Turk J Vet Anim Sci
27 (2003) 443-447

Research Article

Width/Length-Weight Relationships of the Blue Crab (*Callinectes sapidus* Rathbun 1896) Population Living in Beymelek Lagoon Lake

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Received: 29.03.2002

Abstract: In this study, the width/length-weight relationships by sex, combined with the condition factors, of the blue crab (*Callinectes sapidus* Rathbun 1896) population living in Beymelek Lagoon Lake (Antalya) were examined. A total of 1027 samples ranging from 5.1 to 18.1 cm in width and weighing between 8.92 and 448 g were collected and analyzed. The relationship between carapace width/carapace length and weight was $W = 0.6804L^{2.9364}$ with $r^2 = 0.86$ and $W = 0.1907L^{2.5656}$ with $r^2 = 0.88$ (where L = width or length of crab in mm and W = weight in g) and condition factors were 48.196 and 6.638 for all crabs.

Key Words: Blue crab *Callinectes sapidus*, width/length-weight relationship, Beymelek Lagoon Lake

Beymelek Lagün Gölü'nde Yaşayan Mavi Yengeç (*Callinectes sapidus* Rathbun 1896) Populasyonunun Boy/Genişlik-Ağırlık İlişkileri

Özet: Bu çalışmada, Beymelek Lagün Gölü mavi yengeç (*Callinectes sapidus* Rathbun 1896) populasyonunun eşeye göre genişlik/boy-ağırlık ilişkileri ve kondisyon faktörleri incelendi. Genişlikleri 5.1 cm'den 18.1 cm'e değişen ve ağırlıkları 8.92 g ile 442 g arasında olan 1027 örnek analiz edildi. Bütün yengeçler için genişlik / boy –ağırlık ilişkileri, $W= 0,6804L^{2,9364}$ $r^2= 0,86$ ve $W= 0,1907L^{2,5656}$ $r^2= 0,88$ (burada, L = mm olarak yengeç genişlik ya da boyu; W= g olarak ağırlık) ve kondisyon faktörleri 48,196 ve 6,638 olarak hesaplandı.

Anahtar Sözcükler: Mavi yengeç *Callinectes sapidus*, genişlik/boy-ağırlık ilişkisi, Beymelek Lagün Gölü

Introduction

Information about the individual body weight-length/width relationships in population characteristics is in general of great importance for estimating the population size of a stock for the purpose of its exploitation. The weight increment to width-length ratio is used in a given geographic region for observing a species forming and growing. The length-width/weight relationship is regarded as more suitable for evaluating fish (1-4) and crustacean (5-12) populations. In fact, length-width and weight data are useful and standard results of sampling studies.

The importance of the commercial and recreational fishing of the blue crab (*Callinectes sapidus* Rathbun 1896) is increasing, while the occurrence and ecological significance of the blue crab are receiving more interest along the Mediterranean coast of Turkey. In Turkey's, Beymelek Lagoon Lake to the west of Antalya province, blue crabs have been reported by several authors (Figure 1) (13,14). However, the stock status of the blue crab in the Beymelek Lagoon is still unknown, due to poor knowledge of the biological parameters and statistics used for analysis. In addition, no detailed information about the biology of the blue crab is available from Turkey. In this study therefore, some aspects of the biology of the blue crab, including data on length, width, weight, length or width-weight relationships, and size frequency distributions, from samples taken from the lagoon were studied.

Materials and Methods

A number of the biological characteristics of the blue crab were studied. A total 1027 individuals (males and females) caught in Beymelek Lagoon Lake, Antalya,

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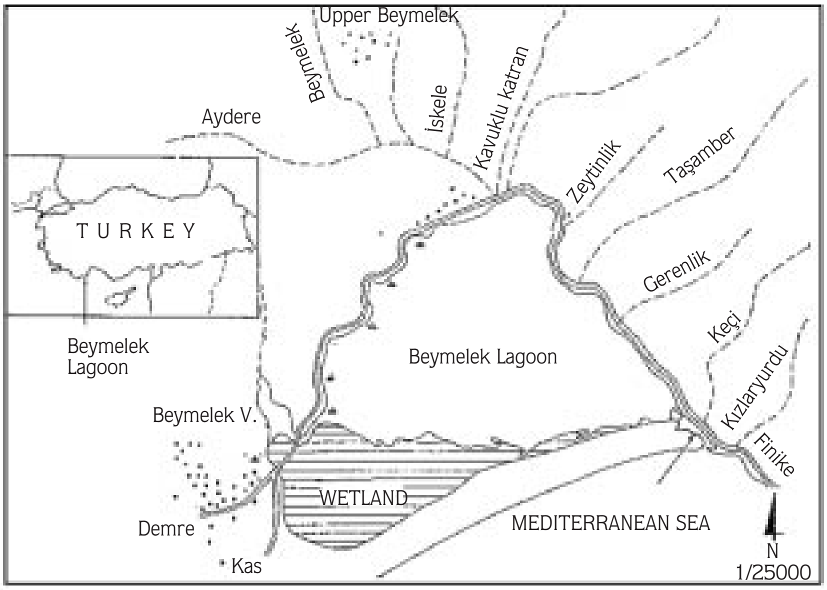

Figure 1. Sampling area for collecting blue crab in Beymelek Lagoon Lake, Antalya, Turkey.

Turkey were analyzed. Sampling took place in the lagoon in 2000 with a small-scale fishing vessel (boat length 5.5 m, engine horsepower 20 HP). The samples were collected with push nets. The mesh sizes of the bag of the push net were 1.2 cm to 2.0 cm of multifilament nylon. The length of the bag was 50 to 75 cm: mouth width and height were 50 cm and 20 cm, respectively. Selected crabs caught with the push net were collected in a plastic box on the boat. Sampling took place from the boat and sometimes in a shallow area by walking on the lake bed. After the operation, the catch was stored in a cold room (not frozen) until the next day for measuring all the blue crabs by width, length and weight to the nearest millimeter for the first two categories and to the nearest gram for the last.

The length-weight relationships of all samples collected were determined by the expression $W = a L^b$, where W is the derived weight (g), L is the carapace length (mm) or width (mm), a is the intercept of the regression curve and b the regression coefficient. The parameters a (intercept) and b (slope) are most easily estimated by linear regression based on logarithms; $\log (W) = \log (a)+b \log (L)$ (15). The significance of regression was assessed by analysis of variance (ANOVA) testing the hypothesis H_o: $\beta = 0$ against H_A: $\beta \neq 0$ (16). Equations expressing the width/length-weight relationships of blue crabs were calculated in relation to sex. For testing possible significant ($P > 0.01$) differences between the sexes Student's t-test was used for comparison of the two slopes.

Results

Size Composition

The carapace width-frequency distribution of the blue crab in the year 2000 catch is shown in Figure 2.

The carapace width of the 1027 crabs ranged from 5.1 to 18.1 cm and the weight ranged from 8.92 to 448 g (Table 1): 61.4% of the blue crabs were between 11 and 15 cm and only 4.2% were smaller than 8 cm.

Width/length-weight relationship

The minimum, maximum and mean carapace widths (cm), carapace lengths (cm), and weights (g) (± SE) used in the analysis of width/length–weight relationships are given in Table 1. The parameters of width-weight relationship, length-weight relationship and width-length relationship estimated from the weight, length and width data are presented in Tables 2 and 3 for male, female and overall blue crabs. The linear regressions between width or length and crab weight were highly significant ($P < 0.01$). The carapace width/length-weight relationships were allometric for both sexes. There were no significant differences in slopes between males and females ($P > 0.01$). The carapace width and length regressions were also highly significant ($P < 0.01$).

Condition factor

Estimated parameters of conversion between the carapace length measurements (width (CW) and length (CL) in cm) and the mean condition factors by the length and width of the blue crabs and standard errors

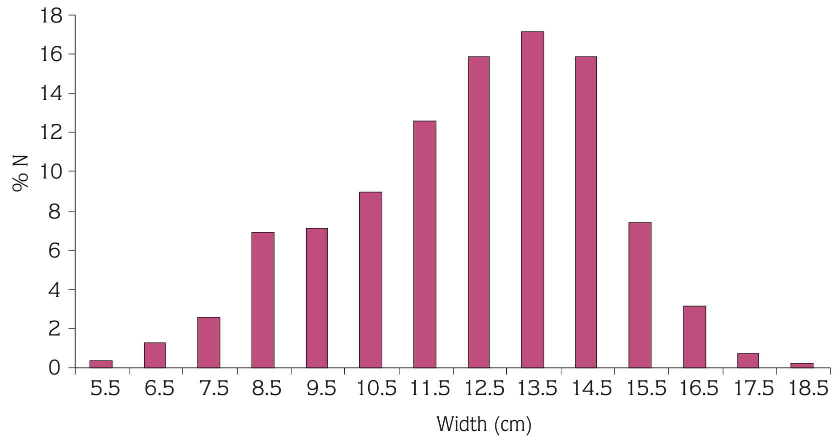

Figure 2. Carapace width-frequency distribution of the blue crab caught in Beymelek Lagoon Lake.

Table 1. Width, length and weight characteristics (mean, minimum and maximum) for the blue crab caught in Beymelek Lagoon Lake. (SE = Standard error)

		Width Characteristics				Length Characteristics				Weight Characteristics			
Sex	n	Mean	SE	Min.	Max.	Mean	SE	Min	Max	Mean	SE	Min	Max
Female	317	11.76	0.147	5.5	17.5	5.39	0.053	2.7	7.8	95.51	2.693	12	290
Male	710	12.52	0.083	5.1	18.1	5.97	0.035	2.5	8.8	145.48	2.375	8.92	448
Both	1027	12.28	0.074	5.1	18.1	5.79	0.030	2.5	8.8	130.05	1.975	8.92	448

Table 2. Parameters of the relationship ($W = a L^b$) between weight and carapace width (CW) and carapace length (CL) for the blue crab caught in Beymelek Lagoon Lake.

	Parameters of width-weight relationship				Parameters of length-weight relationship			
Sex	a	b	SE(b)	r^2	a	b	SE(b)	r^2
Female	0.3913	2.1989	0.0378	0.915	0.8212	2.7707	0.0606	0.869
Male	0.1834	2.6129	0.0309	0.910	0.8348	2.8437	0.0475	0.835
Both	0.6804	2.9364	0.0367	0.861	0.1907	2.5656	0.0295	0.880

Table 3. Estimated parameters of the conversion between the carapace length measurement (width (CW) and length (CL) in cm) and condition factors (K) by the carapace length and width for the blue crab caught in Beymelek Lagoon Lake.

Sex	N	Equation	a	b	SE(b)	r^2	$[K= (W*100)/ CW^3]$	SE	$[K= (W*100)/ CL^3]$	SE
Female	317	CW = a+bCL	0.0091	2.5625	0.0590	0.857	44.609	1.485	5.721	0.081
Male	710	CW = a+bCL	0.7517	2.1177	0.0379	0.815	49.798	1.182	7.048	0.045
Both	1027	CW = a+bCL	0.4480	2.1822	0.0319	0.820	48.196	0.940	6.638	0.044

calculated for sex are given in Table 3. The variation in condition factors between the sexes was not significant for either equation ($p > 0.01$).

Discussion

In studying spiny crab species, such as the blue crab, measuring the length of crabs is often somewhat difficult, and during attempts to measure them, either the extremities of the crab can be broken or the investigator can be injured by the crab. It is therefore convenient to be able to convert into length (width) when only the weight is known or length-weight regression may be extensively used to estimate length from weight because of the difficulties in handling spiny crabs such as the blue crab and the amount of time required to record length in the study of these species. These relationships are often used to calculate the standing stock biomass, condition indices, and used in the analysis of ontogenetic changes and several other aspects of fish or crustacean population dynamics. In addition, for the management of the population crabs caught can be weighed by groups or individually by fishermen, then catches under the size limits can be returned to the habitat.

The relationships between carapace width and weight and carapace length and weight have many uses. They are, for example, indicators of condition, and are used to calculate biomass and to estimate the recovery of edible meat from crabs of various sizes (15). They also have a practical value since they make it possible to convert length into weight and vice versa. On the other hand, body weight and total length, carapace length and carapace width are the most frequently used dimensions in the study of crustaceans (10).

In general, from the length-weight regression equations, the exponent b often lies between 2.5 and 3.5, and is usually close to 3 (1-4). According to Pauly (17), from an extraordinarily large number of length-weight data taken from a wide variety of fishes, values of $b < 2.5$ or $b > 3.5$ are generally based on a very small range of sizes and/or such values of b are most likely to be erroneous. An exponent (b) value of 3 indicates symmetrical or isometric growth; values other than 3 indicate allometric growth. In the present study, the values for the exponent (b) remained below 3 and the calculated width/length-weight equation was allometric.

The values of b ranged from 2.04 to 3.24 for *Callinectes sapidus* from Georgia, and this shows similarities with the b values of the present study (1). In contrast, the values of b for two other marine portunid crabs (*Portunus sanguinolentus* and *P. pelagicus*) are larger in some cases. Even though the change of b values depends primarily on the shape and fatness of the species, various factors may be responsible for the differences in parameters of the length/width–weight relationships among seasons and years, such as temperature, salinity, food (quantity, quality and size), sex, time of year and stage of maturity (17,18).

When the value b is different to 3 or weight growth is negatively allometric with size, the condition factor should be estimated (18). Even though width has been widely used for measuring blue crabs, in this study it was an advantage that two measurable and convertable sizes of crab were used for estimating condition factors. Since females with eggs migrate to the spawning area, ovigerous females were not considered in estimating condition factors. Therefore the condition factors for two equations of the females were similar to those of male crabs. In addition to sex, many factors such as time of year, stage of maturity, stomach contents influence the numerical magnitude of the condition factor. Comparisons should only be made when these factors are roughly equivalent among the samples to be compared (17).

Consequently, the aim of the length/width-weight relationships presented here is to enable crab biologists merely to derive length estimates for blue crabs that are weighed but not measured. In addition, to the best of our knowledge no information currently exists on the weight-length relationships and condition factors of blue crabs from Beymelek, even in Turkey.

Acknowledgments

This study was sponsored by the Ankara University Research Fund, project number 98-11-05-03.

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