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Research Article

Length-Length and Length-Weight Relationships in Nephrops norvegicus from the Aegean Sea (Linnaeus, 1758)

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Abstract

The objective of this study was to determine the length-length, length-width and length-weight relationships in *Nephrops norvegicus* as a basis for conversions. A total of 659 specimens were collected with trawl gears from the commercial trawler *Hapuloğlu* between the 17th and 21st August 2008 in international waters of the middle Aegean Sea. Morphometric equations for the conversions of length and weight were constructed for females, males, and combined sexes. Females were generally smaller than males, and size-frequency distributions total length (TL), carapace length (CL), and body width (BW) revealed significant differences between females and males.

Keywords: *Nephrops norvegicus;* Morphometric equations; Length-weight relationships; Aegean Sea.

Introduction

Nephrops norvegicus (Linnaeus, 1758), called 'kerevit' along Turkish coasts, has an important commercial value. It is extremely popular throughout the Mediterranean region (lagostim in Portugal, cigala in Spain, scampi in Italy, karavida in Greece) and is a target species in fisheries operating at depths of around 400 m within the framework of a more general, multispecies fishery carried out in the Mediterranean Sea (SARDÀ, 1998a). KARLOVAC (1952) described the biology of this species in the Mediterranean. More recently, FROGLIA & GRAMITTO (1981) published the main biological parameters in the Adriatic Sea; ABELLÓ & SARDÀ (1982), SARDÀ *et al.* (1993), have presented various studies on moulting, regeneration, metabolism, feeding, selectivity, and stock assessments, respectively, off the coast of Catalonia in Spain.

The most frequently used dimensions for crustaceans are carapace length, body length, total length, body width, and wet weight (SUKUMARAN & NEELAKANTAN, 1997; PRIMAVERA *et al.,* 1998). It may be convenient to able toconvert into the desired length measurement when

only one of the other length measurements is known and the length-weight regression may be used to estimate length from weight (TOSUNOĞ LU *et al.,* 2007). Very little is known about the biological characteristics of *N. norvegicus* along the Turkish coast of the Aegean Sea, so the objective of this study was to provide the length-length and length-weight relationships in *N. norvegicus* as a basis for rough conversions. For this reason, morphometric relationships of the species including carapace length, total length, body width, and weight were investigated.

Materials and Methods

Length and weight data of *N. norvegicus* were obtained during a selectivity study carried out on the commercial trawler *Hapulo ğlu* in Sı ğacık Bay, located in the international waters of the middle Aegean Sea (Fig. 1), between the 17the and 21st August 2008. The water depth of the trawled areas varied between 240 and 460 m. A 1100 mesh commercial trawl net was used for the hauls, and the mesh size and the number of meshes around the circumference of the cod end were 44 mm and 300 mm, respectively.

All sampled individuals were sorted according to sex by checking the external genital organs. To determine the relationships between the various length measurements, as well as the length-weight relationship, a total of 659 specimens were captured and put in jars containing a 10% seawater-formalin solution. Carapace length, CL, was measured as the distance from the postorbital margin to the mid-dorsal posterior edge of the carapace, to the nearest 0.1 mm using digital callipers; total length, TL, was measured as the distance from the tip of the rostrum to the end of the telson to the nearest 0.1 cm using a 30-cm ruler; body width, BW, was measured as the maximum width of the carapace to the nearest 0.1 mm with digital callipers; and the wet weight, W, was taken using a digital balance with a precision of 0.01 g. Kolmogorov-Smirnov (K-S) tests were used to compare the differences between length distribu-

Fig. 1: Map of sampling area.

tions of individuals for sexes. The relationships CL-TL, BW-CL, BW TL, W-TL, and W-CL were determined by using the regression analysis tool of Statgraphics Centurion. The length-weight relationships (LWR) were calculated using the formula $W = a \times L^b$ for females, males, and combined sexes, by the least squares regression after log transformation of both W and TL/CL/BW, and the association degree between the variables was calculated by the determination coefficient (r^2).

Results and Discussion

During the study, 659 *N. norvegicus* were measured; descriptive statistic values for males, females, and combined sexes are presented separately in Table 1. Mean CL results were 27.5 and 29.8 for females and males respectively. K-S test revealed the existence of significant differences in size distributions of CL ($p<0.001$), and BW ($p<0.05$), but none for TL ($p>0.05$).

Several studies on *N. norvegicus* have been undertaken in the Aegean Sea. Abello et al. (2002) obtained individuals from the north and south Aegean Sea with 20 mm mesh sized cod end bottom trawl and their mean CL measurements were larger than our study, which was undertaken in the middle Aegean Sea. SARDÀ *et al.,* (1998), reported on a 1994–1995 investigation in several Mediterranean locations: mean CL for females and males were found to be 29.3 – 33.3 mm and 34 – 35. 6 mm respectively for the Euboikos Gulf in the western Aegean Sea. On the other hand, our measurements have similarities with some of the mean carapace lengths in other studies. SMITH *et al.* (2003), have several *N. norvegicus* measurements from different locations in the Aegean Sea with 26 mm mesh sized commercial bottom trawls. Some of them are very close to the Turkish coasts, such as the Mytilini surveys in

Table 1
Descriptive statistical values for various measurements of *N. norvegicus* (carapace length, CL; total length, TL; body width, BW; weight, W).

	CL (mm)	BW (mm)	TL (mm)	W (g)
Females (n: 354)				
Minimum	17.2	9.1	65.2	3.1
Maximum	42.3	23.2	148.4	45.2
Mean	27.5	14.3	98.1	14.4
Standard deviation	5.79	3.37	21.68	9.52
Males (n: 305)				
Minimum	19.3	9.3	64.1	2.9
Maximum	49.4	28.3	172.6	88.1
Mean	29.8	15.7	105.2	20.9
Standard deviation	7.51	4.61	26.68	18.94
Combined sexes (n: 659)				
Minimum	17.2	9.1	64.1	2.9
Maximum	49.4	28.3	172.6	88.1
Mean	28.5	14.9	101.3	17.3
Standard deviation	6.71	4.03	24.27	14.91

their study and the smallest mean CL was calculated from this location as 29.8 mm and weight was 18 g. Our combined sexes mean CL was calculated as 28.5 mm and the weight was 17.3 g. Adjacent sampling locations could be one of the reasons for similarity in mean CL between studies. The variations observed among the areas are attributable to environmental conditions or to differing states of exploitation (SARDÀ, 1998b).

Figure 2 shows linear regression lines and length-length relationships for females, males, and combined sexes of *N. norvegicus.* Some morphometric relationships for *N. norvegicus* compared with those from other seas are given in table 2. Our study shows some differences from Northeast England (SYMOND, 1972) and theIrish Sea (FARMER, 1974). This may be due to the population structure of different seas. On the other hand, our results are close to those of STERGIOU & POLITOU (1995) whose study was conducted in adjacent wa-

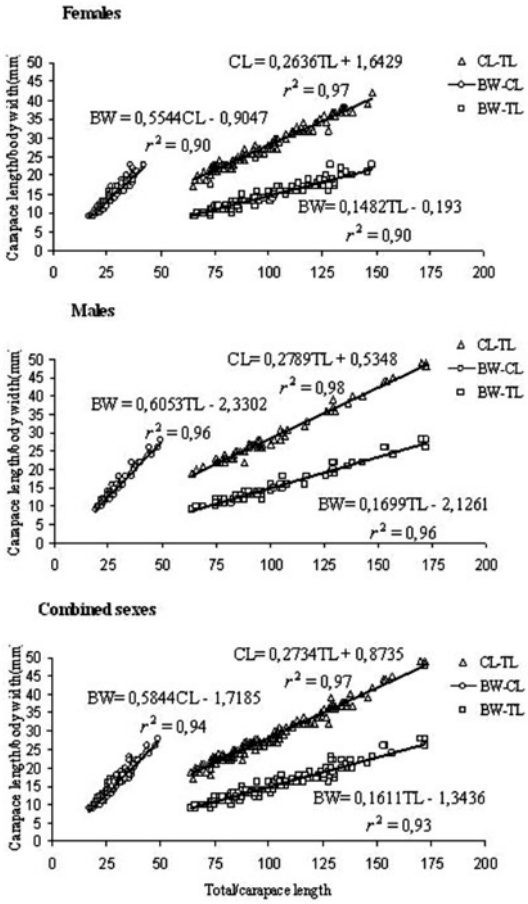

Fig. 2: Linear regression lines and length-length relationships for females, males, and combined sexes of *N. norvegicus* (carapace length, CL; total length, TL; body width, BW).

ters (the Western Mediterranean).

Furthermore, Figure 3 shows the regression lines and length-weight relationships for females, males, and combined sexes of *N. norvegicus* and the association degrees between variables. Combined sexes' determination coefficients (r^2) of W-BW, W-CL and W-TL were found as 0.95, 0.97 and 0.97, respectively. The differences in values between other studies (SYMONDS, 1972; FARMER, 1974; STERGIOU & POLITOU, 1995) could be due to a number of reasons, the most important of which include mesh size of trawl sampling season and sampling location.

Conclusion

Sometimes CL or TL are presented in biological investigations or fisheries studies, especially in gear selectivity estimates (DEVAL *et al.,* 2006; ZENGIN & TOSUNOĞLU,

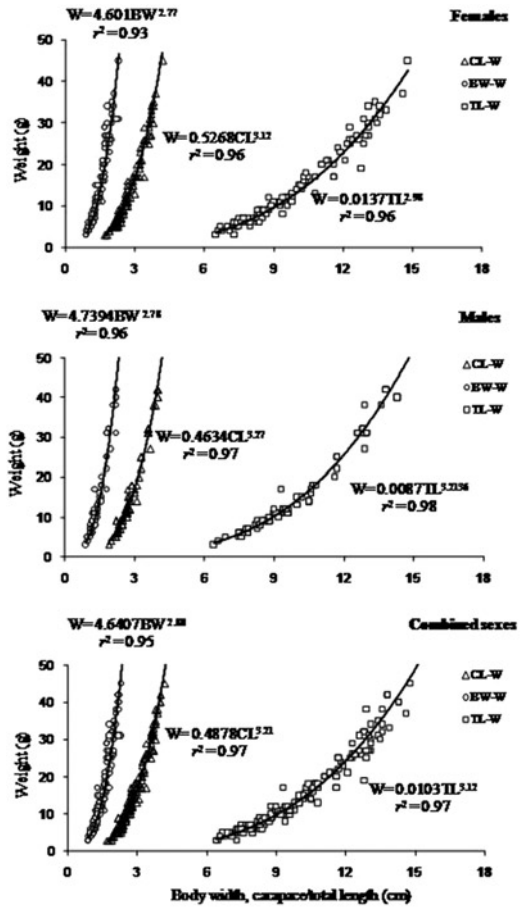

Fig. 3: Regression lines and length-weight relationships for females, males, and combined sexes of *N. norvegicus* and the association degrees between variables (r^2, determination coefficient; carapace length, CL; total length, TL; body width, BW; weight, W).

Table 2
Some morphemetric relationships for N. norvegicus compared with those from other seas (carapace length, CL; total length, TL; body width, BW; weight, W; intercept, a; slope, b; male, M; Female F; combined sexes, C).

	Studies	Areas	a	b	sex
CL-TL	1	NE England	3.02	10.7	M
			3.1	8.35	F
	2	Irish Sea	3.31	-0.18	M
			3.41	-1.82	F
			3.31	0.25	C
	4	Eastern Aegean Sea	0.27	0.53	M
			0.26	1.64	F
			0.27	0.87	C
BW-CL	1	NE England	0.5	-0.22	C
	2	Irish Sea	0.52	-0.78	M
			0.59	-1.48	F
			0.47	-0.27	C
	4	Eastern Aegean Sea	0.6	-2.33	M
			0.55	-0.9	F
			0.58	-1.71	C
W-CL	1	NE England	0.0004	3.11	M
			0.001	2.84	F
	2	Irish Sea	0.0002	3.33	C
	3	Western Aegean Sea	0.47	3.08	C
	4	Eastern Aegean Sea	0.46	3.27	M
			0.52	3.12	F
			0.48	3.21	C

1. SYMONDS (1972); 2. FARMER (1974); 3. STERGIOU & POLITOU (1995); 4. Present study.

2006; TOSUNOĞLU *et al.,* 2007). Various body length measurements, e.g., height, width, and girth, different from total length or carapace length are used to design more selective cod ends (changing mesh shape or mesh size) in order to target fish related to body shape, and also species-selective devices in multispecies fishery.

There are different populations of *N. Norvegicus* in the Aegean Sea and it is possible that there could be different morphological relationships between populations. As a result, with the aid of the length-length and length-weight relationships presented here, we enable fishery scientists or biologists to derive the various length or weight estimates for *N. norvegicus* based on a single measured value. It would thus be advisable for seasonal surveys in further studies to take place to obtain more detailed results.

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