

Length-Weight Relationships for Nine Chondrichthyes Fish Species from Edremit Bay (North Aegean Sea)

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Abstract

Length-weight relationships were calculated for 9 chondrichthyes fish species totaling 284 individuals from Edremit Bay (North Aegean Sea) caught with bottom trawls between June 2007 and June 2009. It was calculated as $W=0.1306 TL^{2.1701}$ ($r^2=0.8645$) for *Dasyatis pastinaca*, $W=0.1139 TL^{2.7088}$ ($r^2=0.9768$) for *Mustelus mustelus*, $W=0.0014 TL^{3.1795}$ ($r^2=0.8742$) for *Myliobatis aquila*, $W=0.0322 TL^{2.5597}$ ($r^2=0.8836$) for *Raja clavata*, $W=0.0215 TL^{2.5654}$ ($r^2=0.7152$) for *Raja miraletus*, $W=0.0029 TL^{3.2142}$ ($r^2=0.9262$) for *Raja radula*, $W=0.000006 TL^{2.8817}$ ($r^2=0.8138$) for *Scyliorhinus canicula*, $W=0.0004 TL^{3.6397}$ ($r^2=0.6365$) for *Scyliorhinus stellaris*, $W=0.1297 TL^{2.4665}$ ($r^2=0.8022$) for *Torpedo marmorata*. In addition, 157 previous studies were carried out on the characterization of L–W relationships for 12 chondrichthyes fish species in Turkey waters. The values of the b values identified by other authors varied from 2.122 to 4.15. The mean value of b was 3.165 (SE = ± 0.025).

Introduction

Fisheries management and research often require the use of biometric relationships in order to transform data collected in the field into appropriate indexes (Anderson & Gutreuter, 1983; Ecoutin & Albaret, 2003). One of the most commonly used in any analysis of fishery data is the length-weight relationship ($W=aL^b$). According to Andrade and Campos (2002), this is particularly useful when sampling large species, because of the difficulty and time required to record weight in the field. Besides the estimation of weight from length (Beyer, 1991; Martin-Smith, 1996), the length-weight relationship has several applications, including the conversion of a growth equation in length into a growth equation in weight (Pauly, 1993; Pérez & Contreras, 1995; Merella, Qetglas, Alemany, & Carbonell, 1997). Establishment of a relationship between length and weight is essential for the calculation of production and biomass of a fish population (Anderson & Gutreuter, 1983; Safran, 1992; Petrakis & Stergiou, 1995; Dulčić & Kraljevic, 1996; Moutopoulos & Stergiou, 2002),

allowing also for morphological comparisons among species or among populations of the same species from different habitats and/or regions (Gonçalves *et al.*, 1997; Moutopoulos & Stergiou, 2002). It is frequently used to follow seasonal variations in fish growth and to estimate condition indexes (Anderson & Gutreuter, 1983; Safran, 1992; Richter, Lückstädt, Focken & Becker, 2000). Estimates of the relationship parameters a and b can be related to ecological processes and life history. They are also useful for between-region comparisons of life histories of a certain species (Pauly, 1993; Petrakis & Stergiou, 1995; Gonçalves *et al.*, 1997; Merella *et al.*, 1997).

Previous studies were carried out on the characterization of L–W relationships for chondrichthyes species in Turkey waters, e.g. Demirhan, Engin, Seyhan and Akamca (2005), Demirhan and Seyhan (2007) in the Southeastern Black Sea, Bök, Gokturk, Kahraman and Alicli (2011) in Marmara Sea, Yeldan and Avsar (2007), Yeldan, Avsar and Manasirli (2008), Yeldan, Avsar and Manasirli (2009) in the Northeastern Mediterranean, Guven, Kebecioglu and Deval (2011) in the Eastern

Mediterranean, Filiz and Mater (2002), Filiz and Bilge (2004), Karakulak, Erk and Bilgin (2006), Ismen, Ozen, Altinagac, Ozekinci and Ayaz (2007), Ozaydin, Uckun, Akalin, Leblebici and Tosunoglu (2007), Cakir-Turker, Koc-Torcu, Basusta and Basusta (2008), Ilkyaz, Metin, Soykan and Kinacigil (2008), Hepkafadar (2008), Yigin and Ismen (2009), Ismen, Yigin, Altinagac and Ayaz (2009) northern and in the east coasts of Aegean Sea. In the present study, length-weight relationships were estimated for nine chondrichthyes fish species (*Dasyatis pastinaca* (Linnaeus, 1758), *Mustelus mustelus* (Linnaeus, 1758), *Myliobatis aquila* (Linnaeus, 1758), *Raja clavata* Linnaeus, 1758, *Raja miraletus* Linnaeus, 1758, *Raja radula* Delaroché, 1809, *Scyliorhinus canicula* (Linnaeus, 1758), *Scyliorhinus stellaris* (Linnaeus, 1758) and *Torpedo marmorata* Risso, 1810) captured in the Edremit Bay (North Aegean Sea) for which few data are available in the scientific literature. The present contribution aims to compensate for this lack of information.

Materials and Methods

Samples were collected at depths ranging from 20 to 100 m in Edremit Bay, North Aegean Sea at monthly sampling intervals using a commercial bottom trawl net from June 2007 to June 2009. Fishes were caught by using deep trawl nets with 24 mm cod end mesh size; tow duration was restricted to 30 min. Fish were measured to the nearest cm (total length) and weighed to the nearest g (total weight). The relationship between total length and weight, $W = aL^b$ was converted into its logarithmic expression: $\ln W = \ln a + b \ln L$. The parameters a and b were calculated by least-squares regression, as was the coefficient of determination (r^2). The b value for each species was tested by a t -test at the $P = 0.05$ significance level to verify if it was significantly different from 3. Species with too small a sample size ($N < 7$) were not taken into account. In the length weight equation a is the intercept and b is slope (=exponent) of the length-weight curve (King, 1996; Cakir-Turker *et al.*,

2008)

Results and Discussion

Analyzed were 284 individuals belonging to 16 Chondrichthyes species from 10 families: Lamnidae, 1 species; Cetorhinidae, 1; Scyliorhinidae 2; Triakidae 2; Squalidae 1; Torpenidae 1; Rajidae, 5; Dasyatidae, 1; Gymnuridae, 1; and Myliobatidae, 1 species. All sample sizes, minimum and maximum length and weight, parameters of length-weight relationship (a and b), and the coefficient of determination (r^2) are given in Table 1 for nine species where a sufficient n was available. In the present study the r^2 values ranged from 0.9768 for *M. mustelus* to 0.6365 for *S. stellaris*. The b values ranged from 2.1701 for *D. pastinaca* to 3.6397 for *S. stellaris*. The kind of growth given with t -test in Table 1. Two species (*D. pastinaca* and *T. marmorata*) showed $b < 2.5$, and in one case (*S. stellaris*) was $b > 3.5$. The mean value of b was 2.82 (SE = ± 0.15). Six species (*D. pastinaca*, *M. mustelus*, *R. clavata*, *R. miraletus*, *S. canicula* and *T. marmorata*) showed negative allometric, and three species (*M. aquila*, *R. radula* and *S. stellaris*) positive allometric growth in Table 1.

Descriptive statistics for seven species (*Carcharodon carcharias* (Linnaeus, 1758), *Cetorhinus maximus* (Gunnerus, 1765), *Galeorhinus galeus* (Linnaeus, 1758), *Gymnura altavela* (Linnaeus, 1758), *Leucoraja naevus* (Müller & Henle, 1841), *Rostroraja alba* (Lacépède, 1803), *Squalus acanthias* Linnaeus, 1758) where sample size was below 7 are presented in Table 2. Despite this small sampling, the length-weight relationship can be computed for these rare specimens (Froese, 2006). Previous studies providing length-weight relationships for some of the species are given in Table 3 for comparative purposes. As can be seen in Table 3, b values identified by other authors varied from 2.122 to 4.15. The mean value of b was 3.165 (SE = ± 0.025). The median value of b was 3.23, whereas 50% of the values ranged between 2.93 and 3.39 (Figure. 1). From the coefficient of the length-weight relationship for *S. canicula* and *M. mustelus*, it is seen that their weight

Table 1. Length-weight relationships for nine Chondrichthyes fish species caught in Edremit Bay, North Aegean Sea. (N: Sample Size; Min: Minimum; Max: Maximum; a and b , Intercept and Slope of Length-Weight Relationships; r^2 , Coefficient of Determination; C, Combined; -A: Negative Allometric; +A: Positive Allometric; 95% C.I. of b : 95% Confidence Intervals of b)

Species	Sex	N	Length (cm)		Weight (g)		Relationship parameters			Type of growth ($b=3$, $P=0.05$)	95% C.I. of b
			Min.	Max.	Min.	Max	a	B	r^2		
<i>Dasyatis pastinaca</i>	C	10	23.5	40.61	128	401.8	0.1306	2.1701	0.8645	-A	2.1701 \pm 0.095
<i>Mustelus mustelus</i>	C	60	39.4	75	2486	13940	0.1139	2.7088	0.9768	-A	2.7088 \pm 0.041
<i>Myliobatis aquila</i>	C	12	41.5	58.5	179.2	645	0.0014	3.1795	0.8742	+A	3.1795 \pm 0.069
<i>Raja clavata</i>	C	33	29.9	74.5	200	3400	0.0322	2.5597	0.8836	-A	2.5597 \pm 0.104
<i>Raja miraletus</i>	C	13	34.5	41.5	184.4	324.2	0.0215	2.5654	0.7152	-A	2.5654 \pm 0.045
<i>Raja radula</i>	C	23	25	51	98.4	1088	0.0029	3.2142	0.9262	+A	3.2142 \pm 0.072
<i>Scyliorhinus canicula</i>	C	108	246	830	63.67	2680	0.000006	2.8817	0.8138	-A	2.8817 \pm 0.281
<i>Scyliorhinus stellaris</i>	C	8	41.5	85	222.6	5804	0.0004	3.6397	0.6365	+A	3.6397 \pm 0.274
<i>Torpedo marmorata</i>	C	9	21	38	225	1275.1	0.1297	2.4665	0.8022	-A	2.4665 \pm 0.102

Table 2. Descriptive statistics for 7 Chondrichthyes fish species caught in Edremit Bay, North Aegean Sea (N: Sample Size; F: Female; M: Male; Min: Minimum; Max: Maximum)

Species	Sex	N	Total Length (cm)			Weight (g)		
			Min	Max	Mean	Min	Max	Mean
<i>Carcharodon carcharias</i>	F	1			180.0			47.5
<i>Cetorhinus maximus</i>	M	1			1180.0			2000000
<i>Galeorhinus galeus</i>	M	2	57.5	63	60.25	642.0	845.8	743.9
<i>Gymnura altavela</i>	F	1			66.0			725.0
<i>Leucoraja naevus</i>	M	1			47.0			815.0
<i>Rostroraja alba</i>	M	2	30.5	70.5	50,5	154.6	170.5	162.55
<i>Squalus acanthias</i>	M	2	65.5	70.2	67.85	850.0	920.0	885.0

Table 3. Length–weight relationship parameters of Chondrichthyes fish species obtained by other authors from coasts of Turkey (C: Combined; F:Female; M:Male; *: unidentified sex; TL:Total Length; DW:Disc Width; N:Sample size; a and b: Intercept and Slope of Length–Weight Relationships; r^2 , Coefficient of Determination)

Species	Area	Sex	Type of Length	Size Range (cm)	Weight (g)	N	a	b	r^2	Authors
<i>D. pastinaca</i>	North Aegean Sea	F	TL	40.3-68	392.42-1750	6	0.0108	2.8574	0.9808	Filiz and Mater (2002)
<i>D. pastinaca</i>	North Aegean Sea	M	TL	40.0-74.2	387.83-2955	8	0.0092	2.9334	0.978	Filiz and Mater (2002)
<i>D. pastinaca</i>	North Aegean Sea	C	TL	40-74.20	387.83-2955	14	0.0085	2.9379	0.9687	Filiz and Mater (2002)
<i>D. pastinaca</i>	İskenderun Bay	F	TL	20.5-88	*	110	0.00091	3.44	0.94	İsmen (2003)
<i>D. pastinaca</i>	İskenderun Bay	M	TL	20-73	*	146	0.00237	3.17	0.95	İsmen (2003)
<i>D. pastinaca</i>	İskenderun Bay	C	TL	20-88	*	256	0.00144	3.31	0.94	İsmen (2003)
<i>D. pastinaca</i>	North Aegean Sea	C	TL	37.3-74.2	333.23-2955	29	0.0149	2.81	0.85	Filiz and Bilge (2004)
<i>D. pastinaca</i>	North Aegean Sea	*	TL	29.2-37.8	*	12	0.1168	2.122	0.642	Karakulak <i>et al.</i> (2006)
<i>D. pastinaca</i>	Saros Bay	C	DW	20.5-66	282-14602	48	0.01259	3.3024	0.99	İsmen <i>et al.</i> (2007)
<i>D. pastinaca</i>	Izmir Bay	*	TL	44.2-138	*	16	0.0023	3.248	0.986	Ozaydin <i>et al.</i> (2007)
<i>D. pastinaca</i>	Northeastern Mediterranean	F	TL	29-100.9	45.3-6800.1	189	0.0025	3.186	0.97	Yeldan and Avsar (2007)
<i>D. pastinaca</i>	Northeastern Mediterranean	M	TL	23.4-69.5	22.5-2950.2	145	0.0014	3.338	0.95	Yeldan and Avsar (2007)
<i>D. pastinaca</i>	Northeastern Mediterranean	C	TL	23.4-109.9	22.5-6800.1	334	0.002	3.242	0.97	Yeldan and Avsar (2007)
<i>D. pastinaca</i>	Central Aegean Sea	C	DW	19-43.2	*	31	0.0102	3.37	0.984	Ilkyaz <i>et al.</i> (2008)
<i>D. pastinaca</i>	Saros Bay	M	TL	40-110.0	440-16560	26	0.00052	3.64	0.951	Yiğın and İsmen (2009)
<i>D. pastinaca</i>	Saros Bay	F	TL	37.5-114.0	282.4-14750	45	0.00078	3.54	0.956	Yiğın and İsmen (2009)
<i>D. pastinaca</i>	Saros Bay	C	TL	37.5-114.0	282.40-16560	71	0.00074	3.55	0.957	Yiğın and İsmen (2009)
<i>D. pastinaca</i>	Northeastern Mediterranean	C	TL	14.60-100.9	22.5-6800	346	0.0033	3.1429	*	Yeldan <i>et al.</i> (2009)
<i>D. pastinaca</i>	İskenderun Bay	M	DW	15-64	96-8660	195	0.0419	3.3169	0.84	Başusta <i>et al.</i> (2012)
<i>D. pastinaca</i>	North Aegean Sea	F	TL	37.5-114	282.4-14750	52	0.0008	3.507	0.96	Yiğın and İsmen (2012)
<i>D. pastinaca</i>	North Aegean Sea	M	TL	40-110	440-16560	32	0.0005	3.609	0.94	Yiğın and İsmen (2012)
<i>D. pastinaca</i>	Central Aegean Sea	F	TL	33.4-138	191.38-21100	42	0.9713	3.51	0.971	Eronat and Özaydin (2014)
<i>D. pastinaca</i>	Central Aegean Sea	M	TL	36.5-80	295.14-4000	36	0.0021	3.29	0.954	Eronat and Özaydin (2014)
<i>D. pastinaca</i>	Central Aegean Sea	C	TL	33.4-138	191.38-21100	78	0.0011	3.46	0.968	Eronat and Özaydin (2014)
<i>D. pastinaca</i>	İskenderun Bay	C	DW	16.60-69.30	94-10564	384	0.0252	3.0804	0.972	Girgin and Başusta (2016)
<i>G. altavela</i>	North Aegean Sea	C	TL	37.5-72	1188-9000	9	0.0268	2.96	0.98	Filiz and Bilge (2004)
<i>G. altavela</i>	Izmir Bay	C	TL	37.6-95	*	17	0.0449	2.84	0.986	Ozaydin <i>et al.</i> (2007)
<i>G. altavela</i>	Northeastern Mediterranean	F	TL	30.2-79.8	450.1-1500	69	0.0011	3.208	0.97	Yeldan and Avsar (2007)
<i>G. altavela</i>	Northeastern Mediterranean	M	TL	30.7-83.5	360.5-2400.1	38	0.0057	3.358	0.97	Yeldan and Avsar (2007)
<i>G. altavela</i>	Northeastern Mediterranean	C	TL	30.2-83.5	360.5-2400.1	107	0.009	3.234	0.98	Yeldan and Avsar (2007)
<i>G. altavela</i>	Central Aegean Sea	C	DW	47.1-88.3	*	9	0.0025	3.27	0.97	Ilkyaz <i>et al.</i> (2008)
<i>G. altavela</i>	İskenderun Bay	M	DW	30-127	250-15800	48	0.017	2.7948	0.73	Başusta <i>et al.</i> (2012)
<i>M. mustelus</i>	North Aegean Sea	F	TL	44-97.5	200-3170	10	0.0008	3.3066	0.9638	Filiz and Mater (2002)
<i>M. mustelus</i>	North Aegean Sea	M	TL	38.3-85.2	116.37-1988	14	0.0006	3.392	0.9829	Filiz and Mater (2002)
<i>M. mustelus</i>	North Aegean Sea	C	TL	38.3-97.5	116.37-3170	24	0.0008	3.3259	0.9745	Filiz and Mater (2002)
<i>M. mustelus</i>	North Aegean Sea	C	TL	38.3-97.5	116.37-3170	35	0.0011	3.25	0.97	Filiz and Bilge (2004)
<i>M. mustelus</i>	Saros Bay	C	TL	58.9-152.2	560-14430	26	0.00131	3.1895	0.986	İsmen <i>et al.</i> (2007)
<i>M. mustelus</i>	Izmir Bay	C	TL	51.4-95.5	*	17	0.0044	2.912	0.982	Ozaydin <i>et al.</i> (2007)
<i>M. mustelus</i>	Izmir Bay	F	TL	38.9-141.1	400-7500	110	0.1353	2.2187	0.902	Hepkafadar (2008)
<i>M. mustelus</i>	Izmir Bay	M	TL	34.0-138.1	500-7300	80	0.0902	2.311	0.9073	Hepkafadar (2008)
<i>M. mustelus</i>	Izmir Bay	C	TL	34.0-141.1	400-7500	190	0.106	2.274	0.91	Hepkafadar (2008)
<i>M. mustelus</i>	Central Aegean Sea	C	TL	25.6-125.1	*	148	0.0027	3.05	0.979	Ilkyaz <i>et al.</i> (2008)

Table 3. Continued

Species	Area	Sex	Type of Length	SizeRange(cm)	Weight (g)	N	a	b	r ²	Authors
M. mustelus	Saros Bay	F	TL	49-152.2	382-14431	24	0.0025	3.0583	0.991	Ismen <i>et al.</i> (2009)
M. mustelus	Saros Bay	M	TL	46.8-148.3	390-10270	46	0.0036	2.964	0.987	Ismen <i>et al.</i> (2009)
M. mustelus	Saros Bay	C	TL	46.8-152.2	382-14431	70	0.0034	2.9789	0.988	Ismen <i>et al.</i> (2009)
M. mustelus	Antalya Bay	F	TL	52.6-87.4	565.2-2260	4	0.0974	2.77	0.999	Guven <i>et al.</i> (2011)
M. mustelus	Central Aegean Sea	F	TL	42-113.3	190-4780	13	0.0017	3.16	0.971	Eronat and Özaydin (2014)
M. mustelus	Central Aegean Sea	M	TL	41.8-91.5	121.8-2690	28	0.0006	3.39	0.981	Eronat and Özaydin (2014)
M. mustelus	Central Aegean Sea	C	TL	41.8-113.3	121.8-4780	41	0.001	3.27	0.971	Eronat and Özaydin (2014)
M. aquila	North Aegean Sea	C	TL	47.5-76.5	274.09-1500	14	0.0008	3.34	0.93	Filiz and Bilge (2004)
M. aquila	Saros Bay	C	TL	23.5-100	184-12990	14	0.01252	3.0233	0.971	Ismen <i>et al.</i> (2007)
M. aquila	Central Aegean Sea	C	TL	23.5-54.5	*	39	0.0058	3.28	0.986	Ilkyaz <i>et al.</i> (2008)
M. aquila	Saros Bay	F	TL	41-121	146-12990	33	0.00007	3.89	0.934	Yiğın and Ismen (2009)
M. aquila	Saros Bay	M	TL	29.5-90.5	120-2848	33	0.00139	3.15	0.918	Yiğın and Ismen (2009)
M. aquila	Saros Bay	C	TL	29.5-121	120-12990	66	0.00027	3.56	0.916	Yiğın and Ismen (2009)
R. clavata	North Aegean Sea	F	TL	20.5-99	28.86-2614.28	21	0.0018	3.2532	0.9281	Filiz and Mater (2002)
R. clavata	North Aegean Sea	M	TL	29.7-67	94.36-1934.8	8	0.0006	3.5629	0.9839	Filiz and Mater (2002)
R. clavata	North Aegean Sea	C	TL	20.5-99	28.86-2614.28	29	0.0016	3.2914	0.9337	Filiz and Mater (2002)
R. clavata	North Aegean Sea	C	TL	20.5-99	28.86-2614.28	37	0.0016	3.3	0.94	Filiz and Bilge (2004)
R. clavata	Southeastern Black Sea	F	TL	34.3-88.2	170-5450	*	0.0003	3.7	0.94	Demirhan <i>et al.</i> (2005)
R. clavata	Southeastern Black Sea	M	TL	48-95	620-5000	*	0.005	3.02	0.96	Demirhan <i>et al.</i> (2005)
R. clavata	Southeastern Black Sea	C	TL	34.3-95	170-5450	*	0.001	3.42	0.91	Demirhan <i>et al.</i> (2005)
R. clavata	Saros Bay	C	DW	6.0-60.0	5.0-4610.0	112	0.013	3.1163	0.997	Ismen <i>et al.</i> (2007)
R. clavata	Northeastern Mediterranean	F	TL	29.3-64.6	110-1120.1	30	0.0046	3.032	0.99	Yeldan and Avsar (2007)
R. clavata	Northeastern Mediterranean	M	TL	38.9-57.8	208-995.1	47	0.002	3.232	0.97	Yeldan and Avsar (2007)
R. clavata	Northeastern Mediterranean	C	TL	29.3-64.6	110-1120.1	77	0.0037	3.08	0.98	Yeldan and Avsar (2007)
R. clavata	Northeastern Mediterranean	F	TL	29.3-64.6	110-1120	37	0.047	3.0174	0.98	Yeldan <i>et al.</i> (2008)
R. clavata	Northeastern Mediterranean	M	TL	35.9-57.8	208-995	53	0.012	3.3884	0.99	Yeldan <i>et al.</i> (2008)
R. clavata	Northeastern Mediterranean	C	TL	29.3-64.6	110-1120	90	0.0034	3.1003	0.99	Yeldan <i>et al.</i> (2008)
R. clavata	Central Aegean Sea	C	DW	29-51.3	*	24	0.0335	2.89	0.956	Ilkyaz <i>et al.</i> (2008)
R. clavata	Saros Bay	F	TL	10.0-88.0	5.0-4622.0	128	0.00181	3.31	0.991	Yiğın and Ismen (2009)
R. clavata	Saros Bay	M	TL	11.0-76.0	6.30-2900	98	0.00146	3.34	0.991	Yiğın and Ismen (2009)
R. clavata	Saros Bay	C	TL	10.0-88.0	5.0-4622.0	226	0.00163	3.32	0.99	Yiğın and Ismen (2009)
R. clavata	Sea of Marmara	C	TL	12.2-70	0.015-2628	24	0.00001	2.867	0.893	Bök <i>et al.</i> (2011)
R. clavata	Sea of Marmara	F	DW	10.5-65.0	*	35	0.028	2.9	0.981	Demirel and Dalkara (2012)
R. clavata	Sea of Marmara	M	DW	9.6-45.0	*	23	0.028	2.887	0.99	Demirel and Dalkara (2012)
R. clavata	Sea of Marmara	C	DW	9.6-65.0	*	170	0.113	2.42	0.774	Demirel and Dalkara (2012)
R. clavata	Central Aegean Sea	F	TL	12.6-70.2	6.01-2160	78	0.0007	3.48	0.991	Eronat and Özaydin (2014)
R. clavata	Central Aegean Sea	M	TL	12.7-60.5	5.97-1200	59	0.0007	3.5	0.974	Eronat and Özaydin (2014)
R. clavata	Central Aegean Sea	C	TL	12.6-70.2	5.97-2160	137	0.0006	3.52	0.963	Eronat and Özaydin (2014)
R. clavata	İskenderun Bay	M	DW	25-70	145-2260	38	0.023	2.6421	0.76	Başusta <i>et al.</i> (2012)

Table 3. Continued

Species	Area	Sex	Type of Length	SizeRange (cm)	Weight (g)	N	a	b	r ²	Authors
<i>R. miraletus</i>	North Aegean Sea	C	TL	30-56.5	100.01-1000.54	13	0.0001	4.0173	0.9251	Filiz and Mater (2002)
<i>R. miraletus</i>	North Aegean Sea	C	TL	30-50.5	100-900	13	0.0001	4.15	0.93	Filiz and Bilge (2004)
<i>R. miraletus</i>	Saros Bay	C	DW	6.5-30.5	6-530	30	0.00891	3.2231	0.968	Ismen <i>et al.</i> (2007)
<i>R. miraletus</i>	Izmir Bay	C	TL	39-53.5	*	12	0.0063	2.948	0.969	Ozaydin <i>et al.</i> (2007)
<i>R. miraletus</i>	Saros Bay	F	TL	25.5-47.7	90-530	29	0.00175	3.28	0.924	Yiğın and Ismen (2009)
<i>R. miraletus</i>	Saros Bay	M	TL	10.5-53.5	5.82-1010	23	0.00246	3.15	0.952	Yigin and Ismen (2009)
<i>R. miraletus</i>	Saros Bay	C	TL	10.5-53.5	5.82-1010	52	0.00173	3.27	0.951	Yiğın and Ismen (2009)
<i>R. miraletus</i>	İskenderun Bay	M	DW	24-54	58-998	11	0.0021	3.262	0.95	Başusta <i>et al.</i> (2012)
<i>R. radula</i>	Northern Aegean Sea	C	TL	17.4-70	*	25	0.003	3.217	0.937	Karakulak <i>et al.</i> (2006)
<i>R. radula</i>	Saros Bay	C	DW	12.5-39	46-1661	49	0.01131	3.2491	0.981	Ismen <i>et al.</i> (2007)
<i>R. radula</i>	Northeastern Mediterranean	F	TL	22.6-68.1	25.6-1610	144	0.0013	3.354	0.99	Yeldan and Avsar (2007)
<i>R. radula</i>	Northeastern Mediterranean	M	TL	21.1-58.1	26.4-1102.5	152	0.0011	3.363	0.98	Yeldan and Avsar (2007)
<i>R. radula</i>	Northeastern Mediterranean	C	TL	21.1-68.1	25.6-1610	295	0.0012	3.358	0.99	Yeldan and Avsar (2007)
<i>R. radula</i>	Saros Bay	F	TL	17-61	40-1661	118	0.00199	3.34	0.974	Yiğın and Ismen (2009)
<i>R. radula</i>	Saros Bay	M	TL	19-54	46-1112	86	0.00251	3.25	0.972	Yiğın and Ismen (2009)
<i>R. radula</i>	Saros Bay	C	TL	17-61	40-1661	204	0.00205	3.32	0.971	Yiğın and Ismen (2009)
<i>R. radula</i>	Central Aegean Sea	F	TL	43.2-61.2	480-1604	10	0.0018	3.33	0.946	Eronat and Özaydin (2014)
<i>R. radula</i>	Central Aegean Sea	M	TL	41.5-57.4	418.58-1160	6	0.0035	3.14	0.959	Eronat and Özaydin (2014)
<i>R. radula</i>	Central Aegean Sea	C	TL	41.5-61.2	418.58-1604	16	0.0017	3.33	0.94	Eronat and Özaydin (2014)
<i>R. alba</i>	Saros Bay	C	DW	9.5-93	8-11723	43	0.00662	3.2012	0.994	Ismen <i>et al.</i> (2007)
<i>R. alba</i>	Izmir Bay	C	TL	25.2-53.4	*	11	0.009	3.478	0.985	Ozaydin <i>et al.</i> (2007)
<i>R. alba</i>	Central Aegean Sea	C	DW	16.1-35.2	*	5	0.0083	3.13	0.99	Ilkyaz <i>et al.</i> (2008)
<i>R. alba</i>	Saros Bay	F	TL	18.1-159	16-33000	67	0.00216	3.25	0.968	Yiğın and Ismen (2009)
<i>R. alba</i>	Saros Bay	M	TL	14-135	7.93 -14500	59	0.00167	3.3	0.995	Yiğın and Ismen (2009)
<i>R. alba</i>	Saros Bay	C	TL	14 -159	7.93- 33000	126	0.00194	3.27	0.98	Yiğın and Ismen (2009)
<i>R. alba</i>	Aegean Sea	C	TL	26.1-52	*	12	0.0021	3.214	0.99	Yapici <i>et al.</i> (2015)
<i>R. alba</i>	Central Aegean Sea	F	TL	25.1-124	74-15000	6	0.0014	3.35	0.997	Eronat and Özaydin (2014)
<i>R. alba</i>	Central Aegean Sea	C	TL	25.1-124	74-15000	10	0.0016	3.32	0.997	Eronat and Özaydin (2014)
<i>S. canicula</i>	North Aegean Sea	C	TL	10.5-50.9	2.68-466.23	637	0.0012	3.26	0.99	Filiz and Bilge (2004)

Table 3. Continued

Species	Area	Sex	Type of Length	Size Range(cm)	Weight (g)	N	a	b	r ²	Authors
<i>S. canicula</i>	Edremit Bay	C	TL	24.6-78.6	63.67-2424	291	0.000006	2.9276	0.8266	Turker-Cakir <i>et al.</i> (2005)
<i>S. canicula</i>	Edremit Bay	C	TL	246-786	63.67-2424	112	0.000002	3.0999	0.864	Cakir-Turker <i>et al.</i> (2008)
<i>S. canicula</i>	Saros Bay	C	TL	9.6-62	2-956	150 1	0.00169	3.1709	0.993	Ismen <i>et al.</i> (2007)
<i>S. canicula</i>	Izmir Bay	C	TL	28.6-51.5	*	187	0.0006	3.437	0.954	Ozaydin <i>et al.</i> (2007)
<i>S. canicula</i>	Central Aegean Sea	F	TL	24.7-48.5	*	350	0.0006	3.48	0.959	Ilkyaz <i>et al.</i> (2008)
<i>S. canicula</i>	Central Aegean Sea	M	TL	25.5-51.2	*	394	0.0015	3.22	0.962	Ilkyaz <i>et al.</i> (2008)
<i>S. canicula</i>	Central Aegean Sea	C	TL	24.7-51.2	*	744	0.0012	3.29	0.955	Ilkyaz <i>et al.</i> (2008)
<i>S. canicula</i>	Saros Bay	C	TL	9.6-91.3	2.1-955.8	188 8	0.0017	3.1735	0.976	Ismen <i>et al.</i> (2009)
<i>S. canicula</i>	Antalya Bay	F	TL	9-38.5	2-205.3	312	0.001	3.33	0.951	Guvan <i>et al.</i> (2011)
<i>S. canicula</i>	Antalya Bay	M	TL	11.9-38.4	3.6-182.6	335	0.0014	3.22	0.979	Guvan <i>et al.</i> (2011)
<i>S. canicula</i>	Antalya Bay	C	TL	9-38.5	2-205.3	647	0.0012	3.27	0.963	Guvan <i>et al.</i> (2011)
<i>S. canicula</i>	Sea of Marmara	F	TL	25.3-50	*	30	0.021	2.471	0.817	Demirel and Dalkara (2012)
<i>S. canicula</i>	Sea of Marmara	M	TL	25-41.7	*	31	0.002	3.041	0.825	Demirel and Dalkara (2012)
<i>S. canicula</i>	Sea of Marmara	C	TL	20-50	*	189	0.004	2.869	0.868	Demirel and Dalkara (2012)
<i>S. canicula</i>	Central Aegean Sea	F	TL	7.8-50.9	0.63-461.66	620	0.0011	3.27	0.983	Eronat and Özaydin (2014)
<i>S. canicula</i>	Central Aegean Sea	M	TL	7.8-51.2	0,31-458	590	0.0012	3.25	0.973	Eronat and Özaydin (2014)
<i>S. canicula</i>	Central Aegean Sea	C	TL	7.8-51.2	0.31-461.66	121 0	0.0012	3.26	0.978	Eronat and Özaydin (2014)
<i>S. stellaris</i>	Central Aegean Sea	C	TL	24.1-78.2	*	11	0.002	3.23	0.995	Ilkyaz <i>et al.</i> (2008)
<i>S. stellaris</i>	Izmir Bay	C	TL	14.5-71	*	34	0.0065	2.817	0.975	Ozaydin <i>et al.</i> (2007)
<i>S. stellaris</i>	Saros Bay	C	TL	16.5-61.6	12.2-1049.3	12	0.0009	3.3653	0.996	Ismen <i>et al.</i> (2009)
<i>S. stellaris</i>	Central Aegean Sea	F	TL	41.6-46.6	265.84-423.26	5	0.0002	3.78	0.658	Eronat and Özaydin (2014)
<i>S. stellaris</i>	Central Aegean Sea	M	TL	25.8-69.7	60.13-1685.6	14	0.0006	3.46	0.968	Eronat and Özaydin (2014)
<i>S. stellaris</i>	Central Aegean Sea	C	TL	25.8-69.7	60.13-1685.6	19	0.0006	3.46	0.964	Eronat and Özaydin (2014)
<i>S. acanthias</i>	North Aegean Sea	F	TL	27-70.5	79.64-1790.14	16	0.0112	2.7745	0.9063	Filiz and Mater (2002)
<i>S. acanthias</i>	North Aegean Sea	M	TL	38-56.5	233.14-783.86	16	0.0023	3.1823	0.9941	Filiz and Mater (2002)
<i>S. acanthias</i>	North Aegean Sea	C	TL	27-70.5	79.64-1790.14	32	0.0031	3.1056	0.9814	Filiz and Mater (2002)
<i>S. acanthias</i>	Aegean Sea	C	TL	27-70.5	79.64-1790.14	32	0.0031	3.11	0.98	Filiz and Bilge (2004)
<i>S. acanthias</i>	Southern Black Sea	F	TL	*	*	151	0.0000004	3.51	0.97	Demirhan and Seyhan (2007)
<i>S. acanthias</i>	Southern Black Sea	M	TL	*	*	24	0.0000008	3.32	0.98	Demirhan and Seyhan (2007)
<i>S. acanthias</i>	Saros Bay	F	TL	17.1-115	20-5784	312	0.0027	3.128	0.975	Ismen <i>et al.</i> (2009)
<i>S. acanthias</i>	Saros Bay	M	TL	20.8-87.5	36-2452	253	0.0072	2.8678	0.956	Ismen <i>et al.</i> (2009)
<i>S. acanthias</i>	Saros Bay	C	TL	17.1-115	20-5784	565	0.0037	3.0477	0.967	Ismen <i>et al.</i> (2009)
<i>S. acanthias</i>	Sea of Marmara	C	TL	41-52	500-950	8	0.00003	2.619	0.957	Bök <i>et al.</i> (2011)
<i>T. marmorata</i>	North Aegean Sea	F	TL	11.0-25.0	27.15-340	11	0.0274	2.9227	0.9933	Filiz and Mater(2002)
<i>T. marmorata</i>	North Aegean Sea	M	TL	9.6-20.5	23.51-156.94	9	0.1191	2.3461	0.9295	Filiz and Mater(2002)
<i>T. marmorata</i>	North Aegean Sea	C	TL	9.6-25	23.51-340	20	0.0488	2.6935	0.9584	Filiz and Mater(2002)
<i>T. marmorata</i>	North Aegean Sea	C	TL	9.2-34	14.88-862.11	37	0.0273	2.91	0.98	Filiz and Bilge (2004)
<i>T. marmorata</i>	North Aegean Sea	C	TL	16.4-38.9	*	22	0.0139	3.103	0.952	Karakulak <i>et al.</i> (2006)
<i>T. marmorata</i>	Saros Bay	C	TL	13.2-28.6	52-450	20	0.0592	2.6433	0.987	Ismen <i>et al.</i> (2007)
<i>T. marmorata</i>	Izmir Bay	C	TL	10.3-37	*	12	0.0535	2.639	0.981	Ozaydin <i>et al.</i> (2007)
<i>T. marmorata</i>	Central Aegean Sea	C	TL	9.9-42	*	35	0.0232	2.98	0.99	Ilkyaz <i>et al.</i> (2008)

Table 3. Continued

Species	Area	Sex	Type of Length	Size Range (cm)	Weight (g)	N	a	b	r ²	Authors
T. marmorata	İskenderun Bay	F	TL	15.2-40	56-1308	61	0.017	3.0396	0.922	Duman and Başusta (2013)
T. marmorata	İskenderun Bay	M	TL	9.3-30.3	16-474	56	0.0315	2.8171	0.9217	Duman and Başusta (2013)
T. marmorata	İskenderun Bay	C	TL	9.3-40	16-1308	117	0.0195	2.9856	0.9263	Duman and Başusta (2013)
T. marmorata	Central Aegean Sea	F	TL	9.6-39.3	7.98-1310.42	59	0.0188	3.02	0.985	Eronat and Özaydin (2014)
T. marmorata	Central Aegean Sea	M	TL	10-27.9	24.57-413.29	48	0.0365	2.79	0.985	Eronat and Özaydin (2014)
T. marmorata	Central Aegean Sea	C	TL	9.6-39.3	7.98-1310.42	107	0.023	2.96	0.939	Eronat and Özaydin (2014)

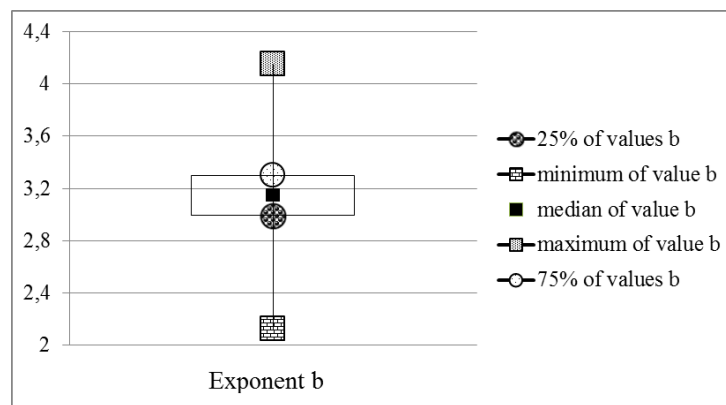


Figure 1.: Box-Whiskers plots of the exponent b of the LWR of the other studys for 12 species from coasts of Turkey. . The central box covers 50% of data values, the horizontal line indicates the median, and the vertical line represents the range of the values

increases rapidly with growth. The length–weight relationship constants of *S. canicula* and *M. mustelus* from Edremit Bay were similar to the the North Aegean Sea data calculated by Cakir-Turker *et al.* (2008) and Ozaydin *et al.* (2007). The results obtained from this study are useful to fisheries scientists, because the data were sampled from a relatively undisturbed area. *S. stellaris* had no length–weight relationship available in Fishbase (Froese & Pauly, 2017) and hence our results contribute to the knowledge of this species. The length ranges covered for each species should be considered when using parameters of length-weight relationships, as to some extent the smallest specimens may change the parameters. The differences in b values may be attributed to one or more factors: the season and effects of different areas, differences in water temperature and salinity, sex, food availability, differences in the number of specimens examined, as well as in the observed length ranges of the species caught. Differences in the sampling design may also affect the relationships, as the numbers of specimens and length ranges of the species were distinct among localities (Tesch, 1971; Sparre, Ursin & Venema, 1998; Mommsen, 1998; Moutopoulos & Stergiou, 2002; Froese, 2006). The results obtained in this study are

useful to fishery scientists because the data were sampled from a relatively undisturbed area. Length–weight relationship for *S. stellaris* was not yet available in Fishbase (Froese & Pauly, 2017) and hence these results contribute to our knowledge of this species.

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