



RESEARCH ARTICLE

First data on some biological aspects of the Caucasian goby, *Ponticola constructor* (Nordman, 1840) (Teleostei: Gobiidae) from the lower Çoruh River Basin (NE Türkiye)

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ABSTRACT

The present study describes for the first time some biological aspects (size composition, sex ratio, length-weight relationship and condition factor) of *Ponticola constructor* (Caucasian goby) inhabiting Borçka Dam Lake and its tributaries from the lower Çoruh River Basin located in the northeastern Türkiye. Fish samples were caught from June 2017 to May 2018 by using trammel nets with various mesh sizes and by pulsed DC electrofishing device. A total of 145 Caucasian goby (78 females and 67 males) ranging from 6.8 cm to 13.4 cm TL were sampled during the study. The sex ratio of female to male was calculated as 1.16:1.00 which did not deviate from the expected ratio of 1:1 ($\chi^2 = 0.834$, $p > 0.05$). The total length-weight relationships were determined as $W = 0.016TL^{2.896}$ ($r^2 = 0.995$, $P < 0.05$) for females, as $W = 0.018TL^{2.841}$ ($r^2 = 0.993$, $P < 0.05$) for males and as $W = 0.017TL^{2.856}$ ($r^2 = 0.994$, $P < 0.05$) for combined sex with the b-values were significantly different from isometric growth ($b = 3$) indicating negative allometric growth of Caucasian goby for all sexes (Pauly's t-test, $P < 0.05$). The regression analysis revealed that the coefficient of determination was $r^2 > 0.99$ showing a highly significant correlation between total length and weight. The differences in slopes (b values) of the LWR were statistically significant for both sexes (ANCOVA, $P < 0.05$). Fulton's condition factor (K) values ranged from 1.124 to 1.312 in females and from 1.076 to 1.426 in males indicating a good growth condition in this habitat. No significant difference was observed in mean K values between females and males (t-test, $P > 0.05$). The present study will provide a baseline on some biological parameters of *Ponticola constructor* to provide a guideline for the fisheries management authority and fisheries scientists for further investigations as well as presents the first known reference on the LWRs of this species for the FishBase database. Furthermore, the reported results may contribute to the conservation and sustainability of this species in the area.

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Introduction

The length and weight data of fishes have commonly been studied to obtain biological information and has become one of the standard methods used in fisheries biology (Le Cren, 1951; Yesilcicek et al., 2015). Length-weight relationships (LWRs) and condition factor are of great importance in fishery assessment studies due to providing information about the growth of the fish, its general wellbeing, and fitness in the existing habitat (Yesilcicek et al., 2015; Jisr et al., 2018). The biometric studies which give information on fish species for an estimated assessment of their biomass are keystone tools for research and management (Zargar et al., 2012). In biometric studies, it is essential to determine the growth characteristics related to the length and weight of the fish (Morato et al., 2001), in addition to the condition of wellbeing of the species influenced by different biological and environmental factors. The length-weight relationships (LWRs) in fish also provide significant information about the general health, growth pattern, life history, habitat conditions, fish fatness and condition, as well as morphological characteristics of the fish (Schneider et al., 2000; Froese, 2006).

In fish populations, sex ratio and size structure provide basic information to assess reproductive potential and estimating stock size (Vicentini & Araújo, 2013). Size structure also plays an important role in maintaining reproductive potential and stability of a fish population. Hence, investigating the change of size structure may provide insight of how resilient a fish population can be (Tu et al., 2018).

Ponticola Iljin, 1927 is a genus of the family Gobiidae which was originally described as a subgenus of *Neogobius* and transferred to the genus level as a result of molecular analysis (Neilson & Stepien, 2009). The genus *Ponticola* is endemic to Black and Caspian Seas and does not occur in Marmara and Mediterranean Seas (Freyhof, 2011). While this genus comprises 18 valid species recorded from the Black Sea and Caspian Sea basins (Fricke et al., 2021), in Turkish freshwaters this genus is represented by only 6 species (Cicek et al., 2020). *Ponticola constructor* (Nordmann, 1840) also, commonly known as the Caucasian goby or Blackbelly river goby is a benthopelagic freshwater species which inhabits a wide variety of flowing waters from cold hill to foot hill streams and never found in brackish water. The Caucasian goby has a restricted distribution area in European and Asian Caucasus. It distributes in western tributaries of River Kuban in northern Caucasus and in coastal Black Sea drainages of southern Caucasus from Coruh to Psyrtskha (IUCN, 2008; Froese &

Pauly, 2022). The Caucasian goby, *P. constructor* is globally listed as Least Concern (LC) category by the IUCN Red List of Threatened Species (IUCN, 2008), however, this species is considered as Endangered (EN) in inland waters of Türkiye due to dams' construction on rivers, habitat loss, water abstraction, eutrophication and pollution (Fricke et al., 2007).

There is no study in the available literature on the biological aspects, such as size structure, sex ratio, length-weight relationships (LWRs) and condition factor of *P. constructor* from different populations in its distribution area. To the best of the author's knowledge, this is the first study on some biological aspects of *P. constructor* both in Çoruh river basin and in its other distribution areas as well. The present study firstly describes the size structure, sex ratio, LWRs and Fulton's condition factor (K) of *P. constructor* inhabiting Borçka Dam Lake and its tributaries located in the lower Coruh river basin in the North Eastern Black Sea region of Türkiye. Hereby, the present study aims to provide a baseline on these issues of *P. constructor* to provide a guideline for the fisheries management authority and fisheries scientists for further investigations. This study also presents the first known reference on the LWR for the Caucasian goby for the FishBase database. Furthermore, the reported results may contribute to the conservation and sustainability of this species in the area.

Material and Methods

Study Area

This study was carried out in Borçka Reservoir and its tributaries, which is located on the lower Çoruh River Basin in North eastern Black Sea region of Türkiye (Figure 1). The reservoir has 419 hm³ volume at normal water level and a surface area of 10,84 km². Coruh River has a total length of 431 km, within 410 km of borders of Türkiye and the last 21 km in Batumi (Georgia) where the river falls into the Black Sea (Yesilcicek & Kalayci, 2020).

Fish Sampling and Measurement

P. constructor samples were caught from June 2017 to May 2018 by using trammel nets with various mesh sizes and by pulsed DC electrofishing device from reservoir and its tributaries. Each fish specimen was measured in total length (TL) to the nearest 1 mm and weighed to the nearest 0.01 g body weight (W). Sex was determined via macroscopic observation of the gonads.

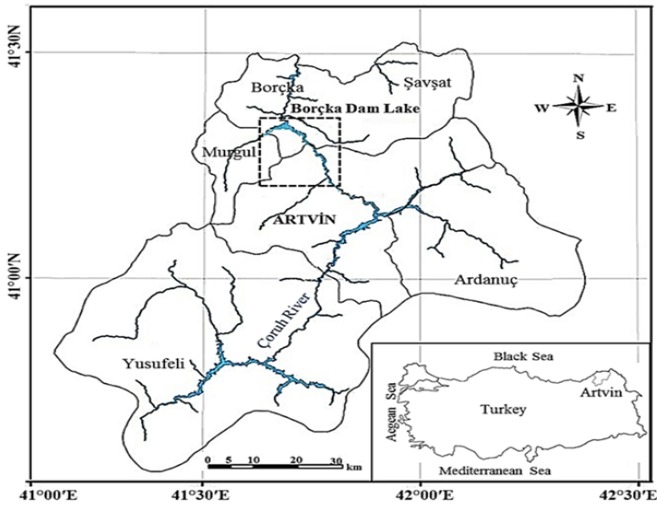


Figure 1. The map of the study area

Length-Weight (L-W) Relationship

The relationships between fish length and weight are expressed by equation (1):

$$W = aTL^b \tag{1}$$

which was converted to logarithmic form as equation (2):

$$\log W = \log a + b \log TL \tag{2}$$

where *W* is total body weight (g), *TL* is the total length (cm), *a*: intercept and *b*: slope regression coefficients. Then the length-weight relationship (LWR) parameters were estimated by linear regression using the log-transformed values of this equation (Ricker, 1973; King, 2007). The model fit to the data was measured by the coefficient of the Pearson r-squared (*r*²) test (Froese, 2006).

Fulton’s Condition Factor (K)

Fulton’s condition factor (*K*) was calculated using the following formula;

$$K = \frac{W}{TL^3} \times 100 \tag{3}$$

where, *W* is total body weight (g) and *TL* is total length (cm) (Le Cren, 1951).

Statistical Analyses

The differences in mean Fulton’s condition factor between sexes were tested by t-test. ANCOVA was used to determine if there was significant difference in slopes (*b* values) between sexes (Zar, 1999). To compare the slopes to confirm whether the *b* value was different from the isometric growth (*b*=3) for

both sexes and combined sex, Pauly’s t-test (Pauly, 1984) was performed using the formula as:

$$t = \frac{Sd_{\log TL} |b-3|}{Sd_{\log W} \sqrt{1-r^2}} \sqrt{n-2} \tag{4}$$

where, *Sd*_{log*TL*} is the standard deviation of the log *TL* values, *Sd*_{log*W*} is the standard deviation of the log *W* values, *r*² is correlation coefficient, *n* is the number of specimens of *P. constructor* used in the calculation. If calculated *t* value is greater than the table *t* values for *n*-2 degrees of freedom the value of *b* is different from isometric growth (*b*=3) (Pauly, 1984; Bilgin et al., 2020). All tests applied in the study were performed at the 0.05 level of significance. Statistical analyses were performed using the SPSS and Microsoft Office Excel software.

Results

Length and Weight Distribution

A total of 145 *P. constructor* (Caucasian goby) individuals were sampled during the study. The total lengths (TL) of all samples examined were between 6.8 cm and 13.4 cm (mean 10.01±0.153 cm) and their body weight ranged from 4.14 to 28.91g (mean 13.21±0.580). Total length (TL) and weight (*W*) characteristics of the Caucasian goby, *P. constructor* by sexes were presented in Table 1.

Length - Frequency Distribution

The total length - frequency distribution of 145 Caucasian goby samples ranging from 6.8 cm to 13.4 cm TL was plotted based on 1 cm class intervals for female and male individuals (Figure 2). The length -frequency distribution showed that most of the individuals of males (67.2%, N=45), females (75.3%, N=58) and all samples (71%, N=103) distributed in the length classes between 7 and 10 cm.

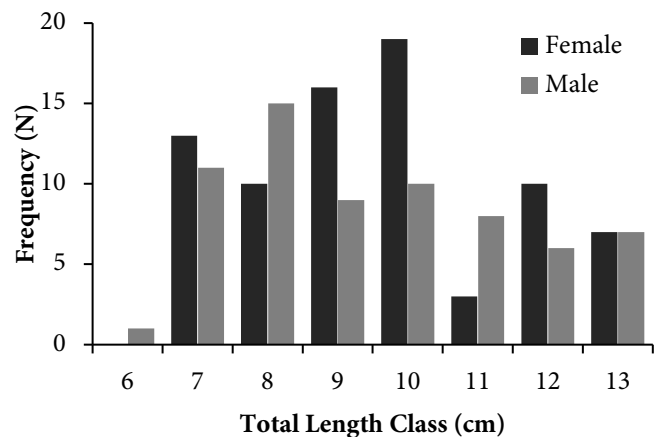


Figure 2. The length - frequency distribution of the Caucasian goby by sexes.

Length-weight relationship (LWR)

The total length-weight relationships were determined as $W = 0.016TL^{2.896}$ ($r^2=0.995$, $N=78$, $P<0.05$) for females, as $W = 0.018TL^{2.841}$ ($r^2=0.993$, $N=67$, $p<0.05$) for males and as $W = 0.017TL^{2.856}$ ($r^2=0.994$, $N=145$, $p<0.05$) for combined sex (Figure 3) with the b-values were significantly different from isometric growth ($b=3$) indicating negative allometric growth of Caucasian goby for all sexes (Pauly's t- test, $p<0.05$). The slopes (b value) of the length-weight relationship were statistically significant for both sexes (ANCOVA, $p<0.05$). The length-weight relationships (LWR) for *P. constructor* by sexes are presented in Figure 3. The correlation coefficient (r^2) for

regression analysis indicated that the Caucasian goby has a high correlation ($r^2>0.99$) between the total length and weight variables for both sexes and combined individuals.

Descriptive statistics and estimated parameters of the length-weight relationship (LWR) of Caucasian goby by sexes from the lower Coruh River Basin, NE Türkiye were presented in Table 2.

Fulton's Condition Factor (K)

Fulton's condition factor (K) values of the Caucasian goby ranged from 1.124 to 1.312 in females and from 1.076 to 1.426 in males. No significant difference was observed in mean K values between females and males (t-test, $p>0.05$) (Table 3).

Table 1. Total length (TL) and weight (W) characteristics of the Caucasian goby, *P. constructor* by sexes

Sex	N	Total Length (cm)		Body Weight (g)	
		Min-Max	Mean±S.E	Min-Max	Mean±S.E
Female	78	7.2-13.4	9.88±0.210	4.72-28.91	12.51±0.788
Male	67	6.8-13.2	9.61±0.255	4.14-28.01	12.02±0.948
Combined	145	6.8-13.4	9.75±0.162	4.14-28.91	12.29±0.606

Note: N: Sample Size, S.E: Standard Error, Min.: Minimum, Max.: Maximum

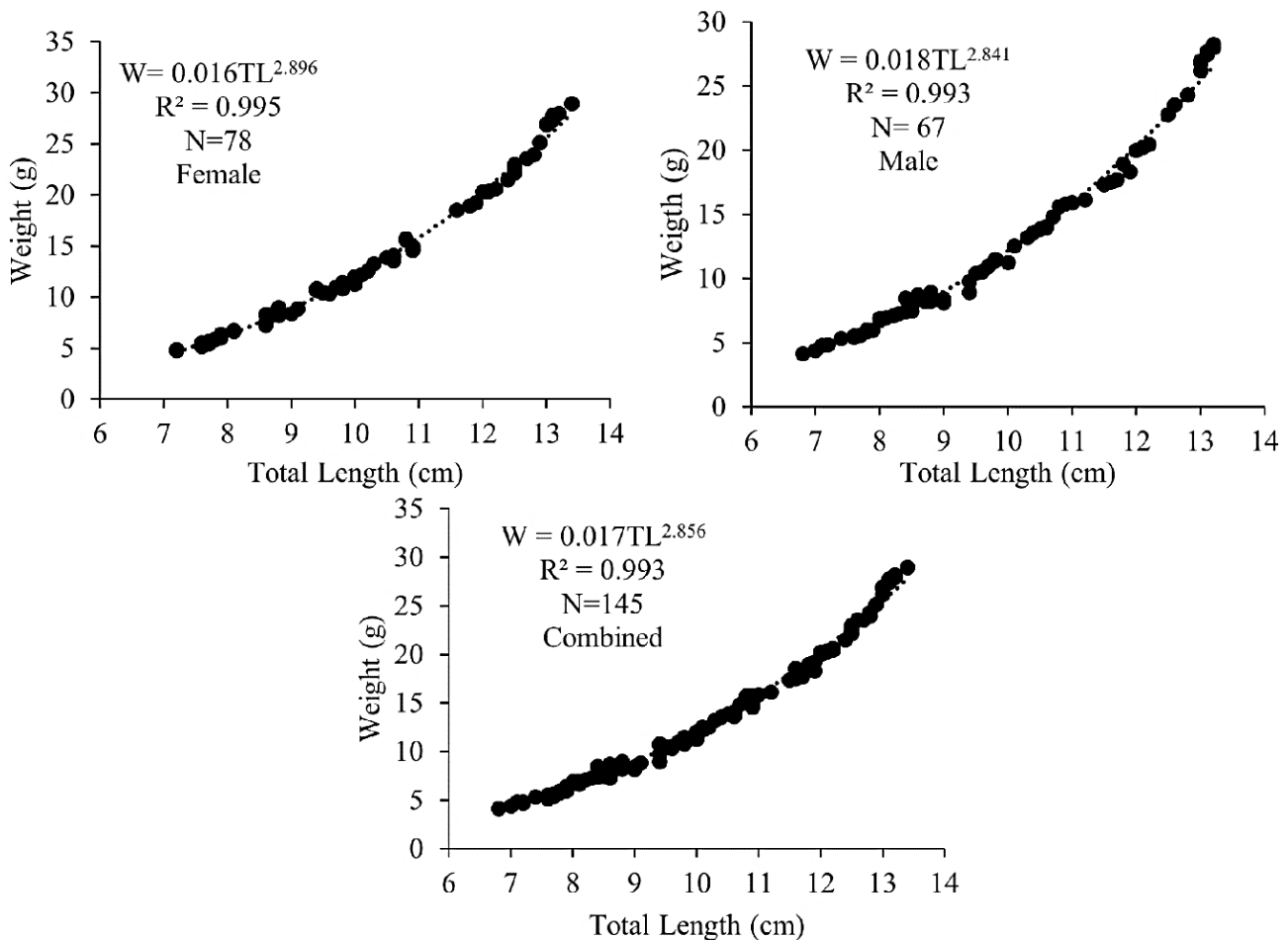


Figure 3. The length-weight relationships (LWR) for the Caucasian goby, *P. constructor* by sexes

Table 2. Descriptive statistics and estimated parameters of the length-weight relationship (LWR) of Caucasian goby, *P. constructor* by sexes from the lower Coruh River Basin, NE Türkiye

Sex	N	Parameters of LWR						
		a	b	S.E. (b)	95% CI of b	R ²	Growth Type	Pauly's t-test
Female	78	0.016	2.882	0.025	2.831-2.933	0.995	- Allometric	p<0.05
Male	67	0.018	2.841	0.033	2.762-2.896	0.993	- Allometric	p<0.05
Combined	145	0.017	2.851	0.021	2.809-2.893	0.994	- Allometric	p<0.05

Note: N: Sample Size, a: Intercept of the relationship, b: Slope; S.E.(b): Standard Error of b, R²: Coefficient of determination, C.I.: Confidence Intervals)

Table 3. Fulton's condition factor (K) values of the Caucasian goby by sexes.

Sex	N	Kmin-Kmax	Kmean±S.E.	t-test
Female	78	1.124-1.312	1.202±0.006	p>0.05
Male	67	1.076-1.426	1.221±0.009	p>0.05

Sex Composition

During the study, of the sampled 145 *P. constructor* individuals, 53.8% (N=78) were females and 46.2% (N=67) were males, accordingly the ratio of female to male was calculated as 1.16:1.00 which did not deviate from the expected ratio of 1:1 ($\chi^2 = 0.834, p>0.05$).

Discussion

In this study, the size composition, sex ratio, length -weight relationship and Fulton's condition factor for the Caucasian goby, *P. constructor* was reported for the first time. There are no previous references for comparison the results of the present study. Therefore, all comparisons were made with the other species among the genus *Ponticola* reported in the available literature.

The values of the coefficient b of the LWRs for Caucasian goby, *P. constructor* in this study were 2.896 for females and 2.841 for males within the expected range of 2.5-3.5 (Froese, 2006), however, the b value of LWR may vary between 2 and 4 (Bagenal & Tesch, 1978). The growth pattern was negative allometric growth (-A growth) for Caucasian goby in both sexes. The value of b>3 indicates that the fish become plump as they increase in length and b<3 shows that the fish gets slimmer with increasing length (Jobling, 2002).

The b value of LWRs for Kura goby, *Ponticola cyrius* from Kura River, eastern Anatolia Region in Türkiye was reported as 2.9795 indicating isometric growth pattern by Çiçek et al. (2019). This value was reported for the same species as 2.938 (-A growth) from Shahrbijar River, Southern Caspian Sea basin in Iran (Asadi et al., 2017) and as 3.214 (+A growth) by Faradonbeh et al. (2015) from Totkabon River (southern

Caspian Sea basin), Guilan in Iran. The b value for *Ponticola bathybius* from the Southern Caspian Sea basin in Iran was reported as 3.32 (+A growth) (Nikmehr et al., 2021). The b value of *Ponticola iranicus* from Sefidroud River was reported as 3.050 for females, as 2.893 for males and as 3.002 for all individuals (Mousavi-Sabet et al., 2016). The b value was determined for *Ponticola gorlap* as 3.64 (+A growth) from Tajan River, Iran (Jamali et al., 2015). The b value of the LWR for Aksu goby, *Ponticola turani* was reported as 2.86 for females and 2.85 for males from Terme Stream with negative allometric growth in both sexes (Yilmaz & Sakalli, 2020).

The parameters of the LWRs in fish may change depending on some factors such as species, habitat, sex, season, the number and length distribution of specimens, degree of stomach fullness, and gonad maturity (Bagenal & Tesch, 1978), also sampling techniques, food availability and feeding intensity (Le Cren, 1951), degree of muscular development, the amount of reserved fat and life history (Gupta & Banerjee, 2015). The LWRs may also be influenced by geographical location and environmental conditions in given year (Balon, 1984).

In the current study, the sex ratio for the Caucasian goby, *P. constructor* of female to male was calculated as 1.16:1.00 which did not deviate from the expected ratio of 1:1. The sex ratio of females to males was reported as 1.0: 0.52 for Aksu goby, *Ponticola turani* in Terme Stream from the northern Türkiye (Yilmaz & Sakalli, 2020). This ratio in Iranian Goby, *Ponticola iranicus* was reported as 1:1.32 in favor of males from the Southern Caspian Sea Basin (Mohammadi-Darestani et al., 2016). Knowledge on the sex distribution in fish populations is most important for the reproduction of the population. In many species, the sex composition (female: male ratio) is usually as 1:1. However, there may be deviations from this ratio

in some species or some age groups (Erkoyuncu, 1995). The sex ratio in fishes may generally vary from species to species, between different populations of the same species and from year to year in the same population as well (Nikolsky, 1963). Furthermore, Mohammadi-Darestani et al. (2016) noted that the sex ratio of gobies can vary in different species and even in the same species under different environmental conditions.

The Fulton's condition factor (K) values calculated for the Caucasian goby, *P. constructor* in the current study varied from 1.124 to 1.312 in females (mean 1.202 ± 0.006) and from 1.076 to 1.426 in males (mean 1.221 ± 0.009) indicating that the species is in a good growth condition in the Borçka Dam Lake and its tributaries.

The mean Fulton's condition factor for Kura goby, *Ponticola cyrius* was reported as 1.43 from Kura River, eastern Anatolia Region in Türkiye (Çiçek et al., 2019), as 0.96 ± 0.14 from Shahrbijar River, a tributary of Sefidrud River in the Caspian Sea basin (Guilan Province, North of Iran) (Asadi et al., 2017) and as 0.94 ± 0.207 from Totkabon River (southern Caspian Sea basin), Guilan in Iran (Faradonbeh et al., 2015). This value was calculated as 1.00 ± 0.18 for *Ponticola bathybius* from the Southern Caspian Sea basin in Iran (Nikmehr et al., 2021). Fulton's condition factor (K) values ranged from 0.72 to 1.48 in females (mean 1.14 ± 0.09) and from 0.84 to 1.31 in males (mean 1.10 ± 0.09) for Aksu goby, *Ponticola turani* from Terme Stream from the northern Türkiye (Yılmaz & Sakalli, 2020). The condition factor is an index reflecting the interaction between biotic and abiotic components in the physiological conditions of fishes. Therefore, this factor may vary among fish species in different localities (Blackwell et al., 2000) and the fluctuating in this index is also based on the seasonal variations of the gonads and feeding intensity (Biswas, 1993). Higher condition factor values ($K \geq 1$) indicate suitability of a specific water body for growth as well as a good level of feeding and appropriate environmental conditions in favor of fish (Ujjania et al., 2012; Abbasi et al., 2019). The differences in Fulton's condition factor (K) values among the present study and other studies previously reported above may be explained by the factors such as species, sampling period and techniques, feeding regime, food presence and utilization, habitat conditions and state of gonadal development.

Information on basic biological data of a fish population is of great importance to understand how fishes react under anthropogenic pressure or other environmental conditions (Trindade-Santos & Freire, 2015). The biological aspects of Gobies have been rarely studied in Northeastern parts of the Anatolia; however, *P. constructor* (Nordman, 1840) has not

been previously studied both from the region and its other distribution areas. There is no information on biological aspects of this species; therefore, the main aim of the present study was to provide preliminary biological data on this species from the lower Çoruh River basin in terms of size composition, sex ratio, as well as length-weight relationship and condition.

Even if *P. constructor* is globally listed as Least Concern (LC) category by the IUCN Red List of Threatened Species (IUCN, 2008), however, this species is considered as Endangered (EN) in inland waters of Türkiye due to dams construction on rivers, habitat loss, water abstraction, eutrophication and pollution (Fricke et al., 2007), thus suggesting that this species should be subject to conservation measures through continuous monitoring of bioecological aspects of the species in the study area. Considering the ecological role of the Caucasian goby, which has no economic value in this ecosystem, investigation of the biological characteristics of this species will be important in terms of both the protection and sustainability of the species as well as the ecosystem in its distribution area.

Conclusion

In conclusion, the present study provides the first data on the size composition, sex ratio, length-weight relationships, and condition factor of Caucasian goby that would be useful for fishery managers and biologists studying in the field of fisheries biology. Potential conservation plans need much more data on the biology of the species. The results of the present study will provide a primary dataset to fisheries management authority and fisheries scientists for further investigations to fully understand the bio-ecological characteristics of this species in addition to take conservation measures and to ensure sustainability of its populations in the area.

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Compliance With Ethical Standards

Conflict of Interest

The author declares that there is no conflict of interest.

Ethical Approval

For this type of study, formal consent is not required. All applicable international, national, and/or institutional guidelines for the care and use of animals were followed.

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