Abstract: Length-weight and length-length relationships are significant in fish biology. These parameters can provide information on the stock condition and growth studies. In this study, we report the length-weight and length-length relationships for *Luciobarbus pectoralis* in the Southeastern Anatolia (Hatay, Turkey). A total of 125 (65 female and 60 male) specimens were captured from Asi River (Orontes River) basin using gill nets in September 2015 and March 2016. The total length and weight of both sexes varied from 15.5-38.0 cm and 35.0-855.0 g. The values of the exponent b of the length-weight relationships were 3.441 for females and 3.443 for males. The length-length relationship between total, fork and standart (TL, Total Length, Fork Length, SL, Standart Length) length measurements were found high correlated (R > 0.99, P < 0.001). This study provides the first comprehensive description of LWRs and LLRs of *L. pectoralis* from the Asi River (Hatay, Turkey) according to their sexes. Besides, new maximum length and weight values are reported for *L. pectoralis*.

Keywords: Cyprinidae, Hatay province, length, Orontes river basin, regression parameters, weight.

Asi Nehri (Türkiye)'nde Bulunan Bıyıklı Bahk *Luciobarbus pectoralis*’in (Heckel, 1843) Boy-Ağrılık ve Boy-Boy İlişkileri

Öz: Bıyıklı biyolojisinde boy-ağrılık ve boy-boy ilişkileri oldukça önemlidir. Bu parametreler, stok durumu ve büyüme çalışmalarını hakkında bilgi sağlamak içindir. Bu çalışmada, Güneydoğu Anadolu'nda (Hatay, Türkiye) bulunan *Luciobarbus pectoralis’*in uzunluk-ağrılık ve uzunluk-uzunluk ilişkilerini tespit edilmiştir. Eylül 2015 ve Mart 2016 tarihlerinde Asi Nehri (Orontes Nehri)'nden solungaç ağları ile toplam 125 (65 dişi ve 60 erkek) örnek yakalanmıştır. Tüm bireyler için örneklerin toplam boy ve ağırlığı 15.5-38.0 cm ve 35.0-855.0 g arasında değişmiş gösterdi. Boy-ağrılık ilişkilerinin b üssü katsayısı, dişiler için 3.441 ve erkekler için 3.443 hesaplandığı. Toplam, çatal ve standart boy ölçümleri (TL, Total Length, Çatal Boy, SL, Standart Boy) ve boy-boy ilişkisi ara sıra yüksek derecede korelasyon bulundu (R> 0.99, P <0.001). Bu çalışmada Asi Nehri'ndeki (Hatay, Türkiye) *L. pectoralis*’in boy-ağrılık ve boy-boy ilişkilerinin cinsiyetlere göre ilik kapsamlı tanımlanması yapılmaktadır. Ayrıca bu çalışmada *L. pectoralis* için yeni bir maksimum uzunluk ve ağrılık bildirilmiştir.

Anahtar kelimeler: Ağrılık, Asi nehr havzasi, boy, cyprinidae, Hatay ili, regresyon parametreleri.
INTRODUCTION

Luciobarbus pectoralis (Heckel, 1843) is a Levantine barbel species found in the south-east Mediterranean region (Fricke et al., 2007). It is widespread in the lower Göksu, Seyhan and Ceyhan drainages (Erguden, 2016) and all over Asi drainage in Turkey (Kottelat & Freyhof, 2007; Ozcan, 2013) and Syria (Freyhof, 2014; Froese & Pauly, 2020).

*L. pectoralis* has been considered as a valid species by most authors (Karaman 1971; Geldiay & Balkı, 1999; Kuru, 2004; Turan et al., 2008) and this species commonly occur from the Orontes basin (Almaça, 1986; Kottelat & Freyhof, 2007). *L. pectoralis* is very similar to *L. capito*. *L. pectoralis* is distinguished from the other conspecific, *L. capito* by having total lateral line scale counts (50-55 vs. in *L. pectoralis*; 52-72, usually 60-66 in *L. capito*), and gill raker counts (17-19 gill rakers on the first gill arch vs. 17-18 in *L. pectoralis*; 12-18 in *L. capito*), (Turan et al., 2008).

The knowledge on length-weight (LWRs) and length-length relationships (LLRs) of fish is helpful in fisheries science. Length and weight relationships are used widely in fisheries exploitation and management. LWRs are essential to recognize the ecology and life cycle of fish species and also very useful to predict weights from more effortless measures of lengths (Froese, 2006; Santos et al., 2002). Besides, LLRs are also great importance for comparative growth studies (Moutopoulos & Stergiou, 2002). These relationships are commonly used in fisheries biology and population dynamics to determine the population structure and stock status of a fish species (Bagenal & Tesch, 1978).

To date, there is no information on LWRs and LLRs for *L. pectoralis* according to their sexes from Southeastern Anatolia, Turkey (Asi River, Hatay). Besides, no information regarding this fish species for Asi River Basin is available in Fishbase (Froese & Pauly, 2020). This study provides the first information on LWRs and LLRs relationships of Levantine barbel collected in Asi River, Turkey (Southeastern Anatolia, Hatay, Turkey).

MATERIAL AND METHOD

Fish samples were collected from two localities in the Asi (Orontes) River drainage (south-eastern Anatolia, Turkey) between September 2015 and March 2016 using gill nets (40 and 44 mm mesh sizes) set at 0-2 m depths (Coordinates: 36 30’ N, 36 24’ E - 36 25’ N, 36 33’ E) (Figure 1). Specimens were transported on ice in a cooler box to the laboratory at Cukurova University. Total length (TL), Standard length (SL), and Fork length (FL) were measured to the nearest millimeter (mm) and total weight (TW) nearest 0.01 gram (g), respectively. Sexes were identified by macroscopic and microscopic examination of the gonads.

Mean length and mean weight for males and females were compared using Student’s t test. Statistical differences in the sex ratio were determined using the Chi-square ($\chi^2$) test.

The LWRs was $W = TL^b$ (Ricker, 1975), the statistical significance level of $R^2$ was estimated, and the parameters $a$ and $b$ calculated by linear regression equation of log TW = $log a + b log TL$, where, $W$ is the weight of the fish in grams; $TL$ is the total length in cm and, $a$ and $b$ are the intercept and the slope of the regression line, respectively. The significance of the regression was assessed by ANOVA, and the “b” value was tested by student’s t-test to verify if it was significantly different from isometric growth (Ricker, 1975; Pauly, 1984). LLRs were established using linear regression analysis: TL–SL, SL–FL and FL–TL. The analyzes were evaluated statistically using SPSS computer package program.

RESULTS

Of the 125 specimens, ranging from 15.5 to 38.0 cm TL, 65 were females (52.0%) and 60 were males (48.0%). The total sex ratio for female and male individuals (M:F) was 0.92:1.00. The difference between the sex ratio was not found to be statistically significant ($\chi^2 = 0.626$, $P>0.05$). The average total length values of the examined samples were found to be 24.07 cm ± 0.82 (15.5-38.0) for females and 24.23 cm ± 0.66 (16.0-35.5) for males. There was a significant difference between both sexes in the overall total length ($t=0.156$, $P<0.05$). The average total weight values were calculated $229.46 g ± 24.44 (35.0-850.0)$ for females and 180.28 g ± 17.40 (37.0-586.0) for males. The t test showed a significant difference between both sexes in overall weight ($t=1.477$, $P<0.05$). The sample size, mean TL, standard error (SE) of TL, size range (cm, TL), mean W, SE of TW and total weight range (g, W) are given in Table 1.
Table 1. Total length (TL) and weight (W) of *L. pectoralis* in Asi River.

| Sex      | n  | Mean  | S.E. | Min  | Max  | Weight | S.E. | Min  | Max  |
|----------|----|-------|------|------|------|--------|------|------|------|
| Both     | 125| 24.15 | 0.53 | 15.5 | 38.0 | 206.65 | 16.69 | 35.0 | 850.0|
| Females  | 65 | 24.07 | 0.82 | 15.5 | 38.0 | 229.46 | 24.44 | 35.0 | 850.0|
| Males    | 60 | 24.23 | 0.66 | 16.0 | 35.5 | 180.28 | 17.40 | 37.0 | 586.0|

n: sample size; S.E: Standard Error, Min: Minimum; Max: Maximum.

The calculated allometric coefficient b ranged from a minimum of 3.441 for females to a maximum of 3.438 for both sexes. The LWRs indicated a positive allometric growth for *L. pectoralis* (Table 2). The LWRs of *L. pectoralis* was calculated as \( W=0.0030TL^{3.441} \) \( (R^2=0.974) \) for females, \( W=0.0026TL^{3.442} \) \( (R^2=0.983) \) for males, and \( W=0.0028TL^{3.438} \) \( (R^2=0.970) \) for both sexes. Estimation of length-weight relationship for females, males and both sexes are shown in Figure 2 and the estimated parameters of the LWR (a and b), SE of b, confidence limit (95%) of a and b, and the determination coefficients \( (r^2) \) are given in Table 2.

Linear regression was highly significant (\( P<0.001 \)) for all species. LLRs presented in Table 3 were highly significant (\( P<0.001 \)), with all the coefficient of determination values \( (r^2) >0.990 \).

**DISCUSSION**

In the present paper, the relations between total length (TL), fork length (FL) and standard length (SL), and between total length and weight relationships were investigated for *L. pectoralis* from two localities (Asi River, Turkey). The length and weight data collected throughout the sampling period are not representative for all months within a year.

The total length and total weight of both sexes varied from 15.5-38.0 cm 35.0-850 g. The average total length of the examined for both sexes was found 24.15 cm ± 0.53, and the average total weight was 206.65 g ± 16.69. Ozcan and Ispir (2019) reported total length as 16.5-21.0 cm and total weight as 23.87-75.65 g for *L. pectoralis* from Menzelet Dam Lake (Kahramanmaraş, Turkey). Erguden (2016) stated that the minimum and maximum values of total lengths and weights of the samples collected from Seyhan Reservoir (Adana, Turkey) ranged between 15.5-33.5 cm and 37.0-412.7 g. Basiacik et al., (2012) declared total length as 13.2-32.3 cm and total weight as 40.0-572.70 g for *L. kottelati* collected from Adıgüzel Dam Lake (Denizli, Turkey). These size and weight differences are related to sex, sampling gear, season, habitat and also considerably affected by such factors as fishing pressure, stress, reproductive activity, nutrition and environment (Le Cren, 1951; Froese, 2006). Besides, the size of fishes may fluctuate depending on sex, feeding, gonadal development, water flow, and their behavior (Tarkan et al., 2006).

Positive allometric growth values were observed for the *L. pectoralis* of b for both sexes, females, and males (Table 2, Figure 2). The values of the parameter b vary between 2.5 and 3.5 (Froese, 2006). In the present study, all b values fell within this expected range. The value of b is different than 3 for the both sexes (b= 3.438), female (b= 3.441) and male (b=3.443) (\( b>3, p<0.05 \)) (Table 2).

![Figure 2](image-url)
There is a little study (Erguden, 2016; Ozcan & Ispir, 2019) for this species in the inland water of Turkey. Thus, the belonging to same genus different *Luciobarbus* species was used compare, due to very close biological characteristics in this study. LWRs of *Luciobarbus* species have been reported for different regions in Table 4. Similarly, Erguden (2016) has reported the b value as 3.225 for *L. pectoralis* from Seyhan Reservoir. Basiacik et al., (2012) have given b value as 3.138 from Adıgüzel Dam for *L. kottelati*. Tarkan et al., (2006) stated the mean value of b as 3.074 as the result of a study on the *L. escherichii* species collected from Omerli Dam Lake (Turkey). On the contrary, the previous report of negative allometric growth of *L. pectoralis* has also been reported by Ozcan and Ispir (2019). In their study, b value was calculated as for both sexes b= 1.778, for the female b= 1.228 and for the males b= 2.478, in Menzelet Reservoir (Ozcan & Ispir, 2019). These differences of b value may depend on the ontogenetic development, seasonal variation, and ecological factors (Alp et al., 2005; Wootton, 1998).

The present data should be considered as representing only a particular season or time of year. Besides, the parameters of b generally do not vary significantly throughout the year, unlike parameter a, which may vary seasonally, daily, and between habitats (Bagenal & Tesch, 1978; Goncalves et al., 1997). According to Tesch (1971), the length-weight relationship in fishes is affected by some factors including season, gonad maturity, diet, habitat, sampling, and also preservation techniques. In the present study, these factors were not taken into account.

*L. pectoralis* has commercial economic value and also local fishermen catch and consume it as food in this region. In recent years, *L. pectoralis* population has been decreasing in the Asi River Basin. The main important reasons for the decline in the abundance of this fish species may be due to overfishing, destruction of their spawning grounds, restrictions in their habitats, and pollution.

Today *L. pectoralis* is considered as Least Concern (LC) in the IUCN Global Red List for Anatolian waters (IUCN, 2020). However, this species has affected and decreased from large parts of the Asi drainage due to pollution, habitat destruction, and water abstraction. Unfortunately, many threats are still not considered due to not enough substantial evidence for this species. Thus, further research is required to reveal details about the habitats situations of regional species in this region.

In the present study, we report the first references available for the length-weight (LWRs) and length-length relationships (LLRs) of the Levantine barbels from Asi River (Southeastern Anatolia, Turkey). Besides, the present study the maximum total length was determined as 38 cm, and this is the new maximum length reported from Turkish inland waters. The results of this study will be useful for fisheries biologists and conservation experts for

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**Table 2.** Length-weight relationships for *L. pectoralis* in Asi River

| Sex     | n   | a     | b     | SE (b) | 95% CI of a | 95% CI of b | r²   | GrowthType | P     |
|---------|-----|-------|-------|--------|-------------|-------------|------|------------|-------|
| Both    | 125 | 0.0028| 3.438 | 0.055  | 0.0020-0.0039| 3.330-3.546 | 0.970 | A (+)      | P<0.05|
| Females | 65  | 0.0030| 3.441 | 0.071  | 0.0017-0.0037| 3.300-3.582 | 0.974 | A (+)      | P<0.05|
| Males   | 60  | 0.0026| 3.443 | 0.059  | 0.0019-0.0040| 3.325-3.561 | 0.983 | A (+)      | P<0.05|

n: Sample size, a: intercept of the relationship; b: slope of the relationship; SE (b): Standard Error of b; r²: Coefficient of determination.

**Table 3.** Morphometric relationships between total length (TL), fork length (FL) and standard length (SL) for *L. pectoralis* in Asi River.

| Sex      | n   | Equation          | a     | b     | SE (b) | r²   | GrowthType | P     |
|----------|-----|-------------------|-------|-------|--------|------|------------|-------|
| BothSexes| 125 | TL = a + bTL      | -0.028| 0.967 | 0.008  | 0.995|            |       |
|          |     | SL = a + bFL      | 0.095 | 0.990 | 0.006  | 0.997|            |       |
|          |     | FL = a + bFL      | -0.016| 1.026 | 0.006  | 0.998|            |       |
| Female   | 65  | TL = a + bTL      | -0.120| 0.998 | 0.009  | 0.997|            |       |
|          |     | SL = a + bFL      | 0.117 | 0.981 | 0.006  | 0.999|            |       |
|          |     | FL = a + bFL      | 0.015 | 1.016 | 0.006  | 0.999|            |       |
| Male     | 60  | TL = a + bTL      | 0.024 | 0.950 | 0.014  | 0.994|            |       |
|          |     | SL = a + bFL      | 0.099 | 0.989 | 0.012  | 0.996|            |       |
|          |     | FL = a + bFL      | 0.087 | 1.049 | 0.011  | 0.997|            |       |

n: Sample size, a: intercept of the relationship; b: slope of the relationship; SE (b): Standard Error of b; r²: Coefficient of determination.

**Table 4.** Geographic comparison of LWRs parameters for *Luciobarbus* species from different areas.

| Species              | Locality       | Sex | n   | Lengthtype | Length (cm) | a     | b     | r²   | Author(s)          |
|----------------------|----------------|-----|-----|------------|-------------|-------|-------|------|-------------------|
| *Luciobarbus kottelati* | Mixed         | 144 | FL  | 4.9-22.6   | 0.0096     | 3.138 | 0.973 |      | Tarkan et al. (2006) |
| *Luciobarbus escherichi* | Mixed         | 12  | TL  | 3.8-112.4  | 0.0079     | 3.098 | 0.970 |      | Coban et al. (2012)  |
| *Luciobarbus esocinus*  | Mixed         | 85  | TL  | 37.4-49.7  | 0.0101     | 2.915 | 0.960 |      | Tarkan et al. (2006) |
| *Luciobarbus escherici* | Mixed         | 22  | TL  | 19.4-42.2  | 0.0060     | 2.871 | 0.970 |      | Hedayati et al. (2016) |
| *Luciobarbus pectoralis* | Mixed         | 77  | TL  | 16.5-20.6  | 0.0639     | 2.418 | 0.404 |      | Ozcan & Ispir (2019) |
| *Luciobarbus pectoralis* | Mixed         | 73  | TL  | 15.5-21.0  | 0.0630     | 1.228 | 0.565 |      | Ozcan & Ispir (2019) |
| *Luciobarbus pectoralis* | Mixed         | 150 | TL  | 15.5-21.0  | 0.0670     | 1.778 | 0.439 |      | Erguden (2016)       |

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the sustainable use of the L. pectoralis population in the Asi River.

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