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RESEARCH ARTICLE

The Length-Weight Relationship and Condition Factor of the Red Cornetfish, *Fistularia petimba* Lacepède, 1803 in the Southeastern Mediterranean Coast of Türkiye (İskenderun Bay)

Deniz Ergüden[1], Servet Ahmet Doğdu[2], Cemal Turan[1]

[1]Iskenderun Technical University, Faculty Marine Sciences and Technology, Department of Marine Sciences, İskenderun, Turkiye
[2]Iskenderun Technical University, Vocational School of Maritime, Department of Underwater Tecnologies, İskenderun, Turkiye

ORCID: D.E. 0000-0002-2597-2151; S.A.D. 0000-0003-2939-5838; C.T. 0000-0001-9584-0261

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Correspondence: Deniz Ergüden
deniz.erguden@iste.edu.tr

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Abstract

Objective: In fisheries biology, length-weight relationship data are commonly used and helpful for determining the weight of an individual fish of known total length or total weight from length-frequency distribution. The present investigation aims to estimate the length-weight relationships and Fulton's condition factors from the southeastern Mediterranean coast of Türkiye.

Materials and Methods: A total of 368 red cornetfish, *Fistularia petimba* Lacepède, 1803 (203 females and 165 males) specimens were collected from the İskenderun Bay (southeastern Mediterranean, Türkiye) within the fishing periods of April 2019 and March 2020, caught by commercial bottom trawler at 28-42 m depths. Fish samples were measured in total length (TL) to the nearest 0.1 cm, and the total weight was scaled to the nearest 0.01 g.

Results: The total length ranged from 21.50-56.60 cm, and the weight ranged from 8.10-94.04 g for Fistularia petimba. The length-weight relationship was found as the $W = 0.00033 \times L^{3.126}$ ($r^2 = 0.963$) for both sexes. The value of *b* is slightly different than 3 and showed positive allometric growth. The condition factor was found to be 0.539 for females, 0.526 for males, and 0.520 for both sexes.

Conclusion: This study is the first investigation of the length-weight relationship and condition factor for *Fistularia petimba* from İskenderun Bay. The present study provides the basic fisheries parameters for this species in the Mediterranean Sea, which will be useful for fisheries management and fish population dynamics.

Keywords: Cornetfish, Fistulariidae, Regression parameters, Condition, Mediterranean Sea

Introduction

The red cornetfish, *Fistularia petimba* Lacepède, 1803, belongs to the Fistulariidae family, represented by a single genus (Froese & Pauly, 2023). The genus *Fistularia* Linnaeus, 1758 contains *Fistularia commersonii* Rüppell, 1838 and *F. petimba*, distributed in the Mediterranean Sea (Golani, 2000; Stern *et al.,* 2017). *Fistularia petimba* differs from its congeneric species *F. commersonii* by a row of bony plates along its posterior lateral line ossifications and the reddish or orange colour (Froese & Pauly, 2023). Stern *et al.* (2017) and Karan *et al.* (2019) confirmed that *F. petimba* is a genetically distinct species in the Mediterranean Sea.

Fistularia petimba is distributed in the western and eastern Atlantic, including the Mediterranean (Cardenas *et al.,* 1997; Froese & Pauly, 2023) and the Indo-Pacific Ocean (Fricke, 1999). *Fistularia petimba* is a reef species that inhabits coastal areas over soft bottoms at depths ranging from 10 to 200 m (May & Maxell, 1996). It feeds mainly on fish, cephalopods, shrimp, stomapods, other crustaceans, and small fishes (Druzhinin, 1977).

Fistularia petimba was first reported in Spain (western Mediterranean) in 1996 (Cardenas *et al.,* 1997). Then, this species was identified in the Azores and Galician waters in the Eastern Atlantic Ocean (Azevedo *et al.,* 2004; Bañón & Sande, 2008). Later, this species was also recorded in the waters of Israel in 2017 (Stern *et al.,* 2017), Türkiye in 2018 and 2019 (Ünlüoğlu *et al.,* 2018; Çiftçi *et al.,* 2019), Cyprus (Michailidis & Manitaras, 2019), Syria (Hussein *et al.,* 2019), Egypt in 2019 (Ragheb, 2022), Lebanon and Greece in 2021 (Kondylatos & Nikolidakis, 2021; Sakr & Bariche, 2021). In addition, recent records are reported from Gökova Bay and Güllük Bay for the Muğla coast from northward along the shores of the eastern Mediterranean in the northern Aegean Sea coast of Türkiye by Cerim *et al.* (2021). Lately, this species has been confirmed from Bandırma Bay and distributed in the Marmara Sea, Türkiye (Uyan & Turan, 2021).

In fisheries biology, length-weight relationship data are reasonably helpful for determining the weight of an individual fish of known total length or total weight from length-frequency distribution (Froese, 1998; Koutrakis & Tsikliras, 2003). These data are used initially to obtain information on the condition of fish and to determine whether somatic growth is isometric or allometric (Le Cren, 1951; Ricker, 1975). Besides, the length-weight relationship is the primary value used for evaluating the status of fish stocks. It provides information for fish growth and health, and the length-weight relationship can be helpful in local and regional morphological and life-historical comparisons between different populations and habitats (Erguden *et al.,* 2011; Erguden & Turan, 2017; Erguden *et al.,* 2018).

Fistularia petimba penetrated the eastern part of the Mediterranean from the Red Sea via the Suez Canal (Stern *et al.,* 2017), and several were reported in the Mediterranean Sea six years ago (CIESM, 2022). *Fistularia petimba* is known to have high reproductive success. This species is a potential hazard to the ecological balance as well as economically affecting commercial fishing in the Mediterranean Sea (Çiftçi *et al.,* 2019).

To date, scarce data reports are available on populations of *F. petimba* in the Mediterranean. Only a few data were reported on the morphometric and meristic characteristics in the Egyptian Mediterranean waters (Ragheb, 2022) and a preliminary biological assessment of *F. petimba* from Cyprus (Papageorgiou *et al.*, 2023). In the present study, we first reported the length-weight parameters of *F. petimba* from İskenderun Bay. To the best knowledge, this study presented the first reference on length-weight relationships and condition factors for this species from İskenderun Bay (southeastern Mediterranean, Türkiye).

Materials and Methods

The red cornetfish of *F. petimba* were collected from İskenderun Bay using commercial trawl fisheries at 28-42 m depths within the fishing periods of April 2019 and March 2020 (Fig. 1). The collected fish specimens were transported with ice in a cooler box to the laboratory. Fish samples were measured in total length (TL) to the nearest 0.1 cm, and total weighed (W) was scaled to the nearest 0.01 g. Sexes were identified by macroscopic and microscopic examination of the gonads. The total length and total weight were measured for males and females separately. According to Fritzsche (1990) and Stern *et al*. (2017), all specimens were identified.

The length-weight relationship was calculated by applying an exponential regression equation $W=aL^b$ where; W is the weight (g), L is the total length (cm), and a and b are regression constants. Then, the parameters were estimated by linear regression on the transformed equation: $log\ (W) = log\ (a) + b \times log\ (L)$ (Ricker, 1975). The parameters a and b were calculated using least-squares regression as the coefficient of determination (r^2).

The sex ratio was calculated with $\chi 2$ test performed to check for any significant difference. The student's t-test was used to test for the difference of b values from 3, representing isometric growth (Pauly, 1993). Analysis of

Figure 1. Study area (İskenderun Bay, Türkiye)

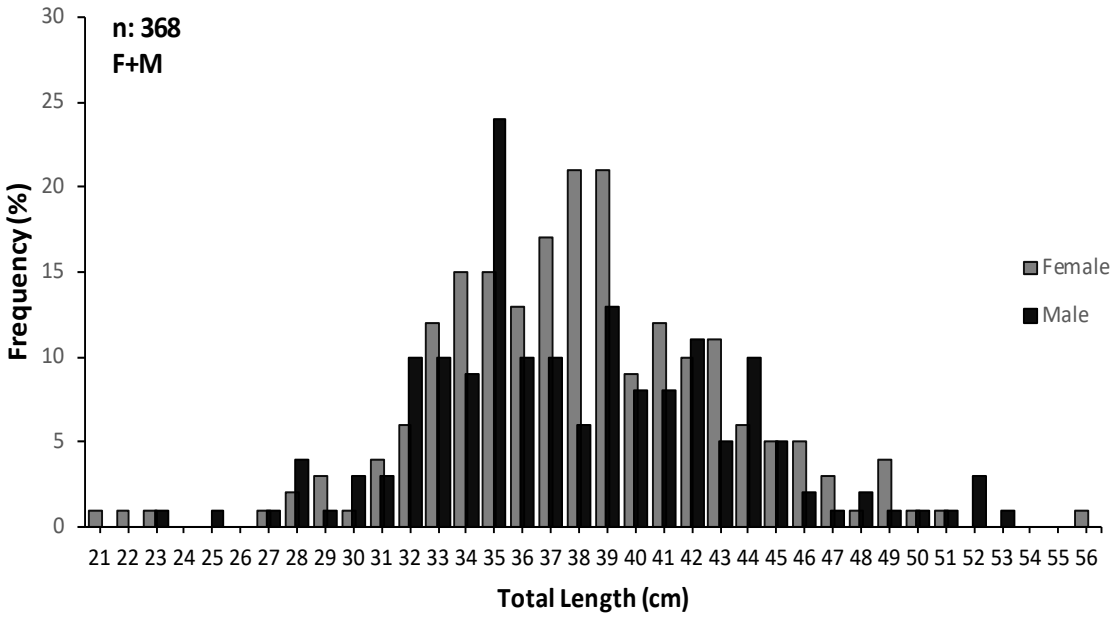

Figure 2. Total length (cm) frequency of males and females specimens of *Fistularia petimba* from İskenderun Bay

variance (ANOVA) was used to test the difference of the *b* values of the length-weight relationship between sexes (Zar, 1999) and statistically analysed using Microsoft Excel 2020 and SPSS Version 26.0 package programs.

Fulton's condition factor (K) was calculated for each sex to assess the condition of specimens and an overall measurement of the fish according to the formula; $K = (W/L^3) \times 100$, where L is length (cm) and W is the weight (g) (Sparre & Venema, 1992).

Results

In the present study, 203 females (55.2%) and 165 males (44.8%) *F. petimba* specimens were collected and investigated during the study period from İskenderun Bay. The sex ratio for female and male samples (M:F) was 1.00:1.23. The male-to-female ratio was not statistically significant at 0.05 ($p>0.05$).

The total length values of females and males ranged from 21.50-56.60 cm and 23.70-53.70 cm, respectively, and also the total weight values of females and males ranged from 8.10-94.04 g and 8.94-86.31 g, respectively (Table 1). There was no significant difference between sexes in overall total length and total weight (t-test, $p>0.05$).

The average total length of the calculated both sexes was found to be 38.31 cm ± 5.319, and the average total weight was 32.15 g ± 14.406. The dominant length class of collected *F. petimba* specimens ranged from 35.00 cm to 35.50 cm for all samples males dominated the 34.00-35.00 cm class, whereas females dominated 38.00-39.50 cm (Fig. 2). The descriptive statistics and estimated parameters of the length-weight relationship values are given in Table 1.

The length-weight relationship parameters were separately evaluated for *F. petimba* population of female, male, and both sexes specimens. The sample size (n), the level of equation parameters, the coefficient of determination (r^2), and the 95% confidence limits and growth type are given in Table 2. The linear regression equations for the length-weight parameters of *F. petimba* were highly correlated ($r^2 > 0.95$).

All values of *b* ranged from 3.106 for females, 3.138 for males, and 3.126 for both sexes for *F. petimba* (Table 2). The value of *b* is slightly different than 3.0, indicating that the species demonstrate positive allometric growth. The slopes (*b* values) of the total length-weight regressions were significantly different between sexes (*t*-test, $p<0.05$).

Table 1. Mean and standard deviation (SD), maximum, minimum for total length (TL) and total weight (TW) parameters of each sex of *Fistularia petimba* (İskenderun Bay, Türkiye)

Sex	n	TL (min-max)	Mean TL ± SD	TW (min-max)	Mean TW ± SD
Female	203	21.50-56.60	38.52±5.151	8.10-94.04	32.74±14.219
Male	165	23.70-53.70	38.28±5.532	8.94-86.31	31.42±14.643
Both Sexes	368	21.50-56.60	38.31±5.319	8.10-94.04	32.15±14.406

Table 2. Length-weight relationships of *Fistularia petimba* from İskenderun Bay, Türkiye (SE: Standard Error, A: Allometric Growth)

n	Sex	*a*	*b*	r^2	SE of *b*	95% CI of *b*	t-test	p	Growth Type
203	Females	0.00036	3.106	0.964	0.042	3.022-3.189	7.604	<0.05	A (+)
165	Males	0.00033	3.138	0.965	0.047	3.045-3.230	7.716	<0.05	A (+)
368	Both Sexes	0.00032	3.126	0.963	0.032	3.073-3.199	10.825	<0.05	A (+)

The length-weight relationships were calculated for females, males, and both sexes and observed as W=0.00036 × $L^{3.106}$ (r^2 = 0.964), W=0.00032 × $L^{3.138}$ (r^2 = 0.965) and W= 0.00033 × $L^{3.126}$ (r^2 = 0.963) respectively (Fig. 3). An ANOVA test calculated a significant statistical difference in length-weight relationship parameters between females and males (p<0.001). The correlation coefficient (r^2) for all relationships is above 0.95, indicating a strong degree of correlation between the variables in all groups.

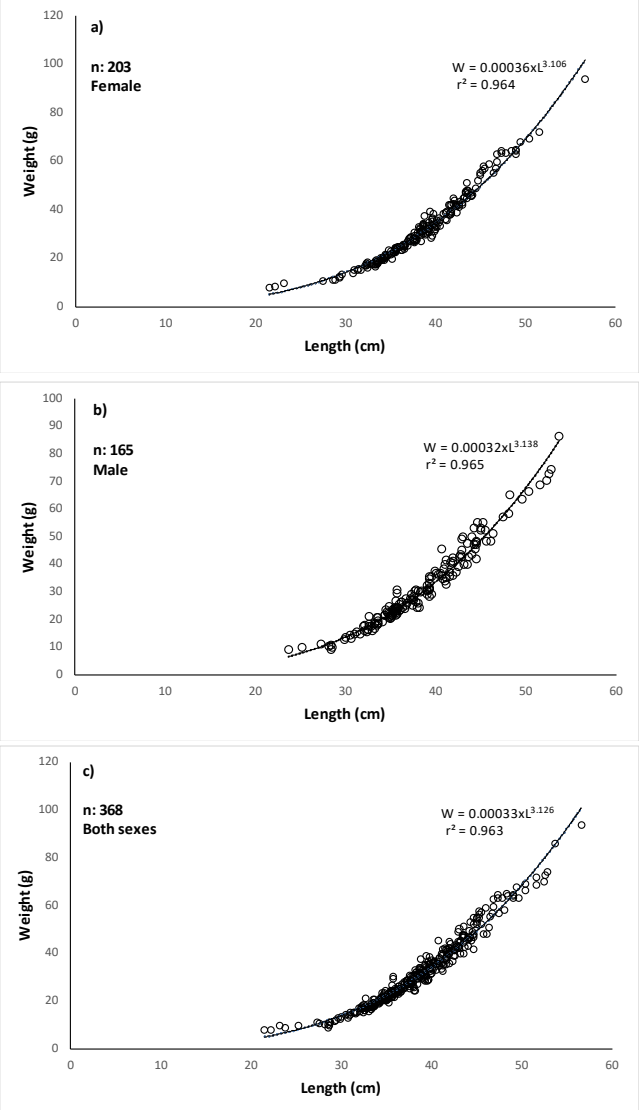

Figure 3. Length-weight relationship of female (a), male (b) and both sexes (c) for *Fistularia petimba* from the İskenderun Bay (south-eastern Mediterranean, Türkiye)

Fulton's condition factor of the present species from the southeastern Mediterranean coast (İskenderun Bay, Turkey) was analysed using the total weight. The condition factor was 0.539±0.057 for females, 0.526±0.047 for males, and 0.520±0.049 for both sexes. Therefore, condition factor values do not show significant variations (p>0.001) for female and male individuals of *F. petimba*.

Discussion

A total of 368 samples of *F. petimba* were collected from İskenderun Bay, southeastern Mediterranean, Türkiye. The population of *F. petimba* comprised 55.2% of female specimens and 44.8% of male specimens. The total length of the examined for both sexes was measured as 27.5-56.6 cm (38.311±5.319) and total weight 8.10-94.04 g (32.747±14.219) (Table 1). Female specimens were found to grow slightly larger than male specimens. Fritzsche (1976) indicated that this species usually has 100 cm and smaller samples, with the mean total length of the samples being 65.9 cm. Durizhinin (1977) reported total lengths of 128.5 cm and weights of 1450 g, with females larger than males for *F. petimba*. Cárdenas *et al.* (1997) similarly reported a large red specimen of 124.0 cm from the Western Mediterranean off Spain in 1996. In our study, the size ranges of the samples consisted of smaller specimens. Thus, maximum length and weight values were not found in the samples collected from İskenderun Bay. So far, the maximum length reported for *F. petimba* is 200 cm (Sanchez, 1991) and the weight is 4.7 kg (Bykov, 1983).

Previously, in Mediterranean studies, Ünlüoğlu *et al.* (2017) reported a total length ranged 35.1-47.4 cm for *F. petimba* from the eastern Mediterranean Sea, Türkiye. Cerim *et al.* (2021) stated that the total length ranged 33.7-50.4 cm for *F. petimba* collected from the South Eastern Aegean Sea (Türkiye). Papageorgiou *et al.* (2023) reported a total length ranged 38.9-43.7 cm for *F. petimba* from the Levantine Sea, Cyprus. In addition, Michailidis & Manitaras (2019) stated a total length of 60.2 cm for *F. petimba* from the Mediterranean waters of Cyprus. On the other hand, Hussein *et al.* (2019) declared that a large specimen of 64.0 cm of total length without filament for *F. petimba was* caught from the Mediterranean coast

Table 3. Previously available length-weight data of *Fistularia petimba* from different regions in the Mediterranean Sea

References	Number of samples	Date	Location/Country	Depth (m)	Fishing Gear	Total Length (cm)	Weight (g)
Cardenas *et al.* (1997)	1	June 1996	Cadiz, Western Mediterranean, Spain	50	Gill net	124.0	950.0
Stern *et al.* (2017)	1	December 2016	Ashdod, Eastern Mediterranean, Israel	80	Trawl net	29.5	65.0
Ünlüoğlu *et al.* (2017)	2	October 2016	Antalya Bay, Mediterranean Sea, Türkiye	30-43	Trawl net	35.1-39.8	-
	2	November 2016	İskenderun Bay, Mediterranean Sea, Türkiye	35-38	Trawl net	43.5-47.4	-
Çiftçi *et al.* (2019)	2	May 2018	Mersin Bay, N.E. Mediterranean Sea, Türkiye	150	Trawl net	46.5-51.3	-
Hussein *et al.* (2019)	1	July 2019	Lattakia, Mediterranean Sea, Syria	45	Gill net	64.2	54.0
Michailidis & Manitaras (2019)	1	September 2019	Gialia, Mediterranean Sea, Cyprus	55	Gill net	60.2	67.0
Cerim *et al.* (2021)	4	October 2019	Gökova Bay, Aegean Sea, Türkiye	15-20	Trawl net	33.7-36.9	-
	1	November, 2019	Güllük Bay, Aegean Sea, Türkiye	65	Trawl net	50.4	-
Sakr & Bariche (2021)	1	November 2017	Tripoli, Eastern Mediterranean, Lebanon	-	Gill net	49.5	-
Kondylatos & Nikolidakis (2021)	1	June 2021	Marathokampos Bay, Aegean Sea, Greece	20	Trammel net	34.2	17.3
Turan & Uyan (2021)	1	October 2021	Bandırma Bay, Marmara Sea, Türkiye	32	Trammel net	34.6	-
Ragheb (2022)	1	March 2019	West of Alexandria, Egypt	40-60	Trawl net	47.3	51.0
Papageorgiou *et al.* (2023)	76	June 2020, March 2021, August 2021 and September 2021	Levantine Sea, Cyprus	-	Trawl net	38.9-43.7	28.1-43.6
This study	368	April 2019 and March 2020	İskenderun Bay, SE. Mediterranean Sea,Türkiye	28-42	Trawl net	21.5-56.6	8.1-94.0

(Lattakia, Syria). The detailed previous Mediterranean studies of length-weight data for *F. petimba* are given in Table 3.

The growth coefficient values *b* ranged from 3.106 (females) to 3.138 (males), and the types of growth are positive allometric. Similarly, the previous studies of positive allometric growth (*b*=3.512) of *F. petimba* have been reported in the Levantine Sea (Cyprus) by Papageorgiou *et al.* (2023). In other studies, *b* values for both sexes of *F. petimba* were estimated as *b*= 3.158 in New Caledonia (Letourneur *et al.*, 1998) and as *b*=3.432 in the southeastern inner continental shelf region (Brazil) (Dias *et al.*, 2014). These previous results are in accordance with the studies performed in İskenderun Bay. Some differences in the *b* exponents could be attributed to the different areas and habitats, environmental conditions, the stomach contents, and stage of gonads as well as to the differences in season, diet, and maturity (Erguden *et al.,* 2011; Erguden *et al.,* 2015; Erguden *et al.,* 2017). In this study, the difference in the exponents may have occurred due to the different sampling regions, seasonal changes, age, maturity, and sex.

The values of *b* equal to 3 indicate that the fish grows isometrically; values different from 3 indicate allometric growth. In the length-weight relationships, the *b* value in the length-weight relationship showed that positive allometry (+) was obtained from the İskenderun Bay populations. According to Froese (2006), an over-proportional increase in length relative to growth in weight is expressed in a value of $b<2.5$, or a value of $b>3.5$ indicates an over-proportional rise in weight relative to growth in length.

The condition factor (*K*) of *F. petimba* from İskenderun Bay (southeastern Mediterranean, Türkiye) was analysed using the body weight. The condition factor value is very important to evaluate the fish health, and the ideal estimated is equal to or close to one. Besides, the condition factors differ from one species to another. In the present study, the condition factor values were estimated at a minimum as 0.520 and a maximum as 0.540 for *F. petimba*. This is because the condition of the fish may differ due to habitat area, diet composition, competition, prey, and top predators (Czudaj *et al.,* 2022; Ragheb, 2022).

The present study is the first reference on length-weight relationships and condition factors according to sex for *F. petimba* inhabiting İskenderun Bay. Determining the population parameters of this species, which will contribute to near-future studies, is very important in terms of the ecological balance in the Mediterranean ecosystem of non-native species entering the Mediterranean waters. In conclusion, this study provides basic information on the length-weight relationships *F. petimba* that would be useful for fishery scientists and managers in the Mediterranean Sea.

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