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-RESEARCH ARTICLE-

Length-Weight Relationship and Condition Factor of Spotted Flounder *Citharus linguatula* (Linnaeus, 1758) in Iskenderun Bay, North-eastern Mediterranean, Turkey

Deniz Ergüden[1*], Sibel Alagöz Ergüden[2], Okan Özdemir[1], Mevlüt Gürlek[1]

[1]Molecular Ecology and Fisheries Genetics Laboratory, Marine Science Department, Faculty of Marine Science and Technology, Iskenderun Technical University, 31220 Iskenderun, Hatay, Turkey

[2]Imamoglu Vocational School, Cukurova University, Imamoglu, Adana, Turkey

Abstract

A total of 252 spotted flounder, *Citharus linguatula* (Linnaeus, 1758) were caught in the Iskenderun Bay from October 2012 to September 2013 using a commercial bottom trawler. Length-weight relationships (LWRs), sex ratio and condition factor of the fish specimens were investigated. Within collected *C. linguatula* samples, most of the individuals ranged from 10.0 to 15.0 cm (80.15%), the minimum and maximum total lengths of the specimens were 7.0 and 18.5 cm, respectively. Negative allometric growth were observed for male, female and both sexes. The sex ratio (females: males) was 1:1.04. Length-weight relationships for females, males and both sexes, were calculated as $W= 0.0099\ TL^{2.874}$, $W= 0.0086TL^{2.920}$ and $W= 0.0092TL^{2.896}$, respectively Fulton's condition factor (KF) values for female (0.7228) and male (0.7095) specimens also showed significant variations ($P<0.01$).

Keywords:

Spotted flounder, *Citharus linguatula*, Length-weight relationship, Condition factor, Iskenderun Bay

Article history:

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Introduction

The spotted flounder, *Citharus linguatula* (Linnaeus, 1758), is commercially important species in the east Atlantic and Mediterranean waters (Nielsen, 1986). *C. linguatula* is a flat and demersal fish that belongs to the family Citharidae. *C. linguatula* is most likely to be found at 10 to 100 m depth although it may be seen in shallow waters to 200 m depth (Froese & Pauly, 2016).

[*]*Corresponding Author: Deniz Erguden, e-mail: deniz.erguden@iste.edu.tr*

In Turkish marine waters, *C. linguatula* is distributed in the territorial waters of the Mediterranean, Aegean and Marmara Seas (Bilecenoglu et al., 2014) and also has commercially value in the Edremit Bay (Türker Çakır et. al., 2005), Izmir Bay (Bayhan et. al., 2009) and Saros Bay (Cengiz et. al., 2014).

Length-weight relationship is an important component in fish and fisheries biology and very useful for fish population dynamics and fisheries management (Froese et al., 2011).
The aim of this study is to determine length and weight parameters and condition factor of *C. linguatula* in the Iskenderun Bay, in order to compare the population characteristics of this species in the other regions. The data on length and weight parameters are expected to be helpful in fisheries management in the North-eastern Mediterranean part of Turkey.

Material and Methods

C. linguatula samples were obtained from the Iskenderun Bay (Figure 1) between October 2012 to September 2013 with commercial trawler, at depths ranging from 24 m to 55 m. Length and sex-ratio distributions were constructed separately for the specimens of species. Specimens were measured to the nearest 0.1 cm total length and weighted to the nearest 0.1 g. The isometric (b = 3) or allometric growth relationship between total length (TL, cm) and total body weight (W, g) was described for these fishes growing with their bodies becoming heavier using a plotted power function; $W = axTL^b$ in which a is the power function coefficient (the regression intercept) and b the exponent (the regression slope), (Ricker, 1975). The relationships were estimated by linear regression analyses based on natural logarithms: $\ln(W) = \ln(a)+b \ln(TL)$.

Prior to the analyses, ln-ln plots of length and weight values were performed for visual inspection of outliers in accordance to Froese (2006). Growths' were considered positively allometric if the estimate of b was approximately equal or greater than 3 and negative if less than 3. Fulton's condition factor (KF) (Cone, 1989) was calculated using the equation: $KF = 100\times(W/L^{-3})$. Where: W = Total body weight (W, g), L = Total length (TL, cm). The scaling factor of 100 was used to bring the KF close to unit.

Figure 1. General view of *Citharus linguatula*

Results

A total of 252 specimens of *C. linguatula* were examined with 48.8% (n=123) female and 51.2% (n=129) male. The ratio of female to male was 1:1.04. Total length values of overall, female and male specimens ranged from 7.0-18.5 cm, 7.6-18.4 cm and 7.0-18.5 cm, respectively. Total weight values of overall were 2.88-46.86 g; of females, 3.46-45.89 g; and males 2.88-46.86 g. The estimated parameters of the length-weight relationships are given in Table 1. There was not significant difference between length of male and female individuals. Females were larger than males (P>0.05). Negative allometric growth was observed for male, female and both sexes. Length-weight relationships for females, males and both sexes were calculated as $W= 0.0099TL^{2.874}$, $W= 0.0086TL^{2.920}$ and $W= 0.0092TL^{2.896}$, respectively (Figure 2, Figure 3 and Figure 4). Fulton's condition (KF) factor values also showed significant variations (P<0.01) with the best and worst performers being female (0.7228) and male (0.7095) for *C. linguatula* specimens, respectively. A comparison concerning the length-weight relationship for the species was also made using the results achieved by previous studies (Table 2).

Table 1. Length-weight relationships of *C. linguatula* from the Iskenderun Bay (the Northestern Mediterranean, Turkey)

Sex	n	Length characteristics				Parameters of the relationship			
		Mean	S.E.	Minimum	Maximum	a	b	S.E(b)	r^2
Male	129	12.59	0.196	7.60	18.40	0.0086	2.920	0.142	0.960
Female	123	12.62	0.206	7.00	18.50	0.0099	2.874	0.039	0.978
Both	252	12.61	0.142	7.00	18.50	0.0092	2.896	0.033	0.969

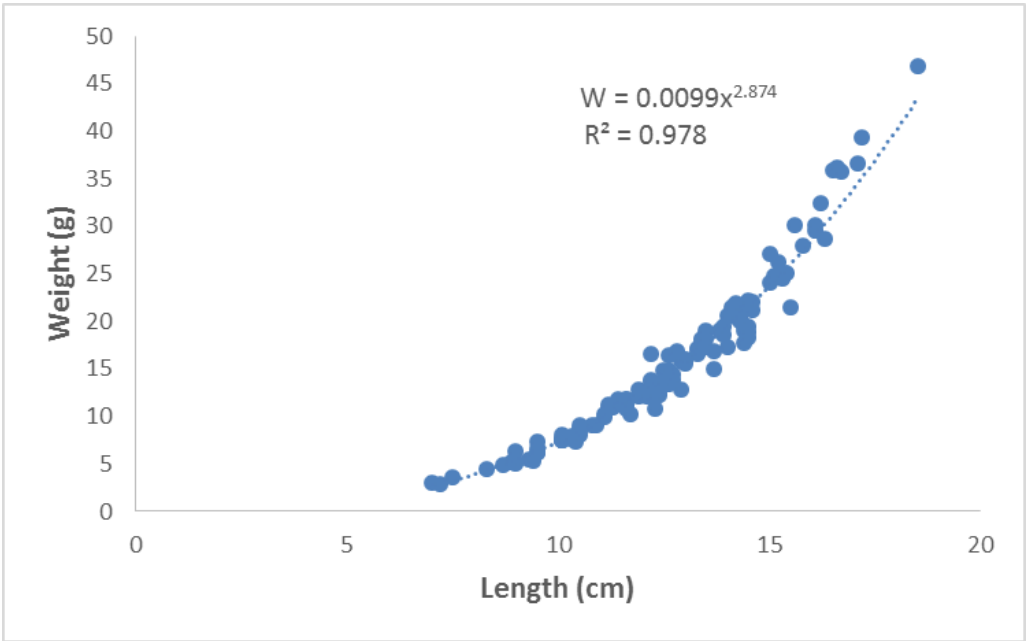

Figure 2. Length–weight relationships females of *Citharus linguatula* from the Iskenderun Bay, North-eastern Mediterranean coast of Turkey

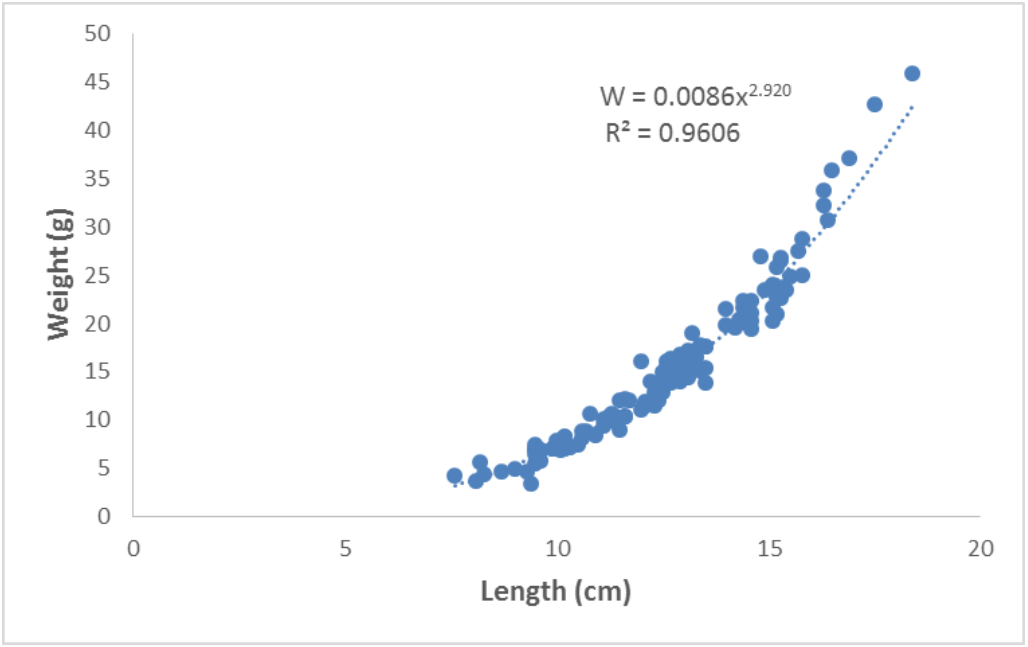

Figure 3. Length–weight relationships males of *Citharus linguatula* from the Iskenderun Bay, North-eastern Mediterranean coast of Turkey

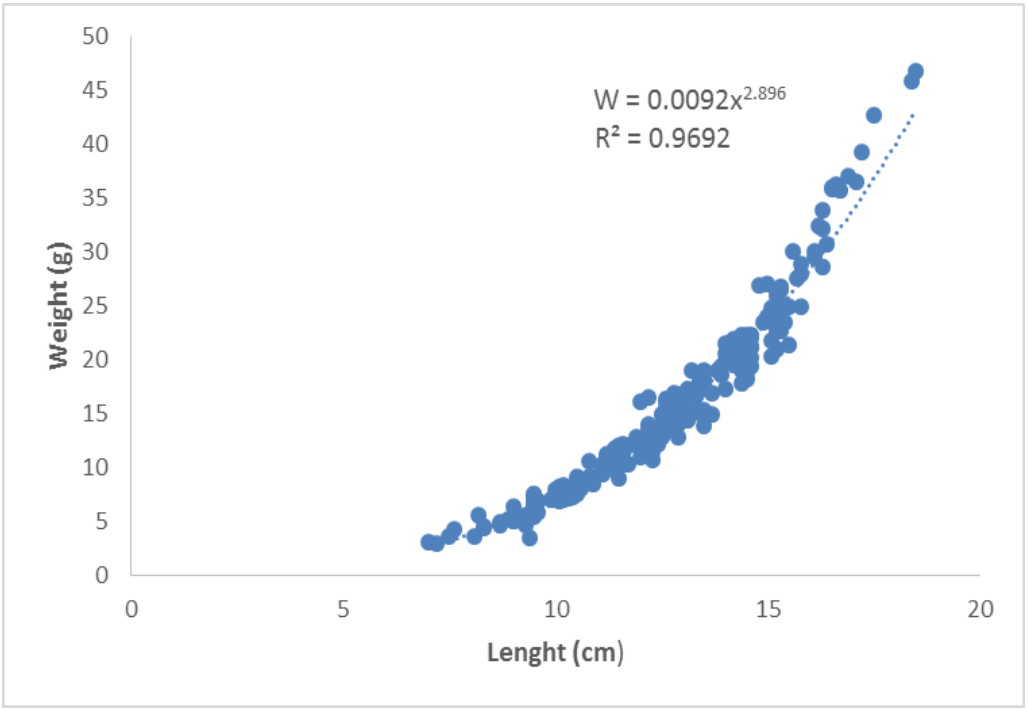

Figure 4. Length–weight relationships of both sexes of *Citharus linguatula* from the Iskenderun Bay, North-eastern Mediterranean coast of Turkey

Table 2. Biogeographic comparison of LWRs parameters for *C. linguatula*

Study	Locality	Country	Sex	n	Lengh Type	L_{min}-L_{max}	a	b	r^2
Merella et al. (1997)	Balearic Island	Spain	-	50	TL	8.60-20.00	0.00300	3.300	0.986
Santos et. al. (2002)	off Algarve coast (southern Portugal)	Portugal	-	1844	TL	13.00-24.30	0.01130	2.870	0.810
Borges et. al. (2003)	Algarve	Portugal	-	125	TL	9.20-23.20	0.01204	2.781	0.846
Mendes et al. (2004)	Nazaré to St André	Portugal	-	170	TL	13.10-24.30	0.00370	3.207	0.747
Torres et. al. (2012)	Gulf of Cadiz	Spain	Both	284	TL	4.90-25.40	0.00560	3.084	0.980
Campillo (1992)	Adriatic Sea	Italy	Both	-	TL	1.00-20.00	0.01110	2.870	-
Abdallah (2002)	off Alexandria	Egypt	-	60	TL	6.80-14.20	0.00800	3.040	0.986
Dulcic & Kraljevic (1996)	Eastern Atlantic	Crotia	-	38	TL	13.10-20.60	0.00915	3.237	0.910
Petrakis & Stergiou (1995)	G.S. Evvoikos	Greece	Both	22	TL	12.0-23.10	0.00856	2.978	0.980
Vassilopoulou and Papaconstantinou (1994)	C. Aegean Sea	Greece	Male	159	TL	6.50-18.50	0.00486	3.117	0.980
	C. Aegean Sea	Greece	Female	239	TL	6.30-23.90	0.00504	3.109	0.970
Moutopoulos & Stergiou (2002)	Kyclades	Greece	Both	19	TL	10.30-17.50	0.05767	2.293	0.540
Stergiou & Politou (1995)	G. N. Evvoikos and Trikeri Channel	Greece	Both	141	TL	5.90-22.00	0.00074	3.447	0.820
Cicek et. al. (2006)	Babadillimanı Bight (NE Mediterranean)	Turkey	-	922	TL	3.50-21.00	0.00580	3.075	0.979
Sangun et. al. (2007)	NE Mediterranean coast	Turkey	-	338	TL	6.50-21.30	0.01140	2.819	0.980
Karakulak et al. (2006)	Gokceada Island	Turkey	-	8	TL	15.10-18.90	0.00090	3.725	0.954
This study	Iskenderun Bay (NE Mediterranean Sea)	Turkey	Both	252	TL	7.00-18.50	0.0092	2.896	0.969
This study	Iskenderun Bay (NE Mediterranean Sea)	Turkey	Male	129	TL	7.60-18.40	0.0092	2.920	0.960
This study	Iskenderun Bay (NE Mediterranean Sea)	Turkey	Female	123	TL	7.00-18.50	0.0099	2.874	0.978

Discussion

There has been several data on the population length structure of *C. linguatula* in the Mediterranean Sea (Abdallah, 2002; Vassilopoulou & Papaconstantinou 1994; Moutopoulos & Stergiou 2002; Cicek et al., 2006; Karakulak et al., 2006; Sangun et. al, 2007). In the present study, females grow slight quicker and to a larger size (18.50 cm) than males (18.40 cm) in the Iskenderun Bay, Turkey (North-eastern Mediterranean). Vassilopoulou & Papaconstantinou (1994) reported that maximum length of *C. linguatula* for males and for females were 18.50 cm and 23.90 cm respectively from the Aegean Sea (Greece).

The equations of the length-weight relationship revealed no differences between sexes, with the coefficient b different from 3, indicating negative allometric growth. In this study, the values found for *C. linguatula* (b=2.896) showed a negative allometric growth. The allometric parameter estimate in the present study closely matches to the estimations given by Santos et al. (2002) and Borges et al. (2003) from the Algarve coast (southern Portugal), and

by Campillo (1992) from the Eastern Atlantic (Italy), and by Petrakis and Stergiou (1995) from Aegen Sea (Greece) and also by Sangun et al. (2007) from the North-eastern Mediterranean (Turkey). However, Abdallah (2002) and Cicek et al. (2006) reported b values closer to isometric growth in Egypt coast and in Babadilli Bight (NE Mediterraenan Sea, Turkey), for *C. linguatula*.

In addition, the value of b in the present study differs from the estimations made by Merella et al. (1997), Mendes et al. (2004) and Torres et al. (2012) where they found positive allometric growths estimated as b=3.300, 3.207 and 3.084. Several factors are known to influence the length-weight relationships in fish, including gonad maturity, stomach fullness, season, health and preservation techniques (Bagenal & Tesch, 1978), all of which were not observed in the present study.

In conclusion, the present study provides some basic essential biological information on the native spotted flounder species, *C. linguatula* for fishery management from the Iskenderun Bay.

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