Length-Weight Relationships and Condition Factors of Six Fish Species in the southern Black Sea (Ordu-Turkey)

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Abstract: Length-weight relationship (LWR) and condition factor (K) of 1440 fish populations covering 6 families and 6 species inhabiting southern Black Sea, were studied. The fishes *Belone belone* (garfish), *Pomatomus saltatrix* (bluefish), *Spicara flexuosa* (picarel), *Scorpaena porcus* (scorpion fish), *Uranoscopus scaber* (stargazer) and *Trachurus trachurus* (horse mackerel) were sampled from Ordu province (Turkey) from November 2017 to september 2018. "b" value indicated isometric growth for *P. saltarix* (3.0913) and *U. scaber* (3.0231), while *B. belone* exhibited negative allometric growth (2.7052) and, *S. flexuosa* (3.0915), *S. porcus* (3.0785) and *T. trachurus* (3.5118) exhibited positive allometric growth. The condition factor varied between 0.11 (*B. belone*) and 2.02 (*S. flexuosa*).

Key words: Length-weight, Condition factor, Fish species, Growth, Black Sea

Güneydoğu Karadeniz'deki (Ordu-Türkiye) Altı Balık Türünün Boy-Ağırlık İlişkisi ve Kondisyon Faktörü

Öz: Araştırmada güneydoğu Karadeniz'de yaşayan 6 familyaya ait 6 balık türünü içeren 1440 balığın boy-ağırlık ilişkisi ve kondisyon faktörü çalışılmıştır. Kasım 2017-Eylül 2018'de Ordu bölgesinden (Türkiye) elde edilen balıklar: *Belone belone* (zargana), *Pomatomus saltatrix* (lüfer), *Spicara flexuosa* (izmarit), *Scorpaena porcus* (iskorpit), *Uranoscopus scaber* (tiryaki) ve *Trachurus trachurus* (istavrit)'dur. "b" değeri *P. saltarix* (3.0913) ve *U. scaber* (3.0231) için izometrik büyümeyi, *B. belone* için negatif allometrik büyümeyi (2.7052) ve *S. flexuosa* (3.0915), *S. porcus* (3.0785) ve *T. trachurus* (3.5118) için pozitif allometrik büyümeyi işaret etmektedir. Kondisyon faktörü 0.11 (*B. belone*) ve 2.02 (*S. flexuosa*) arasında değişmektedir.

Anahtar Kelimeler: Boy-ağırlık ilişkisi, Kondisyon Faktörü, Balık türleri, Büyüme, Karadeniz

1. Introduction

Regular examination and monitoring of fish stocks spread in habitats and ensuring the sustainability of the aquatic system in the best way possible is very important for fisheries management and fishery biology (Froese et al., 2011).The knowledge of some biological parameters of fish such as size values (i.e. minimum, maximum, and mean), and size relationships (i.e. length-weight) helps for the sustainable exploitation of the Black Sea's natural resources (Yankova et al., 2011). Length-weight relationship is used for the estimation of a weight that corresponds to a given length, while condition factor is used for the comparison of overweightness or health based on the assumption that the greater weight of a fish in a given length means the fish is in better condition. Both concepts have been used in fishery studies since the beginning of 20th century (Froese, 2006).

The length-weight relationship is an important tool in fishery management. Primarily, the relationship between fish length and weight can be used to convert length to weight and vice versa. Fish length is often more rapidly and accurately measured than fish weight. The condition of a fish is indicative of recent physical and biological circumstances and provides important information about present and future population success via its association with growth, reproduction, and survival (Le Cren

1951; Kırankaya et al., 2014).

This study focused on the length-weight relationship parameters and condition factor of 6 fish species from Black Sea in order to compare the population characteristics of these species with previous reports.

2. Material and Methods

A totally of 1440 specimens were collected by commercial coastal gillnets along Ordu province (Black Sea coast of Turkey) between November 2017 and September 2018 (Figure 1). Total length (TL) of all samples were measured to the nearest 0.1 cm, the weight (W) of fish was recorded to the nearest the 0.01 g. The length-weight relationships (LWR) were calculated using the $W=aL^b$ equation; where W is the weight, L the total length, and a and b are constants (Ricker, 1975). The parameters a and b were calculated using least-squares regression. When the parameter 'b' is equal to 3, the growth is called isometric but the growth is positive allometric when the 'b' value is more than 3 and negative allometric when the 'b' value is less than 3 (Dutta et al., 2012). Significant difference of b values from 3, which represent isometric growth, was tested with the Student's t-test (Zar 1999). The Fulton's Condition Factor was estimated using following equation: $K=(W/L^3)*100$ (Pauly, 1983).
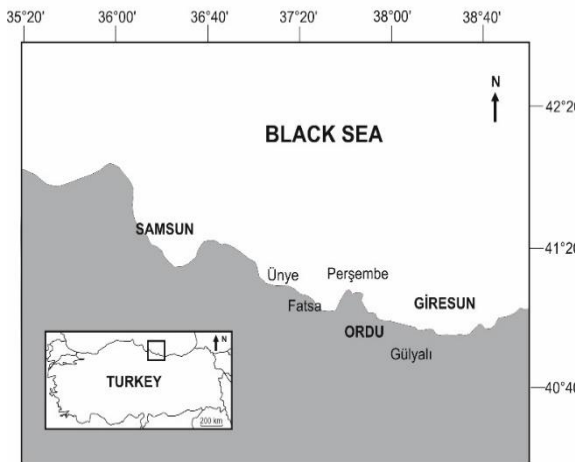

Figure 1. Research area
Şekil 1. Araştırma sahası

3. Results and Discussion

In study, 6 species (*Belone belone* Linnaeus, 1761; *Pomatomus saltatrix* Linnaues, 1766; *Spicara flexuosa* Rafinesque, 1810; *Scorpaena porcus* Linnaeus, 1758; *Uranoscopus scaber* Linnaeus, 1758; and *Trachurus trachurus* Linnaeus, 1758) belonging to 5 families (Belonidae, Pomatomidae, Centracanthidae, Scorpaenidae, Uranoscopidae, Carangidae) were examined.

The sample size, length ranges (minimum and maximum), parameters of the LWR (a and b), growth types, 95% confidence intervals of b, and coefficient of determination R^2 of six species are presented in the Table 1 and LWRs are illustrated in Figure 2. Tesch (1971) stated that of the LWR parameters, "b" value differed between 2 and 4 and values close to 3 represented isometric growth, while values other than 3 represented allometric growth. "b" value, which is an indicator of the fish's body shape, is directly influenced by the characteristics of the fish's habitat (Ricker, 1975). "b" value's being about 3 shows that the fish's body weight increases in parallel with the growth in its length and that its shape does not change, which is called isometric growth. The value's being different from 3 means that weight increase is greater or lower than the increase in length and it also shows the body shape changes, which is called allometric growth (Bagenal and Tesh, 1978). In the study, "b" value determined for 6 fish species varies between 2.7052 (*B. belone*) and 3.5118 (*T. trachurus*) (Table 1). LWR indicated isometric growth for *P. saltarix* and *U. scaber* (W=0.0082*$L^{3.0913}$, W=0.0152*$L^{3.0234}$), while *B. belone* exhibited negative allometric growth (W=0.0031*$L^{2.7052}$) and, *S. flexuosa*, *S. porcus* and *T. trachurus* exhibited positive allometric growth (W=0.0079*$L^{3.0915}$, W=0.0164*$L^{3.0785}$, W=0.0021*$L^{3.5118}$). In addition, according to t test results, it was found that statistically b value was not different from 3 for *P. saltarix* and *U. scaber* (b=3, P>0.05), while it was different from 3 for *B. belone* (b<3, P<0.05) and for *S. flexuosa*, *S. porcus* and *T. trachurus* (b>3, P<0.05).

Table 1. Length-weight relationship parameters for six fish species
Çizelge 1. Altı balık türüne ait boy-ağırlık ilişkisi parametreleri

Species	N	$L_{min-max}$ (cm)	$W_{min-max}$ (g)	a	b	95 % C.I. of b	R^2	Growth Type
B. belone	110	26-43.6	19.83-82.50	0.0031	2.7052	2.5892-2.8212	0.952	-A
P. saltatrix	101	14-26.0	25.87-189.31	0.0082	3.0913	2.9877-3.1948	0.973	I
S. flexuosa	318	11-22.5	14.24-118.00	0.0079	3.0915	3.0103-3.1727	0.947	+A
S. porcus	344	7-27.0	4.08-406.07	0.0164	3.0785	3.0283-3.1288	0.977	+A
T. trachurus	479	7.8-18	2.67-54.47	0.0021	3.5118	3.4594-3.5641	0.973	+A
U. scaber	88	10.5-23.0	21-207.00	0.0152	3.0234	2.9308-3.1161	0.980	I

-A: Negative allometric growth; **+A:** Positive allometric growth; **I:** Isometric growth
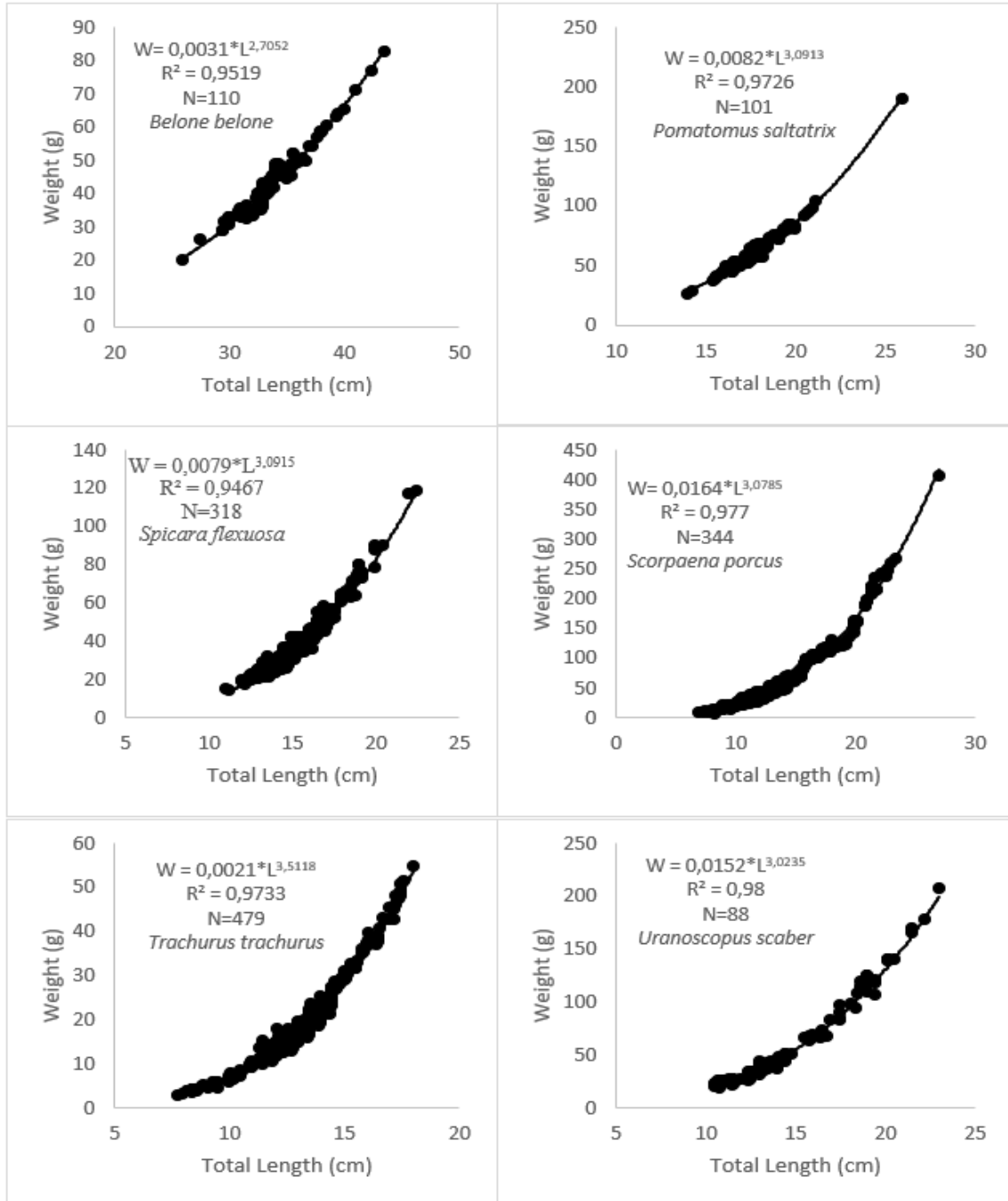

Figure 2. Length-weight relationship of six fish species
Şekil 2. Altı balık türünün boy-ağırlık ilişkisi

Table 2. Mean length, mean weight and mean Condition Factor for six fish species
Çizelge 2. Altı balık türü için ortalama boy, ağırlık ve kondisyon faktörü değerleri

Species	TL Mean±SE (cm)	W Mean±SE (g)	K Mean±SE
B. belone	33.76±0.265	42.73±0.961	0.11±0.001
P. saltatrix	17.85±0.165	62.25±1.976	1.06±0.005
S. flexuosa	14.85±0.100	34.68±0.859	1.01±0.005
S. porcus	13.84±0.188	65.00±2.987	2.02±0.012
T. trachurus	12.82±0.077	17.53±0.397	0.77±0.004
U. scaber	15.08±0.352	64.36±4.701	1.63±0.016

Table 3. Estimated parameters of the length-weight relationship and Fulton's condition factor for six fish species shared different research
Çizelge 3. Farklı çalışmalarda altı balık türü için hesaplanan boy-ağırlık ilişkisi parametreleri ve kondisyon faktörü

Species	References	N	$L_{min-max}$	b	K	Locality
B. belone	Uçkun et al., 2004	347	*26-54	3.40	0.118-0.126 ♀ 0.112-0.134 ♂	Aegean Sea
	Samsun et al., 2006	931	29-58	3.137	-	Black Sea
	Samsun, 1996	643	21.2-52.2	3.1778	0.1053	Black Sea
	This study	**110**	**26-43.6**	**2.7052**	**0.11**	**Black Sea**
P. saltatrix	Kalaycı et al., 2019	672	12.9-26.3	2.978	0.973	Black Sea Marmara Sea
	Cengiz et al., 2013	673	14.3-61.2	3.03	-	Mediterranean
	Bal et al., 2018	1023	12.3-47.3	2.9574	-	Marmara Sea
	This study	**101**	**14-26**	**3.0913**	**1.06**	**Black Sea**
S. flexuosa	Şahin and Genç, 1999	456	1.1-22.5 ♀ 11.3-22 ♂	3.22926 ♀ 3.12604 ♂	0.696-1.229 ♀ 0.721-1.439 ♂	Black Sea
	Ergün, 2018	599	8.7-21.8	2.9727	-	Black Sea
	Mater et al., 2001	412	*9.20-15.50	2.594	1.255	Aegean Sea
	This study	**318**	**11-22.5**	**3.0915**	**1.01**	**Black Sea**
S. porcus	Aydın, 2019	2442	2.8-33.2	3.0559	1.787-2.017	Black Sea
	Alpaslan et al., 2007	168	10.5-32	2.96	1.73	Marmara Sea
	Samsun and Erdoğan Sağlam, 2018	411	6.2-24	2.9548	1.98	Black Sea
	This study	**344**	**7-27**	**3.0785**	**2.02**	**Black Sea**
T. trachurus	Aydın and Karadurmuş, 2012	1307	6.9-19.02	3.17	-	Black Sea
	Bostancı, 2009	158	7.90-16.50	2.9367	0.99	Marmara Sea
	Yücel and Erkoyuncu, 2000	720	9.4-16.8	3.05	0.842	Black Sea
	This study	**479**	**7.8-18**	**3.5118**	**0.77**	**Black Sea**
U. scaber	Demirhan et al., 2007	346	5.2-21.9	3	-	Black Sea
	Karakulak et al., 2006	62	10.8-30.6	2.99	-	Aegean Sea
	Erdoğan Sağlam and Sağlam, 2013	289	4.5-25.1	3.059	0.0140-0.0186	Black Sea
	This study	**88**	**10.5-23**	**3.0234**	**1.63**	**Black Sea**

*Fork Length

4. Conclusions

The results provide basic information on the length-weight relationship and condition of 6 introduced fish populations in southern Black Sea. The changes in the b and K values of the populations of fish species examined can be thought of as the effects of climactic and environmental changes on the ecosystem and thus the growth of fish and also as an indicator of competition among species. As a conclusion, the comparative assessment of fish species living in different habitats and the characteristics of the populations of these species by years is important biological data required for the sustainability of fish stocks and creation of fishery management plans.

4. Acknowledgments

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