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Length-weight Relationships and Morphometry of *Sillago suezensis* from Antalya Gulf-Turkey

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Abstract

The present study reports length-weight, length-length relationships and morphometry of *Sillago suezensis* Golani, Fricke & Tikochinski, 2013 caught from Antalya Gulf (Mediterranean-Turkey). Samples were collected during October 2011-September 2012. A total of 149 individuals, ranging in size between 12.2 and 17.6 cm total length, 12.1 and 43 g total weight, were examined. The length-weight relationship was described by the equation: $\log W = \log 0.0066 + 3.0478 \log L$. The morphometric characteristics on the head have greater variation than those from the body.

Keywords: Antalya Gulf, *Sillago suezensis*, morphometry, length-weight relationships

1. Introduction

Biological invasions represent a significant risk for many ecosystems and have become an issue of increasing concern worldwide. After the opening of the Suez Canal in 1869, a migration has begun from the Red Sea, rarely the opposite direction, known as 'Lessepsian migration' and many species of Indo-Pacific origin penetrating the Eastern Mediterranean Sea (Oral, 2010) [26]. As a result of this migration, various changes have occurred in the Mediterranean (Golani, 1998 [18]; Golani and Appelbaum-Golani, 2010 [16]; Boudouresque, 1999 [6]; Anonymous, 2010 [1]; Streftaris and Zenetos, 2006) [30].

Marine and brackish waters of the Indo-West Pacific regions are the ideal habitat for fishes of Sillaginidae family (Golani *et al.*, 2014) [19] included 34 species belonging to 5 genera (Sillago, Sillaginops, Sillaginopsis, Sillaginodes, Sillaginopodys) (Froose and Pauly, 2015) [15].

The Mediterranean is not a natural habitat for Sillaginids. *Sillago suezensis* is one of the Lessepsian migrant species, first recorded from the Mediterranean Sea by Mouneimne (1977) mistakenly, as *Sillago sihama* (Forsskål, 1775) [4] (Mavruk and Avsar, 2008) [25]. In 2014, the species of the genus *Sillago* in the Northern Red Sea and the Mediterranean Sea was notified as *Sillago suezensis* by Golani *et al.*, 2014 [19].

Studies on the length-weight relationships, ecology, morphometry and growth of Sillaginids in the Mediterranean are very limited. However, some data are available about *Sillago suezensis* (previously known as *Sillago sihama*) with respect to their distribution and identification (Golani, 1998 [18]; Basusta and Erdem, 2000 [6]; Torcu and Mater, 2000 [32]; Bilecenoglu, 2004 [4]; Cinar *et al.*, 2005; Erdem *et al.*, 2006 [11]; Soykan *et al.*, 2006 [29]; Streftaris and Zenetos, 2006 [30]; Corsini-Foka and Economidis, 2007 [8]; Lasram and Mouillot, 2008 [24]; Mavruk and Avsar, 2008 [25]; Katsanevakis *et al.* 2009 [21]; Oral, 2010 [26]; Zenetos *et al.*, 2010 [36]; Edelist *et al.*, 2011 [9]; Golani *et al.*, 2011 [9]; Keskin *et al.*, 2011 [22]; Tuset, 2012 [34]; Erguden and Turan, 2013; [13] Bilecenoglu *et al.* 2014 [5]; Edelist *et al.*, 2014 [14]; Golani *et al.*, 2014 [19]; Lakkis and Sabour, 2014) [23]; length-weight relationships (Torcu Koc *et al.*, 2008; Erguden *et al.*, 2009 [12]; Edelist *et al.*, 2013) [13]; genetic (Tikochinski *et al.*, 2013) [31].

S. suezensis is counted as one of the Lessepsian species that has an economic importance (Erguden and Turan, 2013) [13]. Although abundance of *Sillago suezensis* rapidly increase on coasts of Turkey, there has been limited previous references for biological properties from Antalya Gulf. The objective of this study was to provide information on the length-length, length-weight relationships and morphometric characters of *S. suezensis* in the Antalya Gulf.

2. Material And Methods

Samples (149 individuals) were collected during October 2011-September 2012 by the trammel net in the Antalya Gulf (Mediterranean-Turkey). Fish samples were immediately transported to

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the laboratory in the Department of Biology, Mehmet Akif Ersoy University (Burdur-Turkey). All individuals (preserved frozen) were measured for total length (TL, in cm) to the nearest mm and weighted (W, total wet weight in g) to the nearest 0.01 g.

Metric characters were measured with digital slide calliper on the fish body (24 characteristics; total length, standard length, fork length, body depth at dorsal fin, predorsal distance (first dorsal fin), predorsal distance (second dorsal fin), postdorsal distance (first dorsal fin), postdorsal distance (second dorsal fin), prepectoral distance, prepelvic distance, preanal distance, distance from pelvic to anal fin, first dorsal fin height, first dorsal fin base length, second dorsal fin height, second dorsal fin base length, pectoral fin height, pectoral fin base length, pelvic fin height, pelvic fin base length, anal fin height, anal fin base length, caudal fin depth, caudal fin length), head (9 characteristics; head length, head height, eye diameter, interorbital distance, preorbital distance, postorbital distance, mouth depth, distance mouth-nostril, internostril distance). For the meristic characters, first dorsal fin rays, second dorsal fin rays, pectoral fin rays, pelvic fin rays and anal fin rays were counted (Froese and Pauly, 2015) [15].

Morphometric relationships between parameters (total length - standard length, total length - fork length, total length - head length, total length - head depth, head depth - head length) were calculated using the linear regression equation; $Y=a+bx$, where Y is the dependent variable, ' a ' is the intercept, ' b ' is the slope of the regression line and x is the independent variable. For the calculation of regression equations the Excel 2007 was used.

Length-weight relationship was calculated using the equation $W = aL^b$ (Pauly, 1984) [27], where a is a coefficient related to body form and b is an exponent indicating isometric growth when equal to 3. The b -value of each species was tested by Student's t -test to verify if it was significantly different from isometric growth.

3. Results

A total of 149 specimens of *Sillago suezensis* were caught in the study area during October 2011-September 2012. Body-size, metric characteristics (in % ratios) for *S. suezensis* from Antalya Gulf (Mediterranean- Turkey) were shown in Table 1 and Figure 1. Regression analysis between the different body measurements for *S. suezensis* were shown in Table 2.

Table 1: Body size, metric characteristics (in % ratio) for *Sillago suezensis* from the Antalya Gulf (Mediterranean- Turkey) (n=50).

Body-size measurements	Min	Max	Mean	SD
Total length	12.2	17.6	14.03	1.01
Total weight	19.5	43	21.03	6.04
Metric measurements				
In % of total length				
Standard length	78.85	86.33	83.66	1.3
Fork length	90.71	96.23	93.78	1.08
Body depth at dorsal fin	10.16	27.87	14.53	3.27
Predorsal distance (first dorsal fin)	21.88	30.07	27.81	1.34
Predorsal distance (second dorsal fin)	40.8	58.88	46.15	2.31
Postdorsal distance (first dorsal fin)	45.96	59.84	54.1	2.34
Postdorsal distance (second dorsal fin)	20.59	26.25	23.07	1.2
Prepectoral distance	23.61	26.6	24.84	0.66
Prepelvic distance	23.79	29.25	26.46	1.27
Preanal distance	37.95	50.88	46.8	2.15
Distance from pelvic to anal fin	17.8	24.03	21.1	1.63
1. dorsal fin base length	12.66	18.31	15.78	1.28
1. dorsal fin height	9.74	16.15	13.94	1.35
2. dorsal fin base length	25.13	31.8	28.51	1.58
2. dorsal fin height	6.11	12.93	9.86	1.44
Pectoral fin base length	2.03	4.75	3.11	0.47
Pectoral fin height	12.33	16.35	14.29	0.97
Pelvic fin base length	1.02	2.38	1.62	0.28
Pelvic fin height	9.14	12.77	11.03	0.9
Anal fin base length	21.41	31.47	27.88	1.5
Anal fin height	6.21	12.36	9.7	1.49
Caudal fin depth	4.58	12.76	6.11	1.08
Caudal fin length	8.91	18.85	15.26	1.48
Head length	16.72	24.24	22.21	1.7
Head height	9.68	12.74	11.28	0.64
In % of head length				
Head height	43.13	65.48	51.09	5.05
Eye diameter	19.76	36.31	24.55	3.27
Interorbital distance	15.64	25.72	18.96	2.08
Preorbital distance	36.23	58.82	42.25	4.20
Postorbital distance	25.70	50.04	35.35	5.09
Mouth depth	14.29	23.07	18.17	2.05
Distance mouth-nostril	19.49	39.17	28.68	3.76
Internostril distance	8.15	17.84	12.47	2.11

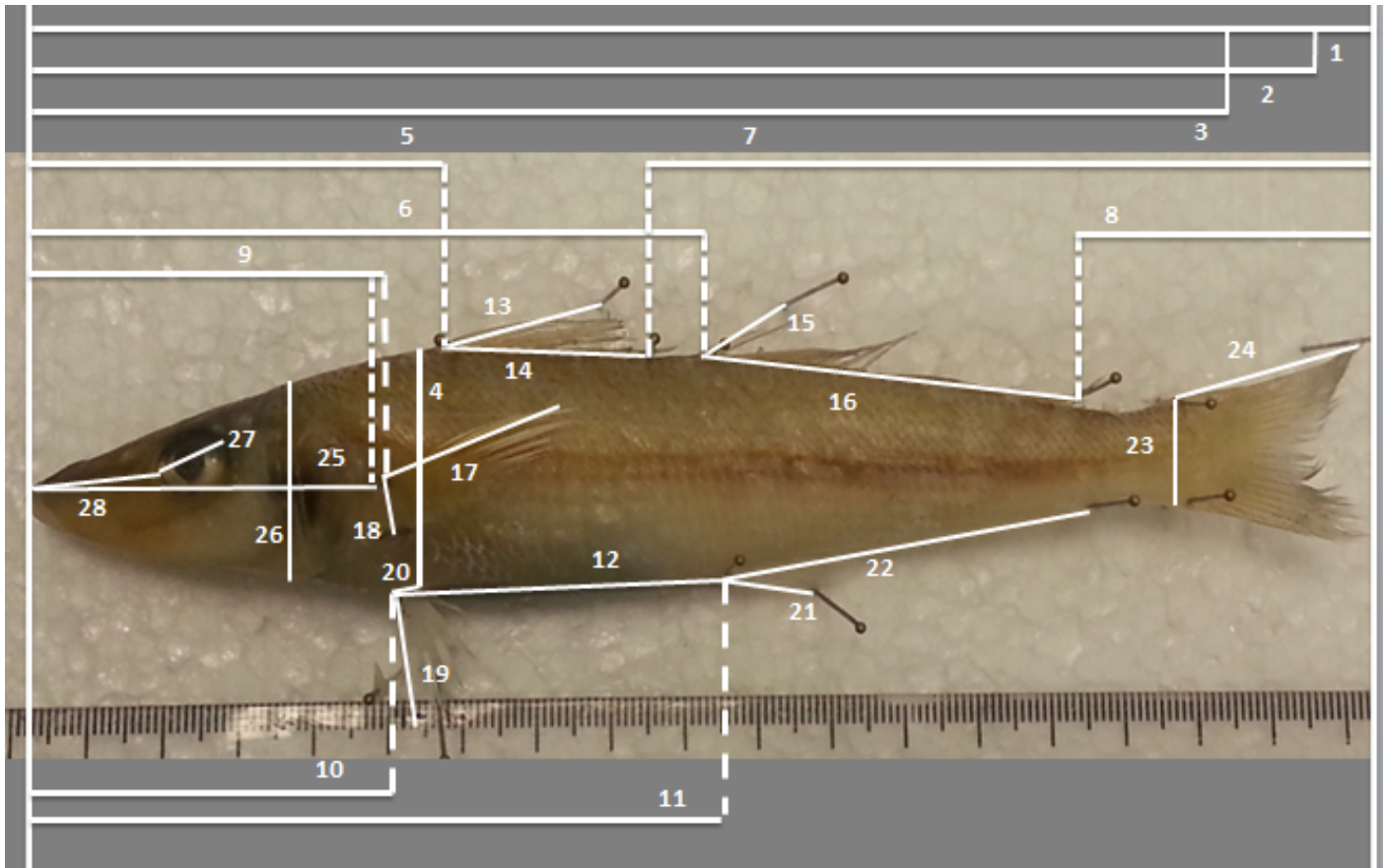


Fig 1. Photograph of *Sillago suezensis*

Abbreviations: **1:** Total length, **2:** Fork length, **3:** Standard length, **4:** Body depth at dorsal fin, **5:** Predorsal distance (first dorsal fin), **6:** Predorsal distance (second dorsal fin), **7:** Postdorsal distance (first dorsal fin), **8:** Postdorsal distance (second dorsal fin), **9:** Prepectoral distance, **10:** Prepelvic distance, **11:** Preanal distance, **12:** Distance from pelvic to anal fin, **13:** First dorsal fin height, **14:** First dorsal fin base length, **15:** Second dorsal fin height, **16:** Second dorsal fin base length, **17:** Pectoral fin height, **18:** Pectoral fin base length, **19:** Pelvic fin height, **20:** Pelvic fin base length, **21:** Anal fin height, **22:** Anal fin base length, **23:** Caudal fin depth, **24:** Caudal fin length, **25:** Head length, **26:** Head height, **27:** Eye diameter, **28:** Preorbital distance

Table 2. Regression analysis between the different body measurements for *Sillago suezensis*

Correlates	Equations	b value ± SD	a value ± SD	R ²
Total Length - Standard Length	TL = b.SL + a	1.16 ± 0.02	0.50 ± 0.21	0.954
Total Length - Fork Length	TL = b.FL + a	1.03 ± 0.02	0.44 ± 0.21	0.9586
Total Length - Head Length	TL = b.HL + a	3.60 ± 0.13	1.97 ± 0.45	0.8152
Total Length - Head Depth	TL = b.HD + a	6.40 ± 0.29	4.14 ± 0.45	0.8035
Head Depth - Head Length	HD = b.HL - a	0.49 ± 0.02	0.10 ± 0.06	0.8206

Abbreviations: TL: Total length; SL: Standard length; FL: Fork length; HL: Head length; HD: Head depth; a: Intercept; b: Slope of the regression line; R²: coefficient of determination; SD: Standard deviation

Length and weight frequency distributions and length-weight relationships of *S. suezensis* were shown in Figure 2. Length frequency distributions showed a range from 12.2 to 17.6 with a dominant mode (83.22% of the total number of specimens)

between 13 and 14.9 cm and weight frequency distributions showed a range from 12.1 to 43 g, with a dominant mode (83.89% of the total number of specimens) between 14 and 24.9 g.

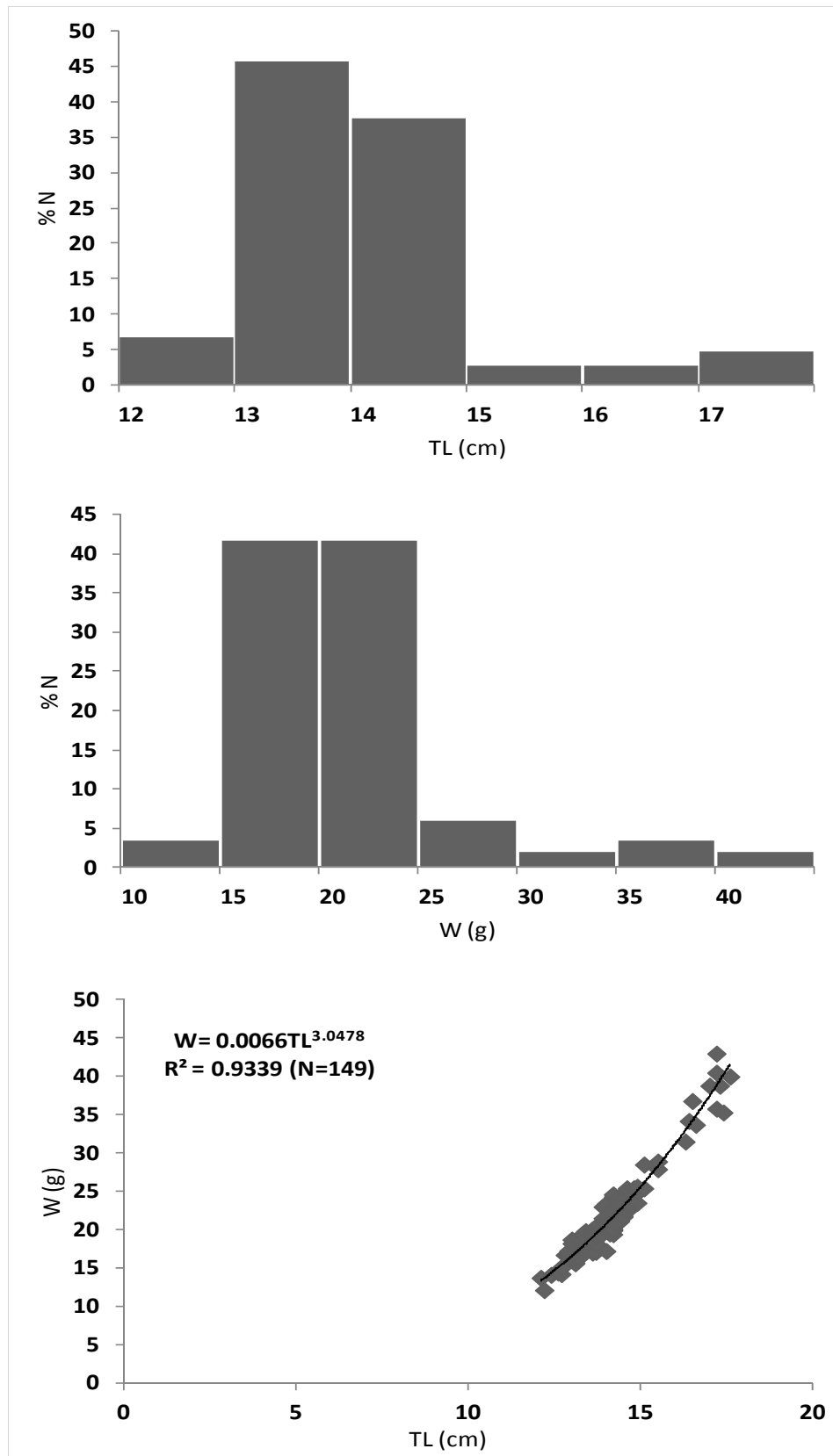


Fig 2: Length and weight frequency distributions and length-weight relationships $W = aTL^b$, in g and cm) for *Sillago suezensis* from the Antalya Gulf (Mediterranean-Turkey).
 Abbreviations: N: Sample size; TL: Total length (cm); W: Weight (g); R²: coefficient of determination.

The mean value of standard length in percentage of total length was found to be 83.66 and the mean value of head length in percentage of total length was found to be 22.21. Mean value of body depth (at dorsal fin) expressed as percentage of total length

was found 14.53. Concerning proportional values, body depth at dorsal fin was the most variable, whereas the least variability was found in pelvic fin base length. The morphometric characteristics on the head express greater variation (SD

between 2.05 and 5.09, mean= 3.45) than those from the body (SD between 0.28 and 3.27, mean= 1.39).

The slope (b) value of the length-weight regression of *S. suzezensis* populations were significantly different from 3. The length-weight relationship showed that the species show positive allometric growth.

4. Discussion

Some metric characteristics (in % ratio) for *S. suzezensis* was calculated. Body depth at dorsal fin in % of standard length (17.3), predorsal distance (first dorsal fin) in % of standard length (33.2), first dorsal fin base length in % of standard length (18.6), second dorsal fin base length in % of standard length (34.1), pelvic fin height in % of standard length (13.2), pectoral fin height in % of standard length (17.1), anal fin base length in % of standard length (33.3) and head length in % of standard length (26.7) have consistent values with the results of Golani *et al.*, 2014 [19]. In addition, only two values of the characteristics (caudal fin length in % of standard length was found as 12 and caudal fin depth in % of standard length was found as 6.8) are different from the values of Golani *et al.*, 2014 [19]. These differences in the proportional value of caudal fin length and caudal fin depth of the populations may be due to sampling differences, calliper readings differences of researchers and ecological characteristics of the marine ecosystems.

Rays in first dorsal fin ranged between IX-XI, second dorsal fin ranged between I, 16-23, pectoral fin range between 14-17, pelvic fin range between 6-7, anal fin range between II, 17-22. Only two values of the characteristic from this research (rays in pectoral fin and rays in anal fin) fit into limited existing data (Golani *et al.*, 2014). However, the variation obtained in the number of second dorsal-fin rays. (16-23) is much higher than that (19-22) of Golani *et al.*, 2014.

The slope (b) value of the length weight regression of *S. suzezensis* population was 3.05. The value of b was within the limits of 2.5-3.5 commonly reported for teleosts by Froese (2005) [14]. Edelist *et al.* (2014) [10] reported some data about length-weight parameters of the species from the Israeli coast (b value is 3.0762). Erguden *et al.* (2009) [12] and Torcu Koc *et al.* (2008) [33] also informed for length-weight relationships of the species (as *Sillago sihama*) from Turkish coasts (b value is 3.064; Erguden *et al.*, 2009 [12] and b value is 3.355; Torcu Koc *et al.*, 2008) [33]. In keeping with to our data, allometric growth was reported for relationships of length-weight from Mediterranean by all of these authors.

The b value shows great variation from one population to another of the same species (Froese and Pauly, 2015) [15]. Differences in b values can be correlated to the one of these following factors (Petraakis and Stergiou, 1995) [22]: (a) differences in the number of specimen examined, (b) area/season effect and (c) differences in the observed length ranges of the specimen caught.

5. Conclusion

The present study aimed to investigate the morphometry, length-weight relationship of *S. suzezensis* in Antalya Gulf, Turkey and that can be used in future stock assessment and biology of this species. However, further and more detailed research are necessary for future assessment.

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