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The Length-Weight Relationhsips (LWRs) of Some Fishes Along the Turkish Coasts of the Black Sea

Karadeniz'in Türkiye Kıyılarındaki Bazı Balık Türlerinin Boy-Ağırlık İlişkileri (LWRs)

Türk Denizcilik ve Deniz Bilimleri Dergisi

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Serap SAMSUN
Ordu University, Faculty of Marine Science, Fatsa, Ordu, Turkey

ABSTRACT

In this study 288 length-weight relationships of some fish species from the Turkish coasts of Black Sea were gathered from 138 studies, which were conducted by several researchers between 1989 and 2021. For all species, the "*b*" values ranged from 2.49 for *Trachurus trachurus* to 3.75 for *Alosa caspia*. The expected range of $2.5<b<3.5$ is confirmed for fish. It is thought that the high *b* value (3.75) given for *A. caspia* may be due to the size composition of the samples. Within species, *a* plot of log (*a*) vs *b* was used to detect outliers in weight–length relationships. In study, two outliers were determined for *Mullus barbatus* while, one outlier was determined for *Belone belone, Alosa immaculata, Merlangius merlangus* and *Neogobius melanostomus*.

Keywords: Regression parameters, fish, growth type, Black Sea, Turkish coasts

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*(corresponding author)
E-mail: serapsamsun@hotmail.com

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ÖZET

Bu çalışmada, 1989-2021 yılları arasında, farklı araştırmacılar tarafından gerçekleştirilen 138 çalışmadan toplanmış, Karadeniz'in Türkiye kıyılarındaki bazı balık türlerine ait 288 boy-ağırlık ilişkisi yer almaktadır. Tüm türler için "*b*" değerleri 2.49, *Trachurus trachurus* ve 3.75, *Alosa caspia* arasında değişmektedir. Balıklar için *b* değerinin 2.5<*b*<3.5 aralığında olması beklenmektedir.
A. aspia için verilen yüksek *b* değerinin (3.75) örneklerin büyüklük kompozisyonundan kaynaklanabileceği düşünülmektedir. Türler içinde, boy-ağırlık ilişkilerindeki aykırı değerleri tespit etmek için log (*a*)'ya karşı *b* grafiği kullanıldı. Çalışmada, *Mullus barbatus* için iki aykırı değer belirlenirken, *Belone belone*, *Alosa immaculata*, *Merlangius merlangus* ve *Neogobius melanostomus* için bir aykırı değer belirlendi.

Anahtar sözcükler: Regresyon parametreleri, balık, büyüme tipi, Karadeniz, Türkiye kıyıları

1. INTRODUCTION

A great number of ecological and physiological factors in fish are related with size rather than age (Erzini, 1994). When considered from this point of view, growth analyses of fish populations are very important, especially in terms of fishery. Increases in the length and weight of a fish in unit of time is expressed in mathematical equations (Çetinkaya *et al*., 2010) and this way different species and populations can be compared and assessed within the context of different growth conditions.
In addition to its significance in many application areas such as fish biology, physiology, ecology and sampling method, length-weight relationships (LWR) enable the comparison of life and morphologies of fish populations or different fish species in different regions (Richter *et al*., 2000; Gonçalves *et al*., 1997).
Recently, there has been an increase in the number of studies investigating the LWRs of different fish species in different seas. In addition, there are also studies in Turkey which have compared LWRs (Gündoğdu *et al*., 2016), reviewed LWRs of fish species in Aegean Sea and freshwaters of Turkey (Akyol *et al*., 2017; Torcu Koç *et al*., 2006). The purpose of this study is to review LWRs of fish species in Black Sea coast of Turkey and to contribute to future studies.

2. MATERIAL AND METHOD

In the study, 288 of LWRs of 138 studies conducted in Turkish coast of the Black Sea between 1989 and 2021 were reviewed. Median values of the *a* and *b* parameters were estimated than all LWRs. A scatterplot between log(*a*) and *b* is applied to show the interdependence between parameters *a* and *b*. Parameter *a* is the coefficient of the arithmetic weight-length relationship and the intercept of the logarithmic form. Parameter *b* is the exponent of the arithmetic form of the weight-length relationship, and the slope of the regression line in the logarithmic form (Froese, 2006). A scatter plot between log(*a*) and b values was drawn for some reported species to determine the outlier values present in LWRs (Froese, 2000).
Fish species were named according to Fishbase (Froese and Pauly, 2022) and ITIS Report (Integrated Taxonomic Information System). Accordingly, the current names of some species are given in Table 1.

Table 1. Valid names of some fish species

Species Name	Valid Species Name
Alosa pontica	*Alosa immaculata*
Gadus euxinus/Gadus merlangus euxinus	*Merlangius merlangus*
Gobius batrachocephalus	*Mesogobius batrachocephalus*
Gobius melanostomus	*Neogobius melanostomus*
Liza aurata	*Chelon auratus*
Mugil so-iuy	*Planiliza haematocheilus*
Psetta maxima	*Scophthalmus maximus*
Psetta maxima maeotica	*Scophthalmus maeticus*
Solea nasuta	*Pegusa nasuta*
Spicara flexuosa	*Spicara flexuosum*

a, *b* and r^2 parameters were given in their original forms. Length (cm) was measured as total (TL) or fork length (FL), weight (g) was measured as whole body weight (W).

3. RESULTS

Table 2 shows LWRs of 138 studies reviewed in the study. The lowest *b* value was found in *Trachurus trachurus* with 2.4854 (Erkoyuncu *et al*., 1994), while the highest b value was found in *Alosa caspia* with 3.75 (Ergüden *et al*., 2011). Average *b* value of all studies was 3,077. The lowest *a* value was found in *Squalus acanthias* with 0.00000004 (Demirhan and Seyhan, 2007), while the highest a value was found in *Gadus euxinus* with 0.2721 (Düzgüneş and Karaçam, 1990). Average a value of all studies was 0.0110.

Table 2. Length-weight relationsips parameters of some fish species along the Turkish coasts of Black Sea (BT: Bottom Trawl, MT: Midwater Trawl, BMT: Beam Trawl, PS: Purse Seine, GN: Gill Net, TN: Trammel Net, L: Longline, HD: Hydraulic Dredge, EG: Encircling Gillnet, SN: Seine Net, D: Dalian (traps), DN: Drift Net, BS: Beach Seine, HL: Hand Line, SF: Spear Fishing, HN: Hand Net)

Species	n	TL_{range}	W_{range}	*a*	*b*	r^2	Sampling Method	mpling Year	Sub-field	Reference
Alosa caspia	30	15.0-21.0	51.00-103.2	0.0013	3.750.954		GN, TN, L	2006-2007	Şile-Karasu	Erguden *et al*. (2011)
Alosa fallax	68	12.4-29.5	12.10-232.07	0.0110	2.8750.913		T, PS, GN, HD	2009-2011	Şile-Sakarya, Sinop-Hopa	Kasapoğlu and Düzgüneş (2014)
Alosa fallax pontica	42	16.1-23.5	26.57-104.72	0.0046	3.1630.958		GN, TN	2010-2011	Southern Black Sea	Yeşilçiçek *et al*. (2015)
Alosa immaculata	567	13.2-34.2	19.7-343.3	0.0078	3.040.952		GN, TN, L	2006-2007	Şile-Karasu	Erguden *et al*. (2011)
Alosa immaculata	730	10.2-38.8	7-535	0.0032	3.2850.992		GN, BT	2004-2005	Samsun	Yılmaz and Polat (2011)
Alosa immaculata	489	13.6-35.2	10.2-300.3	0.0035	3.21260.9780		MT	2010-2011	Sinop-Samsun	Özdemir and Duyar (2013)
Alosa immaculata	1312	11.5-34.9	9.5-381.2	0.028	3.320.98		G, BT	2016-2017	Sinop	Samsun *et al*. (2017)
Alosa maeotica	51	16.0-33.8	29.7-347.2	0.0062	3.090.981		GN, TN, L	2006-2007	Şile-Karasu	Erguden *et al*. (2011)
Alosa pontica	475	8.5-39.9	2.99-503.34	0.0027	3.33790.99		BT	1994-1995	Samsun	Özdamar (1993)
Alosa pontica	65	-	-	0.0081	3.10340.98		-	1988-1994	Sinop	Erkoyuncu *et al*. (1994)
Alosa pontica	1890	11.6-31.6	6.85-318.19	0.00212	3.38870.9835		BT	1992-1994	Sinop-Samsun	Samsun (1995a)
Alosa pontica	227	11.9-27.6	9.99-177	0.0046	3.12370.94		BT, MT	2004-2005	Sinop-Samsun	Kalaycı *et al*. (2007)
Alosa tanaica	431	23.30	-	0.0039	3.18320.99		MT	2008-2009	-	Özdemir *et al*. (2009c)
Alosa tanaica	38	15.5-30.0	29.8-275.1	0.0051	3.180.984		GN, TN, L	2006-2007	Şile-Karasu	Erguden *et al*. (2011)
Arnoglossus kessleri	60	4.3-9.8	1.2-8.94	0.021	2.9840.725		BT	2007	Trabzon	Ak *et al*. (2009a)
Arnoglossus kessleri	1548	2.0-8.1	-	0.0063	3.1820.940		BMT	2012-2013	Rize	Bilgin and Onay (2019)
Belone belone	278	23.7-60.3	12-277	0.0005	3.2450.97		EG	2003-2004	Samsun	Polat *et al*. (2009)
Belone belone	65	-	-	0.0005	3.20300.97		-	1988-1994	Sinop	Erkoyuncu *et al*. (1994)
Belone belone	647	28.8-51.6	26.9-177.2	0.008	3.090.87		GN, BT	2016-2017	Sinop	Samsun *et al*. (2017)
Belone belone	110	26.0-43.6	19.83-82.50	0.0031	2.70520.952		GN	2017-2018	Ordu	Samsun and Erdoğan Sağlam (2021)
Belone belone euxini	682	31.9-56.9	31.97-208.44	0.00047	3.22340.97		EG	1994-1995	Sinop	Samsun *et al*. (1995a)
Belone belone euxini	643	31.2-52.2	31.59-167.69	0.00055	3.17780.97		EG	1995-1996	Sinop	Samsun (1995b)

Table 2. continued

Belone belone euxini	585	28.5-48.8	62.25	0.0018	2.86350.933	EG	2001-2002	Sinop	Samsun *et al*. (2003)
Belone belone euxini	931	29.0-58.0	23.5-258.4	0.00076	3.1370.9363	PS, EG	2000-2001	Sinop	Samsun *et al*. (2006b)
Chelidonichthys lucerna	55	-	-	0.0070	3.08980.99	-	1988-1994	Sinop	Erkoyuncu *et al*. (1994)
Chelidonichthys lucernus	21	14.3-26.8	27.96-169.4	0.01	2.980.96	BT	2013	Zonguldak-Amasra	Türker and Bal (2018)
Chromis chromis	112	72.0-115.1*	5.96-26.56	0.0127	3.1170.834	TN	2018	Ordu	Aydın and Öztürk (2021)
Diplodus annularis	210	12.5-23.4	39.9-249.3	0.031	2.840.92	GN, BT	2016-2017	Sinop	Samsun *et al*. (2017)
Diplodus annularis	295	13.3-23	50.3-235.8	0.0554	2.660.895	TN	2015-2017	Ordu	Erat (2019)
Engraulis encrasicolus	1172	7.5-13.0	-	0.00643	2.9743 -	-	1988-1989	-	Ünsal (1989)
Engraulis encrasicolus	831	6.7-16.1	2.00-26.46	0.002314	3.4157 -	-	1985-1986	Central and Eastern Black Sea	Erkoyuncu and Özdamar (1989)
Engraulis encrasicolus	1420	4.85-16.85	1.46-21.08	0.00247	3.38320.9994	PS	1986-1987	-	Karaçam and Düzgüneş (1990)
Engraulis encrasicolus	1705	6.0-15.3	1.02-20.44	0.0047	3.1002 -	-	1987-1989	-	Özdamar (1991)
Engraulis encrasicolus	842	6.7-16.1	2.00-26.46	0.0023	3.41280.9944	PS	1985-19867	Sinop-Samsun	Özdamar *et al*. (1991)
Engraulis encrasicolus	840	7.24-14.40	1.99-16.49	0.00510	3.0480.970	PS	1993-1994	Eastern Black Sea	Mutlu *et al*. (1993)
Engraulis encrasicolus	43	-	-	0.0053	3.03870.97	-	1988-1994	Sinop	Erkoyuncu *et al*. (1994)
Engraulis encrasicolus	840	7.24-14.40	1.99-16.49	0.0051	3.0480.97	PS	1993-1994	Eastern Black Sea	Düzgüneş *et al*. (1995)
Engraulis encrasicolus	3891	6.1-15.3	1.04-24.25	0.0047	3.09750.98	PS	1994-1995	Sinop-Samsun	Özdamar *et al*. (1995a)
Engraulis encrasicolus	1664	7-13.8	1.9-15.8	0.0054	3.0400.944	-	1997-1998	Rize-Hopa	Gözler and Çiloğlu (1998)
Engraulis encrasicolus	543	6.2-13.5	1.462-18.193	0.00569	3.1170.89	PS	1996-1997	Trabzon-Rize-Hopa	Kayalı (1998)
Engraulis encrasicolus	1247	6.5-14.7	-	0.0086	2.65350.9404	PS	2002-2003	Trabzon-Hopa	Şahin *et al*. (2003)

Table 2. continued

Engraulis encrasicolus		6.0-15.0	-	0.0076	2.92	-	PS	1998-2000	Sinop	Samsun *et al*. (2004)
Engraulis encrasicolus	1245	6.5-15.2	0.98-20.80	0.0066	2.9669	0.96	PS, MT	2004-2005	Sinop-Samsun	Bilgin *et al*. (2006a)
Engraulis encrasicolus	1499	6.0-15.99		0.0101	2.7948	0.95	PS	2004-2005	Trabzon-Hopa	Şahin *et al*. (2006)
Engraulis encrasicolus	575	8.0-14.7	2.85-19.14	0.0174	2.6014	0.85	BT, MT	2004-2005	Sinop-Samsun	Kalaycı *et al*. (2007)
Engraulis encrasicolus	363	10.72	-	0.0093	2.8345	0.98	MT	2008-2009	-	Özdemir *et al*. (2009c)
Engraulis encrasicolus	3442	5.8-14.8	0.99-19.47	0.011	2.742	-	PS	2010-2011	Sinop-Trabzon	Erdoğan Sağlam and Sağlam (2013)
Engraulis encrasicolus	696	8.0-13.6	3.5-16.4	0.0180	2.6182	0.8784	MT	2010-2011	Sinop-Samsun	Özdemir and Duyar (2013)
Engraulis encrasicolus	1588	5.9-14.6	1.06-18.10	0.0124	2.711	0.944	BT, PS, GN, HD	2009-2011	Şile-Sakarya, Sinop-Hopa	Kasapoğlu and Düzgüneş (2014)
Engraulis encrasicolus	19	6.2-13.5	1.72-13.64	0.0182	2.549	0.974	GN, TN	2010-2011	Southern Black Sea	Yeşilçiçek *et al*. (2015)
Engraulis encrasicolus	10062	5.5-14.5	0.9-17.4	0.008	2.86	0.89	GN, BT	2016-2017	Sinop	Samsun *et al*. (2017)
Engraulis encrasicolus	312	7.4-14.1	1.84-22.11	0.002	3.38	0.97	BT	2013	Zonguldak-Amasra	Türker and Bal (2018)
Engraulis encrasicolus	1516	11.28±0.04	-	0.0096	2.8166	0.984	MT	2008-2009	Samsun	Özdemir *et al*. (2018)
Engraulis encrasicolus	579[1]	8.8-12.2	8.7-12.51	0.0082	2.8425	0.9085	PS, MT	2019-2020	Sinop	Özdemir *et al*. (2020)
	1988[2]	5.9-13.8	1.89-13.85	0.0103	2.7863	0.9668				
	697[3]	7.5-13.7	7.4-13.44	0.0092	2.8288	0.9749				
	621[4]	7.8-13.6	3.72-13.91	0.007	2.8854	0.9242				
Engraulis encrasicolus	3336	10.8±0.02♀	-	0.0159	2.5609	0.8093	PS	2013-2014	Rize-Trabzon	Bilgin and Solak (2020)
	2149	10.1±0.03♂	-	0.0078	2.8757	0.8783				
Gadus euxinus	890	13.2-24.9	20.1-119.6	0.2721	2.5734	0.9969	-	1998-1989	Trabzon	Düzgüneş and Karaçam (1990)
Gadus merlangus euxinus	4184	8.5-40.0	3.74-516.20	0.0043	3.1959	0.98	BT	1988-1989	Sinop-Samsun	Samsun *et al*. (1993)
Gadus merlangus euxinus	15875			0.0045	3.1872	0.99	BT	1991-1994	Sinop-Samsun	Samsun (1995b)

Table 2. continued

Gadus merlangus euxinus	14588.7-23.5	3.75-104.23	0.0050	3.1581	0.97	BT	1994-1995	Samsun	Özdamar and Samsun (1995)
Gadus merlangus euxinus	13029.0-24.0	5.70-118.65	0.0039	3.2384	0.9654	BT	1995-1996	Sinop	Samsun and Erkoyuncu (1998)
Gaidropsarus mediterraneus	21 10.8-27.1	5.62-181.19	0.0012	3.616	0.963	BT, PS, GN, HD	2009-2011	Şile-Sakarya, Sinop-Hopa	Kasapoğlu and Düzgüneş (2014)
Gobius batrachocephalus	1845.5-18.0	1.71-77.00	0.024	2.736	0.913	BT	2007	Trabzon	Ak *et al*. (2009a)
Gobius melanostomus	14258.0-20.5	6.25-98.74	0.0243	2.8505		BT	1994-1995	Samsun	Samsun (1995d)
Gobius melanostomus	73 9.1-35.0	8.58-381.42	0.010	3.033	0.886	BT	2007	Trabzon	Ak *et al*. (2009a)
Gobius niger	1197.6-13.2	5.3-28.6	0.0151	2.88	0.86	BT	2002	Trabzon-Rize	Demirhan *et al*. (2005a)
Gobius niger	1137.6-13.2	-	0.0113	3.00	0.91	BT	2002	Southeastern Black Sea	Demirhan and Can (2007)
Gobius niger	2278.0-25.3	5.37-168.7	0.0166	2.8690	0.96	BT, MT	2004-2005	Sinop-Samsun	Kalaycı *et al*. (2007)
Gobius niger	2085.6-15.7	1.69-45.00	0.009	3.041	0.889	BT	2007	Trabzon	Ak *et al*. (2009a)
Gobius niger	12719.1-30.3	55.0-283.3	0.0048	3.1781	0.9267	MT	2010-2011	Sinop-Samsun	Özdemir and Duyar (2013)
Gobius niger	1126.8-15.8	4.09-48.85	0.0180	2.856	0.953	BT, PS, GN, HD	2009-2011	Şile-Sakarya, Sinop-Hopa	Kasapoğlu and Düzgüneş (2014)
Gobius niger	1139.0-26.2	9-205	0.0135	2.9543	0.94	BT	2012-2013	Samsun-Ordu	Çalık and Erdoğan Sağlam (2017)
Hippocampus hippocampus	1632.7-13.7	1.11-4.68	0.004	2.949	0.563	BT	2007	Trabzon	Ak *et al*. (2009a)
Hippocampus guttulatus	2916.5-10.3	1.01-4.61	0.0044	2.898	0.819	BT, PS, GN, HD	2009-2011	Şile-Sakarya, Sinop-Hopa	Kasapoğlu and Düzgüneş (2014)
Lithognathus mormyrus	25 16.0-20.10	55.03-100.30	0.0711	2.3981	0.8171	TN	2017	Ordu	Aydın (2017a)
Lithognathus mormyrus	30615.7-31.0	49.23-393.8	0.0147	2.947	0.942	TN	2017-2018	Ordu	Aydın and Sözer (2019)
Liza aurata	50016.2-44.0	10-917	0.0038	3.21	0.87	-	2001-2002	Sinop-Samsun	Bilgin *et al*. (2006b)
Liza aurata	25520.2-40.8	81.2-618.4	0.044	2.52	0.89	GN, BT	2016-2017	Sinop	Samsun *et al*. (2017)
Merlangius merlangus	54 -	-	0.0034	3.2999	0.97	-	1988-1994	Sinop	Erkoyuncu *et al*. (1994)
Merlangius merlangus	164918.77	53.53	0.0039	3.217	-	GN	-	Eastern Black Sea	Aydın *et al*. (1997)

Table 2. continued

Merlangius merlangus		5.6-43.2	-	0.0052	3.142	-	BT	1991-1996	Trabzon	Genç *et al*. (1999)
Merlangius merlangus	904	7.7-22.7	2.99-79.79	0.0067	3.0248	0.96	BT, MT	2004-2005	Sinop-Samsun	Kalaycı *et al*. (2007)
Merlangius merlangus	2238	8.4-31.5	3.35-259.00	0.00427	3.2016	0.97	BT	2001-2003	Sinop	Samsun (2010)
Merlangius merlangus	2292	5.9-22.2	1.44-73.68	0.0054	3.146	0.919	BT, PS, GN HD	2009-2011	Şile-Sakarya, Sinop-Hopa	Kasapoğlu and Düzgüneş (2014)
Merlangius merlangus	2705	7.6-24.2	3.33-111.54	0.0046	3.195	0.947	GN, TN	2010-2011	Southern Black Sea	Yeşilçiçek *et al*. (2015)
Merlangius merlangus	140	10.0-27.0	9-118	0.0131	2.7723	0.91	BT	2012-2013	Samsun-Ordu	Çalık and Erdoğan Sağlam (2017)
Merlangius merlangus	1891	7.5—23.4	3.7-113.8	0.010	2.90	0.93	GN, BT	2016-2017	Sinop	Samsun *et al*. (2017)
Merlangius merlangus	318	7.8-22.7	2.67-76.28	0.006	3.01	0.96	BT	2013	Zonguldak-Amasra	Türker and Bal (2018)
Merlangius merlangus	1579	7.5-32.6	2.68-279.58	0.0046	3.173	0.9641	BT	2017-2018	Trabzon	Şahin *et al*. (2021)
Merlangius merlangus euxinus	4181	8.50-33.30	3.74-240.59	0.0043	3.1959	0.98	BT	1998-1989	Sinop-Samsun	Özdamar *et al*. (1996)
Merlangius merlangus euxinus	1349♀ 864♂	8.8-27.7	4.61-205.90	0.004856 0.005450	3.1510 3.1108	0.996 0.987	BT	1991	Trabzon	Şahin and Akbulut (1997)
Merlangius merlangus euxinus	24986	5.6-43.2	1.18-782.56	0.0052	3.141	0.989	BT	1991-1996	Trabzon	Genç *et al*. (1999)
Merlangius merlangus euxinus	1122♀ 608♂	- -	- -	0.0037 0.0042	3.2594 3.2065	0.9864 0.9807	BT	1996	Trabzon	Çiloğlu *et al*. (2001)
Merlangius merlangus euxinus	7357	5.0-32.5	-	0.0042	3.24	0.99	-	1990-1993	Black Sea Coastal Waters	İşmen (2002)
Merlangius merlangus euxinus	943	6.7-29.6	2.15-241.2	0.004	3.169	0.983	BT	2007	Trabzon	Ak *et al*. (2009a)
Merlangius merlangus euxinus	596♂ 1167♀	8-19 8.7-30	3.70-56.8 3.92-181.68	0.0036 0.0036	3.273 3.268	0.954 0.971	BT	2007-2008	Eastern Black Sea	Ak *et al*. (2009b)

Table 2. continued

Merlangius merlangus euxinus	793♂ 1091♀	10.3-21 10.1-23.1	6.42-67.16 6.33-96.73	0.0071 0.0060	3.0017 3.0651	0.8807 0.8671	GN	2010-2012	Sinop between Giresun	Erdoğan Sağlam and Sağlam (2012)
Merlangius merlangus euxinus	426	9.4-17.0	6.0-34.5	0.0104	2.8555	0.9333	MT	2010-2011	Sinop-Samsun	Özdemir and Duyar (2013)
Merlangius merlangus euxinus	2173	10.4-19.9	7.8-54.7	0.0068	3.0202	0.9866	BT, GN	2012-2013	Sinop-Samsun	Özdemir *et al*. (2018)
Merluccius merluccius	121	12.5-37.8	13.53-494.95	0.005	3.16	0.98	BT	2013	Zonguldak-Amasra	Türker and Bal (2018)
Mesogobius batrachocephal us	40	7.2-13.3	4.0-25.7	0.0289	2.60	0.88	BT	2002	Trabzon-Rize	Demirhan *et al*. (2005a)
Mesogobius batrachocephal us	37	7.2-13.3	-	0.0203	2.75	0.93	BT	2002	Southeastern Black Sea	Demirhan and Can (2007)
Mesogobius batrachocephal us	35	12.0-23.5	14-120	0.0149	2.7768	0.92	BT	2012-2013	Samsun-Ordu	Çalık and Erdoğan Sağlam (2017)
Mesogobius batrachocephal us	470	12.60-31.80	12.62-377.54	0.0062	3.13	0.9606	TN	201-2018	Ordu	Bengil and Aydın (2020)
Mesogobius batrachocephal us	641	5.3-34.0	1.34-372.90	0.0058	3.148	0.9621	TN	2019	Ordu	Aydın (2021a)
Mugil so-iuy	174	22.5-66.7	101-3260	0.010	2.98	0.968	TN	1995	Trabzon	Okumuş and Başçınar (1997)
Mugil so-iuy		32.0-76.0	300-4450	0.0139	2.9183		-	2004	Eastern Black Sea	Gözler *et al*. (2005)
Mullus barbatus	69	-	-	0.0070	3.1685	0.97	-	1988-1994	Sinop	Erkoyuncu *et al*. (1994)
Mullus barbatus	1561	6.3-19.3	4-103	0.0001	3.3946	0.9515	-	1990-1993	Eastern Black Sea	İşmen *et al*. (2000)
Mullus barbatus	421	6.8-6.9	1.4-63.8	0.0054	3.22	0.96	BT	2002	Trabzon-Rize	Demirhan *et al*. (2005a)
Mullus barbatus	176	6.6-18.4	2.94-60.16	0.0111	2.9633	0.98	BT, MT	2004-2005	Sinop-Samsun	Kalaycı *et al*. (2007)
Mullus barbatus	432	6.8-14.6	-	0.0051	3.24	0.97	BT	2002	Southeastern Black Sea	Demirhan and Can (2007)
Mullus barbatus	2693	5.3-19.0	1.2-73.4	0.0074	3.123	0.962	BT, PS, GN, HD	2009-2011	Şile-Sakarya, Sinop-Hopa	Kasapoğlu and Düzgüneş (2014)

Table 2. continued

Mullus barbatus	672	7.4-22.6	2.68-102.50	0.0066	3.119	0.925	GN, TN	2010-2011	Southern Black Sea	Yeşilçiçek *et al*. (2015)
Mullus barbatus	4928	6.3-18.9	3.62-62.42	0.0109	2.9886	0.9554	BT	2012-2014	İğneada-Rumelifeneri	Yıldız and Karakulak (2016)
Mullus barbatus	84	10.0-19.0	9-70	0.0089	3.0454	0.95	BT	2012-2013	Samsun-Ordu	Çalık and Erdoğan Sağlam (2017)
Mullus barbatus	663	9.0-18.4	7.97-71.29	0.004	3.36	0.92	BT	2013	Zonguldak-Amasra	Türker and Bal (2018)
Mullus barbatus ponticus	14553	4.4-23.5	0.72-143.7	0.0063	3.179	0.990	BT	1991-1996	Trabzon	Genç *et al*. (1999)
Mullus barbatus ponticus	14022	4.4-23.5	0.72-143.70	0.0063	3.182	0.991	BT	1990-1996	Trabzon	Genç (2000)
Mullus barbatus ponticus	714	6.1-21.9	2.08-161.14	0.007	3.139	0.990	BT	2007	Trabzon	Ak *et al*. (2009a)
Mullus barbatus ponticus	699	7.3-18.7	-	0.0107	2.9717	0.99	BT, TN	2004-2005	Sinop	Aksu *et al*. (2011)
Mullus barbatus ponticus	225	9.3-20.1	8.59-87.90	0.0108	2.9819	0.9703	MT	2010-2011	Sinop-Samsun	Özdemir and Duyar (2013)
Mullus barbatus ponticus	1435	6.4-21.5	2.09-105.40	0.0088	3.0338	0.97	GN, SN	2010-2011	Ordu	Aydın and Karadurmuş (2013)
Mullus barbatus ponticus	1602	8.2-19.8	5.6-86.5	0.007	3.15	0.97	GN, BT	2016-2017	Sinop	Samsun *et al*. (2017)
Mullus barbatus ponticus	229	8.7-14.4	6.4-29.4	0.0102	2.9909	0.979	BT, GN	2016-2017	Sinop	Erdem (2018)
Mullus barbatus ponticus	632	9.2-13.3	8.2-68.6	0.0137	2.902	0.92	BT, TN, GN	2015-2016	Sinop	Yılmaz *et al*. (2019)
Mullus surmuletus	80	7.1-14.0	3.21-33.83	0.0042	3.400	0.957	BT, PS, GN, HD	2009-2011	Şile-Sakarya, Sinop-Hopa	Kasapoğlu and Düzgüneş (2014)
Neogobius melanostomus	263	9.0-23.30	9.00-186.65	0.1145	3.0862	0.9281	TN	2001	Rize	Gözler *et al*. (2003)
Neogobius melanostomus	99	8.6-19.1	7.0-104.9	0.0063	3.29	0.93	BT	2002	Trabzon-Rize	Demirhan *et al*. (2005a)
Neogobius melanostomus	99	8.6-19.1	-	0.0047	3.39	0.95	BT	2002	Southeastern Black Sea	Demirhan and Can (2007)
Neogobius melanostomus	471♂ 397♀	7.4-25 7.5-19.7	- -	0.0110 0.0076	3.07 3.23	0.96 0.94	BT	2002-2005	Samsun	Gümüş and Kurt (2009)
Neogobius melanostomus	58	9.0-26.0	8-265	0.0059	3.3062	0.99	BT	2012-2013	Samsun-Ordu	Çalık and Erdoğan Sağlam (2017)

Table 2. continued

Neogobius melanostomus	2408	10.50-26.20	15.28-212.20	0.0069	3.1972	0.9549	TN	2017-2018	Ordu	Aydın (2021b)
Neogobius melanostomus	61	10.7-23.9	15.5-204.9	0.004	3.353	0.979	TN	2019	Ordu	Karadurmuş and Aydın (2021)
Ophidion barbatum	34	16.9-22.2	24.70-55.83	0.0096	2.777	0.918	GN, TN	2010-2011	Southern Black Sea	Yeşilçiçek *et al*. (2015)
Parablennius gattorugine	11	12.6-16.8	26.80-60.78	0.0125	3.021	0.953	GN, TN	2010-2011	Southern Black Sea	Yeşilçiçek *et al*. (2015)
Platichthys flesus	51	19.1-38.5	69.9-620.1	0.007	3.093	0.952	BT	2007	Trabzon	Ak *et al*. (2009a)
Platichthys flesus	16	15.7-32.7	35.59-390.02	0.0052	3.175	0.975	BT, PS, GN, HD	2009-2011	Şile-Sakarya, Sinop-Hopa	Kasapoğlu and Düzgüneş (2014)
Platichthys flesus luscus	48	-	-	0.0078	3.1090	0.98	-	1988-1994	Sinop	Erkoyuncu *et al*. (1994)
Platichthys flesus luscus	988	13.6-29.9	26.7-463.0	0.00341	3.3932	0.9643	BT	1992-1994	Sinop-Samsun	Samsun (1995c)
Platichthys flesus luscus	348	14.9-39.7	32.95-751.08	0.0062	3.1835	0.96	BT	1994-1995	Samsun	Özdamar *et al*. (1995b)
Platichthys flesus luscus	7610	5.5-38.0	1.62-684.40	0.0072	3.125	0.983	BT	1991-1996	Trabzon	Genç *et al*. (1999)
Platichthys flesus luscus	952	14.0-37.5	28.879-611.0	0.0103	3.028	0.9435	BT, TN, BS	1999-2001	Trabzon-Rize	Çiloğlu (2002)
Platichthys	836♂	12-27.9	9.2-262.5	0.0202	2.7898	0.87	BT	1995-1996	Trabzon	Şahin and Güneş (2010)
flesus luscus	762♀	11.2-38.2	17.9-614.0	0.0184	2.8485	0.90				
Pomatomus saltatrix	19	-	-	0.0388	2.5582	0.92	-	1988-1994	Sinop	Erkoyuncu *et al*. (1994)
Pomatomus saltatrix	143	13.2-21.7	23.21-88.19	0.0130	2.8621	0.92	BT, MT	2004-2005	Sinop-Samsun	Kalaycı *et al*. (2007)
Pomatomus saltatrix	628	-	-	0.006	3.195	0.98	BT	2004-2005	Samsun	Özdemir *et al*. (2009a)
Pomatomus saltatrix	820	9.2-23.4	10.1-135.5	0.0037	3.3268	0.99	BT	2005-2006	Samsun	Özdemir *et al*. (2009b)
Pomatomus saltatrix	529	17.52		0.0030	3.3985	0.99	MT	2008-2009	-	Özdemir *et al*. (2009c)
Pomatomus saltatrix	14	11.6-22.2	12-131	0.003	3.336	0.978	BT	2007	Trabzon	Ak *et al*. (2009a)
Pomatomus saltatrix	207	12.2-24	15.4-127.2	0.0045	3.2501	0.9762	MT	2010-2011	Sinop-Samsun	Özdemir and Duyar (2013)

Table 2. continued

Pomatomus saltatrix	25	12.5-20.2	16.00-75.19	0.0092	3.005	0.865	PS, GN, HD	2009-2011	Şile-Sakarya, Sinop-Hopa	Kasapoğlu and Düzgüneş (2014)
Pomatomus saltatrix	125	13.5-23.6	22.01-161.19	0.008	3.12	0.962	-	2014	Samsun	Özpiçak *et al*. (2017)
Pomatomus saltatrix	820	16.1-27.5	32.5-227.9	0.005	3.25	0.95	GN, BT	2016-2017	Sinop	Samsun *et al*. (2017)
Pomatomus saltatrix	38	15.9-22.2	33.11-101.03	0.005	3.15	0.97	BT	2013	Zonguldak-Amasra	Türker and Bal (2018)
Pomatomus saltatrix	672	12.9-26.3	18.51-166.50	0.0104	2.978	0.977	-	2012-2013	-	Kalaycı *et al*. (2019)
Pomatomus saltatrix	101	14.0-26.0	25.87-189.31	0.0082	3.0913	0.973	GN	2017-2018	Ordu	Samsun and Erdoğan Sağlam (2021)
Psetta maxima	1445	-	-	0.0112	3.12	0.99	BT	1990-1996	Trabzon	Zengin *et al*. (2006)
Psetta maxima	760	16.2-79.2	63.5-9160.0	0.0106	3.1268	0.973	BT	2008	Trabzon	Şahin and Güneş (2011)
Psetta maxima	97	32.5-80.0	444.20-9456	0.0069	3.3757	0.9292	MT	2010-2011	Sinop-Samsun	Özdemir and Duyar (2013)
Psetta maxima	16	37.5-70.5	925-7865	0.0113	3.1171	0.93	BT	2012-2013	Samsun-Ordu	Çalık and Erdoğan Sağlam (2017)
Psetta maxima maeotica	1599	7.2-82.0	3-9620	0.0108	3.124	0.992	BT	1991-1996	Trabzon	Genç *et al*. (1999)
Raja clavata	40	-	-	0.0090	2.9208	0.96	-	1988-1994	Sinop	Erkoyuncu *et al*. (1994)
Raja clavata	193	18.0-90.0	15-4800	0.0023	3.2402	0.957	BT	2003-2004	Trabzon	Başçınar and Sağlam (2005)
Raja clavata	52	34.3-95	168-5450	0.001	3.42	0.91	L	2002-2003	Sotheastern Black Sea	Demirhan *et al*. (2005b)
Raja clavata	27	10.7-95.0	4.2-5025.0	0.0019	3.24	0.99	BT	2002	Trabzon-Rize	Demirhan *et al*. (2005a)
Raja clavata	102	27.8-88.2	97.20-3444.8	0.0027	3.1832	0.9783	MT	2010-2011	Sinop-Samsun	Özdemir and Duyar (2013)
Raja clavata	63	13.2-90.0	6.42-4364.00	0.0010	3.288	0.971	BT, PS, GN, HD	2009-2011	Şile-Sakarya, Sinop-Hopa	Kasapoğlu and Düzgüneş (2014)
Raja clavata	10	34.5-75.0	183-2980	0.001	3.4472	0.98	BT	2012-2013	Samsun-Ordu	Çalık and Erdoğan Sağlam (2017)
Sarda sarda	14	-	-	0.0297	2.6799	0.93	-	1988-1994	Sinop	Erkoyuncu *et al*. (1994)
Sarda sarda	1168	21.8-70.5**	110-5000	0.0039	3.3263	0.925	D, PS, TM, DN, BS, HL	2000-2001	-	Oray *et al*. (2004)
Sarda sarda	694	23.5-71.0	122.4-4724.0	0.0054	3.2146	0.983	PS	2003-2005	-	Ateş *et al*. (2008)
Sarda sarda	36	28.1-37.5	233.72-517.82	0.0502	2.562	0.891	BT, PS, GN, HD	2009-2011	Şile-Sakarya, Sinop-Hopa	Kasapoğlu and Düzgüneş (2014)
Sarda sarda	314	24.8-62.8	152.6-2478.5	0.002	3.45	0.97	GN, BT	2016-2017	Sinop	Samsun *et al*. (2017)
Sciaena umbra	329	-	-	0.0045	3.3024	0.96	SF, HN	2002-2003	Trabzon	Engin and Seyhan (2009)

Table 2. continued

Sciaena umbra	217	11.70-48.20	16.43-1934.48	0.0057	3.250.979	-	2019-2020	Samsun, Ordu, Giresun, Trabzon	Aydın and Bengil (2020)
Sciaena umbra	319	11.7-58	16.4-2485.17	0.0065	3.20250.9834	TN	2019-2020	Samsun-Ordu-Giresun-Trabzon	Aydın and Bodur (2021)
Sciaena umbra	54	117-580*	16.4-2485.1	0.000004	3.1900.9934	-	2019-2020	Samsun-Ordu-Giresun- Trabzon	Aydın and Bodur (2021)
Scophthalmus maeticus	506	29.81	494	0.0085176	3.2034 -	BT	1992-1994	Middle Black Sea	Samsun (1995a)
Scophthalmus maeticus	1989	7.2-82.0	-	0.0103	3.13900.9918	BT	1990-1996	Trabzon	Zengin (2000)
Scophthalmus maeticus	1011	23.9-69	212.1-5400	0.0074	3.220.96	GN	2001	Sinop	Samsun *et al*. (2007)
Scophthalmus maximus	168	23.0-72.0	-	0.128736	2.48700.9721	-	-	-	Doğan *et al*. (1990)
Scophthalmus maximus	149	181.0-630.0	-	0.0085	3.180.99	BT	1991	Eastern Black Sea	Avşar (1999)
Scophthalmus maximus	63	10.0-61.0	14.6-4494.4	0.007	3.2480.977	BT	2007	Trabzon	Ak *et al*. (2009a)
Scophthalmus maximus	264	14.0-70.0	34-5550	0.0085	3.15810.989	-	-	-	Eryılmaz and Dalyan (2015)
Scophthalmus rhombus	5	18.9-28.4	44.9-217.3	0.0013	3.570.97	BT	2002	Trabzon-Rize	Demirhan *et al*. (2005a)
Scorpaena porcus	31	-	-	0.0180	3.08000.99	-	1988-1994	Sinop	Erkoyuncu *et al*. (1994)
Scorpaena porcus	572	11.0-25.2	24.84-326.90	0.0219	2.9568	GN	1996	Sinop	Koca and Samsun (1997)
Scorpaena porcus	633	10.7-25.0	-	0.0540	2.590	BT	1996-1997	Sinop	Koca (2002)
Scorpaena porcus	262	6.3-23.5	5.6-257.2	0.0166	3.10150.980	BT	2003-2004	Trabzon	Başçınar and Sağlam (2005)
Scorpaena porcus	470	4.6-17.5	1.3-100.5	0.0124	3.190.94	BT	2002	Trabzon-Rize	Demirhan *et al.* (2005a)
Scorpaena porcus	525	4.6-22.9	1.34-220.0	0.015	3.100.99	BT, TN	2002-2003	Southeastern Black Sea	Demirhan and Can (2009)
Scorpaena porcus	136	8.5-29.2	13-508	0.0173	3.03370.98	BT, MT	2004-2005	Sinop-Samsun	Kalaycı *et al*. (2007)

Table 2. continued

Scorpaena porcus	351	5.0-34.2	2.1-406.1	0.009	3.272	0.880	BT	2007	Trabzon	Ak *et al*. (2009a)
Scorpaena porcus	379♂ 510♀	5.7-23.6 4.9-31.7	- -	0.0166 0.0163	3.0554 3.067	0.995 0.994	BMT	2002-2003	Sinop	Bilgin and Çelik (2009)
Scorpaena porcus	1061	6.7-25.5	-	0.0101	3.2546	0.96	GN	2012	Trabzon	Erbay (2013)
Scorpaena porcus	42	5.4-26.0	3.70-403.71	0.0210	2.982	0.973	BT, PS, GN, HD	2009-2011	Şile-Sakarya, Sinop-Hopa	Kasapoğlu and Düzgüneş (2014)
Scorpaena porcus	943	8.2-27.9	9.19-470.00	0.0091	3.301	0.962	GN, TN	2010-2011	Southern Black Sea	Yeşilçiçek *et al*. (2015)
Scorpaena porcus	50	8.5-21.0	13-165	0.0251	2.8992	0.97	BT	2012-2013	Samsun-Ordu	Çalık and Erdoğan Sağlam (2017)
Scorpaena porcus	411	6.2-24.0	4.10-235.12	0.0217	2.9548	0.9601	BT, GN	2016-2017	Samsun-Ordu-Giresun	Samsun and Erdoğan Sağlam (2018)
Scorpaena porcus	32	5.4-25.5	3.4-305.56	0.026	2.87	0.98	BT	2013	Zonguldak-Amasra	Türker and Bal (2018)
Scorpaena porcus	2442	2.8-33.2	0.31-775.6	0.0165	3.0559	0.9623	TN	2016-2017	Ordu	Aydın (2019)
Scorpaena porcus	344	7.0-27.0	4.08-406.07	0.0164	3.0785	0.977	GN	2017-2018	Ordu	Samsun and Erdoğan Sağlam (2021)
Scorpaena maderensis	78	6.0-10.0	4.32-20.44	0.032	2.84	0.96	BT	2013	Zonguldak-Amasra	Türker and Bal (2018)
Serranus scriba	15	11.3-25.0	16.4-220.0	0.0052	3.3478	0.9809	TN	2017	Ordu	Aydın (2017b)
Solea nasuta	19	-	-	0.0019	3.5805	0.97	-	1988-1994	Sinop	Erkoyuncu *et al*. (1994)
Solea nasuta	100	11.3-21.7	17.29-139.85	0.016	2.755	0.960	BT	2007	Trabzon	Ak *et al*. (2009a)
Solea nasuta	91	3.4-22.6	0.25-55.86	0.0042	3.265	0.987	BT, PS, GN, HD	2009-2011	Şile-Sakarya, Sinop-Hopa	Kasapoğlu and Düzgüneş (2014)
Solea solea	309	11.7-22.2	13.25-104.71	0.0062	3.111	0.901	GN, TN	2010-2011	Southern Black Sea	Yeşilçiçek *et al*. (2015)
Solea solea	528	11.0-27.60	10.70-263.20	0.0028	3.4226	0.96	TN	2015-2016	Sinop	Büyükdeveci *et al*. (2020)
Sparus aurata	109	15.7-21.2	62.2-136.8	0.035	2.70	0.86	GN, BT	2016-2017	Sinop	Samsun *et al*. (2017)
Spicara maena	12	12.1-19.4	4.34-77.52	0.0124	2.942	0.962	GN, TN	2010-2011	Southern Black Sea	Yeşilçiçek *et al*. (2015)
Spicara smaris	25	-	-	0.0061	3.2157	0.97	-	1988-1994	Sinop	Erkoyuncu *et al*. (1994)
Spicara smaris	517	-	-	0.005	3.26	0.975	BT	1991-1992	Samsun, Ordu, Trabzon, Rize	İşmen (1995)
Spicara smaris	6627	6.2-21.5	2.10-121.01	0.0069	3.135	0.986	BT	1991-1996	Trabzon	Genç *et al*. (1999)
Spicara smaris	83	11.2-20.0	14.24-87.67	0.0063	3.1504	0.96	BT, MT	2004-2005	Sinop-Samsun	Kalaycı *et al*. (2007)
Spicara smaris	528	8.3-24.2	3.51-29.4	0.009	3.008	0.856	BT	2007	Trabzon	Ak *et al*. (2009a)

Table 2. continued

Spicara smaris	103	8.0-20.4	8.11-92.23	0.0223	2.722	0.938	PS, GN, HD	2009-2011	Şile-Sakarya, Sinop-Hopa	Kasapoğlu and Düzgüneş (2014)
Spicara smaris	70	11.0-22.5	15-120	0.0075	3.1345	0.96	BT	2012-2013	Samsun-Ordu	Çalık and Erdoğan Sağlam (2017)
Spicara flexuosa	599	8.7-21.8	7.1-129.94	0.0118	2.9727	0.9487	GN	2015-2016	Rize-Hopa	Ergün (2018)
Spicara flexuosa	318	11.0-22.5	14.24-118.00	0.0079	3.0915	0.947	GN	2017-2018	Ordu	Samsun and Erdoğan Sağlam (2021)
Sprattus sprattus	5087	5.60-12.6	0.95-12.39	0.0079	2.8676	0.88	BT, MT	2004-2005	Sinop-Samsun	Kalaycı *et al*. (2007)
Sprattus sprattus	1927	5.007-12.265	0.619-11.520	0.0067	2.9446	0.912	MT	2004-2005	Samsun-Ordu	Polat *et al*. (2008)
Sprattus sprattus	1300	8.55	-	0.0092	2.8121	0.98	MT	2008-2009	-	Özdemir *et al*. (2009c)
Sprattus sprattus	599	5.9-10.9	1.4-8.1	0.0072	2.9278	0.9433	MT	2010-2011	Sinop-Samsun	Özdemir and Duyar (2013)
Sprattus sprattus	423	5.6-10.7	1.08-8.14	0.0064	2.921	0.916	BT, PS, GN, HD	2009-2011	Şile-Sakarya, Sinop-Hopa	Kasapoğlu and Düzgüneş (2014)
Sprattus sprattus	4214	8.5±0.01	-	0.0089	2.8259	0.981	MT	2008-2009	Samsun	Özdemir *et al*. (2018)
Sprattus sprattus	655	5.1-11.8	0.95-9.96	0.007	3.11	0.98	BT	2013	Zonguldak-Amasra	Türker and Bal (2018)
Sprattus sprattus phalericus	4186	3.3-13.0	-	0.0026	3.33	0.99	BT, MT	1990-1992	Black Sea of Turkey	Avşar (1995)
Sprattus sprattus phalericus	372	7.2-13.2	1.62-13.95	0.0021	3.46	0.9987	BT	1991	Trabzon	Şahin (1999)
Sprattus sprattus phalericus	4038	5.2-12.5	0.96-11.81	0.0062	3.0938	0.98	MT	2004-2005	-	Kalaycı *et al*. (2006)
Squalus acanthias	327	22.3-141.0	31-13150	0.0022	3.1413	0.9979	BT	1992-1994	Sinop-Samsun	Samsun *et al*. (1995b)
Squalus acanthias	168♂	32-121	-	0.0045	2.92	0.987	BT	1991	Sinop- Samsun, Ordu, Trabzon, Rize	Avşar (1996)
	160♀	37-136	-	0.0035	2.99	0.993				
Squalus acanthias	267	36.5-141.5	135-16140	0.009	3.3423	0.9607	PS, GN	1994-1995	Giresun, Trabzon, Rize	Düzgüneş *et al*. (2006)

Table 2. continued

Squalus acanthias	1780♂ 1840♀	30.0-120.0 30.0-140.0	117-6473 146-13157	0.0041 0.0053	3.0046 2.9294	0.996 0.9988	BT	1969-1973	Karaburun-Ereğli, Sinop-Samsun	Kutaygil and Bilecik (1998)
Squalus acanthias	176	34.1-144.8	109-15500	$0.4x10^{-8}$♀ $0.8x10^{-8}$♂	3.513 3.319	0.97 0.98	L, PS, GN	2000-2003	Southeastern Black Sea.	Demirhan and Seyhan (2007)
Syngnathus acus	280	15.6-39.2	1.0-16.66	0.0001	3.415	0.898	BT	2010-2011	Western Black Sea	Yıldız *et al*. (2015)
Trachinus draco	338	5.0-35.0	1.01-549.2	0.004	3.433	0.884	BT	2007	Trabzon	Ak *et al*. (2009a)
Trachinus draco	636	5.0-25.8	1.01-131.76	0.0069	3.0051	0.9632	BT	2009-2010	Trabzon	Ak and Genç (2013)
Trachinus draco	88	8.1-31.6	3.69-289.39	0.007	3.01	0.97	BT	2013	Zonguldak-Amasra	Türker and Bal (2018)
Trachurus trachurus	77	-	-	0.0290	2.4854	0.98	-	1988-1994	Sinop	Erkoyuncu *et al*. (1994)
Trachurus trachurus	-	6.5-19.0	-	0.0075	3.017	-	BT	1991-1996	Trabzon	Genç *et al*. (1999)
Trachurus trachurus	720	9.4-16.8	5.27-43.95	0.00759	3.05	-	MT	1995-1996	Samsun-İnebolu	Yücel and Erkoyuncu (2000)
Trachurus trachurus	6035	6.7-19.8	2.40-60.82	0.0062	3.0938	0.99	PS, MT, BT, GN	2003-2004	Sinop-Samsun	Kalaycı (2006)
Trachurus trachurus	1290	-	-	0.0063	3.0931	0.98	MT, PS	2004-2005	Samsun	Samsun *et al*. (2006a)
Trachurus trachurus	747	7.3-18.3	3.34-47.37	0.0086	2.9849	0.96	BT, MT	2004-2005	Sinop-Samsun	Kalaycı *et al*. (2007)
Trachurus trachurus	800	-	-	0.007	3.029	0.99	BT	2004-2005	Samsun	Özdemir *et al*. (2009a)
Trachurus trachurus	902	13.08	-	0.0074	3.0445	0.98	MT	2008-2009	-	Özdemir *et al*. (2009c)
Trachurus trachurus	267	6-15.7	1.75-44.32	0.004	3.249	0.946	BT	2007	Trabzon	Ak *et al*. (2009a)
Trachurus trachurus	1307	6.9-19.02	2.32-59.89	0.0049	3.17	0.96	GN, PS	2011-2012	Ordu	Aydın and Karadurmuş (2012)
Trachurus trachurus		11.0-11.9*	20.0-24.99	0.016	2.881	0.983	PS	2010-2011	Zonguldak	Erdoğan *et al*. (2016)
Trachurus trachurus	489	8.0-16.6	3.03-38.3	0.0056	3.12	0.98	BT	2013	Zonguldak-Amasra	Türker and Bal (2018)
Trachurus trachurus	479	7.8-18.0	2.67-54.47	0.0021	3.5118	0.973	GN	2017-2018	Ordu	Samsun and Erdoğan Sağlam (2021)

Table 2. continued

Trachurus mediterraneus	430	6.3-17.8	3-58	0.0108	2.98	0.97	PS	1996-1997	Trabzon-Rize-Hopa	Kayalı (1998)
Trachurus mediterraneus	1914	6.6-19.3	2.13-66.70	0.0075	3.017	0.989	BT	1991-1996	Trabzon	Genç *et al*. (1999)
Trachurus mediterraneus	1312	9.12-19	-	0.0089	2.955	0.9441	PS	2004-2005	Trabzon-Rize	Şahin *et al*. (2009)
Trachurus mediterraneus	696	-	-	0.0071	3.039	0.98	MT	2008-2009	Samsun	Erdem *et al*. (2010)
Trachurus mediterraneus	439	12.70	18.05	0.0093	2.9565	0.97	PS	2010	Trabzon	Atılgan *et al*. (2012)
Trachurus mediterraneus	526	9.4-15.1	4.6-25.2	0.0032	3.3018	0.8953	MT	2010-2011	Sinop-Samsun	Özdemir and Duyar (2013)
Trachurus mediterraneus	624	6.2-19.5	1.71-64.30	0.0050	3.138	0.972	BT, PS, GN, HD	2009-2011	Şile-Sakarya, Sinop-Hopa	Kasapoğlu and Düzgüneş (2014)
Trachurus mediterraneus	1870	7.1-20.3	3.2-67.7	0.010	2.93	0.89	GN, BT	2016-2017	Sinop	Samsun *et al*. (2017)
Trachurus mediterraneus	128	6.5-11.6	1.21-32.0	0.002	3.49	0.97	BT	2013	Zonguldak-Amasra	Türker and Bal (2018)
Trachurus mediterraneus	1467	7.1-20.3	3.2-67.7	0.0067	3.0848	0.94	PS	2016-2017	Sinop	Samsun *et al*. (2018)
Trachurus mediterraneus pon.	601	7.4-14.5	-	0.0048	3.22		-	-	-	Şahin *et al*. (1997)
Umbrina cirrosa	102	4.8-94	1.0-7051.1	0.009	3.0541	0.996	TN	2018-2019	Ordu	Aydın and Sözer (2020)
Uranoscopus scaber	116	6.1-26.4	3.8-298.7	0.0148	3.0392	0.971	BT	2003-2004	Trabzon	Başçınar and Sağlam (2005)
Uranoscopus scaber	69	5.3-21.8	2.1-201.9	0.0148	3.05	0.98	BT	2002	Trabzon-Rize	Demirhan *et al*. (2005a)
Uranoscopus scaber	346	5.2-21.9	2.0-182.5	0.0167	3.00	0.99	BT, TN	2002-2005	-	Demirhan *et al*. (2007)
Uranoscopus scaber	69	5.3-21.8	-	0.0150	3.05	0.98	BT	2002	Southeastern Black Sea	Demirhan and Can (2007)

Table 2. continued

Uranoscopus scaber	620	1.8-56.4	1.01-551.51	0.008	3.2260.815	BT	2007	Trabzon	Ak *et al*. (2009a)
Uranoscopus scaber	988	5.0-30.0	-	0.0128	3.09180.940	BT	2008	Eastern Black Sea	Ak *et al*. (2011)
Uranoscopus scaber	155	5.2-23.4	2.79-243.40	0.0252	2.8540.979	BT, PS, GN, HD	2009-2011	Şile-Sakarya, Sinop-Hopa	Kasapoğlu and Düzgüneş (2014)
Uranoscopus scaber	606	6.9-25.5	5.46-326.66	0.0103	3.1760.967	GN, TN	2010-2011	Southern Black Sea	Yeşilçiçek *et al*. (2015)
Uranoscopus scaber	82	10.5-23.0	18-207	0.0190	2.94870.96	BT	2012-2013	Samsun-Ordu	Çalık and Erdoğan Sağlam (2017)
Uranoscopus scaber	189	6.6-25.5	4.28-312.65	0.009	3.210.98	BT	2013	Zonguldak-Amasra	Türker and Bal (2018)
Uranoscopus scaber	88	10.5-23.0	21-207	0.0152	3.02340.980	GN	2017-2018	Ordu	Samsun and Erdoğan Sağlam (2021)

Log (a)-b scatter plot and corelation value (-0,571; $p<0.05$) were determined for all indivuduals (Figure 1). Different distributions relative to the regression line in Figure 1 show that the variation in log a is largely a function of the body shape of the species concerned.

Froese (2000) reported that a log a vs b plot must first be made to detect and exclude outliers, when discussing intra-species variation in LWRs. Some of species that have more than five LWR and that have outliers were considered. It was determined that *Mullus barbatus* had two outliers and the others (*Belone belone, Alosa immaculata, Merlangius merlangus* and *Neogobius melanostomus*) had one outlier each (Figure 2).

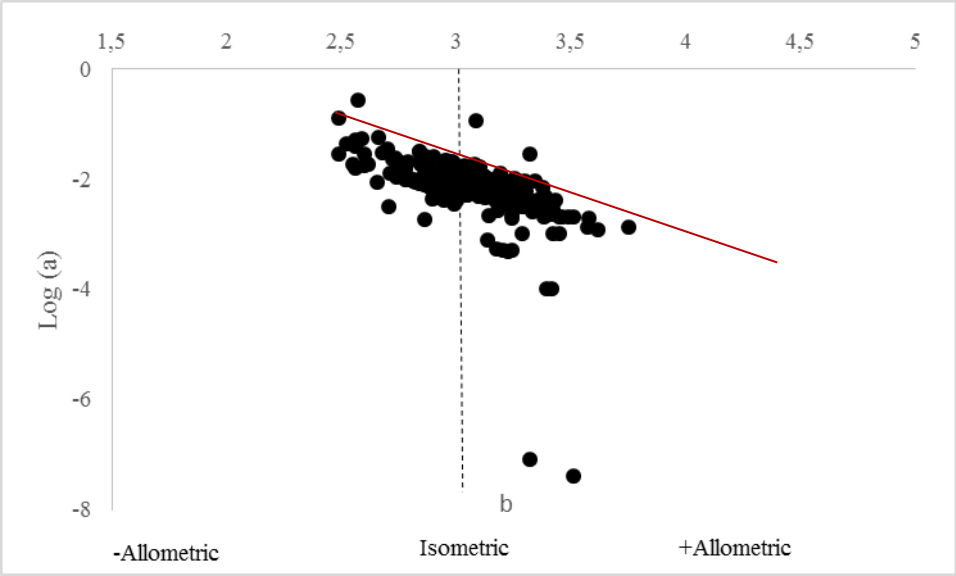

Figure 1. Scatter plot of mean log a over mean b for fish species with body shape information. Areas of negative allometric, isometric and positive allometric change in body weight relative to body length are indicated

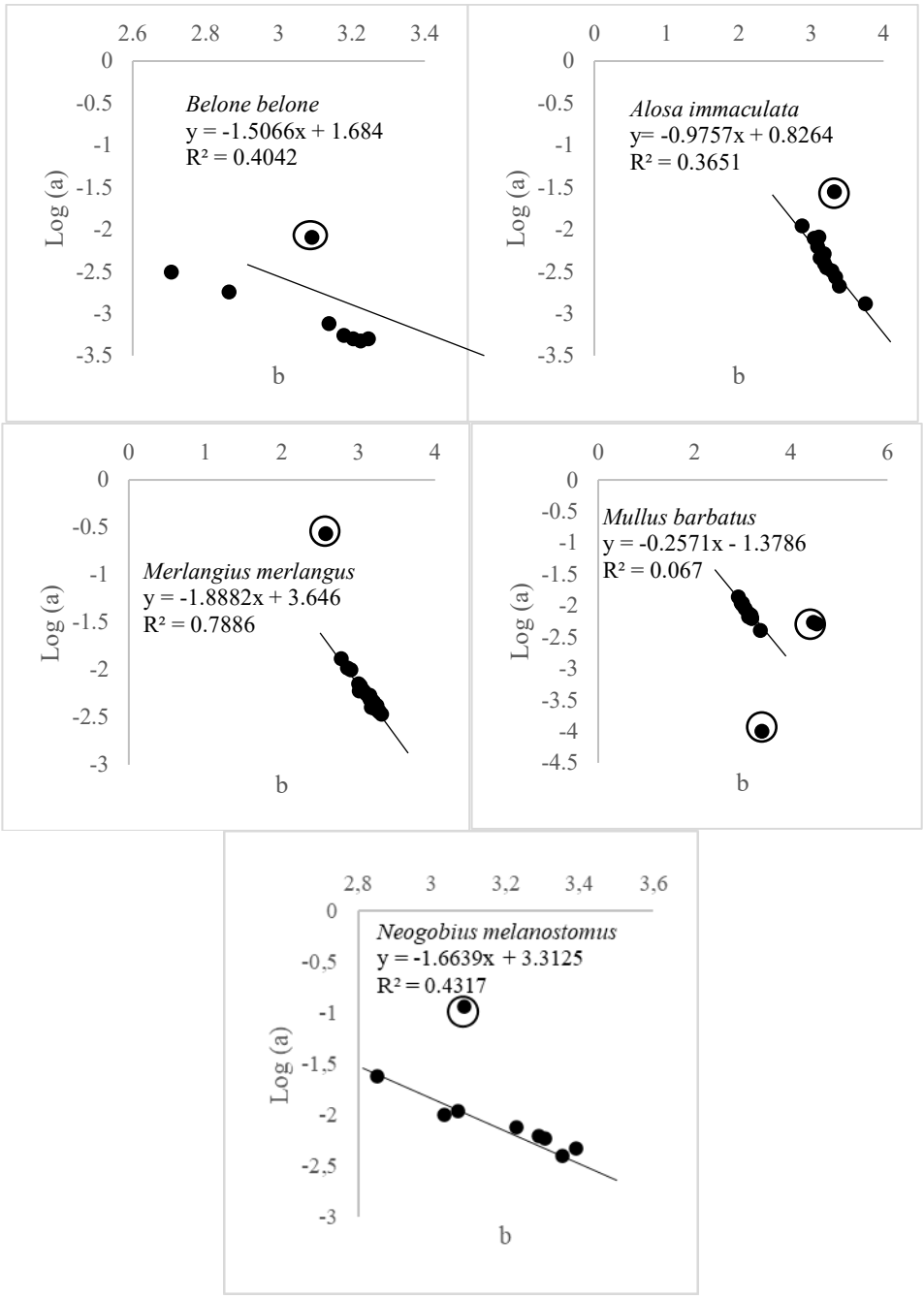

Figure 2. The log a vs b graph of 5 species. The circled points are the outliers.

4. DISCUSSION AND CONCLUSIONS

In the study, LWRs of 138 studies which included 51 species of 29 families studied in Turkish coast of Black Sea were reviewed. Bilecenoğlu *et al*. (2014) reported 154 fish species of 52 families for Black Sea region. In terms of family, 50% of the existing families were studied in Turkish coastline. Most studies fish species belonged to Gadidae, Clupeidae, Engraulidae, Carangidae, Gobiidae, Mullidae and Scopthalmidae families. However, in terms of the number of species, it can be seen that length-weight association of 27% were determined. Akyol *et al*. (2017) reported that of the 448 fish species in Aegean Sea, length-weight association parameters of 46.4% were studied. Gündoğdu *et al*. (2016) reported thatmost of the samples in studies conducted in Turkey came from trawling and thus studies of the same species were in the majority. In the same study, they reported that although *b* value differed depending on a great number of factors, regional differences were more effective.

Froese *et al*. (2011) reported that 100 specimens were sufficient as the number of samples for height-weight association studies; however, they also added that fewer individuals could be accepted for rare species. Akyol *et al*. (2017) that while this number was reasonable for species less than 20 in number which were difficult to find, the number had to be discussed again and for species which were plenty in number but calculated with less number of species, location differences could be important. On the other hand, even though sample size for fish are low ($n<20$) the r^2 value may be significantly strong (e.g. *E. encrasicolus* (0.974), *S. maena* (0.962) and *P. gattorugine* (0.953) from Yeşilçiçek *et al*. (2015), *P. flesus* (0.975) from Kasapoğlu and Düzgüneş (2014), *P. saltatrix* (0.978) from Ak *et al*. (2009a), *R. clavata* (0.98) from Çalık and Erdoğan Sağlam (2017), *S. rhombus* (0.97) from Demirhan *et al*. (2005a), *S. scriba* (0.9809) from Aydın (2017b)).

In the study, two outliers in *M. barbatus* and one each in *B. belone*, *A. immaculata*, *M. merlangus* and *N. melanostomus* were determined according to the log a vs b plot made to detect and exclude outliers. Gündoğdu *et al*. (2016) determined that *Merluccius merluccius* has two outliers and *Arnoglossus latema*, *Citharus linguatula* and *Raja clavata* have one outlier each. A robust regression analysis of log a over b identifies one outlier and after its removal linear regression explains 99% of the remaining variance. The strong interrelationship between parameters a and b is linearized in a plot of log aover band helps in detecting WLRs that are questionable (Froese, 2006).

The b value of LWR is generally expected to be in the range of 2.5-3.5 for fish (Carlander, 1969), and *b* values can be affected by environmental conditions, sampling season, sampling location, sampling techniques and size composition of samples. High the *b* value (3.75) gave for *A. caspia* by Ergüden *et al*. (2011). It is thought that this may be due to the size composition of the samples (15.0-21.0 cm, 51.00-103.2 g).

Coverage of the full-size range, ideally with the number of specimens being equally distributed among size classes (e.g., 10 small, 10 medium-size, and 10 large specimens), in order to avoid over- or underestimation of *b* (Froese *et al*. 2011).

Within-species variance in weight–length relationships can be substantial, depending on the season, the population, or annual differences in environmental conditions. When discussing within-species variation in weight-length relationships, the focus should be on the variation in the condition that is likely to trigger variation in parameters *a* and *b*, once outliers have been identified. Furthermore, when investigating isometric and allometric growth, it should be discussed whether current length-to-weight studies cover a sufficiently wide seasonal and geographic range to be representative for the species (Froese, 2006).

As a result, this study includes length-weight association parameters of most species prevalent in Turkish coastline of Black Sea between 1989 and 2021 and presents a list of resources for future studies.

CONFLICT OF INTERESTS

The authors decelerate that they have no conflict of interests.

ETHICS COMMITTEE PERMISSION

All applicable international, national, and/or institutional guidelines for the care and use of animals were followed by the authors.

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ORCID IDs

Serap SAMSUN:
https://orcid.org/0000-0001-6094-6226

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