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Length-Weight Relationships of 17 Teleost Fishes in the Marmara Sea, Turkey

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ABSTRACT
Length weight relationship parameters were determined for 17 fish (*Arnoglossus kessleri, Blennius ocellaris, Callionymus lyra, Cepola macrophthalma, Citharus linguatula, Lesueurigobius friesii, Merluccius merluccius, Lophius piscatorius, Merlangius merlangus, Gobius niger, Mullus barbatus, Solea solea, Spicara maena, Serranus hepatus, Trachurus trachurus, Trachurus mediterraneus, Uranoscopus scober*) species in the Marmara Sea. Fish samples were collected monthly bases between September of 2011 and July of 2014 with a beam trawl. The growth type of each species were determined and the calculated b values changed in range from 1.2565 to 3.4018.

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Marmara Denizi'nde 17 Kemikli Balığın Boy-Ağırlık İlişkisi

ÖZET
Marmara Denizi'nde 17 balık türünde (*Arnoglossus kessleri, Blennius ocellaris, Callionymus lyra, Cepola macrophthalma, Citharus linguatula, Gobius niger, Lesueurigobius friesii, Lophius piscatorius, Merluccius merluccius, Merlangius merlangus, Mullus barbatus, Solea solea, Spicara maena, Serranus hepatus, Trachurus trachurus, Trachurus mediterraneus, Uranoscopus scober*) boy ağırlık ilişkisi parametreleri belirlenmiştir. Balık örnekleri algarna ile Eylül 2011-Temmuz 2014 tarihleri arasında aylık olarak toplanmıştır. Herbir türün büyüme tipi belirlenmiştir ve hesaplanan b değerleri 1.2565 - 3.4018 arasında değişmiştir.

Araştırma Makalesi

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INTRODUCTION

The morphometric relationships especially length and weight parameters are highly crucial for fisheries science, and population stock assessment studies. It gives information about the growth type of fish, whether growth is isometric or allometric. (Ricker, 1975; Erzini, 1994). The knowledge on length and weight relationship of fishes from varied geographical areas, allows researchers to understand growth and condition differences of same species. The growth in weight for individual basis and biomass can be estimated if the length frequency distributions are known (Goncalves et al., 1997; Petrakis and Stergiou, 1995; Pauly, 1993).

Some of previous studies were conducted on the length and weight relationship of fishes in Black Sea (Erkoyuncu et al., 1994; Kalaycı et al., 2007; Ak et al., 2009; Kasapoğlu and Düzgüneş, 2013), in Aegean Sea (Karakulak et al., 2006; Özaydın and Taşkavak, 2006; Gökçe et al., 2007; İlkyaz et al., 2008) and in Mediterranean (Can et al., 2002; Çiçek et al., 2006, Sangun et al., 2007). Although some of other previous studies were conducted relating the length and weight relationship of fishes in the Sea of Marmara (Keskin and Gaygusuz, 2010; Bok et al., 2011; Demirel and Dalkara, 2012), these studies were approached in a confined geographical area. While Keskin and Gaygusuz (2010) were studied the Northern Sea of Marmara, Bok et al. (2011) were studied in Erdek Bay. In addition to this, Demirel and Dalkara (2012) were studied at 17 stations in the Sea of Marmara.

Aim of this study was to determine the length and weight relationships of some fish species reflecting the current situation of stock structure. The demersal fish distributed in the Sea of Marmara has under the influence of high fishing pressure and benthic pollution. According to these restricted factors related the growth, we aimed to reveal the updated length and weight relationships of species representing of the demersal life of the Marmara Sea.

MATERIAL and METHOD

The 17 fish species individuals were collected from 229 sampling locations of Marmara Sea, Turkey using beam trawl with a cod end 32 mm mesh size. The beam trawl had 5 m width and 50 cm mouth opening. It was donated with a single bag with 6 fathom length and 32 mm mesh size. The tows were conducted between 50 and 150 m. Monthly surveys were performed in each location from September of 2011 to July of 2014 (Figure 1). Fish samples were identified and measured from 0.1 cm length (TL) and 0.01 g weight (W) fish individuals. All length-weight relationships were calculated using the least-squares fitting method to estimate a and b parameters of equation-1 (Sparre et al. 1989)

$$W = a \times L^b, \quad (1)$$

where W is the weight of the fish in grams, L is the total length in cm, and a a is a coefficient related to body form, and b is an exponent indicating isometric growth when equal to 3. The growth type was identified according to equation-2 (Sokal and Rohlf, 1987)

$$ts = (b - 3)/SE(b) \quad (2)$$

where ts is a t-test value, b is a slope, and SE(b) is a standard error of the slope. According to t-test value of b, the growth type was determined as isometric (b=3), negative allometric (b<3), and positive allometric (b>3). All the statistical analyses were evaluated at a 5% significance level (p<0.05).

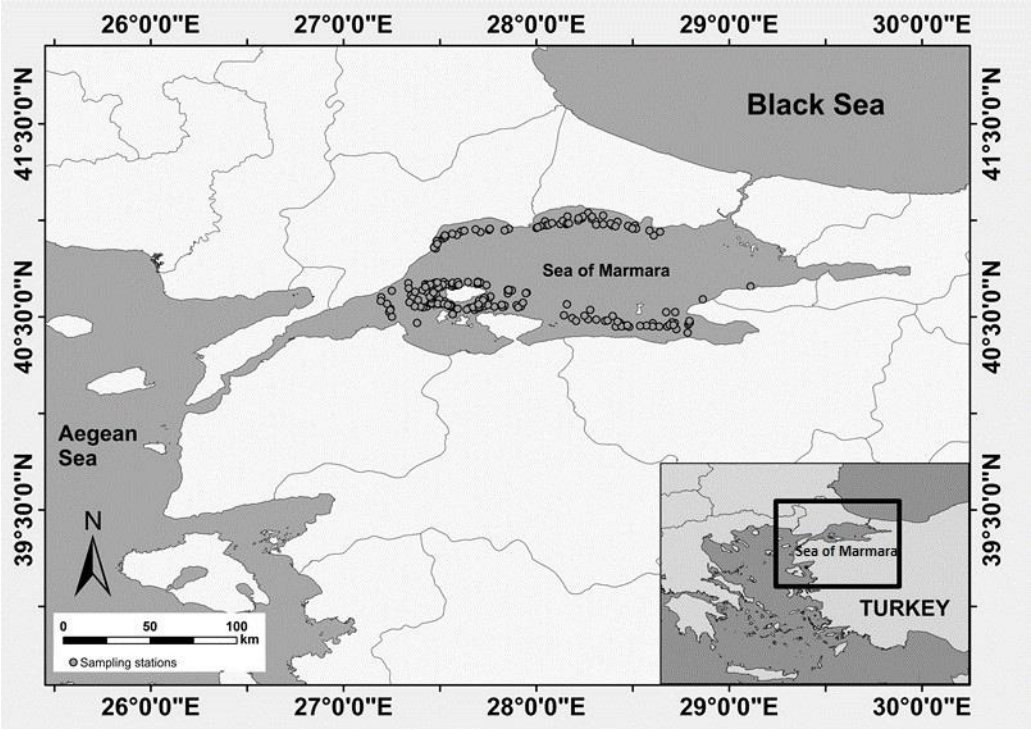

Figure 1. Sampling stations in the Sea of Marmara.
Şekil 1. Marmara Denizi'nde örnekleme noktaları.

RESULTS

The length-weight relationships of 17 fish species (*Arnoglossus kessleri, Blennius ocellaris, Callionymus lyra, Cepola macrophthalma, Citharus linguatula, Gobius niger, Lesueurigobius friesii, Lophius piscatorius, Merluccius merluccius, Merlangius merlangus, Mullus barbatus, Solea solea, Spicara maena, Serranus hepatus, Trachurus trachurus, Trachurus mediterraneus, Uranoscopus scober*) belonging to 16 families in a total of 13,030 individuals were calculated. The fish species, number of individuals, size intervals and mean values (cm and g), coefficient, exponent values (a and b) of length-weight relationship parameters, the standard error of the b, the correlation factor (r^2) and the growth types are presented in Table 1 for each species, respectively.

Correlation coefficient values (R^2) were mostly higher than 0.90. Relatively lower R^2 value was calculated for *C.macrophthalma* (R^2 =0,56) and *L.friesii* (R^2 =0,63). The exponent b values ranged between 1.2565 (*C.macrophthalma*) and 3.4018 (*Spicara maena*) with a mean of 2.8738. In terms of fish growth, b value is supposed to range between 2.5 and 3.5 (Froese, 2006). The b values of the fifteen of 17 species presented in this study were in the range of supposed interval. However, the b values of *C.macrophthalma* and *L.friesii* were found below 2.5. Regarding to the type of growth, four species (*L. piscatorius, M. merluccius, M. merlangus* and *S. maena*) showed positive allometry, nine species (*A. kessleri, B. ocellaris, C. linguatula, G.niger, M.barbatus, S. hepatus, T.trachurus, T.mediterraneus* and *U.scaber*) showed isometry and

Table 1. Descriptive statistics and estimated parameters of weight–length relationship

Species (*Türler*)	n	Length Interval (cm) (*Boy Aralığı*) Min-max (Ave±CI(95%))	Weight Interval (g) (*Ağırlık Aralığı*) Min-max (Ave±CI(95%))	LWR Parameters (*Boy Ağırlık İlişkisi Parametreleri*)					
				a	b	SE(b)	R^2	p	G
Arnoglossus kessleri	917	4.90-13.00 8.90±0.0405	0.79-20.43 5.26±0.0824	0.008140	2.9270	0.039390	0.8578	>0,05	I
Blennius ocellaris	44	7.20-13.10 10.46±0.185	5.39-32.10 17.88±0.903	0.013870	3.0322	0.143319	0.9142	>0,05	I
Callionymus lyra	345	6.00-22.20 14.48±0.150	1.07-60.40 23.15±0.603	0.019548	2.6136	0.071341	0.7965	<0,05	-A
Cepola macrophthalma	97	8.50-50.20 22.38±0.701	1.65-24.52 9.13±0.451	0.174119	1.2565	0.112750	0.5666	<0.05	-A
Citharus linguatula	1597	4.80-24.00 12.99±0.0754	0.84-113.10 19.12±0.418	0.007012	3.0131	0.014450	0.9646	>0.05	I
Gobius niger	331	6.20-14.20 10.29±0.0833	2.85-36.25 13.71±0.340	0.009595	3.0848	0.053755	0.9092	>0.05	I
Lesueurigobius friesii	2856	3.80-9.40 7.42±0.0130	0.87-6.70 3.06±0.0138	0.040605	2.1457	0.030540	0.6336	<0.05	-A
Lophius piscatorius	25	10.00-39.10 23.42±1.74	9.11-835.90 243.30±45.6	0.003952	3.3698	0.131198	0.9663	<0.05	+A
Merluccius merluccius	1376	5.5-40.7 18.23±0.166	0.92-590.0 64.00±1.79	0.0051	3.1377	0.011974	0.9804	<0.05	+A
Merlangius merlangus	1287	6.40-24.02 11.93±0.076	1.75-106.07 14.5±0.346	0.005878	3.0763	0.017184	0.9614	<0.05	+A
Mullus barbatus	44	7.90-20.20 12.74±0.309	5.54-83.77 24.26±2.10	0.014930	2.8731	0.150243	0.8970	>0.05	I
Solea solea	36	9.10-31.20 21.99±0.852	6.48-328.36 105.41±9.99	0.014260	2.8383	0.078724	0.9745	<0.05	-A
Spicara maena	76	8.40-18.10 13.03±0.202	5.39-82.34 28.08±1.52	0.004195	3.4018	0.084280	0.9566	<0.05	+A
Serranus hepatus	2974	3.60-13.40 8.38±0.0228	0.61-37.80 10.58±0.0908	0.016654	3.0016	0.015045	0.9305	>0.05	I
Trachurus trachurus	286	7.80-18.10 10.72±0.0700	3.79-50.01 10.55±0.234	0.010291	2.9060	0.054138	0.9103	>0.05	I
Trachurus mediterraneus	717	6.20-16.60 10.42±0.0508	2.91-25.90 9.07±0.150	0.006677	3.0515	0.036796	0.9058	>0.05	I
Uranoscopus scaber	22	9.20-21.00 16.38±0.574	13.30-176.83 90.17±8.96	0.013316	3.1258	0.09375	0.9832	>0.05	I

Species listed in alphabetical order. n: sample size; L: length type; min: minimum; max: maximum; ave: average; CI: Confidence interval; *a* and *b* relationship parameters; SE(b): Standart error b; R^2: Coefficient of determination; G: growth type, I: isometric, +A: positive allometry, -A: negative allometry.

four species (*C.lyra*, *C.macrophthalma, L.friesii* and *S.solea*) showed negative allometry. *S.hepatus* can be considered as the most isometric growth fish (*b*=3,0016). Length-weight relationship parameters of mentioned species were compared with previous studies conducted around the Marmara Sea (Table 2). Examining previous studies conducted in the Marmara Sea, length-weight relationship parameters of *B. ocellaris* and *L. friesii*, were given only by Bök et al. (2011), *C. linguatula* and *T. mediterraneus* were given only by Demirel and Dalkara (2012) and *A. kessleri* was given only by Keskin and Gaygusuz (2010). The length–weight relationship parameters of the remaining species presented in this study were calculated in several studies in the Sea of Marmara. In terms of less-studied species, the length–weight relationship parameters of *L.friesii* in this study coincide with Bök et al. (2011)'s findings, and growth type was calculated as negative allometric in both two studies. Also, in present study, the growth type of *C.linguatula was found as* negative allometry, which was also presented by both Demirel and Dalkara (2012)'s. Length–weight relationship parameters of some species presented in this study did not overlap with the findings of previous works. While the growth type of *B.ocellaris* and *T.mediterraneus* were calculated as isometric, negative allometry was reported for *B.ocellaris* by Bök et al. (2011) and for *T. mediterraneus* by Demirel and Dalkara (2012). Also, in current study, the growth type of *A.kessleri* was determined as isometric, yet, Keskin and Gaygusuz (2010) was found as positive allometric. These differences on length–weight relationship parameters may be associated with the usage of various sampling gears (beach seines, bottom trawls, etc). Although the same fishing gear was used, some differences were also detected. Such differences in *b* values may occur as a result of geographical or environmental variations. The growth type of *C. macrophthalma* was found as a negative allometric in all studies conducted in the Sea of Marmara. It is thought that this situation is related to body shape rather than the reasons explained above.

Also the *b* values were compared with the studies conducted in the Black Sea, Aegean Sea and the Eastern Mediterranean Sea (Table 3). There was no study in the literature about length-weight relationships of *C. lyra*. It was understood that the length-weight relationships of some species such as *A. kessleri, L. friesii* and *S. solea* were rare. As can be seen in Table 3, the *b* values of some species did not differ due to geographical area. The *b* values of *C. macropthalma* were calculated under 2 in all four studies conducted in the Aegean Sea, as well as the Sea of Marmara. The negative allometry is caused by the ribbon-like body structure independently of geographical variation. It was observed that the growth type of *M. merlangus* showed exactly isometry from both studies realized in Turkish Seas. The highest variation on *b* values between the studies were observed for *C. linguatula*. In the present study, some species sustained lower *b* values (*L. friesii, M. barbatus* and *S. solea*), while others had higher (*L. piscatorius, S. maena*) via previous studies. This situation may related to food competition in area. Some species may become more dominant in food competition by longer time periods. The length-weight relationship variations could be more dependent of plankton availability and abundance in the area for planktivore species such as *T. trachurus, T. mediterraneus.* In almost all studies the growth type was calculated as positive allometric for *M. merluccius* and *U.scaber*. This was due to the predator characteristics of these species. For *M. merluccius*, this situation only differed in the studies conducted around Eastern Mediterranean (Sangun et al., 2007; Ozvarol, 2014). The lower *b* values in eastern Mediterranean may related to little food availability in demersal habitat. Only one study, the b value was calculated as 2.867 for *M. merluccius* in Northern Aegean Sea (Oztekin et al., 2016). This variation most probably related to relatively higher length interval (26.8-83.1 cm TL) of the individuals in that study. It is well known that, the vast majority of energy is transferred to reproduction with the age increased. Thus the slowdown in somatic growth and lower *b* values may observed.

CONCLUSION

The different results have been found in this study by means of *b* values for some species in the Sea of Marmara. Locality difference, ecologic and biologic factors may be responsible for the differences in the parameters of length-weight relationships (Ricker, 1975; Pauly, 1994; Sparre, 1992). These variations may also be arisen from temporal variations between these studies. Differences in fishing pressure and stock status also may contributed to occur in this situation. Seventeen demersal fish species undertaking in this study constitutes major representatives of benthic biodiversity of the Sea of Marmara. These fish are under pressure of high fishing activity, mainly arising from beam trawls and illegal trawl fisheries. So species are faced with high fishing mortality. High fishing mortality causes some changes on the biology of the species, such as a decrease in total length and first sexual maturity length. This effect may be worsen in some species with slow movement capability as flatfis. Consequently, the studies revealing variations on fish biology should conducted continuously to monitor recent situation of fish stocks.

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Table 2. Comparison of length-weight relationship with previous studies conducted in the Sea of Marmara

Species (*Türler*)	Present study (Entire Sea of Marmara)				Demirel and Dalkara, 2012 (Entire Sea of Marmara)				Bok et al., 2011 (Nothwestern part of Marmara Sea)				Keskin and Gaygusuz, 2010 (Erdek Bay)			
	n	b	SE	G	n	b	SE	G	n	b	SE	G	n	b	SE	G
Arnoglossus kessleri	917	2.9270	0.039390	I									24	3.474	0.283	+A
Blennius ocellaris	44	3.0322	0.143319	I					15	2.562	-	-A				
Callionymus lyra	345	2.6136	0.071341	-A	99	2.554	0.077	-A	87	2.832	-	I				
Cepola macrophthalma	97	1.2565	0.112750	-A	20	1.193	0.118	-A	17	1.510	-	-A				
Citharus linguatula	1597	3.0131	0.014450	I	109	2.828	0.054	I								
Gobius niger	331	3.0848	0.053755	I	83	3.129	0.096	I	286	2.980	-	I				
Lesueurigobius friesii	2856	2.1457	0.030540	-A					580	2.530	-	-A				
Lophius piscatorius	25	3.3698	0.131198	+A	15	2.846	0.381	I	40	2.491	-	-A				
Merluccius merluccius	1376	3.1377	0.011974	+A	378	2.886	0.027	-A	319	3.369	-	+A				
Merlangius merlangus	1287	3.0763	0.017184	+A	234	2.836	0.050	-A	166	3.149	-	+A				
Mullus barbatus	44	2.8731	0.150243	I	94	3.004	0.214	I	99	3.326	-	+A				
Solea solea	36	2.8383	0.078724	-A	53	3.055	0.181	I	55	3.171	-	I				
Spicara maena	76	3.4018	0.084280	+A	175	3.025	0.096	I								
Serranus hepatus	2974	3.0016	0.015045	I	379	2.623	0.078	-A	111	2.706	-	-A	5	2.998	0.209	I
Trachurus mediterraneus	717	3.0515	0.036796	I	496	2.727	0.053	-A								
Trachurus trachurus	286	2.9060	0.054138	I	156	2.951	0.163	I	307	3.128	-	+A				
Uranoscopus scaber	22	3.1258	0.09375	I	49	3.061	0.116	I	82	3.154	-	+A				

Table 3. Comparison of the length-weight relationship with previous studies conducted around areas.

Species (*Türler*)	n	Lenght Interval (*Boy Aralığı*)	Area (*Bölge*)	Sampling (*Örnekleme*)	Author (*Yazar*)	*b* Value (*b Değeri*) Other Studies (*Diğer Çalışmalar*)	Present Study (*Bu Çalışma*)
Arnoglossus kessleri	60	4.3-9.8	Eastern Black Sea	Trawl	Ak et al. 2009	2.984	2.927
	7	6.9-7.6	Izmir Bay, Aegean Sea	Trawl	Ilkyaz et al. 2008	2.74	
Blennius ocellaris	36	7.0-14.2	Saros Bay, NE Aegean Sea	Trawl	Ismen et al. 2007	2.93	3.0322
	204	5.8-16.5	Izmir Bay, Aegean Sea	Trawl	Ilkyaz et al. 2008	2.97	
	23	9.2-14.3	Izmir Bay, Aegean Sea	Trawl	Ozaydın et al. 2007	2.906	
	31	6.8-17.2	Northeastern Mediterranean	Trawl, Longline	Sangun et al. 2007	2.605	
	43	4.1-9.6	Northeastern Mediterranean	Trawl	Cicek et al. 2006	2.894	
Callionymus lyra							2.6136
Cephola macrophthalma	136	19.1-49.6	Saros Bay, NE Aegean Sea	Trawl	Ismen et al. 2007	1.853	1.2565
	254	12.2-50.6	Izmir Bay, Aegean Sea	Beach seine, gillnet, trawl	Ozaydın and Taskavak 2006	1.97	
	881	16.2-50.9	Izmir Bay, Aegean Sea	Trawl	Ozaydın et al. 2007	1.669	
	635	16.4-51.6	Izmir Bay, Aegean Sea	Trawl	Ilkyaz et al. 2008	1.65	
Citharus linguatula	1513	6.5-23.7	Izmir Bay, Aegean Sea	Trawl	Ilkyaz et al. 2008	3.13	3.0131
	409	8.4-22.7	Izmir Bay, Aegean Sea	Beach seine, gillnet, trawl	Ozaydın and Taskavak 2006	2.314	
	1724	8.2-24.5	Izmir Bay, Aegean Sea	Trawl	Ozaydın et al. 2007	3.121	
	22	10.3-17.5	Aegean Sea (Greece)	Gillnet, Longline	Moutopoulos and Stergiou 2002	2.293	
	252	7.0-18.5	Northeastern Mediterranean	Trawl	Erguden et al. 2017	2.896	
	922	3.5-21.0	Northeastern Mediterranean	Trawl	Cicek et al. 2006	3.075	
	44	8.0-19.2	Northeastern Mediterranean	Trawl	Ozvarol 2014	2.78	
	338	6.5-21.3	Northeastern Mediterranean	Trawl, Longline	Sangun et al. 2007	2.819	
Gobius niger	208	5.6-15.7	Eastern Black Sea	Trawl	Ak et al. 2009	3.041	3.0848

	112	6.8-15.8	Black Sea	Trawl, Purse Seine, Gillnet	Kasapoglu and Duzgunes 2013	2.856	
	227	8.0-25.3	Middle Black Sea	Trawl, Midwater Trawl	Kalayci et al. 2007	2.869	
	727	6.0-15.6	Izmir Bay, Aegean Sea	Beach seine, gillnet, trawl	Ozaydın and Taskavak 2006	2.914	
	447	7.7-16.5	Izmir Bay, Aegean Sea	Trawl	Ozaydın et al. 2007	3.153	
	618	7.0-16.3	Izmir Bay, Aegean Sea	Trawl	Ilkyaz et al. 2008	3.21	
	272	2.1-12.2	Northeastern Mediterranean	Trawl	Cicek et al. 2006	3.394	
Lesueurigobius friesii	631	4.0-9.1	Izmir Bay, Aegean Sea	Trawl	Ozaydın et al. 2007	3.013	2.1457
	149	4.5-8.4	Izmir Bay, Aegean Sea	Trawl	Ilkyaz et al. 2008	2.89	
Lophius piscatorius	445	11.2-83.0	Saros Bay, NE Aegean Sea	Trawl	Ismen et al. 2007	3.025	3.3698
	94	8.0-48.0	Izmir Bay, Aegean Sea	Beach seine, gillnet, trawl	Ozaydın and Taskavak 2006	2.931	
	15	22.3-67.0	Izmir Bay, Aegean Sea	Trawl	Ozaydın et al. 2007	2.966	
	30	12.0-51.4	Izmir Bay, Aegean Sea	Trawl	Ilkyaz et al. 2008	3.11	
Merluccius merluccius	2041	7.9-66.0	Saros Bay, NE Aegean Sea	Trawl	Ismen et al. 2007	3.149	3.1377
	222	26.8-83.1	Northeastern Aegean Sea	Longline	Oztekin et al. 2016	2.867	
	22	19.7-41.1	Northeastern Aegean Sea	Gillnet, Trammel Net	Karakulak et al. 2006	3.103	
	501	12.3-47.0	Izmir Bay, Aegean Sea	Beach seine, gillnet, trawl	Ozaydın and Taskavak 2006	3.154	
	2711	2.7-48.8	Izmir Bay, Aegean Sea	Trawl	Ozaydın et al. 2007	3.189	
	1499	9.0-45.5	Izmir Bay, Aegean Sea	Trawl	Ilkyaz et al. 2008	3.2	
	152	18.0-50.2	Aegean Sea (Greece)	Gillnet, Longline	Moutopoulos and Stergiou 2002	3.2	
	21	21.5-40.5	Gökova Bay, Aegean Sea	Trammel Net, Longline	Ceyhan et al. 2009	3.036	
	567	3.1-29.9	Northeastern Mediterranean	Trawl	Cicek et al. 2006	3.152	
	31	16.0-28.7	Northeastern Mediterranean	Trawl	Ozvarol 2014	2.899	
	29	13.2-31.0	Northeastern Mediterranean	Trawl, Longline	Sangun et al. 2007	2.353	

Merlangius merlangus	943	6.7-29.5	Eastern Black Sea	Trawl	Ak et al. 2009	3.169	3.0763
	2292	5.9-22.2	Black Sea	Trawl, Purse Seine, Gillnet	Kasapoglu and Duzgunes 2013	3.146	
	1891	7.5-23.4	Central Black Sea	Gillnets, Trawl	Samsun et al. 2017	2.9	
	904	7.7-22.7	Middle Black Sea	Trawl, Midwater Trawl	Kalayci et al. 2007	3.025	
	23	12.5-19.1	Saros Bay, NE Aegean Sea	Trawl	Ismen et al. 2007	2.989	
	100	16.0-31.7	Izmir Bay, Aegean Sea	Beach seine, gillnet, trawl	Ozaydın and Taskavak 2006	2.944	
Mullus barbatus	2693	5.3-19.0	Black Sea	Trawl, Purse Seine, Gillnet	Kasapoglu and Duzgunes 2013	3.123	2.8731
	176	6.6-18.4	Middle Black Sea	Trawl, Midwater Trawl	Kalayci et al. 2007	2.963	
	3386	6.0-24.7	Saros Bay, NE Aegean Sea	Trawl	Ismen et al. 2007	3.095	
	76	12.5-22.3	Northeastern Aegean Sea	Gillnet, Trammel Net	Karakulak et al. 2006	3.273	
	479	7.5-20.0	Izmir Bay, Aegean Sea	Beach seine, gillnet, trawl	Ozaydın and Taskavak 2006	3.176	
	1910	5.4-21.2	Izmir Bay, Aegean Sea	Trawl	Ozaydın et al. 2007	3.233	
	1879	8.-28.2	Izmir Bay, Aegean Sea	Trawl	Ilkyaz et al. 2008	3.22	
	15	19.1-29.0	Aegean Sea (Greece)	Gillnet, Longline	Moutopoulos and Stergiou 2002	2.832	
	2021	3.8-21.5	Northeastern Mediterranean	Trawl	Cicek et al. 2006	3.128	
	1565	8.7-21.5	Northeastern Mediterranean	Trawl	Ozvarol 2014	3.165	
	451	8.2-22.0	Northeastern Mediterranean	Trawl, Longline	Sangun et al. 2007	3.06	
Serranus hepatus	13	9.2-22.0	Northeastern Aegean Sea	Longline	Oztekin et al. 2016	2.582	3.0016
	143	5.7-11.1	Izmir Bay, Aegean Sea	Beach seine, gillnet, trawl	Ozaydın and Taskavak 2006	2.999	
	1285	4.9-12.3	Izmir Bay, Aegean Sea	Trawl	Ilkyaz et al. 2008	3.04	
	2543	6.7-11.6	Izmir Bay, Aegean Sea	Trawl	Ozaydın et al. 2007	2.793	
	584	2.4-10.5	Northeastern Mediterranean	Trawl	Cicek et al. 2006	3.029	

	100	5.8-13.9	Northeastern Mediterranean	Trawl	Ozvarol 2014	2.272	
	573	4.8-13.0	Northeastern Mediterranean	Trawl, Longline	Sangun et al. 2007	3.044	
Solea solea	74	20.4-37.0	Izmir Bay, Aegean Sea	Beach seine, gillnet, trawl	Ozaydın and Taskavak 2006	3.386	2.8383
	110	19.7-31.9	Izmir Bay, Aegean Sea	Trawl	Ozaydın et al. 2007	3.201	
	72	20.8-36.0	Izmir Bay, Aegean Sea	Trawl	Ilkyaz et al. 2008	3.27	
	24	12.0-19.1	Northeastern Aegean Sea	Longline	Oztekin et al. 2016	2.783	
	830	11.0-22.0	Northeastern Aegean Sea	Gillnet, Trammel Net	Karakulak et al. 2006	3.505	
	353	8.8-17.8	Saros Bay, NE Aegean Sea	Trawl	Ismen et al. 2007	3.01	
	1081	8.7-19.9	Izmir Bay, Aegean Sea	Trawl	Ilkyaz et al. 2008	2.97	
Spicara maena	194	7.5-19.5	Izmir Bay, Aegean Sea	Beach seine, gillnet, trawl	Ozaydın and Taskavak 2006	2.767	3.4018
	494	9.0-18.1	Izmir Bay, Aegean Sea	Trawl	Ozaydın et al. 2007	3.002	
	808	14.3-26.0	Aegean Sea (Greece)	Gillnet, Longline	Moutopoulos and Stergiou 2002	3.096	
	1381	4.3-17.8	Northeastern Mediterranean	Trawl	Cicek et al. 2006	3.115	
	298	8.7-17.1	Northeastern Mediterranean	Trawl, Longline	Sangun et al. 2007	3.093	
	1870	7.1-20.3	Central Black Sea	Gillnets, Trawl	Samsun et al. 2017	2.93	
	624	6.2-19.5	Black Sea	Trawl, Purse Seine, Gillnet	Kasapoglu and Duzgunes 2013	3.138	
	446	7.5-20.9	Saros Bay, NE Aegean Sea	Trawl	Ismen et al. 2007	3.367	
Trachurus mediterraneus	31	14.2-26.6	Northeastern Aegean Sea	Gillnet, Trammel Net	Karakulak et al. 2006	3.171	3.0515
	549	9.3-22.6	Izmir Bay, Aegean Sea	Beach seine, gillnet, trawl	Ozaydın and Taskavak 2006	3.275	
	12	6.8-16.3	Izmir Bay, Aegean Sea	Trawl	Ozaydın et al. 2007	3.055	
	191	17.3-34.1	Aegean Sea (Greece)	Gillnet, Longline	Moutopoulos and Stergiou 2002	2.824	
	45	16.5-38.3	Gökova Bay, Aegean Sea	Trammel Net, Longline	Ceyhan et al. 2009	3.374	

	373	7.0-19.1	Northeastern Mediterranean	Trawl, Longline	Sangun et al. 2007	2.81	
	718	2.6-16.0	Northeastern Mediterranean	Trawl	Cicek et al. 2006	2.857	
Trachurus trachurus	267	6.0-15.7	Eastern Black Sea	Trawl	Ak et al. 2009	3.249	2.906
	747	7.3-18.3	Middle Black Sea	Trawl, Midwater Trawl	Kalayci et al. 2007	2.984	
	264	10.5-24.3	Northeastern Aegean Sea	Gillnet, Trammel Net	Karakulak et al. 2006	2.897	
	1205	7.5-33.0	Saros Bay, NE Aegean Sea	Trawl	Ismen et al. 2007	3.196	
	575	10.3-25.6	Izmir Bay, Aegean Sea	Beach seine, gillnet, trawl	Ozaydın and Taskavak 2006	2.938	
	501	6.1-16.9	Izmir Bay, Aegean Sea	Trawl	Ozaydın et al. 2007	3.159	
	159	11.2-24.1	Izmir Bay, Aegean Sea	Trawl	Ilkyaz et al. 2008	3.2	
	12	15.8-28.0	Aegean Sea (Greece)	Gillnet, Longline	Moutopoulos and Stergiou 2002	3.273	
Uranoscopus scaber	620	1.8-56.4	Eastern Black Sea	Trawl	Ak et al. 2009	3.226	3.1258
	155	5.2-23.4	Black Sea	Trawl, Purse Seine, Gillnet	Kasapoglu and Duzgunes 2013	2.854	
	71	12.5-27.4	Saros Bay, NE Aegean Sea	Trawl	Ismen et al. 2007	3.249	
	62	10.8-30.6	Northeastern Aegean Sea	Gillnet, Trammel Net	Karakulak et al. 2006	2.998	
	219	9.2-30.5	Izmir Bay, Aegean Sea	Trawl	Ilkyaz et al. 2008	3.21	
	157	10.1-29.1	Izmir Bay, Aegean Sea	Trawl	Ozaydın et al. 2007	3.188	
	30	12.4-28.4	Aegean Sea (Greece)	Gillnet, Longline	Moutopoulos and tergiou 2002	3.228	
	92	5.2-24.7	Northeastern Mediterranean	Trawl, Longline	Sangun et al. 2007	3.153	

Statement of Conflict of Interest

Authors have declared no conflict of interest.

Author's Contributions

The contribution of the authors is equal.

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