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Width/Length-Weight and Width-Length Relationships for 8 Crab Species from the North-Eastern Mediterranean Coast of Turkey

[1]Levent Sangun, [1]Canan Tureli, [1]Erhan Akamca and [2]Onder Duysak
[1]Faculty of Fisheries, Cukurova University, 01330, Adana, Turkey
[2]Faculty of Fisheries, Mustafa Kemal University, Iskenderun, Turkey

Abstract: In this study, relationships between width/length-weight and width-length by sex and combine were estimated 1133 individuals belonging to 8 species from 5 families in the North-eastern Mediterranean coast of Turkey. Regression coefficient between the regression of W-CL, W-CW and CL-CW for female, male and both were found very high ($p<0.001$) and the median value of b W-CL were 3.135, 3.132 and 3.081; W-CW were 3.135, 3.132 and 3.081, respectively. The r^2 values ranged from 0.91-0.99.

Key words: Crabs, width/length-weight relationships, width-length relationships, north-eastern mediterranean

INTRODUCTION

The crabs have wide distributions; their habitat is on sand, on rock, pelagic zone and under the sea. The importance of the crab increases because of their consumption, therefore the biological studies of crabs come in to be fairly important recently. If it is the economical crabs, in the north-eastern Mediterranean coast are excepted, the weight-length relationship and stock status hasn't been studied until now and there is no sufficient official data about crabs in Turkey. Most of researchers, have generally studied about economical crabs (Abbe, 2002; Cesar *et al*., 2003; Atar and Secer, 2003; Olvera and Peterson, 2004; Gokce *et al*., 2006). Some studies are about other crabs (Rosenberg and Langer, 2001; Josileen and Menon, 2005; Artuz, 2007).

In biological studies, weight-length relationships are allowing the conversation of growth-in-length equations to growth-in weight for use stock assessment model (Moutopoulos and Stergiou, 2002). In this study, we investigated and reported relationships between weight-carapace length, weight-carapace width and carapace length-carapace width for 8 crab species in north-eastern Mediterranean.

MATERIALS AND METHODS

The crab's data were collected from the north-eastern Mediterranean coast of Turkey in 2006. Crabs Species were caught by trawl and longline gears at depths which was ranged from 5-100 m and caught with hand on sand. The crabs were weighted with a digital balance to an accuracy of 0.01 g and carapace length and carapace width were measured with a precision of 0.01 cm for their total length. The relationship between length and weight is usually expressed by the equation:

$$W = aL^b$$

This equation can also be denoted as its logarithmic form:

$$\log W = \log a + b \log L$$

where:

W = Weights
L = Carapace length or carapace width
a = Intercept
b = Slope

a and b are estimated by the linear regression analysis from logarithmically transformed data and the association degree between weight-length variables is calculated by the determination coefficient (r^2) (Sangun *et al*., 2007; Santos *et al*., 2002). The significance of linear regression is assessed by Analysis of Variance (ANOVA).

RESULTS

The 8 species of crab belonging to 5 families were sampled. From this species, *Carcinus mediterraneus* Czerniavsky (1884), *Callinectes sapidus* Rathbun (1896), *Maja verrucosa* H. Milne Edwards (1834), *Ocypode cursor* (Linnaeus, 1758) are native species of Mediterranean, *Charybdis longicollis* Leene (1938), *Ixa monody* Holthuis and Gottlieb (1956), *Myra fugax* Fabricius (1798) are *Pacific* sp. and *Dorippe lanata* Linnaeus (1767) is *Atlantic* sp. Weight (g), carapace length (cm) and

Corresponding Author: Levent Sangun, Cukurova University, Faculty of Fisheries, 01330, Adana, Turkey

carapace width (cm) were measured from each species. The sample size, means, standard error of the mean and maximum-minimum value for female, male and both were given in Table 1.

a and b parameters, the standard error of the slope and the coefficient of determination (r^2) were given in Table 2. ANOVA test between weight/carapace length-carapace width relationships of crabs were given in

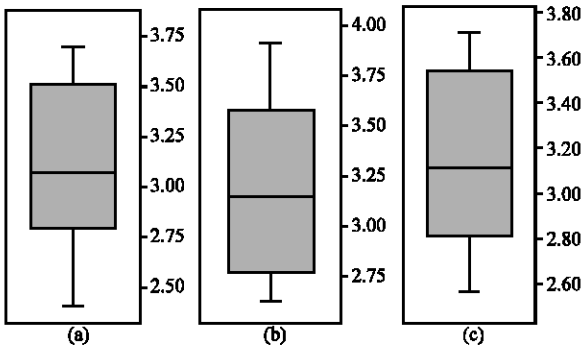

Fig. 1: Box-Whiskers plot of the exponent b of the W-CL relationships ($W = aL^b$) for 8 crab species caught in the study area, the central box covers 50% of data values. The horizontal line shows the median and the vertical line represents the range of the values (1: Female, 2: Male, 3: Both)

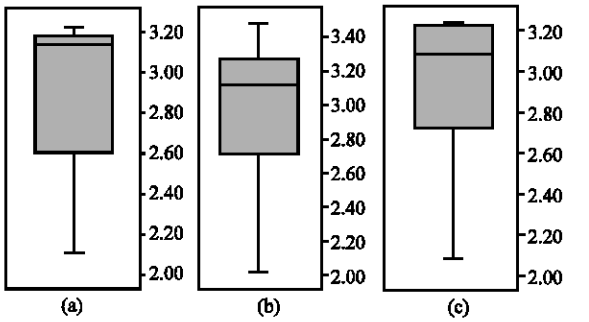

Fig. 2: Box-Whiskers plot of the exponent b of the W-CW relationships ($W = aL^b$) for 8 crab species caught in the study area, the central box covers 50% of data values. The horizontal line shows the median and the vertical line represents the range of the values (1: Female, 2: Male, 3: Both)

Table 1: Weight (W), Carapace Length (CL) and Carapace Width (CW), characteristics (mean, standard error of means (SE), minimum and maximum)

Family/Species	N	W, mean±SE(min-max)	CL, mean±SE(min- max)	CW, mean±SE(min-max)
Portunidae				
C. mediterraneus				
Female	28	47.16±3.61 (21.28-97.50)	44.66±1.02 (33.40-53.20)	65.95±1.60 (49.80-82.50)
Male	48	53.78±2.96 (23.47-99.30)	47.03±0.80 (36.45-57.07)	68.98±1.18 (53.64-85.40)
Both	76	51.33±2.31 (21.28-99.30)	46.15±0.64 (33.40-57.07)	67.87±0.96 (49.80-85.40)
C. longicollis				
Female	125	10.29±0.49 (1.98-29.97)	22.59±0.34 (14.19-31.85)	36.20±0.57 (22.46-52.40)
Male	75	16.26±1.12 (2.07-42.49)	25.44±0.58 (14.18-35.71)	41.35±0.99 (24.35-59.06)
Both	200	12.53±0.56 (1.98-42.49)	23.66±0.32 (14.18-35.71)	38.13±0.54 (22.46-59.06)
C. sapidus				
Female	321	118.14±2.40 (28.10-230.50)	5.53±0.04 (3.60-7.00)	12.45±0.10 (7.90-16.50)
Male	166	187.97±4.80 (50.90-346.70)	6.38±0.07 (4.00-8.24)	14.36±0.15 (8.99-18.10)
Both	487	141.94±2.73 (28.10-346.70)	5.82±0.04 (3.60-8.24)	13.10±0.09 (7.90-18.10)
Leucosiidae				
I. monodi				
Female	38	4.39±0.56 (0.82-11.88)	18.00±0.63 (11.27-25.33)	47.89±2.03 (29.09-69.25)
Male	37	4.41±0.53 (0.74-10.42)	18.05±0.62 (13.37-24.14)	49.60±2.25 (34.85-71.50)
Both	75	4.40±0.39 (0.74-11.88)	18.03±0.44 (11.27-25.33)	48.73±1.51 (29.09-71.50)
M. fugax				
Female	23	11.19±1.20 (3.17-19.44)	33.60±1.60 (18.92-43.0)	26.11±1.09 (14.41-32.51)
Male	33	16.79±1.04 (6.00-27.27)	39.66±0.96 (28.32-48.40)	30.32±0.70 (21.41-36.49)
Both	56	14.49±0.87 (3.17-27.27)	37.17±0.95 (18.92-48.40)	28.59±0.67 (14.41-36.49)
Majidae				
M. verrucosa				
Female	48	351.22±21.99 (107.0-681.0)	15.29±0.35 (10.13-19.18)	12.48±0.37 (7.00-16.62)
Male	32	336.75±26.05 (124.00-622.0)	14.93±0.46 (9.63-18.92)	11.99±0.46 (6.98-16.14)
Both	80	345.43±16.73 (107.0-681.0)	15.14±0.28 (9.63-19.18)	12.29±0.29 (6.98-16.62)
Ocypodidae				
O. cursor				
Female	42	21.13±1.84 (1.63-41.45)	26.35±0.92 (11.42-34.23)	33.16±1.12 (15.00-46.63)
Male	61	17.53±1.67 (1.85-37.70)	23.87±0.93 (12.01-33.39)	29.28±1.03 (15.83-39.77)
Both	103	19.00±1.25 (1.63-41.45)	24.88±0.67 (11.42-34.23)	30.86±0.78 (15.00-46.63)
Dorippidae				
D. lanata				
Female	36	14.16±0.91 (5.95-25.31)	24.21±0.45 (18.50-28.55)	29.88±0.64 (22.70-36.22)
Male	20	21.76±1.23 (12.50-33.30)	27.57±0.39 (24.34-30.67)	34.36±0.56 (29.86-39.14)
Both	56	16.87±0.88 (5.95-33.30)	25.41±0.38 (18.50-30.67)	31.48±0.54 (22.70-39.14)

Table 2: Regression parameters of the relationships between W-CL, W-CW and CL-CW

	$W = a \times CL^b$				$W = a \times CW^b$				$CL = a + bw \times CW$			
Species	a	b	SE (b)	r^2	a	b	SE (b)	r^2	a	b	SE (b)	r^2
C. mediterraneus												
Female	0.0003	3.167	0.122	0.98	0.00009	3.134	0.090	0.98	2.638	0.638	0.020	0.98
Male	0.0002	3.268	0.054	0.99	0.00005	3.253	0.057	0.99	0.598	0.673	0.015	0.99
Both	0.0002	3.210	0.057	0.98	0.00002	3.158	0.049	0.98	1.370	0.660	0.012	0.98
C. longicollis												
Female	0.0003	3.346	0.055	0.97	0.00009	3.223	0.066	0.97	1.399	0.588	0.013	0.97
Male	0.0003	3.378	0.062	0.98	0.00008	3.234	0.061	0.98	1.350	0.583	0.006	0.99
Both	0.0002	3.377	0.039	0.97	0.00009	3.216	0.043	0.97	1.588	0.579	0.007	0.97
C. sapidus												
Female	0.7005	2.971	0.027	0.97	0.1646	2.589	0.033	0.96	0.706	0.387	0.004	0.97
Male	1.3898	2.626	0.036	0.97	0.2016	2.554	0.039	0.97	0.315	0.425	0.006	0.97
Both	0.7490	2.943	0.022	0.97	0.1284	2.700	0.026	0.96	0.443	0.411	0.003	0.97
I. monodi												
Female	0.00009	3.674	0.221	0.95	0.00002	3.194	0.158	0.96	2.928	0.315	0.007	0.99
Male	0.0000	6 3.768	0.221	0.96	0.00002	3.029	0.154	0.95	4.465	0.272	0.007	0.99
Both	0.0000	8 3.700	0.142	0.96	0.00003	3.003	0.110	0.96	3.450	0.299	0.006	0.99
M. fugax												
Female	0.0021	2.413	0.110	0.96	0.0019	2.632	0.150	0.95	-2.893	1.408	0.042	0.99
Male	0.0005	2.833	0.083	0.98	0.0008	2.908	0.121	0.98	-1.106	1.347	0.052	0.96
Both	0.0013	2.566	0.065	0.97	0.0014	2.741	0.086	0.97	-2.176	1.381	0.031	0.99
M. verrucosa												
Female	0.2600	2.628	0.051	0.98	1.6583	2.110	0.049	0.98	2.835	0.992	0.019	0.99
Male	0.2099	2.697	0.062	0.98	2.0284	2.024	0.052	0.98	3.447	0.958	0.014	0.98
Both	0.2137	2.696	0.042	0.98	1.7507	2.084	0.038	0.98	3.250	0.966	0.013	0.99
O. cursor												
Female	0.0005	2.978	0.048	0.93	0.00009	3.135	0.074	0.91	-0.734	0.817	0.021	0.97
Male	0.0009	3.023	0.330	0.99	0.0002	3.320	0.083	0.98	-2.064	0.888	0.022	0.99
Both	0.0009	3.018	0.026	0.99	0.0002	3.238	0.059	0.98	-1.839	0.865	0.016	0.99
D. lanata												
Female	0.0001	3.699	0.109	0.98	0.0003	3.164	0.081	0.98	3.769	0.683	0.023	0.99
Male	0.0003	3.911	0.112	0.99	0.0009	3.490	0.100	0.99	4.018	0.685	0.019	0.99
Both	0.0001	3.710	0.072	0.98	0.0002	3.234	0.056	0.98	3.130	0.709	0.015	0.99

Table 3: ANOVA test between W-CL, W-CW and CL-CW relationships

Species		df	MS for W-CL	MS for W-CW	MS for CL-CW
C. mediterraneus					
Female	Regression	1	4.407**	4.473**	770.985**
	Error	26	0.006	0.004	0.809
Male	Regression	1	7.165**	7.155**	1396.138**
	Error	46	0.002	0.002	0.738
Both	Regression	1	11.891**	11.958**	2261.836**
	Error	74	0.004	0.003	0.797
C. longicollis					
Female	Regression	1	43.497**	42.725**	1725.265**
	Error	123	0.012	0.018	0.810
Male	Regression	1	37.407**	37.365**	1833.342**
	Error	73	0.013	0.013	0.188
Both	Regression	1	88.500**	87.708**	3938.195**
	Error	198	0.012	0.016	0.577
C. sapidus					
Female	Regression	1	49.358**	48.219**	155.707**
	Error	319	0.004	0.008	0.013
Male	Regression	1	22.517**	22.316**	115.708**
	Error	164	0.004	0.005	0.025
Both	Regression	1	95.892**	94.204**	350.228**
	Error	485	0.005	0.009	0.019
I. monodi					
Female	Regression	1	23.912**	24.688**	551.228**
	Error	36	0.081	0.060	0.269
Male	Regression	1	22.735**	22.276**	501.782**
	Error	35	0.050	0.063	0.319
Both	Regression	1	46.657**	46.798**	1045.192**
	Error	73	0.064	0.062	0.393

Table 3: Continued

Species		df	MS for W-CL	MS for W-CW	MS for CL-CW
M. fugax					
Female	Regression	1	7.894**	7.731**	1270.530**
	Error	21	0.016	0.024	1.089
Male	Regression	1	5.267**	5.127**	924.486**
	Error	31	0.005	0.009	1.402
Both	Regression	1	16.383**	16.100**	2689.974**
	Error	54	0.010	0.015	1.301
M. verrucosa					
Female	Regression	1	10.219**	10.131**	272.105**
	Error	46	0.003	0.005	0.109
Male	Regression	1	6.728**	6.710**	204.622**
	Error	30	0.004	0.004	0.039
Both	Regression	1	16.934**	16.815**	478.578**
	Error	78	0.004	0.006	0.086
O. cursor					
Female	Regression	1	25.069**	24.785**	1428.580**
	Error	40	0.006	0.013	0.934
Male	Regression	1	57.253**	55.619**	3021.614**
	Error	59	0.007	0.035	1.892
Both	Regression	1	85.378**	83.193**	4578.760**
	Error	101	0.006	0.028	1.715
D. lanata					
Female	Regression	1	6.215**	6.256**	240.280**
	Error	34	0.005	0.004	0.289
Male	Regression	1	1.248**	1.246**	56.103**
	Error	7	0.001	0.001	0.041
Both	Regression	1	10.432**	10.472**	440.324**
	Error	54	0.004	0.003	0.213

**$p<0.01$

Table 3 and between weight-carapace lengths, weight-carapace width Box-Whiskers plot were shown in Fig. 1 and 2.

DISCUSSION

We collected 1133 individuals belonging to 8 species from 5 families. The best represented family was Portunidae with three species and 743 individuals. The remaining 4 families were represented only by one species (Table 1). The r^2 values are ranged from 0.91-0.99. The b values between weight-carapace length for female, male and both are ranged from 2.413 for *Myra fugax* to 3.699 for *Dorippe lanata*, from 2.626 for *Callinectes sapidus* to 3.911 for *Dorippe lanata* and from 2.566 for *Myra fugax* to 3.710 for *Dorippe lanata*. The mean value of b was 3.110 (SE = ±0.16), 3.188 (SE = ±0.17) and 3.156 (SE = ±0.15) (Table 2). Box-Whiskers plot shown that, the median value of b was 3.073, 3.146 and 3.114 between weights-carapace length, respectively (Fig. 1). The b values between weight-carapace width for female, male and both are ranged from 2.110 for *Maja verrucosa* to 3.223 for Charybdis longicollis, from 2.024 for Maja verrucosa to 3.490 for Dorippe lanata and from 2.084 for *Maja verrucosa* to 3.238 for *Ocypode cursor*. The mean value of b was 2.898 (SE = ±0.14), 2.977 (SE = ±0.17) and 2.922 (SE = ±0.14) (Table 2). Box-Whiskers plot shown that, the median value of b between weight-carapace width were 3.135, 3.132 and 3.081, respectively (Fig. 2). The ANOVA test was detected highly significant ($p<0.01$) differences in regression coefficient between the regression of W-CL, W-CW and CL-CW for all sex (Table 3).

For *Callinectes sapidus*, the weights, carapace length and carapace width were measured between 28.10 and 230.50 g for female and between 50.90 and 346.70 g for male; between 3.60 and 7.00 cm for female and between 4.00 and 8.24 cm for male; between 7.90 and 16.50 cm for female and between 8.99 and 18.10 cm for male, respectively. Some investigators reported similar results in their studies (Cesar *et al*., 2003; Atar and Secer, 2003; Tureli and Erdem, 2003; Gokce *et al*., 2006). The b value between W-CL and W-CW is ranged from 2.971-2.589 for female and from 2.626-2.554 for male in our study. In previous studies, in Beymelek Lagoon Lake and Camlik Lagoon Lake, the b value between W-CL and W-CW was ranged from 2.1989-2.7707 for female and from 2.6129-2.8437 for male; from 3.090-2.872 for female and from 3.102-2.861 for male (Atar and Secer, 2003; Gokce *et al*., 2006) and in Iskenderun bay, the b value between W-CL was 2.64 for female and 2.81 for male (Tureli and Erdem, 2003). In the weight-length regression equation, the exponent b value generally was ranged from 2.5-3.5 (Dulcic and Kraljevic, 1996; Jones *et al*., 1999; Gokce *et al*., 2006). It is depended on variation of temperature, salinity, sex, food, stage of maturity and seasons of an each year.

CONCLUSION

This is the first detailed study on both economical and uneconomical crabs. It will be helpful and a guideline for future studies about this species or other species in Turkey and other country.

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