

# Length-Weight and Length-Length Relationships and Condition Factor of An Endemic Fish Species (*Capoeta tinca* (Heckel, 1843)) Inhabiting Bayat Pond (Ankara, TÜRKİYE)

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**Abstract:** The aim of this study is to determine the length-weight relationship, length-length relationship, and Fulton's condition factor (K) of *Capoeta tinca*, which is endemic to Turkey. A total of 52 samples were obtained from Bayat Pond in 2017. The total length (TL) of the samples ranged between 20 and 34 cm. Total weights (W) of them also varied from 85 to 446g. Strong correlations were found between length and weight. In the length-weight relationship equation, a and b were found as 0.0144 and 2.9028, respectively. The b value was not statistically different from 3 (t-test, P>0.05). Therefore, this species showed isometric growth in the Bayat Pond. The value of Fulton's condition factor was 1.0485. Total length - Fork length (FL), Total Length - Standard length (SL) and Fork length - Standard length conversion equations were calculated. There was a high correlation between all length types. In this study, the length-weight relationship, length-length relationship, and Fulton's condition factor values of *Capoeta tinca* inhabiting Bayat Pond were determined for the first time.

**Keywords:** Anatolian khramulya, condition factor, length-weight relationships, length conversion.

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## 1. INTRODUCTION

Morphometric data and statistical relationships are widely used in fisheries biology studies (Yılmaz et al., 2007; Bostancı et al., 2014; Yazıcı and Yazıcıoğlu, 2020; Yazıcı et al., 2020; Olentino et al., 2021; Sidiq et al., 2021). Length-weight relationship parameters calculated using morphometric data are important for fish biology and fisheries management (Garcia et al., 1989; Haimovici and Velasco, 2000; Moutopoulos and Stergiou, 2002). Length-weight relationships provide estimation of fish length-to-weight and comparison of fish growth between different regions or localities (Koutrakis and Tsikliras, 2003; Oscoz et al., 2005). Because direct measures of weight can be time-consuming in the field, length-weight regressions have been widely used to estimate weight from length (Sinovčić et al., 2004). In addition, length-weight relationships indicate

whether fish growth is isometric or allometric (Le Cren, 1951; Ricker, 1975).

Length-length relationships allow conversion between different length types (Yazıcıoğlu and Yazıcı, 2016). Many studies have used these relationships (Yılmaz et al., 2010; Borah et al., 2018; Biolé et al., 2020). These relationships are very useful for comparing the results of studies using different length types. Condition factor, also known as condition coefficient or length-weight factor, is a parameter that shows the relative fatness of a fish. Changes in condition factors primarily reflect sexual maturity and nutritional level (Le Cren, 1951; Williams, 2000).

Anatolian khramulya, *Capoeta tinca* (Heckel, 1843) belongs to the Cyprinidae family and is an endemic fish species for Turkey (Geldiay and Balık, 2007). According to Turan et al.

(2006) defined the *C. tinca* populations in Sakarya and Kızılırmak as a separate species with the name *Capoeta baliki* based on some morphological characters. However, subsequent molecular studies show that *C. baliki* is not much different from *C. tinca* and remains only a minor synonym (Çiçek et al., 2021). The Sakarya, Kızılırmak, and Çoruh river basins, as well as those streams in the Marmara area that are hydrologically related to the Black Sea, all have significant populations of *C. tinca*. However, it is absent from Thrace and the Mediterranean Basin, which make up Turkey's European region (Erk'akan, 1983). This species, which shows omnivorous feeding characteristics (Geldiay and Balık, 2007), can live in highly polluted rivers and has a wide ecological tolerance (Ekmekçi, 2002). They can easily adapt to stagnant waters, streams, natural lakes, and ponds. Spawning times are between May and June, and males reach reproductive maturity at 2 years old and females at 3 years old (Ekmekçi and Özeren, 2003).

There are many studies on *C. tinca* in different habitats (Gül and Yılmaz, 2002; Yılmaz and Polat, 2009; Birecikligil et al., 2016; Buhan et al., 2016). However, there is no research specific to the Bayat Pond. In addition, since the species is endemic to Turkey, its biological information is very valuable. Therefore, in this study, it was aimed to determine the length-weight and length-length relations and condition factor values of *C. tinca*.

## 2. MATERIAL AND METHOD

Bayat Pond, located within the borders of the Ayaş district of Ankara (Turkey) province, was built to meet the irrigation needs of the village of Bayat (Bayar, 2019). It is located in the north of the Asartepe Dam, which is the largest dam in the district, and its bird-fly distance is 19200 meters (Nazır, 2020).

A total of 52 *C. tinca* were obtained from local fishermen carrying out commercial activities in Bayat Pond in 2017. The total length (TL), fork length (FL) and standard length (SL) of the fish were measured with an accuracy of 0.01 cm and their weights were weighed with an accuracy of 0.1 g.

$W = a \times L^b$  equation was used to calculate the length-weight relationship (Ricker, 1975). In the equation,  $W$  is body weight (g),  $L$  is length (cm),  $a$  is the point where the curve that determines the length-weight relationship intersects the y-axis and  $b$  is the slope of the curve that determines the length-weight relationship. The  $a$  and  $b$  parameters of the length-weight relationship were estimated by transforming the equation into linear regression of the form  $\text{Log } W = \text{Log } a + b \text{ Log } L$ . Whether the  $b$  parameter is different from isometric growth ( $b=3$ ) in the length-weight relationship was tested with the t-test (Zar, 1999).

The following equation was used to calculate the condition factor (Ricker, 1975).

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

Here,  $K$  = Fulton's condition factor,  $W$  = fish weight (g), and  $L$  = fish length (cm).

In order to compare the measured total, fork and standard length data with the length values in other studies, the total length-fork length, total length-standard length and fork length-standard length relations were revealed. Length-length relationships were calculated using linear regression analysis (Zar, 1999).

## 3. RESULTS

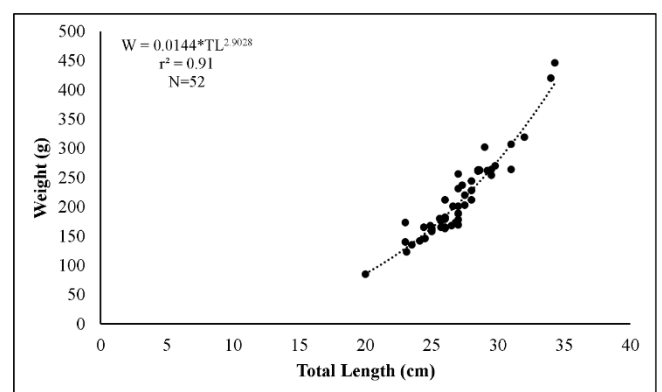
The average total, fork and standard length values of *C. tinca* samples obtained from Bayat Pond are 26.97 cm, 24.88 cm, and 22.73 cm, respectively. The average weight value is 211.3 g and ranges between 85 and 446 g (Table 1). The female: male ratio could not be determined due to the large number of specimens whose sex could not be determined, and all analyzes were made by considering female, male and undefined specimens.

**Table 1.** Descriptive statistics of length and weight of *C. tinca* specimens living in Bayat Pond.

Variable	N	Average	Min	Max	Se	Sd
Weight (g)		211.3	85.00	446.00	9.40	67.81
Total Length-TL (cm)		26.97	20.00	34.00	0.37	2.67
Fork Length-FL (cm)	52	24.88	18.50	32.00	0.34	2.51
Standard Length-SL (cm)		22.73	17.00	29.50	0.31	2.24

**N:** Sample count, **Min:** Minimum, **Max:** Maximum, **Se:** Standard error, **Sd:** Standard deviation

The length-weight relationship equation was determined as  $W = 0.0144 * TL^{2.9028}$  and the  $r^2$  value was determined as 0.91. It was determined that the  $b$  value was not different from the 3 representing isometric growth (t test:  $P > 0.05$ , 95% confidence interval of  $b$  value was 2.627-3.179). According to this result, the species grows isometrically in Bayat Pond (Figure 1).



**Figure 1.** The length-weight relationship of *C. tinca* living in Bayat Pond.

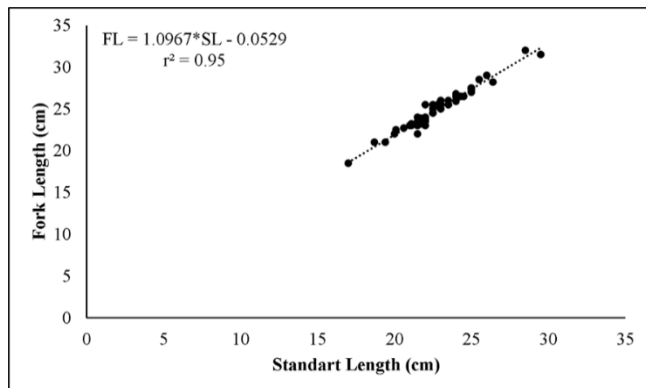
The average condition factor of *C. tinca* was 1.0485. While the minimum condition value in the sample is 0.0859, the maximum condition value is 1.4219. According to the descriptive statistical data of the condition factor, the standard error was calculated as 0.0145 and the standard deviation as 0.1044.

Length-length relationships of the species were subjected to linear regression and the equations and values obtained are presented in Table 2.

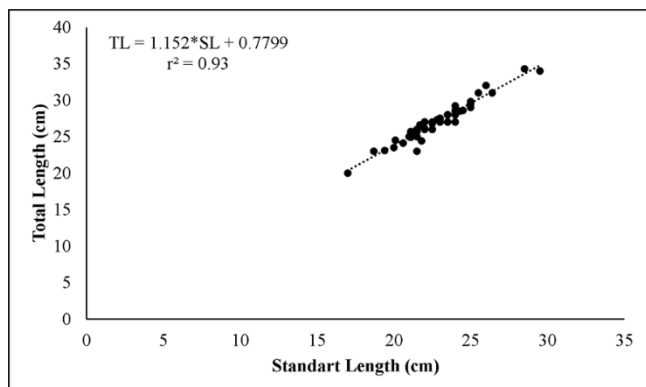
**Table 2.** Length transformations of *C. tinca* population in Bayat Pond.

Equation	a	b	r <sup>2</sup>
TL= a + bFL	1.276	1.033	0.944
TL= a + bSL	0.779	1.152	0.935
FL= a + bSL	-0.053	1.097	0.958

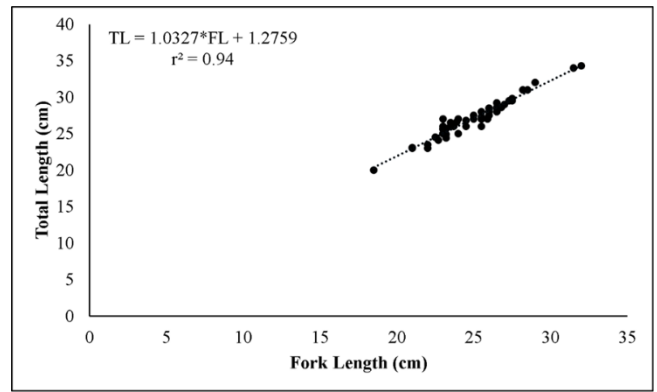
While the strongest relationship was found between fork length and standard length (Figure 2), the lowest relationship was determined between total length and standard length (Figure 3). Strong relationships were also detected between total length and fork length (Figure 4), and there was high agreement between the length types in general.



**Figure 2.** The fork length-standard length relationship of *C. tinca*



**Figure 3.** The total length-standard length relationship of *C. tinca*



**Figure 4.** The total length-fork length relationship of *C. tinca*

## DISCUSSION AND CONCLUSIONS

This study provides length-weight and length-length relations and condition factor values for *C. tinca* living in Bayat Pond.

In fish, weight is related to neck strength. In other words, weight gain in fish is expressed as a neck force. The “a” value in the length-weight relationship equation in fish shows the average condition of the individuals, while the “b” value shows the shape of the fish according to the conditions it is in. This value varies between 2.5 and 3.5 in different species (Erkoyuncu, 1995). On the other hand, it is known that the b value in fish varies between 2 and 4 (Bagenal and Tesch, 1978). In a fish population, if b=3, isometric growth is mentioned, if b value is greater than 3, positive allometric growth is mentioned, and if it is small, negative allometric growth is mentioned (Ricker, 1975; Avşar, 2005). The b value obtained in this study was not statistically different from 3. This result shows that the species has isometric growth in Bayat Pond. The findings obtained from the studies on *C. tinca* are presented in Table 3.

**Table 3.** Length-weight relationship parameters obtained in different studies on *C. tinca*.

References	Location	Sex	a	b	r <sup>2</sup>
Gül and Yılmaz, (2002)	Delice River	C	0.000039	2.811	-
Yılmaz and Polat, (2009)	Çakmak Dam Lake	C	0.0091	3.119	0.98
	Derbent Dam Lake	C	0.0043	3.352	0.97
	Divanbaşı Pond	C	0.0106	3.089	0.99
	Gamlık Stream	C	0.0213	2.828	0.99
	İstavloz Stream	C	0.0212	2.849	0.99
	Kızılırmak River (Samsun)	C	0.0075	3.207	0.99
	Küplüağzı Stream	C	0.0173	2.860	0.98
	Mertırmacı Stream	C	0.0212	2.819	0.97
	Tersakan Stream	C	0.0092	3.136	0.99
	Yakakent Stream	C	0.0434	2.544	0.97
Gaygusuz et al., (2013) *	Porsuk Stream	C	0.009	3.017	0.98
Kahraman et al., (2014) *	Sakarya River	C	0.0408	2.634	0.81
Birecikligil et al., (2016)	Kızılırmak River (Nevşehir)	C	0.017	2.839	0.95
Buhan et al., (2016)	Almus Dam Lake	C	0.0057	3.174	0.98
Zencir and Korkmaz, (2016) *	Sakarya River	C	0.019	2.855	0.95
Emiroğlu et al., (2020)	Seydisuyu and Porsuk Stream	C	-	2.943	0.98
This study	Bayat Pond	C	0.0144	2.903	0.91

C: Combined sex, \*: *Capoeta baliki*

Although the obtained length-weight relationship parameters overlap with many studies in other habitats, there are some differences (Table 3). It is thought that these differences are caused by the number of samples, length-weight distributions, sampling time, size type used and ecological conditions of the environments. As a matter of fact, length-weight relationship parameters in fish are not constant and may vary depending on factors such as nutritional adequacy, feeding rate, gonad development and breeding period (Bagenal and Tesch, 1978). In addition, considering the parameters a, it can be said that the species grows better in Bayat Pond compared to many other habitats.

In this study was found that the average condition factor of *C. tinca* was 1.0485 in Bayat Pond. The average condition factors of this species in other studies were reported as 1.4179 by Gül and Yılmaz (2002) in Delice River, 1.3126 by Dirican and Çilek (2012) in Çamlığöze Dam Lake, 1.1375 by Dirican et al. (2012) in Kılıçkaya Reservoir and 0.96 by Birecikligil et al. (2016) in the Nevşehir region of the Kızılırmak River. Although the condition values of *Capoeta tinca* living in Bayat Pond are lower than the populations of Delice River, Çamlığöze Dam Lake and Kılıçkaya Reservoir, they are higher than their congeners in the Nevşehir region of Kızılırmak River. These differences are natural because the condition factor reflects changes in gonad development and nutritional level in fish (Wootton, 1990) and differs depending on habitat, year, season, age group, sex, sexual maturity, and breeding period (Erkoyuncu, 1995).

In this study, the relations between the different length types of the species were determined, and the conversion between the length types was ensured. When we look at the literature, some studies on the species have presented length conversion equations and high correlation coefficients have been obtained (Birecikligil et al., 2016; Zencir and Korkmaz, 2016; Emiroğlu et al., 2020). The preference of various

length measurements in different studies makes comparisons and interpretation of results difficult. For these reasons, it is very important to present the length conversion equations in the research.

In conclusion, it can be said that *C. tinca* grows isometrically in Bayat Pond and its condition is generally low compared to other habitats. In addition, information about the biology of endemic fish species is very valuable. Because determining effective fishing policies and obtaining information about the future of the species is only possible by correctly determining their biology.

#### Ethics Committee Approval

Ethics committee approval is not required as fish samples are purchased from commercial fishermen. In addition, animal rights and ethical rules were followed in laboratory processes and no experimental application was made.

#### Author Contributions

Laboratory processes and data acquisition: Ö. S.; Calculating from data and designing the article: R. Y; Other: All authors have read and agreed to the published version of manuscript.

#### Conflict of Interest

The authors have no conflicts of interest to declare.

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