Study on the growth parameters of *Capoeta trutta* (Heckel, 1843) in Shour River, Iran

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Abstract

In this study growth characteristics of 815 tuwini (*Capoeta trutta*) in Shour River were investigated during July 2010 through June 2011. The population was composed of 62.94% females and 32.02% males. Sex ratio was 1: 1.96, with significant differences observed at 1:1 (x^2= 150.6; df= 1; p<0.05). The age distribution of this population ranged from <1 to 6 years. The distribution of length and weight was between 95 and 300 mm. The average length, except in <1 year olds, was statistically significant between sexes and average weight in all age groups was statistically significant between sexes (p<0.05). Weight-length relationship was determined as $W=0.0115L^{2.9475}$ (R=0.91) in males and $W=0.0096L^{3.0025}$ (R= 0.88) in females. Von-Bertalanffy growth equation was $L_t= 24.5(1-e^{-0.333(t+2.54)})$ for males and $L_t= 36.4 (1- e^{-0.129(t+4.02)})$ for females. Growth performance index was also estimated as Φ=2.301 in males and Φ=2.223 in females.

Keywords: *Capoeta trutta*, Growth parameters, Shour river, Iran

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Introduction

The *C. trutta* is a cyprinid species native to the Middle East (Iran, Iraq, Syria and Turkey), encompassing much of the Iranian part of Tigiris-Euphrates basin, including most tributaries of Karoun River (Abdoli, 2000; Coad, 2008). This fish has a fusiform body, very small scales, sub-terminal mouth, 3-rows pharyngeal teeth with the formula of 2.3.4 - 4.3.2, and the most recognizable characteristic of this kind of fish is black spots scattered on its body (Abdoli, 2000).

On one hand because of its abundance and on the other hand because of its economical and recreational importance, and also the lack of information on this species due to its specific regional distribution, this species was chosen for the present research. This kind of fish is widely distributed in the south of China, north of India, Turkmenistan, Aral Sea, the Middle East and Anatolia (Alp, 2005) and has 7 species and 3 subspecies in Iran (Poria *et al*., 2014). Compared with other species of Cyprinidea in Western Iran, Many aspects of tuwini biology remain unstudied. Studies conducted In Shour River (South west Iran) (Javaheri *et al*., 2012) and in Meymeh River (Western Iran) (Patimar and Farzi, 2011) provided some information on the biology of this species. Poria *et al*. (2014) studied the reproductive characteristics of *C. trutta* in Gamasyab River, Kermanshah Province in Iran.

According to the IUCN classification, the species is listed in the category "DD" (data deficient). Populations of this species are found in some lakes and rivers of Iraq and Turkey (Coad, 2008), where some studies have been conducted (Polat, 1987; Unlu, 1991; Gul *et al*., 1996, Duman, 2004; Kalkan, 2008; Oymak, 2009).

Length and age-based information including estimates of growth and mortality are the most important life-history characteristics required to assess the status of exploited fish populations and to explore and test alternative fishery management strategies (Megrey, 1989; Charnov, 1993; Campana, 2001).

We hypothesized that the populations of this species inhabiting the Iranian tributaries differ from those of Turkey and Iraq in life history traits. The aim of this study is to determine age and growth characteristics of *C. trutta* population habiting in Shour River. This study has also been important in ensuring a sustainable *C. trutta* fisheries management of the yearly biological parameters.

Materials and methods

A total of 815 *C.trutta* were captured from July 2010 to June 2011 in Shour River. The sampling was carried out using gill-nets with various mesh sizes (12×12, 18×18, 24×24 and 32×32). The stations were located at a latitude of 320017/6 N and longitude of 490512/3 E and 320555/1N and 485904/6 E and 320543/9 N and 485911/6 E for station 1, 2 and 3, respectively (Fig. 1).

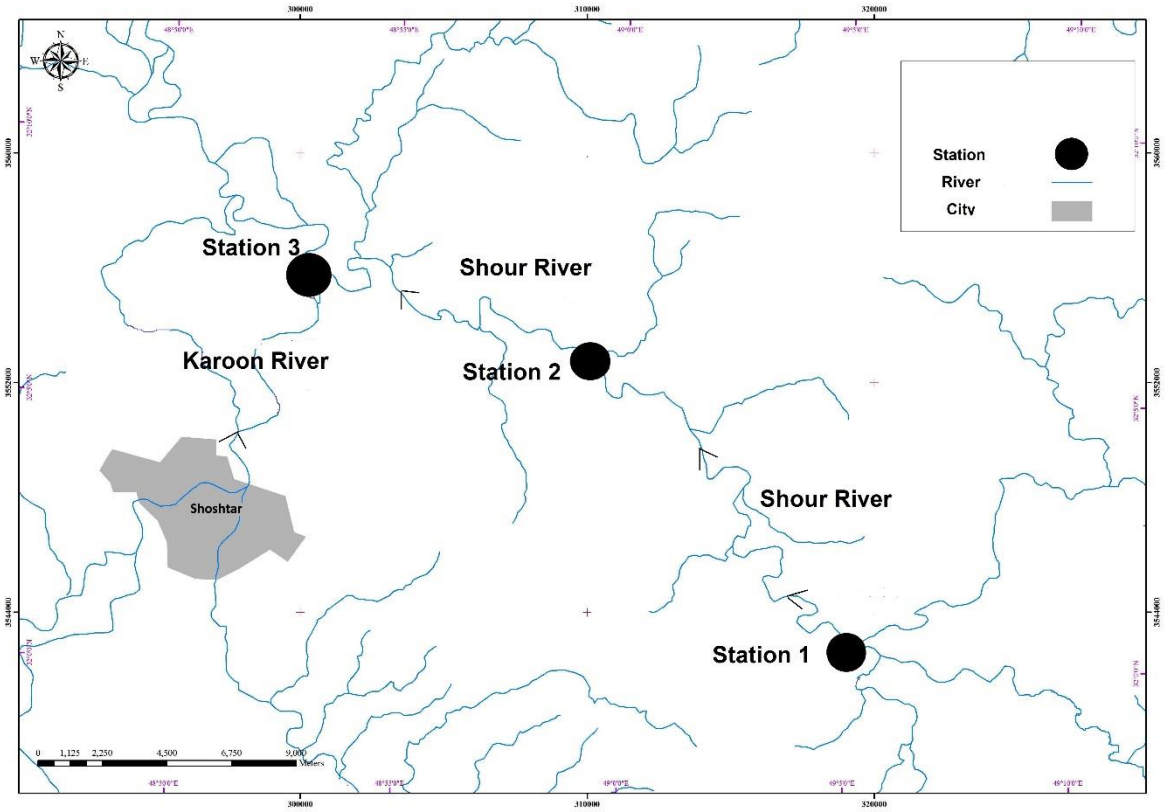

Figure1: Map of stations of studied area.

The *C. trutta* samples were transported to the laboratory in an ice-box and their total length (TL) and weight (TW) were measured to the nearest 1.0 mm and 0.1 g, respectively. After preparing the scales, age reading was then carried out through microscopic examination using circular patterns and annuli number on the scales (Bagenal, 1978; Barber and Walker, 1988; Biswas, 1999). For age determination, scales were taken from above the lateral line, and below the anterior part of dorsal fin. The scales were kept in 5% KOH and then 10 scales from each fish were transferred into 10% ethyl alcohol for 3 min and age determination was carried out under a binocular microscope (Bagenal and Tesch, 1978). Sexes were determined by Examining the gonad tissue, either by eye for larger fish or with the aid of a microscope for smaller fish.

The length-weight relationship were estimated from the formula, $W=a\ L^b$, Where W is total body weight (g), L is the total length (mm). and a and b are coefficients of the functional regression between W and L (Biswass, 1999). To determine the pattern of growth Pauly formula was used: (Froese and Bionhal, 2000).

$$T=\left(\frac{SdlnL}{SdlnW}\times\frac{\text{:b}-3\text{:}}{\sqrt{1}-\text{r2}}\times\sqrt{n-2}\right.$$

Absolute growth rates were calculated with the formulae given by (Ricker, 1979).

Absolute growth rate = (y2 - y1)/ (t2 - t1)

Where y1 and y2 are the respective fish sizes and fish lengths at the time t1 and t2.

The relative growth was determined by the following formula (Biswass, 1999):

$$G=\frac{(LnW2-LnW1)}{T2-T1}$$

Where W_2 and W_1 are the mean weight in grams at age *t*2 and *t*1, respectively, and *t*2 and *t*1 are the ages of the specimens.

The Von Bertalanffy growth equation for males and females were as follows:

$L_t = L_\infty (1\text{-}\exp\{-K[t-t0]\})$ where L_∞ is the average asymptotic total length, K the growth coefficient, which determines how fast the fish approaches L_∞, and t0 the hypothetical age for L (t) =0 mm. Growth was examined as a ratio of length and weight. Growth performance index (Phi-prime index) was computed from the equation $\Phi=2 \log L_\infty+\log K$ (Sparre and Venema, 1992).

Student's t-test was applied to determine the significance of differences between the isometric growth (b= 3) and the estimated b-value of the equation. Statistically significant differences between sexual and age group were tested with Student's t-test. Analysis of variance (ANOVA) was run for all the collected data for fish samples using SPSS (ver.16) computer programs.

Results

Age and length composition

Length and weight frequencies and age distribution of *C.trutta* were observed in the present study (Fig. 2). Age distributions of *C.trutta* species are shown in Fig. 3, although age ranged from 0 to 6 years, 2 and 3 year classes were dominant; the numbers of other year classes were rather low. Fish length in the samples ranged from 95 to 295 mm.

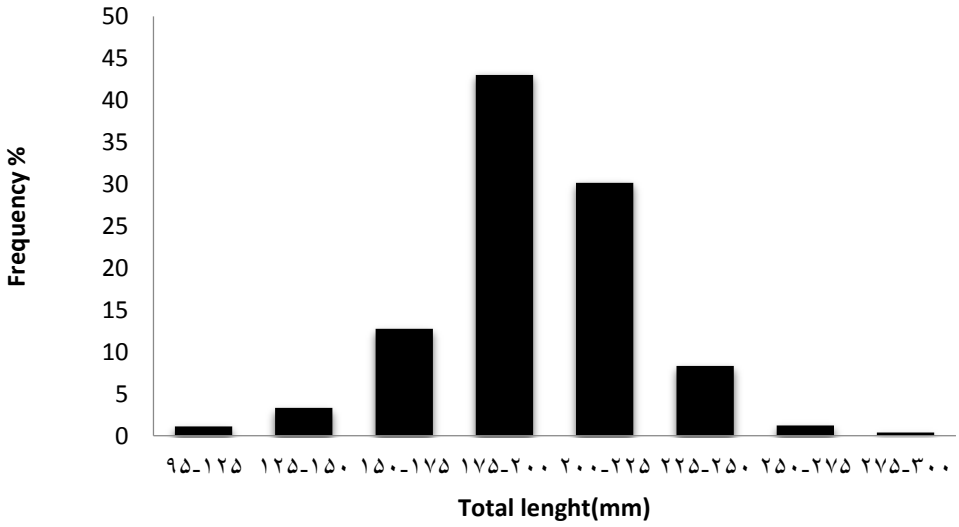

Figure 2: Length frequency distribution of *Capoeta trutta*.

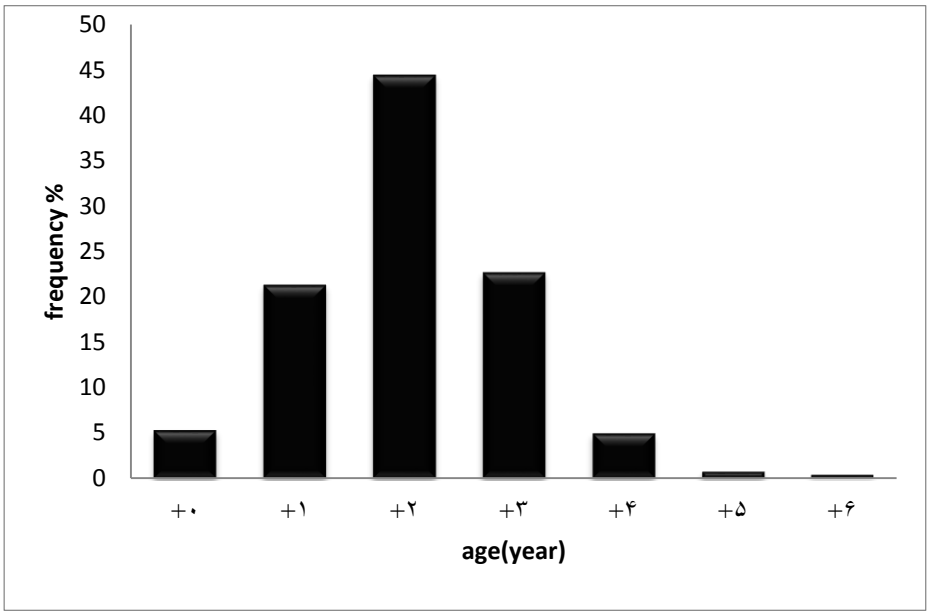

Figure 3: Age distribution of Shour River *Capoeta trutta*.

Growth in length and age-length relationship

The mean length (mm) and yearly increase in length and standard deviation are given in Table 1 and the mean weight and yearly weight increase are given in Table 2. Age-length curves in both sexes are also given in Figs. 4 and 5. Age-length relationship of the species was calculated as Lt=24.5(1-exp {-0.333[t+2.54]}), Lt=36.4 (1-exp {-0.129[t+4.02]}) for males and females (Table 3).

Table1: The length and yearly length increase in both sexes of *Capoeta trutta* (SD: standard deviation, AGRL: Absolute growth rate in length).

Age	Average male TL(mm)± SD	Average female TL(mm)± SD	AGRL in female	AGRL in male
<1	148.06±17.14 [a]	150± 15 [a]		
1	174.27± 13.41 [b]	180± 11.93 [c]	30	26.21
2	193.25±14.36 [d]	199± 13.68 [e]	19	18.98
3	205.84 ±15.08 [f]	216.45±16.02 [g]	17.45	12.59
4	217.5± 16.20 [i]	232.7±13.88 [j]	16.25	11.66
5	-	251.66±15.88	18.96	-
6	236	278±14.84	26.34	

Data with different letters are significantly different (p<0.05)

Growth in weight and length-weight relationship

The weight of males and females samples ranged 21 from 122 and 32 from 266 g, respectively. Females were heavier and larger than males in all age groups. Table 2 shows the maximum annual increase between the ages <1 and 1 year in males, and between 5 and 6 years in females.

Table 2: The weight and yearly weight increase in both sexes of *Capoeta trutta* (SD: standard deviation, AGRW: Absolute growth rate in weight).

Age	Average male TW(g) ± SD	Average female TW(g) ± SD	AGRW in female	AGRW in male
<1	35.15±9 [a]	39±19.89[a]		
1	53.51±12.99 [c]	59.46±12.41[b]	36.18	**46.20**
2	68.52±15.07 [e]	78.20± 16.06[f]	15.01	**47.18**
3	86.01±17.97 [g]	90.36 ±20.62[h]	49.17	**12.16**
4	98.62±17.78[i]	120.6 ±21.79[j]	12.61	**24.30**
5	-	148.4 ±23.15	-	**8.27**
6	122	227.5±54.44	-	**7.91**

The small Latin letters show that there are significant differences at $p<0.05$.

Table 3: Von Bertalanffy growth parameters (L_∞, K and t0) and performance index (ø)' for *Capoeta trutta*.

L∞ (cm)	K (yr $^{-1)}$	t0 (yr)	ø'	sex
36.4	0.129	-4.02	2.233	Female
24.5	0.333	-2.54	2.301	male

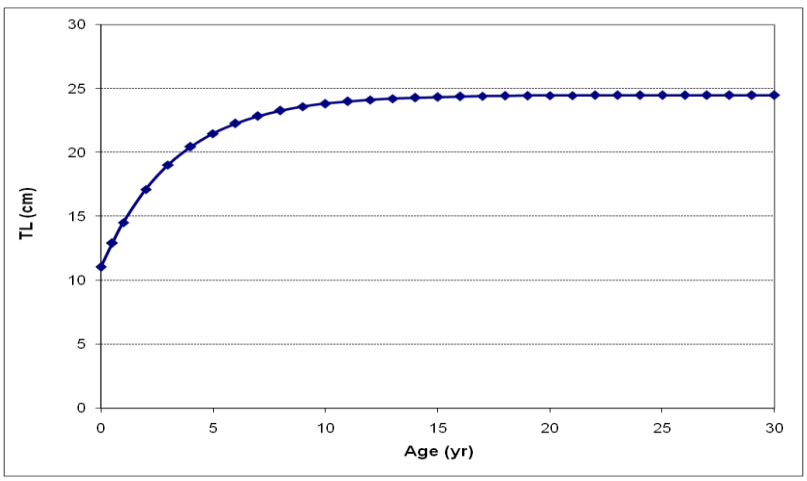

Figure 4: Von Bertalanffy growth curves in male of Shour River *Capoeta trutta.*

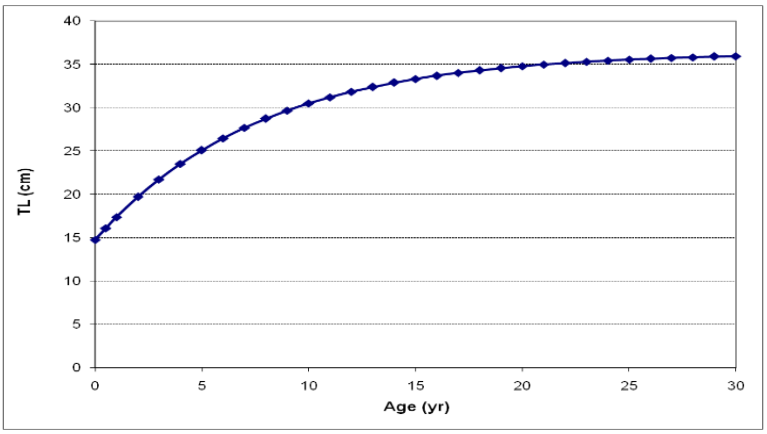

Figure 5: Von Bertalanffy growth curves in female of Shour River *Capoeta trutta.*

Length-weight relationship was calculated as $W=0.0115L^{2.9475}$ in males and $W=0.0096L^{3.0025}$ in females (Figs. 6,7).

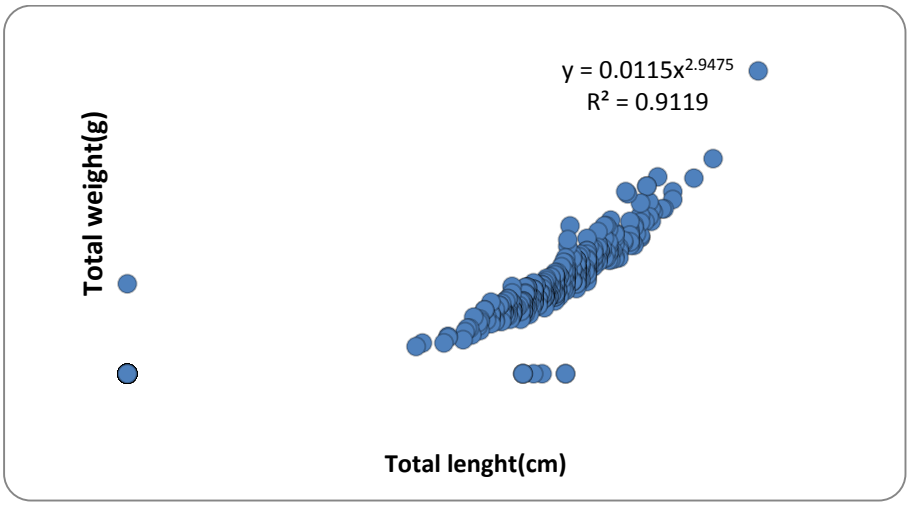

Figure 6: Length-weight relation in Female of Shour River *Capoeta trutta.*

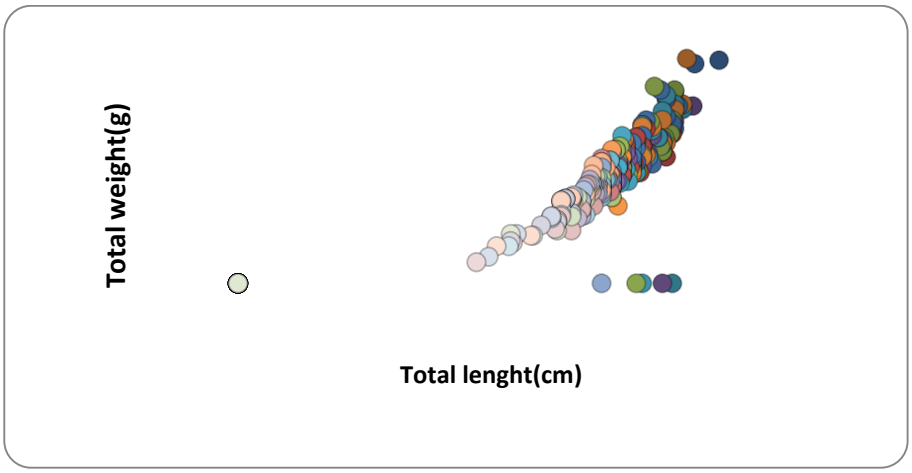

Figure 7: Length-weight relation in male of Shour River *Capoeta trutta.*

Relative growth rate (RGR)

As seen in Fig. 8, the relative growth rate decreases in older fish and maximum RGR was observed in 1 year olds.

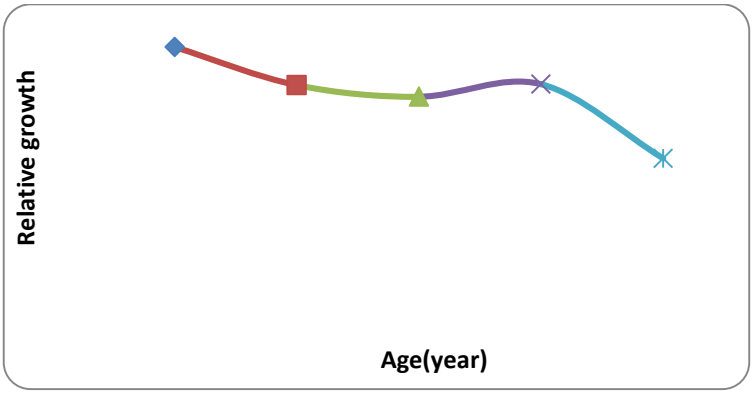

Figure 8: Relative growth of Shour River *Capoeta trutta.*

Discussion

Age composition of *C. trutta* in the present study was determined as <1-6 years. The age composition was determined by several studies; Unlu (1991) 1-6, Polat (1987) 1-7, Gül et al. (1996) 1-6 and Kalkan (2008) 0-7. As it can be seen in Fig. 3, individuals at the age of two years were dominant in the population and numbers of fish reduced in all the other age classes. These results are in agreement with those of Kockman *et al*. (2002), Unlu (1991), while they disagree with the findings of Kalkan (2008). The differences among the age distribution values may be related to the kind of nets or mesh-size of the nets or may be explained as an adaptive response to the different ecological conditions of the study areas.

In all ages, except in the <1 year olds, the females were longer than males and mean length between females and males in all age groups, except in the <1 year olds, were statistically significant (p<0.05). The maximum absolute growth rate in length observed in 1 year olds in both sexes was similar to that reported by Kalkan (2008) in Karayaka Dam Lake in Turkey. The mean weight between females and males in all age groups were statistically significant (p<0.05) and females were heavier than males in all age groups. The maximum absolute growth rate in weight in males was in the <1 year olds , and in females in the 6 year olds, but Kalkan (2008) reported the maximum absolute growth rate in weight in 4 year olds in both sexes. The differences among the studies could be due to the variations of sampling methods, sampling time and the number of specimens in the area of study (Aydin and Karadurmus, 2013). The maximum increase in relative length and maximum yearly growth increase was between the age groups <1 and 1. These findings are similar to those of Kalkan (2008). Growth parameters

showed differences in terms of species, population and age groups.

In the present study, the exponent (b) in the length-weight relationship was b=2.9475 for females and b=3.0025 for males, that T test indicated that the pattern growth of *C.trutta* was isometric in both sexes. The exponent (b) values of the *C. trutta* population are given in Table 4, in comparison with (b) values estimated in the present study. The exponent (b) in this table ranged from 2.68 to 3.24 and our results are between the same range. The variation in the exponents (b) may have resulted from the different stages in the ontogenetic development and differences in ecologic factors, nutrition level, age, maturity, sex and species. The value of $L\infty$ in females was higher than that in males.

Sex ratio of a certain population is one of the most important parameters for population ecological studies. In this study sex ratio was 1: 1.96 that was in accordance with results of Sen *et al*. (2008) but different with results obtained by Kalkan (2008). In general, the sex ratio of reproductive-aged fishes is known to vary with the age and size at which fish begin to participate in breeding, resistance to physical environmental stress in each sex, water temperature and/or pH during the sex determination period, population density, and other factors (Cao *et al*., 2009).

Kalkan (2008) noted a similar situation (Table 4) which might be due to differences in their growth rates. The theoretical maximal length values were close to the size of the largest fish examined. Growth coefficient values (K = 0.333 per year for males and 0.129 per year for females) indicated relatively low attainment of maximal size. These parameters are not similar to those reported by Kalkan (2008) (Table 4). The differences in parameters may have resulted from differences in the ecological conditions, such as water temperature and food abundance. As seen in Table 4 phi-prime index obtained in the present study agreed with those reported by previous authors as being 2.33 and 2.28 in males and females, respectively. Ecological differences can be effective on growth parameters that in turn affect phi-prime index (Emre *et al*., 2010).

Table 4: Some parameters age, growth, length-weight relationships of the different *Capoeta* species from different regions in world.

Reference	Species	Age (yr)	Ǿ	a	B	t0 (yr^{-1})	K (yr^{-1})	L∞ (cm)	Sex
Kalkan (2008)	*C.trutta*	1-7	2.67	0.0115	3.032	-2.41	0.0571	89.5	Female
		0-7	2.54	0.0116	2.932	-2.65	0.0604	76.4	male
Abdoli *et al*. (2008)	*C.c.capoeta*	0-3	2.39	- -	3.052	0.742	0.472	23	Female
		0-3	2.18		3.050	-1	0.462	19	male
Ahmet *et al*. (2005)	*C.c.angora*	1-10	2.59	0.0242	2.8067	-0.598	0.101	62.25	Female
		1-7	2.47	0.0348	2.6811	-0.761	0.133	47.25	male
Demirci and Ozdilek (2010)	*C.capoeta*	0-4	2.51	0.005	3.24	-0.92	0.44	27.3	Female + male
Korkmaz *et al*. (1999)	*C.c.umbla*	0-5	2.40	- -	3.039	-0.536	0.163	44.33	Female
		0-5	2.47		2.99	-0.562	0.166	42.55	male
Turkman *et al*. (2002)	*C.c.umbla*	1-12	2.47	0.0139	2.93	-0.83	0.146	45.7	Female
		1-10	2.39	0.0117	2.99	-0.98	0.139	42.3	male
Present study	*C.trutta*	0-6	2.233	0.0132	3.0025	-4.02	0.129	36.4	Female
		0-5	2.28	0.0108	2.9	-2.54	0.333	24.5	male

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