Length-Weight Relationship and Condition Factor of Aksu goby, *Ponticola turani* (Kovačić & Engin, 2008) from Terme Stream (Turkey)

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Research Article

Abstract

The present study describes the length-weight relationship (LWR) and condition factor of *Ponticola turani* (Aksu goby) based on 214 individuals from Terme Stream, the northern Turkey. Fish were collected by electrofishing in four different months between June 2015 and August 2016. LWRs of females and males were not significantly different within the same sampling month and among sampling months. The *b* value of LWR was calculated as 2.86 for females and 2.85 for males. Negative allometric growth was detected in both sexes, without significant difference between their *b* values. Fulton's condition factor (K) ranged from 0.72 to 1.48 in females and from 0.84 to 1.31 in males; the relative condition factor (K_n) ranged from 0.65 to 1.26 for females and from 0.76 to 1.18 for males. There was a significant difference in mean K of sexes, whereas no considerable difference was detected between their mean K_n. This research reports some biological parameters of Aksu goby for the first time.

Keywords: Allometric growth, Fulton's condition factor, relative condition factor

Terme Çayı (Türkiye)'ndan Aksu Kayabalığı, *Ponticola turani* (Kovačić & Engin, 2008)'nin Boy-Ağırlık İlişkisi ve Kondisyon Faktörü

Özet

Bu çalışma, Türkiye'nin kuzeyindeki Terme Çayı'dan 214 bireye dayanarak *Ponticola turani* (Aksu kayabalığı)'nin boy-ağırlık ilişkisini ve kondisyon faktörünü açıklamaktadır. Balıklar, Haziran 2015 ile Ağustos 2016 arasında dört farklı ayda elektroşok yöntemiyle toplanmıştır. Dişi ve erkeklerin boy-ağırlık ilişkileri aynı örnekleme ayında ve farklı örnekleme ayları arasında önemli farklılık göstermemiştir. Boy-ağırlık ilişkisinin *b* değeri dişiler için 2,86 ve erkekler için 2,85 olarak hesaplanmıştır. Her iki eşeyde de negatif allometrik büyüme saptanmıştır ve *b* değerleri arasında anlamlı bir fark bulunmamıştır. Fulton'un kondisyon faktörü (K) dişilerde 0,72 ile 1,48 ve erkeklerde 0,84 ile 1,31 arasında dağılım gösterirken; nispi kondisyon faktörü (K_n) dişiler için 0,65 ile 1,26 ve erkekler için 0,76 ile 1,18 arasında değişmiştir. Eşeylerin ortalama K değerleri arasında anlamlı bir fark tespit edilirken, K_n değerleri arasında önemli bir fark saptanmamıştır. Bu araştırma Aksu kayabalığının bazı biyolojik parametrelerini ilk kez rapor etmektedir.

Anahtar kelimeler: Allometrik büyüme, Fulton'un kondisyon faktörü, nispi kondisyon faktörü

INTRODUCTION

Ponticola Iljin, 1927 is a genus of the family Gobiidae. It was originally described as subgenus of *Neogobius* and transferred to the genus level because of molecular analysis (Neilson and Stepien, 2009). *Ponticola* is endemic to Black and Caspian Seas and does not enter Marmara and Mediterranean Seas (Freyhof, 2011). This genus includes 17 valid species identified in the Black Sea and Caspian Sea basins (Fricke et al., 2020). It is represented in Turkish freshwaters by 8 species (Çiçek et al., 2015), 2 of which are endemic to Turkey (Kovačić and Engin, 2008; Çiçek et al., 2018).

Aksu goby, *Ponticola turani* (Kovačić and Engin, 2008) is one of the strict freshwater inhabitants among the species of the genus *Ponticola* (Freyhof, 2011). It is categorized as vulnerable (VU) by the International Union of Conservation for Nature (IUCN) (Freyhof, 2014). To the best of our knowledge, no study has been carried out on the biology of this species. To this end, length-weight and length-length relationships and condition factor of Aksu goby inhabiting Terme Stream were examined.

MATERIALS and METHODS

Terme Stream is located by the east of Samsun in the Central Black Sea region (Turkey). It is formed by the merging of Yeşilköy, Ayazma and Çağlayan streams which was born from the northern slopes (1100-1300 m) of the Canik Mountains. Terme Stream takes Kızlar stream, flowing from the east, near Şeyhli Village, and moves towards the northeast. It is poured into the Black Sea from the Çaltı Cape, 4 km east of Terme district (Figure 1). The total length from upstream to downstream is approximately 55 km (Uncu, 1995). Uğurlu (2006) reported the occurrence of 14 species from Terme Stream: *Alburnus derjugini*, *Barbus tauricus*, *Carassius gibelio*, *Capoeta tinca*, *Neogobius fluviatilis*, *Babka gymnotrachelus*, *Oncorhynchus mykiss*, *Ponticola turani*, *Rhodeus amarus*, *Rutilus rutilus*, *Salmo labrax*, *Squalius sp*, *Syngnathus abaster* and *Vimba vimba*.
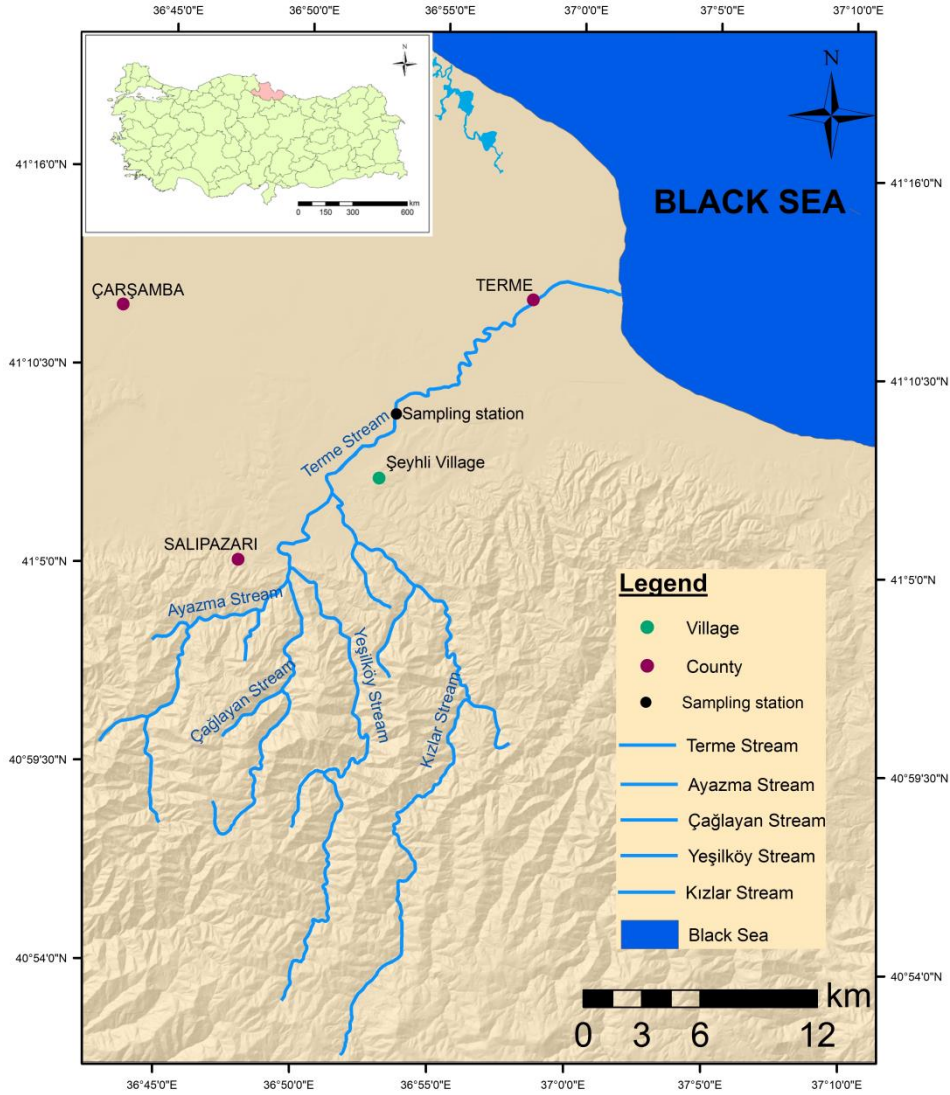

Figure 1. The map of the sampling area

Fish samplings were carried out through four events in June 2015, February 2016, April 2016, and August 2016. Specimens were collected by electrofishing from one locality (41º09' N-36º53' E) in Terme Stream. A few of the caught fish were preserved in 4% formaldehyde for the species identification. All other samples were immediately stored in ice, brought to the laboratory, and kept in a freezer at -18 °C for further analysis. The species were identified according to Kovačić and Engin (2008). All frozen fish were thawed at the room temperature, washed in tap water, and dried with a paper towel. Then, the total length (TL) and standard length (SL) of each specimen were measured by caliber to an accuracy of ± 0.01 mm and length data were converted to cm for standard use, and fish

weight (W) was weighed by a digital balance to an accuracy of ± 0.01 g. Gonads were examined for sex determination. The deviation of the female: male ratio from the expected 1:1 ratio was checked by the chi-square (x^2) test (Zar, 1999).

Length-weight relationships were determined by applying the exponential regression equation $W=aL^b$, where W is the fish weight (g), L is the total length (cm), a and b are equation parameters (Bagenal and Tesch, 1978). Variables a and b were estimated by linear regression of the logarithmic transformation of the equation in question. LWRs were obtained separately for females, males, and all individuals. The parameter b values of LWRs of females and males were compared for a significant difference in the same sampling month and among sampling months by ANCOVA test, sex, or sampling period as the main factor and total length as a covariate. In determining the growth type of fish, the difference of b value from 3 was examined (t-test, $b=3$ isometric growth, $b<3$ negative allometric growth, $b>3$ positive allometric growth) (Zar, 1999).

The conditions of Aksu goby individuals were evaluated both by Fulton's condition factor (K) and the relative condition factor (K_n). Fulton's condition factor is calculated with the formula $K=W/L^3 x100$ (Ricker, 1975) and the relative condition factor with $K_n=W/\hat{W}$ (Le Cren, 1951), where W is the fish weight (g), $\hat{W}$ is the weight (g) obtained from the length-weight relationship, and L is the total length (cm) of the fish. K and K_n values of fish were determined separately according to sampling month and total length class (1 cm interval) of female and male specimens. The differences between condition factors of females and males in the same sampling month were checked by t-test, and ANOVA test was used to compare the differences in mean K and K_n among four sampling months (Zar, 1999). The TL-SL relationship was determined separately for females, males, and both sexes using linear regression ($y=a+bx$).

RESULTS and DISCUSSION

Of the total of 214 individuals, 140 (65%) were females and 74 (35%) were males. The overall sex ratio of females to males was calculated as 1: 0.52. This ratio was found to be different from the expected 1: 1 ratio ($x^2=20.355$, P<0.001). In June 2015 and February 2016, it was 1: 0.65 ($x^2=2.483$, P>0.05) and 1: 0.44 ($x^2=1.923$, P>0.05), respectively. However, female to male ratio was 1: 0.56 ($x^2=6.050$, P<0.05) in April 2016 and 1: 0.40 ($x^2=11.571$, P<0.010) in August 2016. The sex ratio may change at different times in the same population, being influenced by several factors such as reproductive behavior, food availability, and environmental conditions (Nikolsky, 1963). Given the fact that the study species can show complex reproductive behavior in which males excavate nests and defend territories, obtaining different sex ratios by the same method at different times is possible.

Length and weight descriptive statistics as well as the parameters of the length-weight relationship of *P. turani* for each sampling month are given in Table 1. Total length ranged from 4.68 cm to 10.76 cm and total weight from 1.12 g to 12.92 g. The values of coefficient b in this study were within the expected range of 2.5-3.5 (Froese, 2006), but they can vary between 2 and 4 (Bagenal and Tesch, 1978). The parameter b of monthly LWRs of females and males ranged from 2.77 (August) to 3.12 (February) and from 2.45 (April) to 2.95 (August), respectively. No significant difference was observed in the b values of LWRs of females and males within the same sampling month and among sampling months (ANCOVA, P>0.05). TThe variable b of LWR was calculated as 2.86 for females, 2.85 for males, and 2.84 for combined sexes. The difference between the b values of females and males was found insignificant (ANCOVA, P>0.05). The variations in b values from 3 were statistically significant (lower) according to sampling months and sexes. This result indicates that the growth of *P. turani* is negative allometric, meaning that the fish become less stout as length increases (Neumann et al., 2012). Length-weight relationships in fish are not constant over the entire year and vary depending on the factors such as food availability, feeding rate, gonad development and spawning period (Bagenal and Tesch, 1978), all of which were not considered in this study. The parameters estimated in the present work should be used only for sampling time since *P. turani* specimens were collected in different months and years.

Table 1. Descriptive statistics and estimated parameters of the length-weight relationship (LWR) of *P. turani* from Terme Stream

| Sampling date	Sex	N	TL (cm)		W (g)		Parameters of LWR			
			Min	Max	Min	Max	*a*	*b*	95% CI of *b*	*r²*
June 2015	F	35	6.10	10.19	2.57	9.91	0.015	2.85	2.65-3.05	0.96
	M	23	7.13	9.64	3.52	8.70	0.016	2.80	2.19-3.41	0.81
	Both	58	6.10	10.19	2.57	9.91	0.018	2.76	2.56-2.94	0.94
February 2016	F	9	7.03	9.06	3.82	9.05	0.008	3.12	2.37-3.88	0.93
	M	4	7.51	9.22	4.90	8.81	0.014	2.88	0.95-4.81	0.92
	Both	13	7.03	9.22	3.82	9.05	0.010	3.04	2.49-3.60	0.93
April 2016	F	51	5.81	9.44	2.85	9.18	0.017	2.81	2.58-3.04	0.93
	M	29	7.32	10.47	5.05	12.37	0.037	2.45	2.15-2.76	0.91
	Both	80	5.81	10.47	2.85	12.37	0.020	2.74	2.62-2.86	0.96
August 2016	F	45	4.68	10.76	1.10	11.19	0.017	2.77	2.62-2.92	0.97
	M	18	4.80	10.34	1.20	12.92	0.013	2.95	2.84-3.05	0.99
	Both	63	4.68	10.76	1.10	12.92	0.015	2.85	2.74-2.95	0.98
Total	F	140	4.68	10.76	1.10	11.19	0.015	2.86	2.77-2.93	0.98
	M	74	4.80	10.47	1.20	12.92	0.015	2.85	2.75-2.94	0.98
	Both	214	4.68	10.76	1.10	12.92	0.015	2.84	2.79-2.89	0.98

F, female; M, male; N, sample size; TL, total length; W, weight; Min, minimum; Max, maximum; CI, confidence interval, *r²*, coefficient of determination

Fulton's condition factor (K) ranged from 0.72 to 1.48 (mean 1.14) in females and from 0.84 to 1.31 (mean 1.10) in males (Table 2). A significant difference was observed in mean K between females and males (*t*-test, P>0.05). In females, the lowest mean K was found in February and the highest in April; in males, the lowest mean K was found in June and the highest in August (Table 2). There was a significant difference in the mean K of females and males among sampling months (ANOVA, P<0.05). The mean K values of sexes were not statistically different within February and August. The mean Fulton's condition factor concerning length group is shown in Figure 2. For both sexes, the highest mean K value was observed in the 5.5-6.49 cm length group. After that, the K values of specimens with a total length of more than 6.49 cm displayed a downward trend in both females and males. This situation may be attributed to factors such as feeding regime and state of gonadal development.

Table 2. Descriptive statistics of Fulton's condition factor (K) and the relative condition factor (K_n) for females and males of Aksu goby inhabiting Terme Stream

Sampling date	Variable	Sex	N	Mean	SD	Min	Max
June 2015	K	F	35	1.10	0.06	0.94	1.24
		M	23	1.04	0.09	0.84	1.21
		Both	58	1.08	0.08	0.84	1.24
	K_n	F	35	0.99	0.06	0.87	1.14
		M	23	1.00	0.09	0.80	1.15
		Both	58	0.98	0.07	0.77	1.15
February 2016	K	F	9	1.08	0.08	0.96	1.23
		M	4	1.07	0.08	0.98	1.16
		Both	13	1.08	0.08	0.96	1.23
	K_n	F	9	1.05	0.08	0.92	1.18
		M	4	0.99	0.07	0.90	1.05
		Both	13	0.99	0.07	0.88	1.12
April 2016	K	F	51	1.17	0.10	0.95	1.48
		M	29	1.12	0.09	0.97	1.31
		Both	80	1.15	0.09	0.95	1.48
	K_n	F	51	1.00	0.08	0.81	1.21
		M	29	1.01	0.06	0.87	1.12
		Both	80	0.99	0.07	0.79	1.17
August 2016	K	F	45	1.15	0.10	0.72	1.30
		M	18	1.16	0.06	1.07	1.25
		Both	63	1.15	0.09	0.72	1.30
	K_n	F	45	1.02	0.08	0.71	1.17
		M	18	0.98	0.05	0.90	1.05
		Both	63	1.00	0.07	0.67	1.12
Total	K	F	140	1.14	0.09	0.72	1.48
		M	74	1.10	0.09	0.84	1.31
		Both	214	1.13	0.09	0.72	1.48
	K_n	F	140	1.00	0.08	0.65	1.26
		M	74	1.00	0.08	0.76	1.18
		Both	214	1.03	0.08	0.69	1.30

F, female; M, male; N, sample size; SD, standard deviation; Min, minimum; Max, maximum
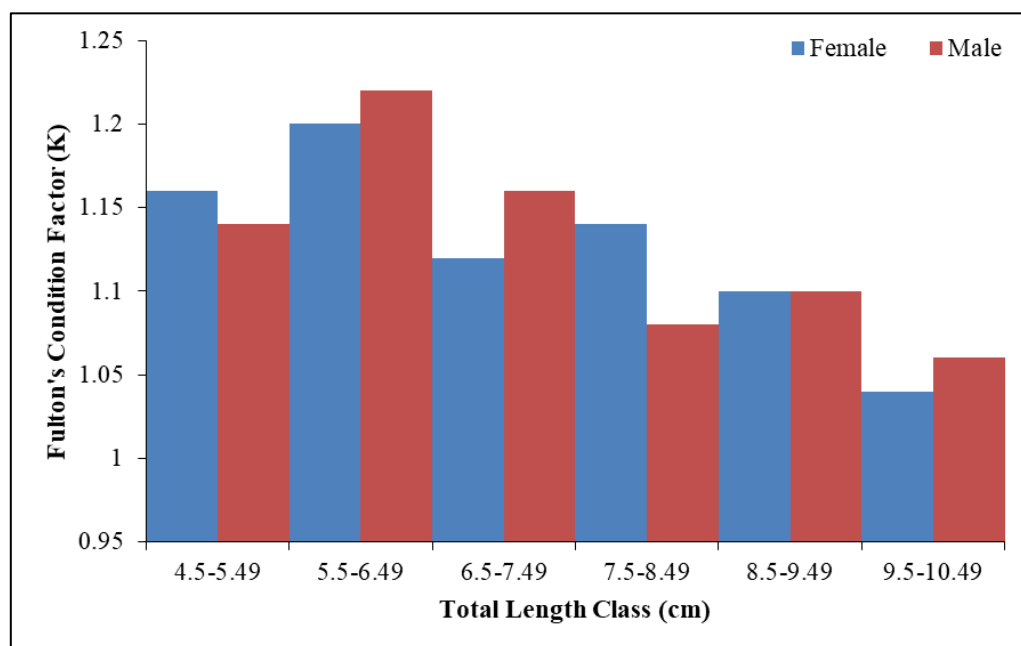
Figure 2. Mean Fulton's condition factor per length class for both sexes of *P. turani* from Terme Stream
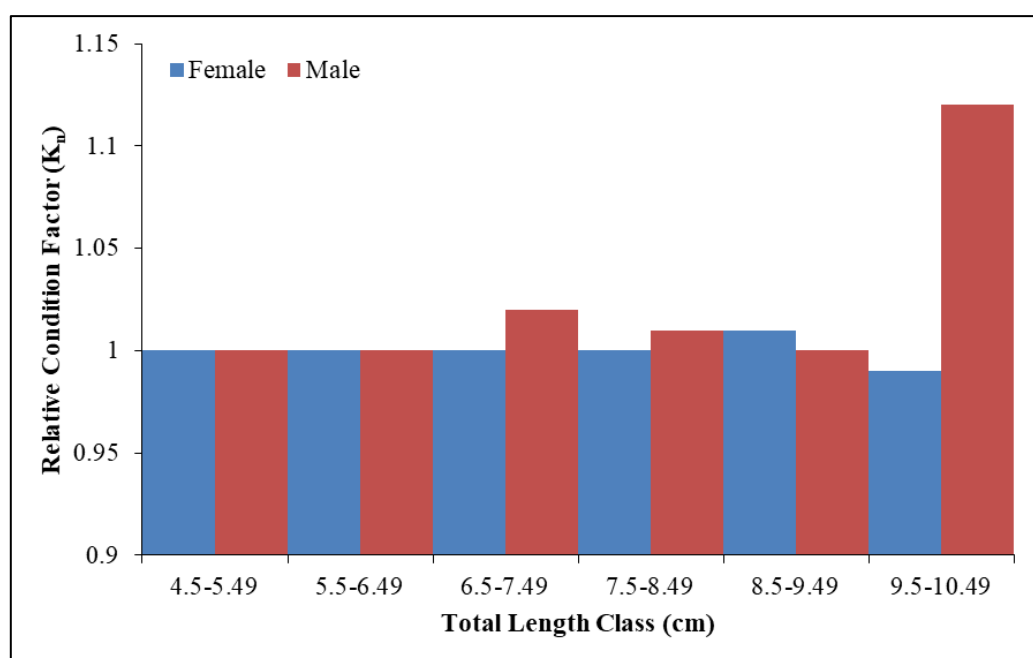
Figure 3. Mean relative condition factor per length class for both sexes of *P. turani* from Terme Stream

The relative condition factor (K_n) ranged from 0.65 to 1.26 (mean 1.00) for females and from 0.76 to 1.18 (mean 1.00) for males (Table 2). No significant difference was detected in mean K_n between sexes (*t*-test, P>0.05). In females, the highest mean K_n was found in February and the lowest mean K_n was found in June; in males, the highest mean K_n was found in April and the lowest mean K_n was found in August (Table 2). No significant difference was detected in mean K_n between females and males within the same sampling month (*t*-test, P>0.05) and among sampling months (ANOVA, P>0.05). The lowest and highest mean K_n values were observed in the 9.5-10.49 cm length class (Figure 3). The mean K_n values were 1 or above in the other length classes for both females and males. According to Le Cren (1951), $K_{n \geq} 1$ status indicates good condition, whereas $K_n < 1$ status indicates the poor condition. K_n values of *P. turani* show that it is good in terms of condition.

The condition factor is an important variable that indicates whether any fish are healthy or not or whether it feeds adequately or not. The changes observed in the condition factor value primarily information about the development of gonad and the degree of nutrition (Wootton, 1990). On the other hand, the condition factor is affected by several factors including habitat, season, age, and reproductive period (Williams, 2000), yet they were not accounted for in the current study.

The relationship between total length and standard length was obtained as TL=2.617+1.157SL (R^2=0.998) for females, TL=0.538+1.202SL (R^2=0.994) for males, and TL=0.112+1.186SL (R^2=0.991) for all specimens.

In conclusion, this study provides the first data on the length-weight and length-length relationships, and condition factors of Aksu goby that would be useful for fisheries biologists and managers in Turkey. Potential conservation actions require much more data on the species biology.

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