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RESEARCH ARTICLE

Length-weight relationship and condition factor of freshwater blenny *Salaria fluviatilis* (Asso, 1801) in Asi River (Hatay, Turkey)

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ABSTRACT

In this study, a total of 109 specimens (57 female and 52 male) of *Salaria fluviatilis* were captured by tulle net and scooped net between October 2017 and March 2018 from the Asi River system, Turkey. The length-weight relationship was W =0.0013L$^{3.054}$ (r^2= 0.967) for both sexes with isometric growth. The values of the exponent *b* of the length-weight relationships (LWRs) were 3.055 for females and 3.052 for males. The b values for females, males, and both sexes were not significantly different from 3.0 (P>0.05). Fulton condition factor (CF) was calculated 1.3955±0.034 for females, 1.4495±0.042 for males and 1.4212±0.027, for both sexes. Estimations of LWRs and CF for both sexes of *S. fluviatilis*, captured from Asi River, were provided for the first time.

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Introduction

The freshwater blenny *Salaria fluviatilis* (Asso, 1801) is a member of the family Blenniidae and is well-known in the Mediterranean Region. *S. fluviatilis* is mainly a riverine species, naturally found in drainages around the northern Mediterranean and from Turkey, Israel to Portugal, and in Morocco and Algeria (Oliveira et al., 1992; Crivelli, 1996; Kottelat and Freyhof, 2007; Froese and Pauly, 2020). *S. fluviatilis* was reported from Seyhan Reservoir (Alagoz, 2005),

Ceyhan River (Alp and Kara, 2007) and drainage of the Black Sea (Bostancı et al., 2016), Aegean and some Mediterranean regions of Turkey (Geldiay and Balık, 1999; İlhan et al., 2013; Erguden, 2016; İnnal, 2019; Çiçek et al., 2020).

S. fluviatilis a common inhabitant of stony and gravel bottoms of rivers and brooks (Bath, 1986). It is generally preferred rubble and gravel substrate. Adults feed on small benthic organisms such as small snails and shrimps, and all kinds of insect larvae (Wilson, 2009). This species can reach up to 15.4 cm in total length (Laporte et al., 2012), and the maximum age is 5 (Kottelat and Freyhof, 2007). Females

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deposit a layer of eggs on the underside of the nest stone and the eggs are guarded against predators by the males (Cote et al., 1999). *S. fluviatilis* individuals start breeding at the end of the first year and a female can lay around 1200 eggs at one time (IUCN, 2020). Females lay an average of 200-300 eggs at a time, 2-30 times (Çoker et al., 2019). The number of eggs in a nest is around 500-8000 (Gasith and Goren, 2009).

S. fluviatilis is considered as Least Concern (LC) in the IUCN Global Red List for inland waters (IUCN, 2020), this species has affected and decreased from large parts of the Asi River drainage due to pollution, habitat destruction, and water abstraction. Thus, it is considered a locally endangered species listed by the IUCN Red List (Crivelli, 2006; Fricke et al., 2007).

Length-weight relationships (LWRs) are calculated for estimating the weight of a given length. LWRs are also useful for comparing life history and morphological aspects of populations inhabiting different habitats. Besides, LWRs are necessary for stock assessment and fisheries management (Pauly, 1983; Petrakis and Stergiou, 1995; Goncalves et al., 1997; Koutrakis and Tsikliras, 2003). Because the LWR values; in the length values for estimation of biomass, in the estimation of weight from a given length, and in stock estimation models transforming growth in length and growth in weight equations to each other for comparison of life cycle of a fishes from different areas are widely used by many researchers (Binohlan and Pauly, 1998; Froese, 2006).

Condition factor (CF) is used for comparing the fish's health or the fatness of the fish (Froese, 2006). The condition factor is an index reflecting interactions between biotic and abiotic factors in the physiological condition of the fishes. The condition of the fish is calculated from the estimation of the length-weight relationships. Thus, CF is also an essential parameter for the evaluation of fish stocks, and this parameter is widely used for studies of fisheries and fish biology.

Figure 1. *Salaria fluviatilis* (Asso, 1801) captured in the Asi River

To date, a few studies regarding length-weight relationships of *S. fluviatilis* were in the eastern Mediterranean and the Aegean Sea for the inland waters of Turkey (İlhan et al., 2013; Erguden, 2016; İnnal, 2019). However, LWRs and condition factors according to sexes for *S. fluviatilis* have not been reported from Turkey. Besides, there is no information on LWRs and CF for *S. fluviatilis* from the Asi River system (Southeastern Anatolia, Turkey). In the present paper, author reported on the estimations of LWRs and CF for both sexes of *S. fluviatilis*, captured from Asi River, were provided for the first time.

Material and Methods

A total of 109 (57 female and 52 male) specimens were captured from Asi (Orontes) River system using tulle net and scooped net at 0-2 m depths between October 2017 and March 2018 (Coordinates: 36° 48' N, 36° 10' E – 36° 53' N, 36° 15' E). Species identification follows Geldiay and Balık (1999) and confirmed based on FishBase (Froese and Pauly, 2020) (Figure 1). Total length (TL) was measured to the nearest 0.1 cm by means of a vernier caliper and total weight was recorded to the nearest 0.01 g on a precision balance. The sex of each specimen was determined by examining the gonads macroscopically. Chi-square (χ^2) analysis was used to test the significant differences between the sex ratio.

The relationship between the length and weight of the fish samples were estimated using the equation

$$W = aL^b \text{ (Ricker, 1975)}$$

where W is the weight of the fish, TL is the total length, and a and b are constants. The relationship between total length, TL, and weight was calculated for females, males, and all individuals. The significance of the regression was assessed by ANOVA. The student's t-test was applied to determine the significance of differences (95% level) between the isometric growth ($b=3$) and the estimated b value of the equation.

Fulton's coefficient of condition factor (CF) was calculated by the formula given below.

$$CF = \frac{W}{L^3} \times 100$$

where; L is length (cm) and W is weight (g) (Bagenal, 1978; Sparre and Venema, 1992).

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

Results

Of the 109 specimens, 57 were (52.30%) females, 52 were males (47.70%). The sex ratio for female and male individuals

(F:M) was 1.00:0.91. The χ^2 test showed (χ^2= 3.819, P>0.05) that there was no significant difference in sex ratio from the expected 1:1. Total length in females ranged from 1.7-7.1 cm with a mean of 3.23±1.32 cm. Total length in males ranged from 2.0-6.8 cm with a mean of 3.29±1.33 cm. The mean total weights of females and males values were 0.78±1.10 g and 0.81±1.09 g, respectively (Table 1). The t-test showed that there was significant difference between sexes in overall total length and total weight (t=1.477, P<0.05). Females were more abundant length class (in 3.5-2.5 cm) than males (in 3.0-2.0 cm) in the length class. The dominant length class in the total samples was 2-2.5 cm (Figure 2).

The *b* values of length-weight relationship, which were not significantly different between sexes (ANOVA, P>0.05), indicated isometric growth for females (b=3.055), males (b=3.052) and both sexes (b=3.054). The estimated parameters of the length-weight relationship parameters are given in Table 2. The LWRs were described as W =0.0012xL^{3.055} (r² = 0.969) for females, W =0.0012xL^{3.052} (r² = 0.965) for males, and W =0.0013xL^{3.054} (r²= 0.967) for both sexes. Estimation of length-weight relationship for female, male, and both sexes are given in Figure 3.

The length-weight relationships were isometric growth in *S. fluviatilis* samples for females, males, and both sexes. The *b* values for females, males, and both sexes were not significantly different from 3.0 (*b*=3, P>0.05), (Table 2). In addition to the present study, a comparison of published length-weight relationship parameters in different regions for *S. fluviatilis* is given in Table 3.
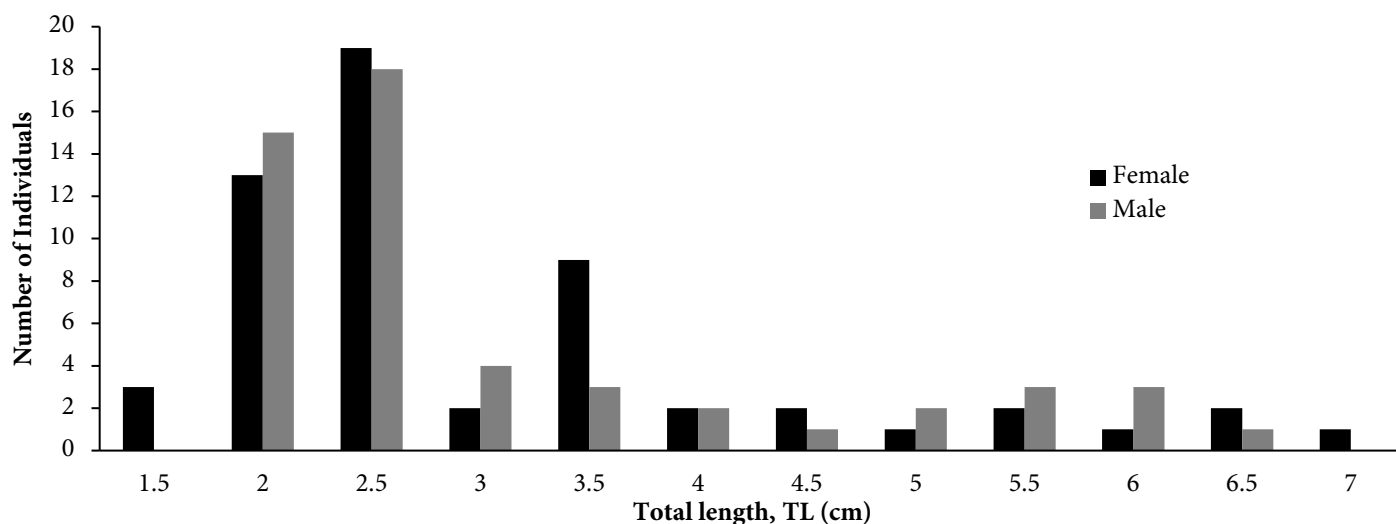

Figure 2. Length frequency distributions of *S. fluviatilis* collected in Asi River

Table 1. Mean and standard deviation, minimum, maximum, for total length (TL) and weight (W) characteristics according to sexes of *S. fluviatilis* occurring in the Asi River
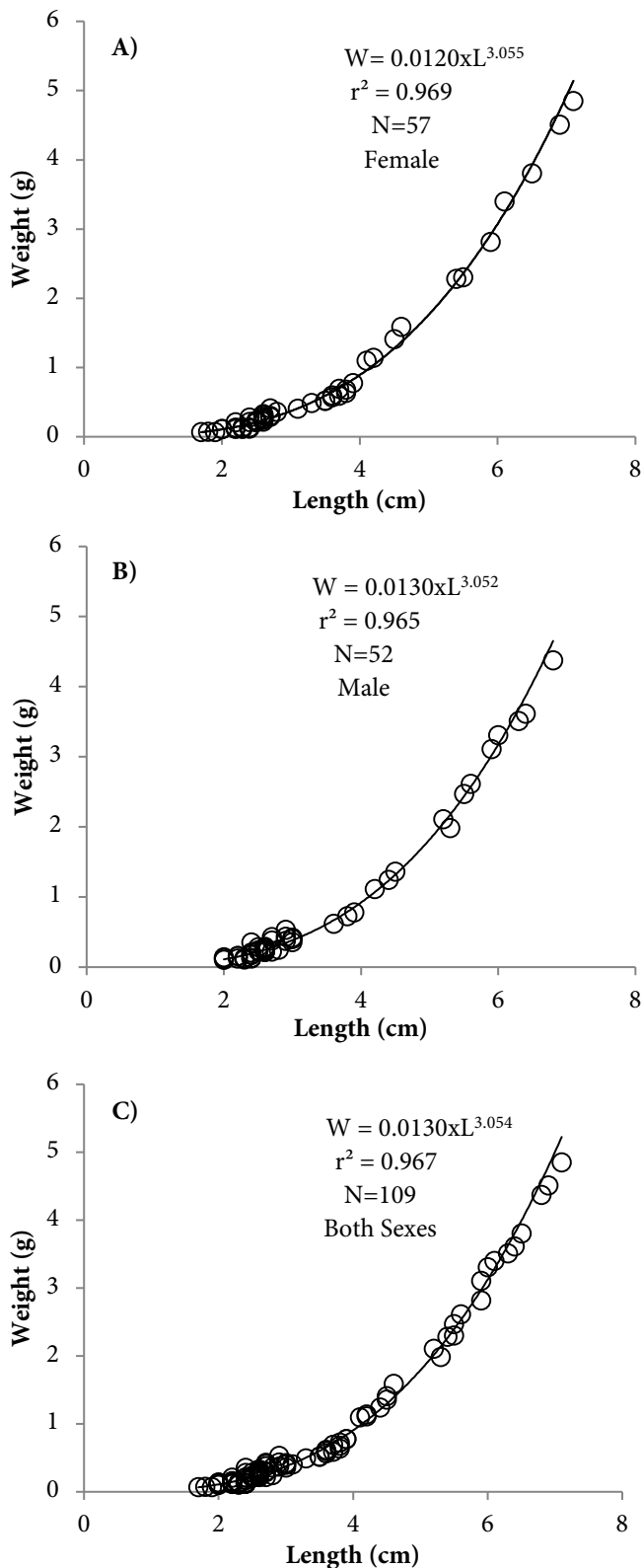
Sex	N	L_{min}-L_{max} (cm)	Mean±SD	W_{min}-W_{max} (cm)	Mean±SD
Female	57	1.70-7.10	3.23±1.32	0.07-4.85	0.78±1.10
Male	52	2.00-6.80	3.29±1.33	0.10-4.37	0.81±1.09
Both	109	1.70-7.10	3.26±1.32	0.07-4.85	0.78±1.10

Note: N: Sample Size; S.D: Standard Deviation Min: Minimum; Max: Maximum

Table 2. Length-weight relationship parameters for *S. fluviatilis* in Asi River (Southeastern Anatolia)

Sex	N	a	b	±S.E(b)	95% C.I. of b	r²	t-test	P	Growth
Female	57	0.00120	3.055	0.073	2.908-3.201	0.969	0.587	>0.05	Isometry
Male	52	0.00120	3.052	0.082	2.888-3.216	0.965	0.974	>0.05	Isometry
Both	109	0.00130	3.054	0.054	2.947-3.154	0.967	1.097	>0.05	Isometry

Note: N: Sample Size, a: Intercept of the relationship; b: Slope of the relationship; S.E.(b): Standard Error of b; r²: Coefficient of determination, C.I.: Confidence Interval

Figure 3. Length-weight relationship of *S. fluviatilis*. (A), female (B), male and (C), both sexes in Asi River (Southeastern Anatolia, Turkey)

The present study, Fulton condition factor (CF) value was estimated as 1.3955±0.034, for females, as 1.4495±0.042 for males and as 1.4212±0.027 for both sexes. Condition factor values showed no significant variations (P>0.05) of *S. fluviatilis* for between sexes.

Discussion

Investigations carried out on 109 specimens of *S. fluviatilis*, captured in the Asi River, revealed a sex ratio (males: females) of 1.00:0.91. Besides, it was also observed that females were more dominant in the population (Figure 2). In a study conducted in Ceyhan River by Alp & Kara (2007) reported the female/male ratio (F:M) as 0.69:1.00. Neat et al. (2003) determined as 0.73 in Lake Kournas, 0.58 in the Fango River, and 0.61 in Lake Garda (Italy). In the present study, the sex ratio of *S. fluviatilis* in the Asi River was slightly different from those in these previous reports, but similarly, females are dominant than males. According to Cote et al. (1999) The differences in the sex ratio of *S. fluviatilis* may be due to the egg guarding behavior of the males.

Total lengths of examined specimens of *S. fluviatilis* ranged between 1.7 and 7.1 cm. This finding is similar to the studies from different regions, e.g., 2.0-7.0 cm Kleanthidis et al. (1999) from Greece (Lake Trichonis); 2.0-7.5 cm (Erguden, 2016) from the Southeastern Anatolia, Turkey; 2.1-7.5 cm from western Mediterranean brackish water of Turkey (İnnal, 2019). Other results having considerably lower length range were also reported from different locations such as 2.4-6.5 cm from Rhios estuary, NW Aegean, Greece (Koutrakis and Tsikliras, 2003), 2.3-4.8 cm from Lake Iznik, Turkey (Tarkan et al., 2006). However, as a different result, İlhan et al. (2013) from Turkey Inland waters (7 drainage basin) declared maximum length (TL= 12.9 cm) for *S. fluviatilis*. The length differences in values might be explained with the habitat differences, environmental factors and catch period. Moreover, the size of fishes may fluctuate due to gender, season, feeding rate, gonadal development, water flow, and their behavior (Tarkan et al., 2006).

The values of the exponent *b* provide information on fish growth. When *b*=3, the increase in weight is isometric. When the value of *b* is higher than 3, the weight increase is allometric (positive if *b*>3, negative if *b*<3). In the present study, the *b* values ranged from 3.055 for female to 3.052 for male individuals of *S. fluviatilis*.

Based on previously reported studies, positive allometry and isometry were observed in *S. fluviatilis* from the west and the east Mediterranean inland waters of Turkey (Table 3). The presented paper, the *b* values were generally in similar results for *S. fluviatilis* reported from other geographical areas (Kleanthidis et al., 1999; Tarkan et al., 2006; İlhan et al., 2013; Erguden, 2016). The observed small differences could be due to the fishing equipment, season, fishing pressure, sampling

Table 3. Length-weight relationships of *S. fluviatilis* from different regions

Author(s)	Locality	Sex	N	Lt	Length (cm)	a	b	r^2
Kleanthidis et al. (1999)	Lake Trichonis, Greece	Female	441	TL	2.0-7.0	0.01020	3.080	0.941
		Male	409	TL	2.0-7.0	0.00680	3.330	0.980
Koutrakis and Tsikliras (2003)	Rhios estuary, NW Aegean, Greece	Mixed	5	TL	2.4-6.5	0.01220	2.986	0.986
İlhan et al. (2013)	Turkey Inland waters (7 drainage basin), Turkey	Mixed	652	TL	2.0-12.9	0.0135	3.004	0.986
Tarkan et al. (2006)	Lake İznik, Marmara	Mixed	92	TL	2.3-4.8	0.00960	3.060	0.933
Erguden (2016)	Seyhan Reservoir, Turkey	Mixed	97	TL	2.0-7.5	0.01170	3.084	0.962
İnnal (2019)	Western Mediterranean Brackish water, Turkey	Mixed	100	TL	2.1-7.5	0.00620	3.308	0.960
This study	Asi River, Turkey	Mixed	109	TL	1.7-7.1	0.00130	3.054	0.967

Note: Lt: Length type

procedure, sample size, length range, reproduction season and environmental or habitat factors (Petrakis and Stergiou, 1995). However, the previous two reports of positive allometric growth of *S. fluviatilis* has also been reported by Kleanthidis et al. (1999) (male samples; b=3.330 for Lake Trichonis, Greece) and by İnnal (2019) (b=3.308 for W. Mediterranean brackish water). On the contrary, Koutrakis and Tsikliras (2003) from Rhios estuary of Greece has reported negative allometric growth (b=2.986). These differences could be the result of environmental variations or habitat factors (Hossain et al., 2015), including seasonal effect, degree of stomach fullness, gonad maturity, food richness (Gonzalez et al., 2004; Ruiz-Campos et al., 2006), sex, health, reproductive period, and seasonal variation (Bagenal and Tesch, 1978; Alp et al., 2005).

According to Bagenal and Tesch (1978) and Goncalves et al. (1997), the parameters of *b* generally do not vary significantly throughout the year, unlike parameter *a,* which may vary seasonally, daily, and between habitats. Besides, several factors are known to influence the LWRs in fish, including habitat, general fish condition, gonad maturity, season, and preservation of fish (Tesch, 1971; Bagenal and Tesch, 1978; Wootton, 1990), these factors were not accounted in the present study.

The coefficient of determination (r^2) was found to be >0.96, a highly significant value of the result. The regression analysis has demonstrated that fish length had a highly significant correlation with weight (P<0.001).

Le Cren (1951) and Ricker (1975), reported the condition factor of fish populations may show variations with gonad development, feeding activity and seasonal changes in growth.

In this study, CF values were also calculated, where the lowest and highest estimations were found to be 1.3955 and 1.4495, respectively, with a mean value of 1.4212±0.027 for both sexes. Le Cren (1951) declared that CF values greater than 1 indicated the good condition of the fish whereas a value <1 is indicative of the reverse nature. The present results revealed that both males and females indicate that both of the sexes are in good condition for *S. fluviatilis.*

Conclusion

The present study provides the first reference on LWRs and CF, of *S. fluviatilis*. Besides, the CF value of *S. fluviatilis* calculated for both sexes showed that it was in a very good condition in terms of its optimum growth in the Asi River. This study is also useful for fishery biologist, sustainable fishery management, and conservation.

S. fluviatilis is considered a locally endangered species listed by the IUCN Red List (Crivelli, 2006; IUCN, 2020). Besides, this species is locally threatened inland waters of Turkey due to dams built on rivers, habitat destruction, pollution, and water abstraction in the next years (Fricke et al., 2007). Today, *S. fluviatilis* has affected and decreased from large parts of the Asi drainage due to water pollution habitat destruction and introduction of exotic species. Therefore, a conservation action should be taken as a high priority for this species.

Acknowledgements

Compliance with Ethical Standards

Conflict of Interest

The author declares that there is no conflict of interest.

Ethical Approval

This study was conducted in accordance with ethics committee procedures of animal experiments. All procedures were performed in accordance with the Law on Veterinary and Medical Activities and National Animal Welfare Act. Therefore, ethics approval was not required.

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