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Length–weight relationships of 22 fish species from the Gallipoli Peninsula and Dardanelles (northeastern Mediterranean, Turkey)

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Abstract: Length–weight relationships are presented for 22 fish species from the Gallipoli Peninsula and Dardanelles between September 2006 and October 2009. The b values ranged between 2.78 and 3.28. All species' length–weight relationships were highly significant ($P < 0.001$).

Key words: Length–weight relationship, Gallipoli Peninsula, Dardanelles, Turkey

1. Introduction

Length–weight relationships (LWRs) have several applications. Establishment of a relationship between length and weight is necessary for the calculation of fish condition and biomass of a fish population (Anderson and Gutreuter, 1983; Petrakis and Stergiou, 1995). LWRs are also useful for life history and morphological comparisons of populations from different locations (Moutopoulos and Stergiou, 2002), and these relationships allow conversion of a growth equation in length to a growth equation in weight (Gonçalves et al., 1997).

Information concerning the LWRs of the fish species in the study area is incomplete. The current data from previous investigations of LWRs for fish species comes from Saros Bay by İşmen et al. (2007), İşmen et al. (2009), Özekinci et al. (2009), and Yığın and İşmen (2009); Gökceada by Karakulak et al. (2006); Edremit Bay by Çakır et al. (2008); and Çanakkale by Özen et al. (2009). For this reason, the present study provides data on LWRs of 22 fish species from the Gallipoli Peninsula and Dardanelles.

2. Materials and methods

Samples were collected by handlines, gill nets, and trammel nets at depths of 0–40 m from the Gallipoli Peninsula and Dardanelles, between September 2006 and October 2009 (Figure).

Fish were identified based on Mater et al. (2003). The scientific name for each species was checked according to Froese and Pauly (2012). Fish were weighed to the nearest gram (total weight) and measured to the nearest centimeter (total length). LWRs were estimated by fitting an exponential curve, $W = aL^b$ (Le Cren, 1951). Parameters *a* and *b* of the exponential curve were estimated by linear regression analysis over log-transformed data $\log W = \log a + b \log L$, where W is the total weight (g), L is the total length (cm), *a* is the intercept, and *b* is the slope, using the least-squares method. The degree of association between the variables was computed by the determination coefficient, r^2. The growth type was identified by Student's t-test. The coefficients obtained were analyzed with SPSS 19.0.

3. Results and discussion

A total of 2524 individuals of 22 species belonging to 10 families were sampled. The sample size, minimum and maximum lengths and weights, estimated parameters of LWR (*a* and *b*), standard error of *b*, determination coefficient (r^2), and growth type (GT) are given in Table 1 for each species, respectively.

The *b* coefficient provides an indication of the growth pattern for a specific population (Bagenal and Tesch, 1978). More precisely, when the *b* parameter has value greater than 3.0 the species presents a positive allometric growth; values of *b* lower than 3.0 display negative allometric growth. If *b* equals 3.0, isometric growth is indicated. In this study, the *b* values ranged from 2.78 for *Pagellus bogaraveo* to 3.28 for *Sardinella aurita*. All species' LWRs were highly significant ($P < 0.001$).

Comparison of LWRs between the present study and other studies is shown in Table 2. LWR parameters (*a* and *b*) of the fish could be attributed to the degree of gonad maturity, sex, diet, sample preservation techniques,

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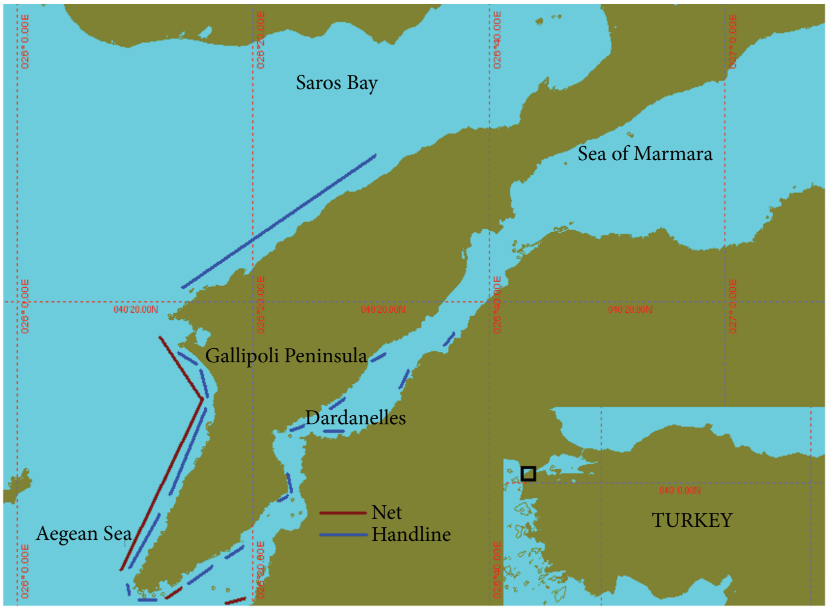

Figure. Study area.

Table 1. Length–weight relationships for 22 fish species from the Gallipoli Peninsula and Dardanelles.

Family	Species	N	Length range		Weight range		a	b	SE(b)	r^2	GT
			L_{min}	L_{max}	W_{min}	W_{max}					
Belonidae	*Belone belone*	30	30.7	71.5	28.59	446.87	0.0005	3.19	0.065	0.98	+
Carangidae	*Trachurus mediterraneus*	489	11.6	27.1	8.95	172.28	0.0060	3.13	0.018	0.98	+
	Trachurus trachurus	151	10.2	19.0	9.49	64.56	0.0086	3.01	0.022	0.96	0
Centracanthidae	*Spicara smaris*	114	11.3	18.9	14.91	73.69	0.0105	3.01	0.073	0.94	0
Clupeidae	*Sardina pilchardus*	146	11.6	16.1	7.55	34.14	0.0055	3.12	0.075	0.92	+
	Sardinella aurita	26	16.4	24.6	37.58	144.89	0.0014	3.28	0.163	0.95	+
Labridae	*Coris julis*	30	14.5	20.2	31.89	84.87	0.0063	3.18	0.154	0.94	+
Mullidae	*Mullus barbatus*	102	8.7	20.1	6.83	99.13	0.0062	3.22	0.051	0.98	+
Scombridae	*Scomber japonicus*	69	15.0	26.4	23.56	157.88	0.0039	3.23	0.089	0.98	+
	Scomber scombrus	58	16.4	29.0	31.74	191.30	0.0061	3.08	0.104	0.94	0
Scorpaenidae	*Scorpaena scrofa*	134	8.6	29.1	15.11	454.42	0.0221	2.96	0.035	0.98	-
Serranidae	*Serranus cabrilla*	41	11.9	23.5	20.26	181.27	0.0116	3.03	0.079	0.97	0
	Serranus scriba	53	12.0	22.6	25.02	203.79	0.0093	3.16	0.075	0.97	+
Sparidae	*Diplodus annularis*	282	8.7	19.4	10.63	126.22	0.0153	3.05	0.025	0.98	0
	Diplodus vulgaris	50	9.9	28.4	16.71	347.08	0.0199	2.92	0.037	0.99	-
	Lithognathus mormyrus	45	18.6	28.1	83.01	259.65	0.0187	2.86	0.083	0.97	-
	Oblada melanura	97	12.7	26.1	27.66	222.36	0.0180	2.89	0.037	0.98	-
	Pagellus acarne	228	11.2	23.8	18.36	182.23	0.0119	3.03	0.041	0.96	0
	Pagellus bogaraveo	92	11.4	20.9	19.31	105.62	0.0238	2.78	0.086	0.92	-
	Pagellus erythrinus	32	11.1	24.2	21.11	164.21	0.0209	2.84	0.062	0.98	-
	Sarpa salpa	99	8.1	32.0	7.4	442.00	0.0126	3.02	0.027	0.99	0
	Spondyliosoma cantharus	156	9.4	31.7	12.75	659.18	0.0083	3.26	0.045	0.97	+

N = Sample size; min and max = minimum and maximum; *a* and *b* = the parameters of the relationships; S.E. = standard error; r^2 = the coefficient of determination; GT = growth type; 0 = isometric; + = positive allometry; - = negative allometry.

assisted in both field work and the laboratory.

Table 2. Comparison of length–weight relationships between the present study and other studies.

Species	N	This study[1]			N	Saros Bay[2]			N	Gökçeada Island[3]			N	Edremit Bay[4]		
		L_{min}	L_{max}	W–L equation		L_{min}	L_{max}	W–L equation		L_{min}	L_{max}	W–L equation		L_{min}	L_{max}	W–L equation
Belone belone	30	30.7	71.5	$W = 0.0005L^{3.19}$				-				-				-
Coris julis	30	14.5	20.2	$W = 0.0063L^{3.18}$	16	16.4	22.1	$W = 0.0039L^{3.15}$	35	13.4	18.2	$W = 0.0082L^{3.05}$				-
Diplodus annularis	282	8.7	19.4	$W = 0.0153L^{3.05}$	108	8.8	15.6	$W = 0.0160L^{3.01}$	372	7.7	17.7	$W = 0.0068L^{3.31*}$	887	7.3	13.8	$W = 5.10^{-5}L^{2.82*}$
Diplodus vulgaris	50	9.9	28.4	$W = 0.0199L^{2.92}$	23	10.2	19.1	$W = 0.0092L^{3.13*}$	93	9.0	25.0	$W = 0.0858L^{2.43*}$				-
Lithognatus mormyrus	45	18.6	28.1	$W = 0.0187L^{2.86}$				-				-				-
Mullus barbatus	102	8.7	20.1	$W = 0.0062L^{3.22}$	3386	6.0	24.7	$W = 0.0076L^{3.09*}$	76	12.5	22.3	$W = 0.0049L^{3.27}$	45	10	18.5	$W = 6.10^{-3}L^{3.27}$
Oblada melanura	97	12.7	26.1	$W = 0.0180L^{2.89}$				-	316	9.1	19.8	$W = 0.0034L^{3.46*}$				-
Pagellus acarne	228	11.2	23.8	$W = 0.0119L^{3.03}$				-				-				-
Pagellus bogareveo	92	11.4	20.9	$W = 0.0238L^{2.78}$	2355	6.5	25.1	$W = 0.0074L^{3.19*}$				-				-
Pagellus erythrinus	32	11.1	24.2	$W = 0.0209L^{2.84}$	2480	7.2	27.0	$W = 0.0105L^{3.05*}$	169	9.9	29.8	$W = 0.0124L^{3.01*}$	181	7.8	22.8	$W = 1.10^{-4}L^{2.65*}$
Sarpa sarpa	99	8.1	32.0	$W = 0.0126L^{3.02}$				-	80	11.1	31.2	$W = 0.0087L^{3.13*}$				-
Sardina pilchardus	146	11.6	16.1	$W = 0.0055L^{3.12}$				-				-	87	8	14.2	$W = 3.10^{-5}L^{2.76*}$
Sardinella aurita	26	16.4	24.6	$W = 0.0014L^{3.28}$				-	50	16.4	26.2	$W = 0.0062L^{3.07*}$				-
Scomber japonicus	69	15.0	26.4	$W = 0.0039L^{3.23}$	45	12.2	22.0	$W = 0.0016L^{3.52*}$	25	18.1	31.2	$W = 0.0064L^{3.10*}$				-
Scomber scombrus	58	16.4	29.0	$W = 0.0061L^{3.08}$	100	13.6	24.0	$W = 0.0028L^{3.29*}$	54	22.0	31.1	$W = 0.0025L^{3.38*}$	52	15.8	21.7	$W = 1.10^{-7}L^{3.81*}$
Scorpaena scrofa	134	8.6	29.1	$W = 0.0221L^{2.96}$				-	15	12.3	39.1	$W = 0.0180L^{3.00}$				-
Serranus cabrilla	41	11.9	23.5	$W = 0.0116L^{3.03}$	34	11.0	27.5	$W = 0.0086L^{3.06}$	91	11.9	19.8	$W = 0.0112L^{2.99}$	602	8.7	23.4	$W = 7.10^{-5}L^{2.62*}$
Serranus scriba	53	12.0	22.6	$W = 0.0093L^{3.16}$				-	311	10.2	21.3	$W = 0.0065L^{3.24}$				
Spicara smaris	114	11.3	18.9	$W = 0.0105L^{3.01}$	1449	8.2	18.6	$W = 0.0118L^{2.91}$	130	11.5	18.7	$W = 0.0138L^{2.87*}$	139	10.5	15.7	$W = 3.10^{-5}L^{2.85*}$
Spondyliosoma cantharus	156	9.4	31.7	$W = 0.0083L^{3.26}$	45	9.6	22.7	$W = 0.0092L^{3.17}$	46	8.2	28.7	$W = 0.0192L^{2.87*}$				-
Trachurus mediterraneus	489	11.6	27.1	$W = 0.0060L^{3.13}$	446	7.5	20.9	$W = 0.0031L^{3.33*}$	31	14.2	26.6	$W = 0.0047L^{3.17}$	76	7.3	22.5	$W = 7.10^{-6}L^{3.09}$
Trachurus trachurus	151	9.7	19.0	$W = 0.0086L^{3.01}$	1205	7.5	33.0	$W = 0.0046L^{3.19*}$	264	10.5	24.3	$W = 0.0113L^{2.90*}$	174	7.8	24.3	$W = 2.10^{-5}L^{2.87*}$

*b-values significantly different from those of this study. 1 = using gill net, handline, and trammel net; 2 = İşmen et al. (2007) using bottom trawl; 3 = Karakulak et al. (2006) using gill net and trammel net; 4 = Çakır et al. (2008) using bottom trawl; N = sample size; W = weight; L = length; min = minimum; max = maximum.

stomach fullness (Wootton, 1990), number of specimens analyzed, area/season effects, sampling duration (Moutopoulos and Stergiou, 2002), fishing gear used (Kapiris and Klaoudaos, 2011), and size selectivity of the sampling gear (İşmen et al., 2007). Therefore, the possible reasons for differences in LWRs between other studies and this study may be related to one or more factors given above.

According to Froese et al. (2011), a sample size of about 100 specimens is considered to be adequate for the estimation of LWRs; there is no need to kill thousands of specimens only for LWR estimates.

Özen et al. (2009) reported the LWRs of 17 less-studied fish species from Çanakkale sampled using a beach seine. Although sampling area and, naturally, environmental conditions are very similar, none of the species that they mentioned were present in this study. Cengiz et al. (2011, 2012) emphasized that the variety of species within a region and/or between regions may be related to environmental conditions and different fishing gears used for sampling. The probable reason for differences in the variety of species between Özen et al. (2009) with this study is most likely due to different fishing gears used.

In conclusion, the data of this study could be used as a reference by biologists in surveys regarding fisheries management in the area, and to compare similar parameters in ongoing fishery studies for different Turkish and Mediterranean areas.

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