

Length-weight relationship and condition factor of endemic genus *Seminemacheilus* (Teloestei=Nemacheilidae) for Turkey

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ABSTRACT. This study was aimed to determine the length-weight relationships and Fulton's condition factors of the genus *Seminemacheilus* that is endemic for Turkey. The specimens were collected from 2017 to 2019 using an electrofishing device (SAMUS 1000MP). The total length and the total weight of the examined specimens ranged from 3.5 to 9.1 cm and from 0.31 to 7.52 g, respectively. Based on the results, the growth coefficient values b ranged from 2.56 (*S. ispartensis*) to 3.48 (*S. attalicus*). Also, the condition factor of the studied fishes ranged from 0.77 (*S. dursunavsari*) to 1.11 (*S. attalicus*). This study represents the first reports of length-weight relationship data for *S. ahmeti*, *S. attalicus*, *S. dursunavsari*, *S. ekmekciae*, and *S. ispartensis* from Turkish inland waters and four new maximum total lengths for the *Seminemacheilus* species. The results of this study provide useful information for further fisheries management, fish population dynamic studies and comparisons in future studies.

Keywords: Central Anatolia, *Seminemacheilus*, population dynamic, positive allometric

Introduction

The genus *Seminemacheilus* has six valid species, all of which are endemic to Central Anatolia. Six species viz. *Seminemacheilus lendlii*, *S. ispartensis*, *S. ahmeti*, *S. dursunavsari*, *S. ekmekciae*, and *S. attalicus* were reported from Turkish inland waters (Erk'akan et al., 2007; Çiçek et al., 2015; 2020; Sunger et al., 2018; Çiçek, 2020; Yoğurtçuoğlu et al., 2020). The *Seminemacheilids* has no trading value, but it is important for the Anatolian inland water bodies in Turkey for ichthyofauna and biodiversity (Kottelat, 2012).

Length-weight relationship (*LWR*) studies are a pre-requisite for assessing population characteristics of fishes (Le Cren, 1951) and provide basic knowledge in fisheries biology such as understanding the life cycle, evaluation of fish stocks, ontogenetic changes and growth studies, and conservation (Tabatabaei et al., 2015; Keivany et al., 2016; Jafari-Patcan et al., 2018; Eagderi et al., 2019). Therefore, these data are necessary for the management and conservation of fish populations.

Condition factor (*K*) is computed from the relationship between weight and length of fish species, with the aim of describing the "condition" of that fish individual (Froese, 2006). It is assumed that the growth

of fish in ideal conditions maintain an equilibrium in length and weight and is a useful index for monitoring feeding intensity, age and growth rate, and for assessing the status of the aquatic ecosystem of fishes (Zamani-Faradonbe et al., 2015; Radkhah and Eagderi, 2015).

Despite the ecological importance of freshwater fishes, information about the length-weight relationship parameters and condition factors are often limited. Although *LWR* of *S. lendlii* is determined, there is no knowledge about the other five species of *Seminemacheilus* (Erk'akan et al., 2013; Mangit et al., 2017).

Therefore, this study aimed to determine the length-weight relationship and Fulton's condition factor for six species of the endemic genus *Seminemacheilus* inhabiting Turkish inland waters.

Materials and methods

A total of 287 specimens of the *Seminemacheilus* species were collected from 2017 to 2019 from Kizilirmak, Sakarya, Konya Closed, and Mediterranean basins using an electrofishing device (Samus 1000) (Table 1; Fig. 1). After anesthesia, the specimens were fixed in 10% buffered formalin and transferred to the laboratory. The total length (*TL*) and the total

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weight of each individual were measured using digital calipers to the nearest 0.01 cm and 0.01 g, respectively. The length-weight relationship was determined by the method of least squares using the equation $W = a(TL)^b$ and logarithmically transformed into $\log(W) = \log(a) + b\log(TL)$ (Froese, 2006), where W is the whole-body weight (g); TL is the total length (cm); a is the intercept, and b is the slope. Prior to regression analyses, log-log plots of the length-weight pairs were performed to identify outliers (Froese et al., 2011). Outliers perceived in the log-log plots of all species were evacuated from the regression. The degree of correlation between the variables was assessed by the determination coefficient r^2 . The significance level of r^2 was estimated by ANOVA. The student's t-test (ts) was used to determine whether parameter b is significantly different from the expected or theoretical value of 3 (i.e. $b = 3$, $P < 0.05$). All statistical analyses were performed in Excel 2016 and PAST v3.26. The condition factor (K) was determined by using the formula of $K = (W \times 100) / (TL)^3$, where TL is the total length (cm) and W is the whole-body weight of fish (g) (Fulton, 1904; Froese, 2006).

Results and discussion

The present study provides the LWRs data of six *Seminemacheilus* species, five of which have been determined for the first time. Moreover, based on our collected specimens, new maximum total lengths were recorded for four species, including *Seminemacheilus ahmeti* (7.5), *S. dursunavsari* (9.1), *S. ekmekciae* (8.2), and *S. ispartensis* (8.6). Table 2 provides the number of individuals, size range (TL (cm) and W (g)) and Fulton's Condition Factor. Regression parameters a and b , the 95% confidence limits of b , the 95% confidence limits of a , determination coefficient (r^2), and the type of growth for the studied species are given in Table 3.

The parameter b of the studied fishes ranged from 2.56 for *S. lendlii* to 3.48 for *S. attalicus*. It was reported that the value of b is generally between 2.5 and 4.0 (Tesch, 1971), though the ideal value of b is 3.0 (Froese, 2006). In this study, the b -values of the studied fish species are in the expected range. In a length-weight relationship, b -values that are higher and lower than 3 indicated positive and negative allometry, respectively. Based on the results, the growth pattern was positively allometric for *S. ahmeti*, *S. attalicus* and *S. ekmekciae*, isometric for *S. dursunavsari* and negatively allometric for *S. ispartensis* and *S. lendlii*.

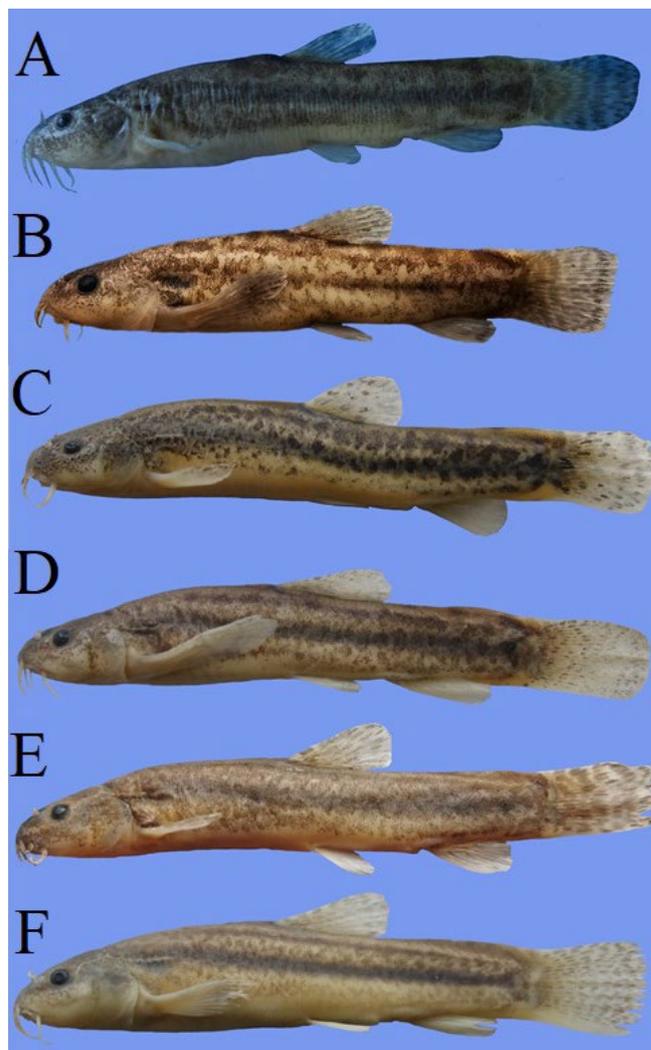


Fig.1. A - *Seminemacheilus ahmeti*, 49.7 mm standard length; B - *Seminemacheilus attalicus*, 55.5 mm standard length; C - *Seminemacheilus dursunavsari*, 57.3 mm standard length; D - *Seminemacheilus ekmekciae*, 53.4 mm standard length; E - *Seminemacheilus ispartensis*, 55.9 mm standard length; F - *Seminemacheilus lendlii*, 49.6 mm standard length.

The determination coefficient (r^2) between length and weight varied from 0.966 for *S. lendlii* to 0.988 for *S. attalicus*. The correlation coefficient (r) indicated a positive relationship between the length and weight of the studied species.

The values of condition factors (K) of the studied species ranged from 0.77 (*S. lendlii*) to 1.11 (*S.*

Table 1. Sampling stations data.

Species	Province	Habitat	Basin	Latitude	Longitude
<i>S. ahmeti</i>	Kayseri	Sultan Marsh	Kızılırmak	38°12'05"N	35°13'19"E
<i>S. attalicus</i>	Antalya	Kırkgöz wetland	Mediterranean	37°05'59"N	30°32'53"E
<i>S. dursunavsari</i>	Konya	Input of Alanözü pond	Eastern Mediterranean	37°07'48"N	32°42'19"E
<i>S. ekmekciae</i>	Konya	20 km nearest to Kulu	Konya Closed	39°02'13"N	32°48'36"E
<i>S. ispartensis</i>	Isparta	Isparta Creek	Mediterranean	37°52'22"N	30°46'47"E
<i>S. lendlii</i>	Afyonkarahisar	Spring canals at Hacibeyli village	Sakarya	39°03'20"N	30°16'49"E

Table 2. Descriptive statistics for length and weight and Fulton's Condition Factor (*K*) for six species.

Species	N	TL(cm)		W (g)		Mean <i>K</i> (Range)
		Min	Max	Min	Max	
<i>Seminemacheilus ahmeti</i> *	125	3.3	7.5	0.31	4.76	1.03 ± 0.11 (0.77-1.32)
<i>Seminemacheilus attalicus</i> *	35	4.0	7.9	0.55	5.65	1.11 ± 0.10 (0.77-1.27)
<i>Seminemacheilus dursunavsari</i> *	32	4.0	9.1	0.55	7.52	0.77 ± 0.08 (0.99-1.13)
<i>Seminemacheilus ekmekciae</i> *	65	4.3	8.2	0.66	5.96	0.99 ± 0.11 (0.80-1.21)
<i>Seminemacheilus ispartensis</i> *	15	4.2	8.6	0.78	5.35	1.02 ± 0.09 (0.84-1.20)
<i>Seminemacheilus lendlii</i>	15	4.2	7.7	0.78	3.82	0.99 ± 0.11 (0.84-1.20)

N - number of individuals; Min - minimum; Max - maximum; *K* - Fulton's Condition Factor

* first listing species

attalicus). Condition factor is an index that reflects the interactions between biotic and abiotic factors on the physiological state of fish; therefore, it is widely used to assess the state of the aquatic ecosystem, in which fish live. (Anene, 2005).

Conclusions

Seminemacheilus is the endemic genus to Central and Southwestern Anatolia of Turkey. This genus inhabits small streams and shallow ponds with sandy and clay bottoms covered by dense vegetation. All these species now live in very small habitats as the wetland has been drained and dried due to drought and habitat destruction in recent years.

This genus needs protection due to various ecological disturbances in its habitats. However, there is insufficient information about its biological properties. This study provides the first baseline data on the length-weight relationship and condition factor for the genus *Seminemacheilus*.

Conflict of interests

The authors declare no conflict of interests.

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Table 3. Estimated parameters of length-weight relations and type of growth for six species.

Species	N	Regression parameters			95% CL of <i>a</i>	95% CL of <i>b</i>	GT
		<i>a</i>	<i>b</i>	<i>r</i> ²			
<i>S. ahmeti</i> *	125	0.0063	3.28	0.970	0.0050-0.0078	3.16-3.40	+A
<i>S. attalicus</i> *	35	0.0045	3.48	0.988	0.0028-0.0062	3.31-3.73	+A
<i>S. dursunavsari</i> *	32	0.0078	3.12	0.984	0.0046-0.0105	2.97-3.39	I
<i>S. ekmekciae</i> *	65	0.0057	3.30	0.969	0.0044-0.0071	3.18-3.44	+A
<i>S. ispartensis</i> *	15	0.0187	2.62	0.985	0.0109-0.0252	2.44-2.95	-A
<i>S. lendlii</i>	15	0.0208	2.56	0.966	0.0134-0.0329	2.29-2.80	-A

N - number of individuals; GT - type of growth; *a* - intercept; *b* - slope; CL - confidence limits; *r*² - determination coefficient.

* first listing species

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