish Black Sea).

0.5 and 5.2 cm respectively. In a latter study, Can *et al.* (2007) found CLs of *C. aestuarii* species varied between 0.9 and 3.8 cm for females (an average of 2.6 cm) and 0.5 and 4.8 cm for males (an average of 3.1 cm) in Aegean Sea. More recently, Ozcan *et al.* (2009) reported that the CW variation was 2.08 and 5.21 cm for males and 1.99 and 4.07 cm for females, respectively in Homa lagoon in Aegean Sea. In the same lagoon (Homa), Kocak *et al.* (2011) stated average CLs for male and female individuals as 4.46 and 2.91 cm, respectively. In the present study, CLs of females and males varied between 1.4 and 7 cm (average of 4.8 cm) and 1 and 6.6 cm (average of 5.24 cm), respectively. Ozcan *et al.* (2009) reported that CLs ranged from 1.68 to 4.24 cm whereas Kocak *et al.* (2011) reported CLs for females and males as 3.96 and 5.16 cm, respectively. However, in our study CLs varied between 1.4 and 7 cm for females, and 1 and 6.6 cm for males. There are differences in average CLs between ours and the previous studies. These observed discrepancies might be either resulted from, once again, different sampling methods or locations hosting varying types of populations *e.g.* more young individuals in lagoons from Aegean Sea (Can *et al.*, 2007). Lagoon systems are breeding and growing areas of a great number of species. So, densities of young and mature individuals can typically and drastically change depending on the seasons (Healy, 1997; Can *et al.*, 2007).

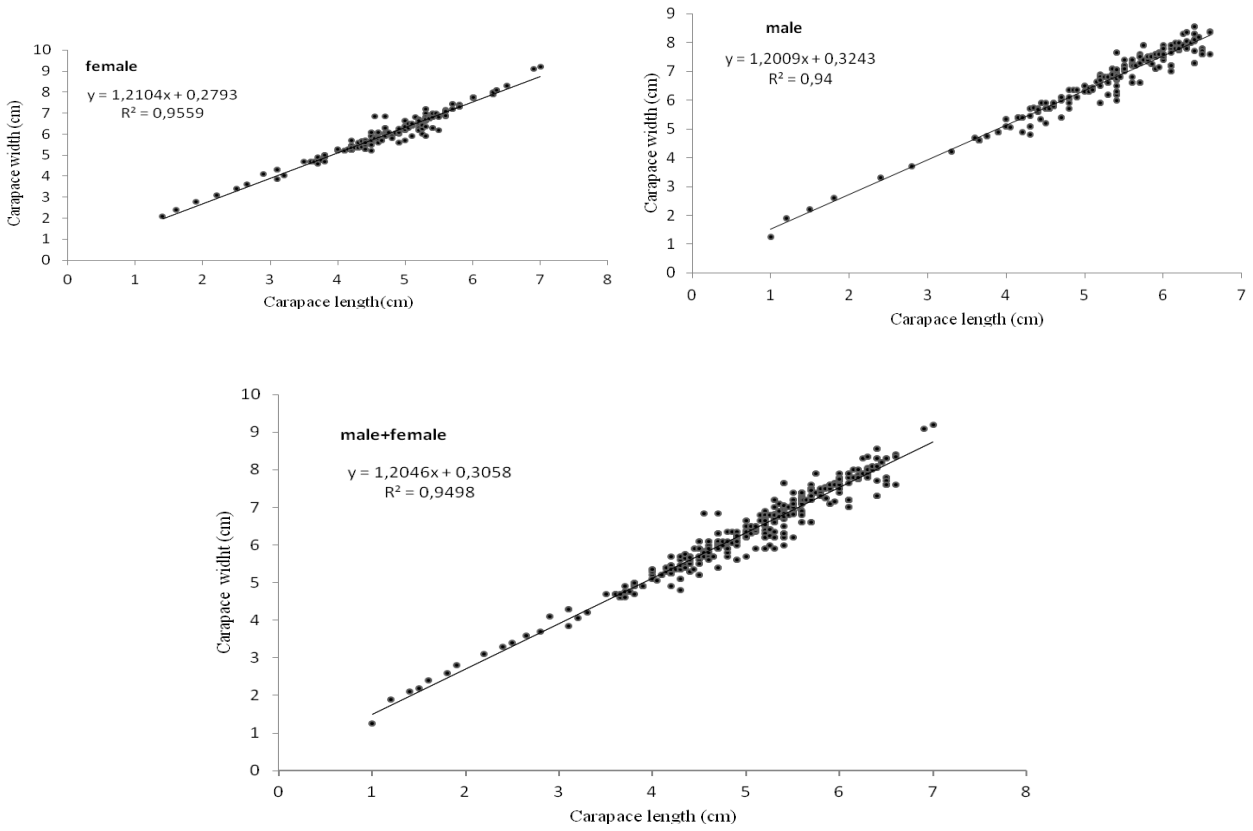

Fig. 5. The relationship between carapace length and carapace width for *Carcinus aestuarii* Nardo, 1847 from Ordu (Turkish Black Sea).

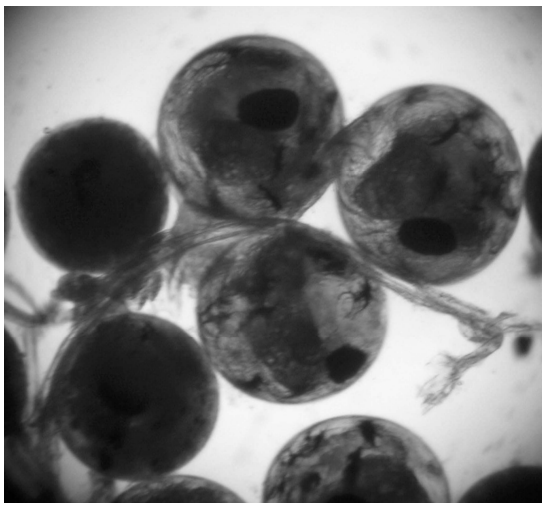

Fig. 6. Eyed egg stage of crab of *Carcinus aestuarii* Nardo, 1847 from Ordu (Turkish Black Sea).

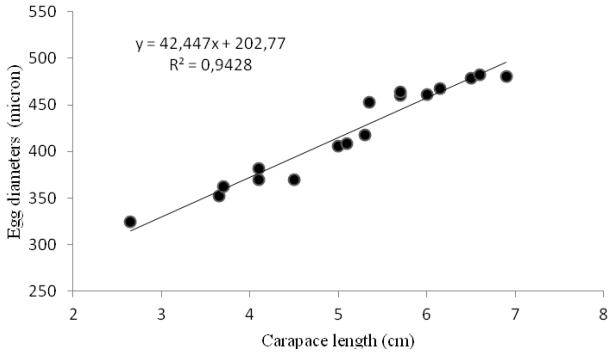

Fig. 7. The relationship between carapace length and egg diameter for *Carcinus aestuarii* Nardo, 1847 from Ordu (Turkish Black Sea).

The ratio of CW to CL ranged from 0.76 to 1.46 in the current study. Yamada and Hauck (2001) reported a ratio of < 1.27 for adult crabs, which is within the range of our findings.

In this study, the minimum, maximum and average weights of females were determined as 1.8, 172 and 61.54 g, respectively and of males as 0.76, 164.4 and 86.9 g, respectively. Ozcan *et al.* (2009) reported the weights in the same order as 2.24, 41.32 and 17.6 g for males and 2.35, 19.08 and 8.45 g for females. Our findings are much higher than those in the previous work, supporting that Ozcan *et al.* (2009) sampled the young individuals more intensively in the lagoon system.

Table IV.- Fecundities of 17 berried females crabs, *Carcinus aestuarii* Nardo, 1847 from Ordu (Turkish Black Sea), with their respective carapace width (CW), carapace length (CL), body weight (W), egg numbers /g gonad, and egg batch weight (EBW).

Carapace width (CW) (mm)	Carapace length (CL) (mm)	Body weight (W) (g)	Eggs numbers /1g	Egg batch weight (EBW) (g)
3.6	2.65	11.3	32 124.90	5.6
4.7	3.65	24	29 235.20	7.5
4.9	3.7	32.4	27 925.30	9.2
5.2	4.1	33.17	26 879.70	8.86
5.2	4.1	35.1	28 652.6	9.54
5.5	4.5	46.54	30 962.96	7.8
6.4	5	71.1	27 735.85	13.55
6.45	5.1	69.73	23 770.50	9.1
6.8	5.3	75.23	22 954.55	10.2
6.8	5.35	94.3	21 764.71	14.9
7.2	5.7	89.92	20 400.20	12.04
7.2	5.7	92.3	20 370.37	12.7
7.4	6	134.2	18 378.38	14.5
8	6.15	138.9	18 004.90	16.2
8.6	6.5	165.4	19 700.40	15.8
8.6	6.6	172.4	20 200.10	17.3
9.1	6.9	180.7	19 212.40	17.9

Can *et al.* (2007) determined b values of CL/CW-W relationships as 2.30-2.92 for males and 2.66-2.81 for females. Ozcan *et al.* (2009) presented CL/CW- W relationships as $W=0.0002\ CW^{3.086}$ and $W=0.0005\ CL^{3.053}$ for males and as $W=0.0003CW^{2.934}$ for females and $W=0.0007\ CL^{2.881}$ for both sexes. Kocak *et al.* (2011) claimed the relationship between CW and W as 2.91 and 2.89 for males and females, respectively. In our study, CW-W relationship was found as $W=0.235CW^{3.08}$ for males and $W=0.218\ CW^{3.078}$ for females. The relationship between CL and W was found as $W=0.595\ CL^{2.95}$ for males and $W=0.628\ CL^{2.87}$ for females. Our *b* values from CW-W and CL-W relationship demonstrated positive allometric growth for males and females. The growth parameters in our study are higher than those of the former studies. The regional differences may present spatial variations in the b values as a result of the influence of water quality or food availability for crabs (Mutlu *et al.*, 1992; Kucuksezgin *et al.*, 1995). Observed differences can also be due to the different sampling methods, sampling season, habitat or diet as well as stomach fullness (Bagenal and Tesch, 1978; Sparre *et al.*, 1989; Erkan *et al.*, 2008).

Average number of eggs, batch weight and egg diameter were determined as 272162.8 (min:179 899.4, max:375 820.8, STD:53 396), 11.9 g (min:5.6, max:17.9, STD:3.8) and 420 µm, (min:324.6, max:482, STD:52), respectively. Ozbek *et al.* (2012) reported an average egg number per individual with 2.8 cm CL as 42 201(min; 6 000, max; 126 969). Our findings of egg number per individual with 6.6 cm CL are much higher than those reported by the later study due to the size effect.

A strong relationship was determined between CL and the egg diameters ($R^2=0.94$) in the present study, which is the first record about the fecundity and egg diameters of this species. However, studies in other crabs species with similar size like *Callinectes amnicola* reported an egg diameter of 290 µm (Lawal-Are, 2010). Another study on a smaller crab speicies *Liocarcinus navigator* caught from the Black Sea determined the egg diameter as 347.2 µm (Aydın *et al.*, 2012).

In conclusion, the present study indicated that *C. aestuarii* population in the Black Sea costs had a bigger size as well as higher growth parameters and fecundity compared with those in the Aegean Sea coasts of Turkey. Although this investigation is the first attempt to explore the biology of *C. aesturaii* in the Eastern Black Sea. Further detailed studies that will deal with the biology and reproduction of the species over a year round are required to sustain healthy benthic ecosystems

REFERENCES

ABELLÓ, P., AAGAARD, A., WARMAN, C.G. AND DEPLEDGE, M.H., 1997. Spatial variability in the population structure of the shore crab *Carcinus maenas* (Crustacea, Brachyura) in shallow water tidal fjord. *Mar. Ecol. Prog. Ser*., **147**:97-103.

AYDIN. M., KARADURMUS, U. AND ERBAY, M., 2012. Length-weight relationships and reproduction characteristics of *Liocarcinus navigator* (Herbst, 1794). *Ege J. Fish. aquat. Sci*., **29**: 193-197.

BILGIN, S. AND ÇELIK, E.Ş., 2004. The Crabs of the Sinop Coasts of the Black Sea (Turkey). *Sci. Eng. J Fırat Univ.*, **16**: 337-345.

BAGENAL, T.B. AND TESCH, F.W., 1978. Age and growth. In: *Methods for assessment of fish production in fresh waters* (ed. T. Bagenal), IBP handbook 3. Blackwell Scientific Publications. Oxford, pp. 101-136.

CAN, E., TIRAŞIN, E.M. AND CIHANGIR, B., 2004. An Investigation of the crab *Carcinus aestuarii*, (Nardo, 1847) in the Çakalburnu Lagoon. *Turkish J. aquat. Life*, **2**: 77-84.

CAN, E., TIRAŞIN, E.M., CIHANGIR, B. AND YILMAZ, U., 2007. Weight-carapace width relationship of the Mediterranean green crab (*Carcinus aestuarii*, Nardo 1847) in Cakalburnu Lagoon, Izmir Bay. *Rapp. Comm. Int. Mer. Médit*., **38**: 443.

CARLTON, J.T. AND COHEN, A.N., 2003. Episodic global dispersal in shallow water marine organisms: the case history of the European shore crabs *Carcinus maenas* and *C. aestuarii*. *J. Biogeogr*., **30**:1809-1820.

CHEN, R.B., WATANEBE, S. AND YOKOTA, M., 2004. Feeding habits of an exotic species, the Mediterranean green crab *Carcinus aestuarii*, in Tokyo Bay. *Fish. Sci*, **70**:430-435.

ERKAN, M., BALKIS, H., KURUN, A. AND TUNALI, Y., 2008. Seasonal variations in the ovary and testis of *Eriphia verrucosa* (Forskal, 1775) (Crustacea: Decapoda) from Karaburun, SW Black Sea (SC). *Pakistan J. Zool.*, **40**: 217-221.

FISCHER, W., SCHNEIDER, M. AND BAUCHOT, M.L., 1987. *Méditerranée et Mer Noire (Zone de Pêche 37). Fiches FAO d'identification des espèces pour les besoins de la pêche*, pp. 1530.

HEALY, B., 1997. Long-term changes in A Brackish lagoon, Lady's Island Lake, South-East Ireland. *Biol. Environ. Proc. R. Ir. Acad., B*, **1**: 33-51.

JONES, C.M., CONAUGHA, J.R., GEER, P.J. AND PRAGER, M.H., 1990. Estimation of spawning stocks size of blue crab, *Callinectes sapidus*, in Chesapeake Bay, 1986-1987. *Bull. Mar. Sci.*, **46**: 159-169.

KOÇAK, C., ACARLI, D., KATAĞAN, T. AND ÖZBEK, M., 2011. Morphometric characters of the Mediterranean green crab (*Carcinus aestuarii* Nardo, 1847) (Decapoda, Brachyura) in Homa Lagoon, Turkey. *Turk. J. Zool*., **35**:551-557.

KUCUKSEZGIN, F., BALCI, A., KONTAS, A. AND ALTAY, O., 1995. Distribution of nutrients and chlorophyll-a in the Aegean Sea. *Oceanol. Acta*, **18**: 343-352.

LAWAL-ARE, A.O., 2010. Reproductive biology of the blue crab, C*allinectes amnicola* (DeRocheburne) in the Lagos Lagoon, Nigeria. *Turkish J. Fish aquat. Sci.*, **10**: 1-7.

MORI, M., MANCONI, R. AND FANCIULLI, G., 1990. Notes on the reproductive biology of *Carcinus aestuarii* Nardo (Crustacea, Decapoda) from the lagoon of San Teodoro (Island of Sardinia, Italy). *Riv. Idrobiol*., **29**: 763–774.

MUTLU, E., ÜNSAL, M. AND BINGEL, F., 1992. A preliminary view on the faunal assemblage of soft-bottom crustaceans along the near shores of the Turkish Black Sea. *Acta Adriat*., **3**: 177-189.

ÖZBEK, M., KOÇAK, C. AND ACARLI, D., 2012. Reproductive biology of the Mediterranean green crab *Carcinus aestuarii* Nardo, 1847 (Crustacea, Brachyura, Portunidae) in Homa Lagoon, Aegean Sea, Turkey. *Oceanol. Hydrobiol. St.*, **41:** 77-80.

OZCAN, T., BAKIR, K. AND KATAĞAN, T., 2009. Length/width-weight relationships of the Mediterranean Green Crab *Carcinus aestuarii* Nardo, 1847 in the Homa Lagoon, Aegean Sea Turkey**.** *J. Fish.Sci.com.*, **3**:1-4.

PRAGER, M.H., McCONAUGHA, J.R., JONES, C.M. AND GEER, P.J., 1990. Fecundity of blue crab, *Callinectes sapidus*, in Chesapeake Bay: Biological, statistical and management considerations. *Bull. Mar. Sci*., **46**: 170-179.

QUILES, J.A., RICO, V., TUSET, V.M., SANTANA, J.I. AND GONZALES, J.A., 2001. Notes on the biology of *Cancer bellianus* (Brachyura,Cancridae) around the Canary Islands. *Hydrobiologia*, **449**:193-199.

SPARRE, P., URSİN, E. AND VENEMA, S.C., 1989. *Introduction to tropical fish stock assessment*. Part 1. Manual. FAO Fisheries Technical Paper No:306.

TEPOLT, C.K., BAGLEY, M.J., GELLER, J.B. AND BLUM, M.J., 2006. Characterization of microsatellite loci in the European green crab (*Carcinus maenas*). *Mol. Ecol. Notes*, 343-345.

ULAŞ, A. AND AYDIN, C., 2011. Length-Weight Relationship of *Eriphia verrucosa* Forskal(1775) from the Aegean Sea (Linneus, 1758). *J. Anim. Vet. Adv.*,**8**:1061-1062.

WENNER, E.L., 1989. Incidence of insemination in female blue crabs, *Callinectes sapidus*. *J. Crust. Biol.*, **9**: 587-594.

YAMADA, S.B. AND HAUCK, L., 2001. Field identification of the European green crab species. *Carcinus maenas* and *Carcinus aestuarii*. *J Shellfish Res.*, **20**:905-912.

(Received 25 July 2013, revised 18 September 2013)