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RESEARCH ARTICLE

Morphologic characteristics and length-weight relationships of *Sciaena umbra* (Linnaeus, 1758) in the Black Sea coast

Mehmet Aydın[1*] (iD) • Barış Bodur[1] (iD)

[1] *Fatsa Faculty of Marine Science, Ordu University, Turkey*

ABSTRACT

In this study, the morphological characteristics and length-weight relationships of *Sciaena umbra* (Linnaeus, 1758) belonging to the Sciaenidae family, which is represented by five species in the Mediterranean basin and two species in the Black Sea, were investigated. Sampling was carried out in the Black Sea Region (Samsun, Ordu, Giresun, Trabzon) between March 2019 and February 2020. A total 54 of individuals were sampled and 15 different metric measurements were performed in each sample to determine their morphological characteristics. The mean total length and weight were estimated as 357.8 mm (117-580) and 845.3 g (16.4-2485.1), respectively. Total length was compared with morphometric characters and the lowest ratio was found with eye diameter (4.3%) and the highest ratio was with anal distance (59.9%). In the relation between the total length and morphological characters of the highest and the lowest correlation were observed in dorsal distance with $r^2=0.993$ and the anal height with $r^2=0.938$. A strong correlation ($r^2 = 0.993$) was found between the total length and weight relationship and the growth was positive allometric b> 3. This paper reports the first documented of morphometric characteristics of the species. It is considered to contribute to fisheries biology and international scientific literature.

Introduction

The brown meagre, *Sciaena umbra* Linnaeus, 1758, is one of the five species of the Sciaenidae (croakers or drums) family present in the Mediterranean Sea (Fischer et al., 1987). It is a demersal species with a wide distribution from the East Atlantic Ocean to the Mediterranean, Aegean, Black Sea and Azov Sea (Artüz, 2006; La Mesa et al., 2008; Chao, 2015). This species, which mostly lives on rocky and hard substrata, can grow up to a maximum length of 70 cm, but they are mostly found around

* Corresponding author
E-mail address: maydin69@hotmail.com (M. Aydın)

30 cm (Bauchot, 1987). The brown meagre is distributed in all the coasts of Turkey. This species is social and lives in small groups (20-150 individuals) (Artüz, 2006). The brown meagre is a sedentary and gregarious species living in shelters on rocky bottoms close to caves or large crevices in which it can shelter, or hidden within Posidonia and Zostera beds (Harmelin, 1991; Keskin, 2007). It is a nocturnal fish but it can sometimes to be found during the day (Frimodt, 1995). The brown meagre occurs in shallow coastal waters but especially when the water temperature down they prefer deeper waters and it may be found 200 m depth (Chauvet, 1991; Artüz, 2006). In the North Mediterranean Region, it has been reported that the species stocks have decreased significantly due to factors such as its life history, behavioral characteristics, habitat degradation, and pressures of small-scale professional and amateur fishing (Harmelin, 1991). In addition, spearfishing had a negative impact on its stocks (Harmelin-Vivien et al., 2015). There are 289 different species belonging to the Sciaenidae family (Chao, 1986; Chao, 2015; Parenti, 2020). The family is represented by two species (*Sciaena umbra* and *Umbrina cirrosa*) in the Black Sea (Fischer et al., 1987; Chao, 2015). There are some studies on the growth, reproduction and feeding habits of the species (Chakroun and Ktari, 1981; Fabi et al., 1998; Froglia and Gramitto, 1998; Chakroun-Marzouk and Ktari, 2003; Fabi et al., 2006; Derbal and Kara, 2007; Engin and Seyhan, 2009). However, there is no detailed study on the morphometric character of the species. Identification of morphometric characters is very important for fish fauna studies in marine ecosystem and determination of intra-species variations (Çoban et al., 2013). In addition, length-weight relationships allow morphological comparisons between different fish species or fish populations from different habitats and different regions (Gonçalves et al., 1997; Oscoz et al., 2005; Gül et al., 2017).The aim of this study was to provide data on the length and weight and morphometric characters of *S. umbra* species in the Black Sea.

Material and Methods

A total of 54 individuals were collected on a monthly and transported to the laboratory then measurements were made during the day. Fifteen metric measurements from *S. umbra* were performed. These measurements were 1. Total length (TL), 2. Standard length (SL), 3. Head length (HL), 4. Post-orbital distance (POD), 5. Eye diameter (ED), 6. Pre-dorsal distance (PDD), 7. Length of D1 fin basis (D1L), 8. Length of D2 fin basis (D2L), 9. Pre-anal distance (PAD), 10. Length of anal fin basis (AL), 11. Depth of anal fin (DAF), 12. Max. body depth (MBD), 13. Caudal peduncle minimal depth (CPMD),

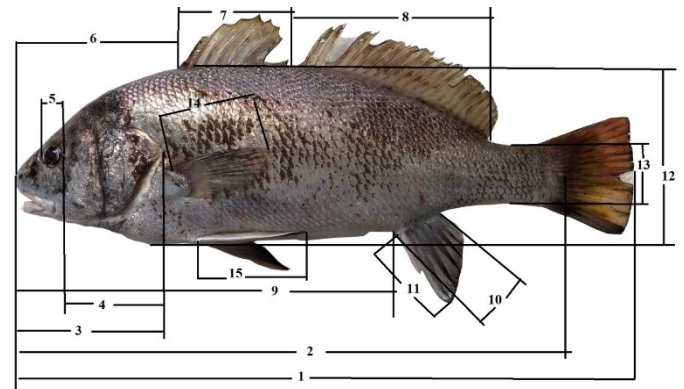14. Pectoral length (PecL), 15. Pelvic length (PelL), respectively (Figure 1).

Figure 1. Overview of the morphometric measurements of *Sciaena umbra* (1:Total length (TL), 2: Standard length (SL), 3: Head length (HL), 4: Post-orbital distance (POD), 5: Eye diameter (ED), 6: Pre-dorsal distance (PDD), 7: Length of D1 fin basis (D1L), 8: Length of D2 fin basis (D2L), 9: Pre-anal distance (PAD), 10: Length of anal fin basis (AL), 11: Depth of anal fin (DAF), 12: Max. body depth (MBD), 13: Caudal peduncle minimal depth (CPMD), 14: Pectoral length (PecL), 15: Pelvic length (PelL)

All individuals were measured for total length (TL, mm) to the nearest 0.1 and weighted (W, g) to the nearest 0.01. Digital compass with 0.1 cm sensitivity was used for morphometric measurements. Lengths that cannot be measured with calipers are used with a ruler. Thirteen morphometric characters were evaluated as TL%. Regression analysis of differences body parts against TL of the fish were drawn by least square method. Dependent and independent variables, TL and morphometric measurements were transformed using log 10.

Length-weight relationship was estimated using the equation $W = aL^b$ (*W*: Weight (g), *L*: total length (cm)), where "*a*" is the coefficient and "*b*" is an exponent indicating isometric growth when equal to 3. The "*b*" value was tested by student's t-test to verify if it was significantly different from isometric growth (Ricker, 1975; Pauly, 1984).

Results

Length and Weight Relationships

A total of 54 different size of *S. umbra* (36 female, 18 male) were sampled with the smallest individuals 117 mm and the largest 580 mm. Length and weight relationships of *S. umbra* was shown in Figure 2.

A strong correlation relationship between length and weight ($r^2 = 0.993$) was calculated. The value of "b=3.190" is different than 3 (p> 0.05). It was determined that growth was positive

allometric b> 3. The length-weight relationship parameters for *Sciaena umbra* were given regardless of gender (Table 1).
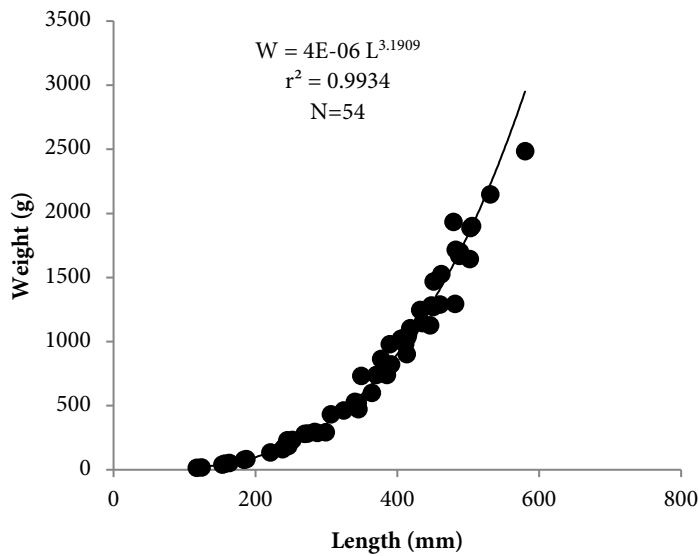

$$W = 4E\text{-}06\ L^{3.1909}$$
$$r^2 = 0.9934$$
$$N=54$$

Figure 2. Total length and weight relationships of *Sciaena umbra*

Table 1. The length-weight relationship parameters for *Sciaena umbra* in the Southern Black Sea region

N	a	b	95% CI (+SD)	r^2	Pauly t-test	P
54	0.000004	3.190	3.118-3.263 ($\pm$0.035)	0.993	5.06	> 0.05

Note: N: Number of individuals; a: Intercept; b: Slope; CI: Confidence interval; SD: Standard deviation; r^2: Determination coefficient; P: Probability of the t-test (H_0: b = 3).

Morphologic characteristics

S. umbra has a double dorsal fin. The second dorsal fin is longer than the first and located very close to each other. In addition, juvenile individuals have high first dorsal fin. As the individuals grow, the first dorsal and second dorsal highs are almost similar. The pectoral fin position is ahead of the position of the first dorsal and pelvic fin and the length of the pectoral fin does not extend until the end of the pelvic fin. Even though its appearance can change in different habitats, in generally its

dorsal part is dark brownish and purplish in color and the lower part of the line lateral has a lighter bronze metallic color. Dorsal fins are bronze metallic light brown, the first rays of the pelvic fin are white, while the other parts are dark black like the anal fin. Also, the anal fin has a white and very thick bony structure. It is surrounded by a black band at the ends of the caudal and dorsal fins and the caudal fin has a single lobed structure. *S. umbra* has a single continuous lateral line extending to hind margin of caudal fin. Scales ctenoid (edge comb-like) cover entire body, except tip of snout. The head is covered with cycloid scales. The head length is about 25.9% of the total length (Table 3). The eye size is relatively larger than the head. Even though some species of the Sciaenidae has barbels, this species has not. Swim bladder is located between the viscera and the backbone and the organ is a carrot-shaped form (Figure 3). The inflated swim bladder is 15 cm long and has a diameter of 5 cm for a fish with a length of 44.3 cm.

S. umbra has 3-4 rows of villiform teeth in both jaws and it also has dense pharynx teeth. On the first gill arch has 14-15 short, blunt shape gill raker (Figure 4).

Six meristic characters were examined. The lists of meristic characters used for analysis of *S. umbra* are presented in Table 2. The first dorsal fin has 10 spine rays and the second dorsal fin has one spine ray and 23 soft rays. The anal fin has two spine rays and 7 soft rays. The second spine of ray is almost 7 times the length of the other spine.

Table 2. Meristic features of *Sciaena umbra*

Meristic features	
Dorsal fin	D1 X, D2 I 23
Pelvic fin	I, 5
Anal fin	II, 7
Pectoral fin	12
Caudal fin	16
Gill rakers	14-15
Linea lateral	72-76

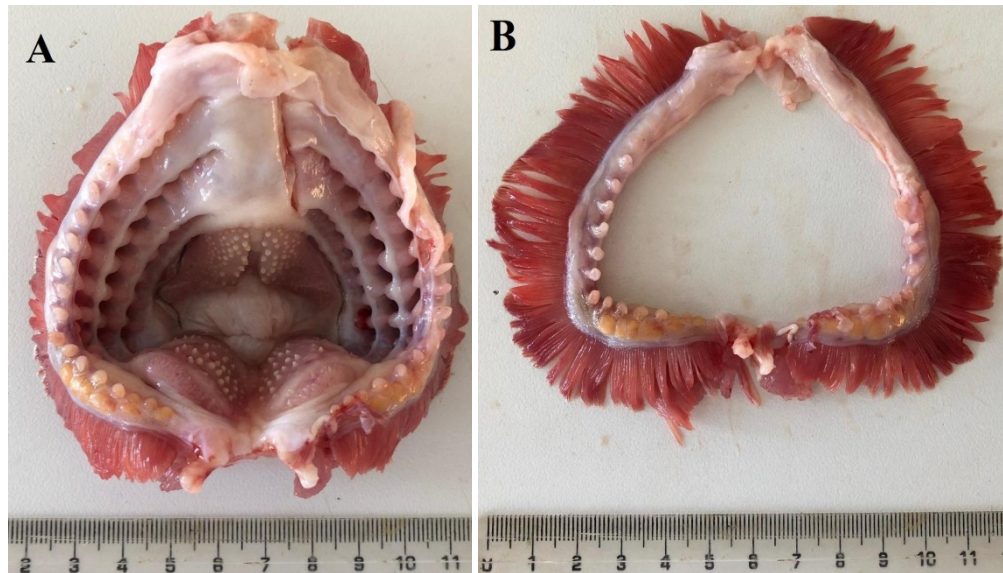**Figure 3.** Swim bladder of *Sciaena umbra*

Figure 4. Pharynx teeth (A) and the first gill arch (B) of *Sciaena umbra*

Table 3. Some metric properties of *Sciaena umbra*

Characters	Mean	±SE	Min.	Max.	%TL
Total length (mm)	357.8	116.42	117.0	580.0	---
Standard length (mm)	306.1	104.67	91.5	490.0	---
Head length (mm)	92.8	33.60	29.5	152.1	25.9
Post-orbital distance (mm)	52.9	21.43	12.7	88.7	14.8
Eye diameter (mm)	15.3	4.90	6.51	25.1	4.3
Pre-dorsal distance (mm)	108.6	39.38	33.6	181.1	30.4
Length of D1 fin basis (mm)	65.7	22.47	20.0	112.9	18.4
Length of D2 fin basis (mm)	110.8	36.65	35.1	178.0	31.0
Pre-anal distance (mm)	214.3	75.64	63.5	340.0	59.9
Length of anal fin basis (mm)	27.5	8.50	10.8	39.6	7.7
Depth of anal fin (mm)	53.3	12.40	23.0	76.4	14.9
Max. body depth (mm)	100.5	35.42	28.5	156.1	28.1
Caudal peduncle minimal depth (mm)	29.2	10.80	7.2	50.4	8.2
Pectoral length (mm)	59.2	18.91	20.8	88.6	15.5
Pelvic length (mm)	61.2	15.71	26.7	88.5	17.1
Total weight (g)	845.3	646.03	16.4	2485.1	---

Morphometric characters

The mean total length and weight of the individuals sampled was 357.8 mm (117-580) and 845.3 g (16.4-2485.1), respectively. The mean, standard errors, minimum and maximum values of the morphometric properties of all samples are given in Table 3. In addition, the morphometric properties of the *S. umbra* were proportional to the total length and the smallest ratio was eye size (4.3%) and the highest ratio was the pre-anal distance (59.9%). The maximum body depth of the species is 28.1% of the total length.

The relationship between the morphometric characteristics and total length were analyzed with regression equations. Correlation coefficients of morphometric lengths-total length relationships were given in Table 4. The closest relationship was found between total length (TL) and pre-dorsal distance (PDD)

according to linear regression values (r^2=0.993) and the weakest relationship with depth of anal fin (DAF) (r^2=0.938).

Table 4. Linear regression statistics of various morphometric measurements of *Sciaena umbra* against total length

Regression Formula		r^2
HL	= 0.2865TL – 9.6954	0.985
POD	= 0.1822TL – 12.254	0.979
ED	= 0.0412TL + 05998	0.957
PDD	= 0.3371TL – 11.952	0.993
D1L	= 0.1897TL – 2.1849	0.966
D2L	= 0.3122TL – 0.9396	0.983
PAD	= 0.6454TL – 16.616	0.986
AL	= 0.0712TL – 2.0365	0.950
DAF	= 0.1031TL – 16.434	0.938
MBD	= 0.2991TL – 6.5069	0.969
CPMD	= 0.0912TL – 3.3690	0.965
PecL	= 0.1597TL + 2.0764	0.966
PelL	= 0.1315TL + 14.1080	0.950

Note: 1. Total length (TL), 2. Head length (HL), 3. Post-orbital distance (POD), 4. Eye diameter (ED), 5. Pre-dorsal distance (PDD), 6. Length of D1 fin basis (D1L), 7. Length of D2 fin basis (D2L), 8. Pre-anal distance (PAD), 9. Length of anal fin basis (AL), 10. Depth of anal fin (DAF), 11. Max. body depth (MBD), 12. Caudal peduncle minimal depth (CPMD), 14. Pectoral length (PecL), 15. Pelvic length (PelL).

Discussion

In the study, a total of 54 individuals were sampled (36 females and 18 males). Length of all individuals ranged from 117-580 mm with 357.8 mm average. Karakulak et al. (2006) reported the maximum length as 29.8 cm, Karachle and Stergiou (2008) as 16 cm, Bilge et al. (2014) as 40.4 cm for *S. umbra* in the Aegean Sea. Cengiz et al. (2019) declared that the largest individual was 41.7 cm for the Aegean Sea. Engin (2003) determined the maximum length as 72 cm for Black Sea. Considering these results, it can be said the population in the Black Sea has larger individuals than the Aegean Sea population. The "a" and "b" coefficients obtained in the relationship between length and weight may differ depending on reasons such as environmental factors, nutrient abundance, reproductive activities (Mommsen, 1998).

In this study, "b" value was calculated as 3.1909 and it was determined that growth was positive allometric (b>3). Few studies on the species reported that the growth were negative allometry (Karachle and Stergiou, 2008; Maci et al., 2009; Crec'hriou et al., 2013), while most of study reported to be positive allometric growth (Morey et al., 2003; Karakulak et al., 2006; La Mesa et al., 2008; Engin and Seyhan, 2009; Grau et al., 2009; Bilge et al., 2014; Chater et al., 2018). The "b" value may be different from one population to another of the same species.

The fluctuating can be assigned to factors such as food availability, feeding rates, whether sampling was done during the spawning season, differences in the number of specimen sampled, the period of sampling (Bagenal and Tesch, 1978; Moutopoulos and Stergiou, 2002; Mahé et al., 2018). Karachle and Stergiou (2008) and Maci et al. (2009) were used very small individuals in their study. Therefore they maybe have estimated the "b" value less than 3. Crec'hriou et al. (2013) reported "b" value as 2.91. It can be said to be use few individuals (n: 16). It is determined that the species has a highly developed swim bladder. Similarly, Picciulin et al. (2016) stated that the swim bladder of the species has a highly developed (Figure 3), it can make sounds using the muscles in the lower parts and they can establish social relationships with other individuals around them. There may be some changes in the morphometric characters of the fish after adaptation of a fish species to different environmental conditions (Blackith and Albrecht, 1959; Avşar, 1995). Morphometric measurements are used to determine similarities or differences between one stock and another. In addition, it is widely use taxonomic categories for fisheries biology area (Dwivedi and Dubey, 2013). Although the *S. umbra* species is distributed to the East Atlantic Ocean, the Mediterranean, Aegean, Marmara, Black Sea and the Sea of Azov (Artüz, 2006; Chao, 2015), there are very few biological studies (Engin, 2003, Engin and Seyhan, 2009) on the species, but no data are available about morphometric characters. Recent recreational fishing activity particularly from spearfishing had a negative impact on its stocks on the Mediterranean Sea and Black Sea (Harmelin-Vivien et al., 2015). On the one hand, in recent years a large part of the coastal area of the Southern Black Sea has been filled up for the highway and airport construction as well as land acquisitions. It is thought that this development had a positive impact on *S. umbra* species in terms of population increase. Lately, a noticeable increase has been observed on such species (Aydın and Sözer, 2016). Since the habitat structure of the Black Sea is limited rocky areas, does not allow the shelter for small individuals. It is thought that filled coastal areas provide suitable habitats for these species' juveniles.

Conclusion

The scientists rarely provided samples for research this species because of high economic value, living in limited areas and fishing requires special skills. Consequently, there is few study on the species. Thus, this is the first documented of morphometric characteristics of the species. This paper is considered to contribute to fisheries biology and international scientific literature.

Acknowledgements

Compliance with Ethical Standards

Authors' Contributions

Author MA designed the study, BB wrote the first draft of the manuscript, and both authors conducted field work and lab work together. Both authors read and approved the final manuscript.

Conflict of Interest

The authors declare that there is no conflict of interest.

Ethical Approval

This study was conducted in accordance with ethics committee procedures of animal experiments.

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