

## The Length-Weight Relationship and Condition Factor of Striped Sea Bream *Lithognathus mormyrus* (L., 1758) in the southern Black Sea Region

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**Abstract:** In this study, length-weight relationship and condition factor of *Lithognathus mormyrus* were determined in the Black Sea. A total of 306 individuals (170 female and 136 male) were caught between 2017 and 2018 with trammel nets. The mean length and the mean weight of the specimens were determined as 18.18 cm  $\pm$  2.01 (Min: 15.7 cm- Max: 31.0 cm) and 79.16 g  $\pm$  38.20 (Min: 49.23 g - Max: 393.8 g), respectively. The length - weight relationship was described for all individuals by the following formula  $W = 0.0147 L^{2.947}$  ( $R^2 = 0.942$ ) with a negative allometric growth. Fulton condition factor (K) was calculated, 1.27 $\pm$ 0.092 for all individuals.

**Keywords:** Black Sea, Ordu coast, *Lithognathus mormyrus*, length, weight .

## Güney Karadeniz Bölgesi'ndeki Mırmır *Lithognathus mormyrus* (L., 1758)'ın, Boy Ağırlık İlişkisi ve Kondisyon Faktörü

**Öz:** Bu çalışmada, Güney Karadeniz Bölgesi'ndeki *Lithognathus mormyrus*'un boy-ağırlık ilişkisi ve kondisyon faktörü belirlenmiştir. Toplam 306 birey (170 dişi ve 136 erkek) fanyalı ağlarla 2017 ve 2018 yılları arasında örneklenmiştir. Türün ortalama boy ve ağırlık verileri sırasıyla 18.18 cm  $\pm$  2.01 (Min: 15.7 cm - Mak: 31.0 cm) ve 79.16 g  $\pm$  38.20 (Min: 49.23 - Mak: 393.8) olarak hesaplanmıştır. Boy-ağırlık ilişki formülü tüm bireyler için;  $W = 0.0147 L^{2.9475}$  ( $R^2 = 0.9421$ ) olarak ve büyüme negatif allometrik olarak hesaplanmıştır. Fulton kondisyon faktörü (K) tüm bireyler için 1.27  $\pm$  0.092 olarak belirlenmiştir.

**Anahtar sözcükler:** Karadeniz, Ordu sahilleri, *Lithognathus mormyrus*, ağırlık, boy.

## INTRODUCTION

The striped sea bream *Lithognathus mormyrus* (Linnaeus, 1758) is a demersal species, naturally found in Eastern Atlantic, South Africa and Western Indian (Bauchot & Hureau, 1990). It is also widely abundant in the Aegean Sea, Mediterranean Sea, and Sea of Marmara (Bilecenoğlu et al., 2014). The species is more prevalent in sandy and muddy areas (Bauchot & Hureau, 1986; Fischer et al., 1987; Smith

& Smith, 1986). Although they commonly distribution 10-20 m depths, the depth range is 0-150 m (Bauchot & Hureau, 1990). They can reach up to 55 cm in total length and the highest estimated age is 12 (Fischer et al., 1987; Kraljević et al., 1996). Striped sea bream is a carnivore species that feeds on benthic organisms on muddy and sandy substrates. Its main preferences are bivalves, copepods, polychaetes and

amphipods (Froglia, 1977; Jardas, 1985). Striped sea breams are hermaphrodites where juveniles are male, after 14 cm total length female character is dominant (Vasil'eva, 2007).

It is known that, the adaptation of species inhabiting the Mediterranean Sea, by passing the Turkish Straits System, to the Black Sea (Aydın, 2017). This species is also thought to adapt the Black Sea ecosystem in this way. The first record of this species in the Black Sea coast of Turkey was reported by Satılmış et al., (2014) from Sinop province, the second occurrence was recorded by Engin et al., (2015) from Istanbul, Trabzon, Rize and Artvin provinces, than it was recorded by Aydın (2017) in the province of Ordu, and the author stated that it was found in a school. Later, by Aydın (2018) the species maximum length was reported as 30 cm, maximum weight 336.39 g and maximum age 7, for the Black Sea. Also the species was reported from Romanian coasts by Stanciu & Ilie (1980), from Georgian coasts by Vasil'eva (2007), and from Crimea coasts by Guchmanidze & Boltachev, (2017).

Length-weight relationships (LWRs) are used for estimating weight of a given length, condition factor is used for comparing the fish's health or fatness of the fish, and both concepts have been used for many years in fisheries research (Froese, 2006). Length-weight relationships in estimation of the condition of the fish, length values for estimation of the biomass, estimation of weight from a given length, in stock estimation models transforming growth in length and growth in weight equations to each other, comparison of life cycle of a fish's from different areas are widely used by fisheries researchers (Froese, 2006; Akyol et al., 2017).

In this study, the length and weight relationship for *L. mormyrus* is reported, a species that has migrated from the Mediterranean and adapted to the Black Sea.

## MATERIAL and METHOD

The study was carried out on shores of the Black Sea (Figure 1). A total of 306 *L. mormyrus* individuals (170 female and 136 male) were caught from the Ordu coast of southern Black Sea between 2017 and 2018 by using trammel nets (40-44-48 mm mesh size) set at 2-100 m depths.

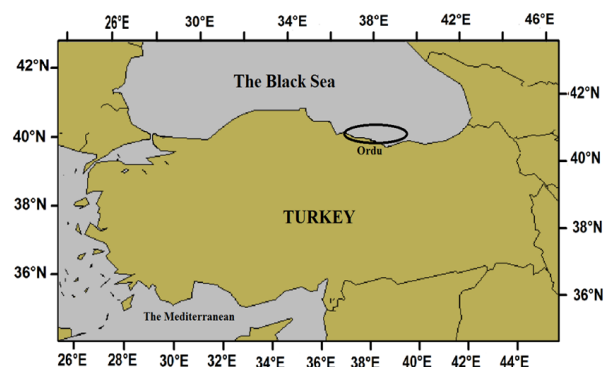


Figure 1. Sampling Region.

Captured fish specimens were preserved in ice boxes for examination in the laboratory. Total length (nearest 0.1 cm) and total weight (nearest 0.01 g) were recorded. The sex of each specimen was determined by examining the gonads macroscopically. The length-weight relationship (LWR) of the fish was calculated by applying the exponential regression equation  $W = aTL^b$ , where "a" and "b" are constants (Ricker, 1975). Pauly (1983) revealed that the regression coefficient "b" in length-weight relationship of marine organisms is usually 3. If  $b=3$ , growth is isometric where length increment is proportionate to weight increment. If it is greater than 3, the growth is positive allometric and if it is lower than 3, the marine organism exhibits negative allometric growth.

Fulton's coefficient of condition factor (K) was calculated by  $K=100W/L^3$ , where L is length (cm) and W is weight (g) (Le Cren, 1951; Bagenal, 1978; Sparre & Venema, 1992).

The relationships among the variables were identified using the regression analysis. The observed differences were evaluated statistically using SPSS 22.0 and Student's t-test (Sokal & Rohlf, 1969).

## RESULTS

In this study, 170 (55.55%) of the specimens were female and 136 (44.44%) male. The total sex ratio for female and male individuals (M:F) was 0.8:1. The difference between the sex ratios was found to be statistically significant ( $\chi^2 = 3.778$ ,  $df = 1$ ,  $P < 0.05$ ). When the *L. mormyrus* population in the Black Sea examined, 94.8 % of the individuals were between 19-20 cm total length group (Figure 2). The highest percentage was observed for 17 cm TL (35.3 %) length group.

The average total length of the examined individuals was found  $18.18 \text{ cm} \pm 2.10$ , and the average total weight was  $79.16 \text{ g} \pm 38.20$ . The female and male's average total length were  $18.06 \text{ cm} \pm 1.56$  and  $18.33 \text{ cm} \pm 2.46$ , respectively (Table 1).

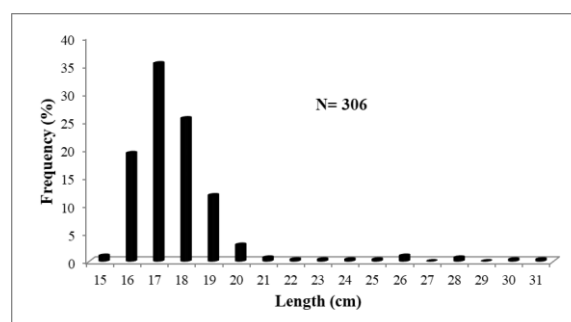


Figure 2. Size frequency distributions of *L. mormyrus* in the southern Black Sea region.

The largest sampled individual was 31 cm long and 393.8 g, which is the largest individual ever sampled from

the southern Black Sea (Table 1). The mean length and the mean weight of the specimens were determined as Table 1.

**Table 1.** Mean and standard deviation, maximum, minimum for length (L) and weight (W) parameters of each sex of *L. mormyrus*.

S	N	Length (cm)			Weight (g)		
		Mean ± SD	Min.	Max.	Mean ± SD	Min.	Max.
Σ	306	18.18±2.10	15.7	31.0	79.16±38.20	49.23	393.8
♂	136	18.33±2.46	15.7	30.0	83.01±46.53	49.23	336.3
♀	170	18.06±1.56	16.0	31.0	76.08±29.71	51.24	393.8

Σ: All, ♂: Male, ♀: Female S: Sex; N= Number of individuals, Min: Minimum; Max: Maximum; SD: Standard deviation

The analysis of length-weight relationship of *L. mormyrus* showed that the respective values of “b” were 2.947 for all individuals, 2.815 for females and 3.014 for males. The value of “b” is only slightly different than 3 for the male group and is not significantly different than 3 for the female and the all individuals with p> 0.05 (Table 2).

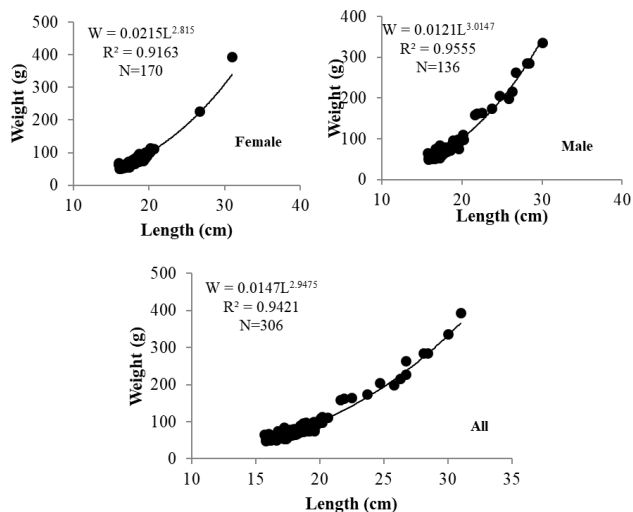
Negative allometric growth values were observed for the striped sea bream of (b) for females and all individuals, while the males showed an isometric growth (Figure 3). The length - weight relationship for all individuals was found as  $W = 0.0147 L^{2.947}$  ( $R^2 = 0.942$ ). Estimation of length-weight relationship for female, male and all individuals are given in Figure 3.

**Table 2.** Length-weight relationship parameters for each sex and all individuals for *L. mormyrus* from southern Black Sea.

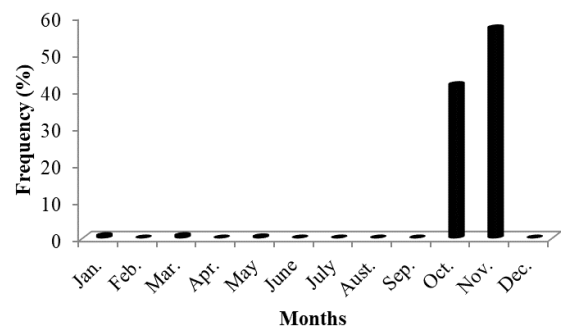
S	N	a	b	95% Confidence Interval (±SD)	R <sup>2</sup>	Pauly t-test	P
Σ	306	0.0147	2.947	2.865-3.029 (±0.041)	0.942	1.252	< 0.05
♂	136	0.0121	3.014	2.903-3.125(±0.056)	0.955	0.261	< 0.05
♀	170	0.0215	2.815	2.685-2.944 (±0.065)	0.916	2.818	> 0.05

Σ: All, ♂: Male, ♀: Female S: Sex; N: Number of individuals, SD: Standard deviation a: intercept, b: slope, R<sup>2</sup>: determination coefficient, P: probability of the t-test (H<sub>0</sub>: b = 3).

Out of 306 sampled individuals 98.4 % were caught in October and November (Figure 4). Though many were caught from shallower waters (2-15 m), the *L. mormyrus* individuals caught in March were from 90 m depth.



**Figure 3.** Length-weight relationship of female, male and all individuals for *L. mormyrus* from the southern Black Sea region.



**Figure 4.** *L. mormyrus* species presence frequency in the southern Black Sea region.

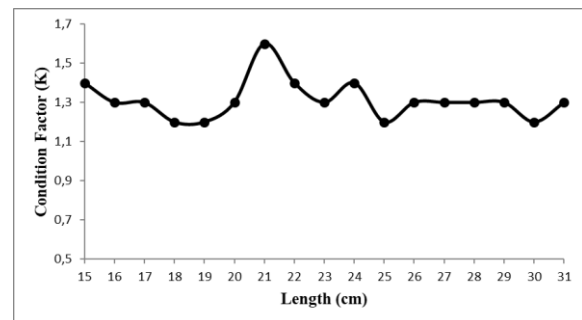
In this study, Fulton condition factor (K) were also calculated, where the lowest and highest estimations were found to be 1.003 and 1.681 respectively with a mean value of  $1.27 \pm 0.092$  for all individuals (Table 3).

**Table 3.** Fulton’s coefficient of condition factor (K) for *L. mormyrus* in the Black Sea.

N	K=100W/L <sup>3</sup>			
	Mean (K)	± SD	Minimum	Maximum
306	1.27	0.092	1.003	1.681

N= Number of individuals, K: condition factor, SD: standard deviation, W: total weight, L: total length.

The K values according to length groups are shown in Figure 5.



**Figure 5.** Relationships between condition factor (K) and L (cm) for *L. mormyrus* in the the southern Black Sea region.

**DISCUSSION**

In this study the M/F ratio was found to be 0.8/1. Many studies (Table 4) reported higher female ratios for the species population. In a study conducted in Iskenderun Bay by Türkmen & Akyurt (2003) reported the male/female ratio (M/F) as 1.09/1.00. Kraljević et al., (1996) in Adriatic Sea reported 1/1.62, Monteiro et al., (2010) from Portugal as 1/1.7, and from Antalya by Sümer et al., (2014) it was reported as 0.56/1.

The average total length of the examined individuals was found 18.18 cm (15.7-31.0), and the average total weight was 79.16 g (49.23-393.8). Fischer et al., (1987) reported that *L. mormyrus* can reach up to 55 cm and commonly to be around 30 cm. Reported maximum lengths of no study conducted from Aegean Sea and Mediterranean Sea coasts of Turkey are not as much as the common length reported by

Fischer et al., (1987) (Table 4). Only a study conducted in the Black Sea by Aydın, (2018) reported such length. In this

study the maximum length was found to be 31 cm, and this is the new maximum length reported from Turkish waters.

**Table 4.** Length-weight relationships of *L. mormyrus* from different areas.

N	Lmax (cm)	Wmax (g)	a	b	R <sup>2</sup>	Locality	References
202	37.6	670.0	0.0106	3.023	0.969	N. Adriatic Sea	Kraljević et al., (1996)
3335	27.7	303.2	0.0113	3.046	0.982	İskenderun Bay	Türkmen & Akyurt (2003)
73	14.3	---	0.0110	3.196	0.981	Aegean Sea	Koutrakis & Tsikliras (2003)
1688	34.1	520.9	0.0085	3.108	0.985	Greece	Kallianiotis et al., (2005)
36	27.8	---	0.0098	3.043	0.952	S. Aegean Sea	Akyol et al., (2007)
13	26.0	211.0	0.0084	3.100	0.950	N. Aegean Sea	Gökçe et al., (2007)
55	26.4	---	0.0118	3.010	0.982	C. Aegean Sea	İlkyaz et al., (2008)
339	27.4	329.0	0.0132	3.036	0.971	Antalya	Emre et al., (2010)
548	42.7	895.4	0.0001	3.023	0.995	Portugal	Monteiro et al., (2010)
105	20.5	103.5	0.0070	3.159	0.955	İzmir Bay	Acarlı et al., (2014)
169	22.7	---	0.0124	2.934	0.999	S. Aegean Sea	Bilge et al., (2014)
338	30.1	363.0	0.0141	2.999	0.980	Antalya	Sümer et al., (2014)
2015	16.5	46.6	0.0110	2.907	0.901	N. Aegean Sea	Altın et al., (2015)
25	20.1	100.3	0.0711	2.398	0.817	Black Sea	Aydın (2017)
449	34.5	540.3	0.0100	3.094	0.979	Algeria	Boufersaoui et al., (2018)
306	31.0	393.8	0.0147	2.815	0.916	Black Sea	This study (2019)

The LWRs parameters are extremely important for fish biology and fisheries management (Garcia et al., 1989). The relationship between length and weight for this species shows that growth shows negative allometry ( $b = 2.9475$ ) for combined sexes. Suau (1970) reported positive allometric growth ( $b = 3.43$ ) in the study conducted from Spanish coasts, Kraljević et al., (1995) in the northern Adriatic isometric growth ( $b = 3.05$ ) and in the central Adriatic negative allometric growth ( $b = 2.69$ ), again Kraljević et al., (1996) from northern Adriatic reported isometric growth, Türkmen & Akyurt (2003) reported isometric growth ( $b=2.979$ ) in their study conducted in Iskenderun Bay, Monteiro et al., (2010) from coasts of Portugal reported isometric growth (3.023), Sümer et al., (2014) reported isometric growth (2.999) from Antalya, Aydın (2017) reported negative allometry from the Black Sea (2.398) and Boufersaoui et al., (2018) reported isometric growth (3.094) from coasts of Algeria (Table 4). Even though isometric growth was reported by almost all the previous studies, there are some differences. These differences could be the result of ecological differences between seas, environmental differences or differences in food availability (Frost, 1945). At the same time, sex, length, age, reproductive period may also cause these differences (Ricker, 1975).

The studies on the presence of *L. mormyrus* in the Black Sea Basin are given in Table 5. Except one study (Aydın, 2017), all are regional records from the Black Sea. Only Aydın (2017) study provides LWR of 25 individuals

**Table 5.** Length and weight values obtained in other studies carried out in the Black Sea

References	Maximum length (cm)	Maximum weight (g)	Black Sea Region
Satılmış et al., (2014)	25.4	196.01	Turkey (Sinop)
Engin et al., (2015)	22.6	-	Turkey (Rize)
Guskov (2017)	15-24	70-250	Rusya (Caucasus)
Guchmanidze & Boltachev (2017)	19.6	-	Georgian (Batumi)
Guchmanidze & Boltachev (2017)	21.9	138.3	Rusya (Crimea)
Guchmanidze & Boltachev (2017)	17.2	65.4	Rusya (Crimea)
Guchmanidze & Boltachev (2017)	21.8	102.6	Rusya (Crimea)
Aydın (2017)	20.1	100.3	Turkey (Ordu)
Aydın (2018)	30.0	336.39	Turkey (Ordu)
This study (2019)	31.0	393.8	Turkey (Ordu)

Max. = Maximum

In the study, minimum K value was estimated 1.003, for maximum as 1.681. Matić-Skoko et al., (2007) studies K value was 1.245, and K values reported by Alssalam et al., (2016) were between 1.38-1.59. Both studies K values are in the range of this study's K values.

During the study' October and November samplings, 20-30 individuals were obtained. Even though the species was mainly sampled between 1-10 m depths, in March it was sampled from 90 m in depth. When considered the number of individuals obtained from the Black Sea it can be stated that this species has adapted to the region and that a stock has formed.

This research is the first study focusing on the weight-length relationship and condition factor for the population of *Lithognathus mormyrus* in the Black Sea, and also gives a new maximum length data record for this species in this region.

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