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Weight-Length Relationships for 39 Fish Species from the North-Eastern Mediterranean Coast of Turkey

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Abstract

Weight-Length relationships (WLRs) were estimated for 39 fish species from the north-eastern Mediterranean coast of Turkey. Samples were collected using trawl and longline gears at depths ranging from 5 to 100 meters. Captures were made between the years 2001 and 2003. The best-represented family was Sparidae with seven species, distantly followed by Serranidae (five species), Bothidae, Centracanthidae, Mullidae, Ophichthidae and Triglidae (two species). The remaining 17 families were represented only by one species. The estimates for the parameter *b* of the WLR ($W = aL^b$) ranged between 2.334 and 3.564 with a median of 2.987.

Key words: weight-length relationships, fish, North-Eastern Mediterranean

Introduction

The estimation of population size of a fish stock for the purpose of its rational exploitation often requires knowledge of individual body WLRs in the population (Dulčić and Kraljević, 1996).

WLRs have several applications, namely on fish biology, physiology, ecology and fisheries assessment. In biological studies, WLR enables seasonal variation in fish growth to be followed and the calculation of condition indexes. WLR gives us life history and morphological comparisons between different fish species or between different fish populations from different habitats (Gonçalves *et al*., 1997; Petrakis and Stergiou, 1995, Santos *et al*., 2002). This study was conducted to determine WLRs of 39 fish species from the north-eastern Mediterranean Sea coast of Turkey.

Materials and Methods

Weight-Length data reported in this study were collected between 2001 and 2003 from the north-eastern Mediterranean coast of Turkey. Species were caught by trawl and longline gears at depths, ranging from 5 to 100 meters. Fish species were identified according to Aksiray (1987), Whitehead *et al*., (1986). The individuals were weighted with a digital balance to an accuracy of 0.01 g and measured with a precision of 0.1 cm for their total length.

The relationship between the length and weight of a fish is usually expressed by the equation, $W=aL^b$. Where W is body weight (g), L is total length (cm), a is a coefficient related to body form and b is an exponent indicating isometric growth when equal to 3 (Edwards, 1976; Draper and Smith, 1981; Beverton and Holt, 1996).

The parameters a and b of WLR were estimated by the least-square method from logarithmically transformed data, and the association degree between weight-length variables was calculated by the determination coefficient (r^2). The statistical significance level of r^2 and 95% confidence limits of the parameters a and b were estimated (Santos *et al*., 2002).

Values of the exponent b provide information on fish growth. When b=3, increase in weight is isometric. When the value of b is other than 3, weight increase is allometric, (positive allometric if $b>3$, negative allometric if $b<3$). The null hypothesis of the isometric growth (H_0: b =3) was tested by t – test, using the statistic: $t_s =(b-3)/S_b$, where S_b is the standard error of the slope, for $\alpha=0.05$ for testing significant differences among slopes (b) between two regressions for the same species (Morey *et al*., 2003).

Results and Discussion

For this particular study, 7778 individuals belonging to 39 fish species from 24 families were sampled. The best represented family was Sparidae with seven species, distantly followed by Serranidae (five species) and Bothidae, Centracanthidae, Mullidae, Ophichthidae and Triglidae (two species). The remaining 17 families were represented only by one species.

In numerical terms, the most abundant species were *Pagrus caeruleostictus* with 684 individuals, followed by *Upeneus moluccensis* (651) and *Leiognathus klunzingeri* (632).

The results obtained in the estimation of WLRs of 39 selected fish species, along with several descriptive statistics are given in Table 1.

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Table 1. Descriptive statistics and W-L relationship parameters for 39 selected fish species of the north-eastern Mediterranean coast of Turkey (N: sample size; W: weight (g); min: minimum; max: maximum; L: length (cm); S.D.: standard deviation; S.E.: standard error; C.I.: confidence interval; *b*: slope)

Family / Species	N	*W*, mean±S.D. (W_{min}- W_{max})	*L*, mean±S.D. (L_{min}- L_{max})	*W-L* equation	Determination Coefficient (r^2)	S.E. of b^a (95% C.I. of *b*)	Growth Type
Balistidae							
Balistes capriscus	123	34.98±28.45 (3.25 – 121.58)	12.03±4.09 (5.9 – 40.9)	$W = 0.0678L^{2.429}$	0.89^{**}	0.126 (2.179 – 2.678)	Allometric (-)
Bleniidae							
Blennius ocellaris	31	23.17±11.58 (4.27 – 41.14)	10.98±2.35 (6.8 – 17.2)	$W = 0.0411L^{2.605}$	0.95^{**}	0.169 (2.261 – 2.950)	Allometric (-)
Bothidae							
Bothus podas	90	8.56±8.90 (2.38 – 47.14)	8.89±2.40 (6.2 – 15.7)	$W = 0.0096L^{3.002}$	0.98^{**}	0.063 (2.877 – 3.128)	Isometric
Arnoglossus laterna	291	7.88±3.15 (0.94 – 16.49)	9.58±1.48 (4.5 – 13.4)	$W =0.0122L^{2.835}$	0.95^{**}	0.055 (2.158 – 2.943)	Allometric (-)
Bregmacerotidae							
Bregmaceros atlanticus	16	1.73±0.48 (1.06 – 2.57)	6.75±0.48 (5.95 – 7.6)	$W = 0.0032L^{3.289}$	0.83^{**}	0.585 (2.034-4.543)	Allometric (+)
Citharidae							
Cihtarus linguatula	338	18.12±10.17 (2.00 - 57.50)	13.15±2.74 (6.5 – 21.3)	$W =0.0114L^{2.819}$	0.98^{**}	0.350 (2.751 – 2.888)	Allometric (-)
Cynoglossidae							
Cynoglossus sinusarabici	96	12.85±6.50 (4.75 – 39.17)	11.81±2.03 (8.2 – 18.2)	$W =0.0308L^{2.414}$	0.91^{**}	0.112 (2.192 – 2.637)	Allometric (-)
Carangidae							
Trachurus mediterraneus	373	19.87±11.83 (2.46 - 60.59)	13.15±2.19 (7-19.1)	$W = 0.0128L^{2.810}$	0.88^{**}	0.078 (2.656 – 2.964)	Allometric (-)
Centracanthidae							
Spicara maena	298	18.36±7.86 (5.26 – 55.23)	11.96±1.57 (8.7 – 17.1)	$W = 0.0080L^{3.093}$	0.91^{**}	0.082 (2.932 – 3.254)	Isometric
Spicara smaris	176	19.13±8.18 (5.12 – 52.64)	11.99±1.67 (7.5 – 16.9)	$W = 0.0288L^{2.594}$	0.92^{**}	0.085 (2.426 – 2.761)	Allometric (-)
Engraulidae							
Engraulis encrasicolus	392	11.14±6.28 (2.00 – 34.99)	11.37±2.29 (7 – 17)	$W = 0.0156L^{2.661}$	0.96^{**}	0.040 (2.581-2.740)	Allometric (-)
Gadidae							
Merluccius merluccius	29	53.06±26.12 (14.20 – 11.63)	22.09±4.21 (13.2 - 31)	$W = 0.0337L^{2.353}$	0.93^{**}	0.184 (1.975 – 2.731)	Allometric (-)
Haemulidae							
Pomadasys incisus	23	44.80±17.24 (23.31 – 86.09)	15.01±1.91 (11.9 - 19)	$W = 0.0199L^{2.834}$	0.97^{**}	0.162 (2.497 – 3.171)	Isometric
Leiognathidae							
Leiognathus klunzingeri	632	5.23±3.09 (0.43 – 15.49)	7.27±1.46 (1.9 – 10)	$W = 0.0075L^{3.224}$	0.97^{**}	0.035 (3.158- 3.294)	Allometric (+)
Monacanthidae							
Stephanolepis diaspros	52	25.61±12.14 (8.19 – 55.12)	10.89±1.77 (7.3 – 14.2)	$W = 0.0276L^{2.832}$	0.98^{**}	0.092 (2.647 – 3.018)	Isometric
Mullidae							
Mullus barbatus	451	17.75±12.36 (4.96 – 106.26)	11.64±2.15 (8.2 – 22)	$W = 0.0032L^{3.060}$	0.94^{**}	0.051 (2.959 – 3.160)	Isometric
Upeneus moluccensis	651	13.70±11.31 (3.41 - 69.90)	10.79±2.01 (7-18)	$W = 0.0024L^{3.564}$	0.98^{**}	0.027 (3.511 – 3.617)	Allometric (+)
Ophichthidae							
Echelus myrus	14	116.36±57.46 (4.19 – 213.68)	52.41±11.41 (30.9 – 67.5)	$W = 0.0131L^{2.277}$	0.98^{**}	0.151 (1.947 – 2.607)	Allometric (-)
Ophisurus serpens	41	71.24±44.36 (2.7 – 172.40)	36.58±8.58 (12.1 – 50.1)	$W = 0.0015L^{2.959}$	0.99^{**}	0.790 (2.799 – 3.119)	Isometric
Scombridae							
Scomber japonicus	11	52.81±14.53 (41.75 – 93.06)	18.83±1.35 (17.1 - 22)	$W = 0.0056L^{3.113}$	0.95^{**}	0.353 (2.317 – 3.913)	Isometric
Serranidae							
Ephinephelus aeneus	24	409.74±262.43 (45.48 – 855.32)	30.98±8.44 (16 – 42.2)	$W = 0.0120L^{2.987}$	0.99^{**}	0.037 (2.909 – 3.064)	Isometric
Ephinephelus marginatus	48	135.39±94.33 (16.95 – 411.90)	20.165±4.17 (13.1 – 29.4)	$W = 0.0116L^{3.065}$	0.91^{**}	0.208 (2.647 – 3.484)	Isometric
Serranus cabrilla	126	26.24±17.28 (3.56 – 74.49)	12.65±3.05 (7.1 – 18.9)	$W = 0.0662L^{3.220}$	0.98^{**}	0.054 (3.113 – 3.328)	Allometric (+)
Serrauıs hepatus	573	9.96±3.70 (1.69 - 38.56)	8.42±1.10 (4.8 - 13)	$W = 0.0143L^{3.044}$	0.95^{**}	0.041 (2.963 – 3.125)	Isometric
Serranus scriba	8	45.61±11.46 (32.73 – 65.51)	14.96±1.04 (13.6 - 17)	$W = 0.0044L^{3.409}$	0.95^{**}	0.441 (2.331 – 4.487)	Allometric (+)

** $P< 0.01$; * $P < 0.05$

Table 1. (Continued)

Family / Species	N	W, mean±S.D. (W_{min}–W_{max})	L, mean±S.D. (L_{min}–L_{max})	W–L equation	Determination Coefficient (r^2)	S.E. of b^a (95% C.I. of b)	Growth Type
Sparidae							
Boops boops	172	40.62±15.49 (10.66–110.76)	16.77±1.90 (11.20–21.1)	$W = 0.0072\ L^{3.083}$	0.93**	0.096 (2.894–3.271)	Isometric
Diplodus annularis	154	30.12±7.37 (14.4–51.45)	12.14±0.99 (10.3–15)	$W = 0.0370L^{2.677}$	0.90**	0.110 (2.459–2.895)	Allometric (–)
Diplodus sargus	36	113.81±70.38 (22.13–309.50)	17.96±3.48 (11.2–25.3)	$W = 0.0108L^{3.166}$	0.99**	0.064 (3.036–3.297)	Allometric (+)
Pagellus acarne	83	37.46±8.35 (16.49–57.43)	14.48±1.04 (11–17)	$W = 0.0186L^{2.841}$	0.91**	0.146 (2.551–3.131)	Isometric
Pagellus erythrinus	222	24.65±15.12 (1.97–61.91)	12.36±2.82 (7.9–31.58)	$W = 0.0145L^{2.905}$	0.94**	0.072 (2.763–3.047)	Isometric
Pagrus caeruleostictus	684	21.06±15.03 (2.36–125.26)	11.32±2.52 (5.5–20.4)	$W = 0.0125L^{2.995}$	0.97**	0.031 (2.934–3.056)	Isometric
Sparus aurata	298	87.99±44.64 (15.01–236.30)	18.22±2.99 (10.3–31.8)	$W = 0.0220L^{2.835}$	0.90**	0.080 (2.678–2.992)	Allometric (–)
Synodontidae							
Saurida undosquamis	416	36.41±17.99 (5.67–122.73)	17.6±2.7 (10.6–26.1)	$W = 0.0039\ L^{3.159}$	0.96**	0.044 (3.073–3.246)	Allometric (+)
Tetraodontidae							
Lagocephalus lagocephalus	27	70.77±50.39 (13.85–198.18)	15.80±2.93 (12.3–22.5)	$W = 0.0066\ L^{3.302}$	0.85**	0.408 (2.461–4.142)	Allometric (+)
Trachinidae							
Trachinus draco	54	17.16±12.33 (4.5 1–53.18)	13.05±2.97 (9–20)	$W = 0.0052L^{3.090}$	0.99**	0.044 (3.002–3.178)	Isometric
Triglidae							
Chelidonichthys lucernus	474	22.14±16.18 (2.79–154.32)	13.26±2.40 (6.7–24.5)	$W = 0.0166L^{2.743}$	0.95**	0.043 (2.659–2.828)	Allometric (–)
Chelidonichthys lastoviza	75	20.04±17.57 (2.49–85.86)	11.59±3.08 (6.5–19.3)	$W = 0.0085L^{3.079}$	0.99**	0.049 (2.981–3.176)	Isometric
Trichiuridae							
Trichiurus lepturus	84	53.35±27.68 (14.19–167.95)	42.95±6.05 (20.5–58.8)	$W = 0.0083L^{2.334}$	0.73**	0.238 (1.860–2.809)	Allometric (–)
Uranoscopidae							
Uranoscopus scaber	92	56.54±55.85 (2.15–307.96)	14.08±3.94 (5.2–24.7)	$W = 0.0103L^{3.153}$	0.99**	0.056 (3.042–3.265)	Allometric (+)

** $P < 0.01$; * $P < 0.05$

The WLRs were highly significant (P<0.01) for 39 species. The determination coefficients (r^2) ranged between 0.734 for *Trichiurus lepturus* and 0.998 for *Ephinephelus aeneus*. In addition r^2 values were > 0.90 for 34 species (87%), > 0.80 for 4 species (0.10) and > 0.70 for 1 species (0.03).

The *b* values ranged from 2.334 for *Trichiurus lepturus* to 3.564 for *Upeneus moluccensis*. The median value of *b* was 2.987

In terms of growth type, the results showed that 14 species had negative allometries (b<3), 16 species isometries (b=3) and 9 species positive allometries (b>3). In addition, to the best of our knowledge, no information currently exists on the weight-length relationships of *Bregmaceros atlanticus*, *Echelus myrus*, *Ophisurus serpens* and *Lagocephalus lagocephalus* in the Mediterranean Sea (Fishbase, 2005).

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