

Population structure, growth and reproduction properties of barbel (*Barbus plebejus* Bonaparte, 1832) living in Çığlı stream, Van, Turkey

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Abstract

This study was carried out to determine population structure, growth and reproduction properties of barbel. A total of 198 individuals were sampled. Ages of samples were found between I and VI years, fork lengths between 4.3 and 16.6 cm and total weights between 1.2 and 65.8 g. Length-weight relationship was calculated as $W=0.0146 \times L^{2.934}$. Munro's phi prime index was estimated as 1.95, L_{∞} as 26.42 cm W_{∞} as 216.92 g, and condition factor as 1.265 ± 0.01 . First sexual maturation was determined in 6.0-6.9 cm-group males, and second sexual maturity was recorded in 10.0-10.9 cm-group females. Individual fecundity was defined between 568 and 4171 eggs/female and relative fecundity was calculated as 64964.55 ± 5855.49 eggs/kg female. Barbel did not show good growth and reproduction performance in the stream, because of fishing pressure.

Keywords: Barbel, Growth, Population structure, Reproduction, Çığlı stream

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Introduction

Çığlı stream is also known as Zapbaşı stream. The altitude of study areas is between 1950 and 2100 m. Çığlı stream is a tributary of Zab River which is a main branch of Tigris. The sources of the stream are mountains near the Turkey and Iran border and leaves Turkey from Çukurca. The length in Turkey is 189 km and it flows into Tigris at about 40 km to Southern Musul (Bakış, 2007). Three dams are planned on the Çığlı stream, and the construction of one has begun. Except for these dams, there are historical constructions on the Çığlı stream that were constituted in the VII-VIII century B.C. by Urartian (Belli, 2005; Bildirici, 2008).

Barbel species prefer sandy and pebbly bottoms and with flowing, clean, cold and high oxygen content water. Barbel is disturbed from east Asia to western Europe and some parts of Africa and in many of the catchment areas of Turkey (Karaman, 1971; Kuru, 1975; Karataş and Akyurt, 1997; Yıldırım *et al.*, 2001; Geldiay and Balık, 2002; Elp *et al.*, 2006a; Elp *et al.*, 2006b). For sustainable fisheries, natural resources should be protected. Therefore, the resources shall be investigated and managed based on scientific foundation. An investigation on barbell in the Çığlı stream was not carried out before. It is hoped that this study can make a contribution to knowledge on population structure, growth, and reproduction of this population.

Materials and methods

This study was carried out in Çığlı stream and its tributary. The region in which fieldwork was conducted is in coordinates between 38°10'58.51" N-44° 15'09.89" E and 37° 59'56.371" N-44° 06'48.53" E. Its altitude is between 1939 m and 2080 m. The distance of the study area from the Turkey-Iran Border is about to 12 km (Fig. 1). The species, belonging to *Cyprinidae* family, is known as “*biyikli balik*” in Turkey. Fish samples were caught monthly with electroshock and hand nets in the stream and its tributary. Field work of the study was conducted between April 2008 and July 2009. Totally 198 fish were sampled, sex was determined in 196 individuals and age was determined in 161 fish. Sex could not be determined on two samples because of crushing during transporting of fish. In the measurement of length, fork length (FL) was used. Total (W) and gonad (G_w) weights measurements were carried out in fresh caught fish. Samples were weighted as soon as they were taken from the water.

The age (determined from scales), length and weight composition of the population was determined. In estimation relationships of the length-weight, the formula of $W=a \times FL^b$, of the age-length, the formula of $L_t=L_{\infty} \times (1-e^{-K(t-t_0)})$, of the age-length, the formula of $W_t=W_{\infty} \times (1-e^{-K(t-t_0)})^b$, (Çetinkaya *et al.*, 2005) and growth performance index, the formula of $\phi' = \text{Log } K + 2 \times \text{Log } L_{\infty}$ (Pauly and Munro, 1984) were used.

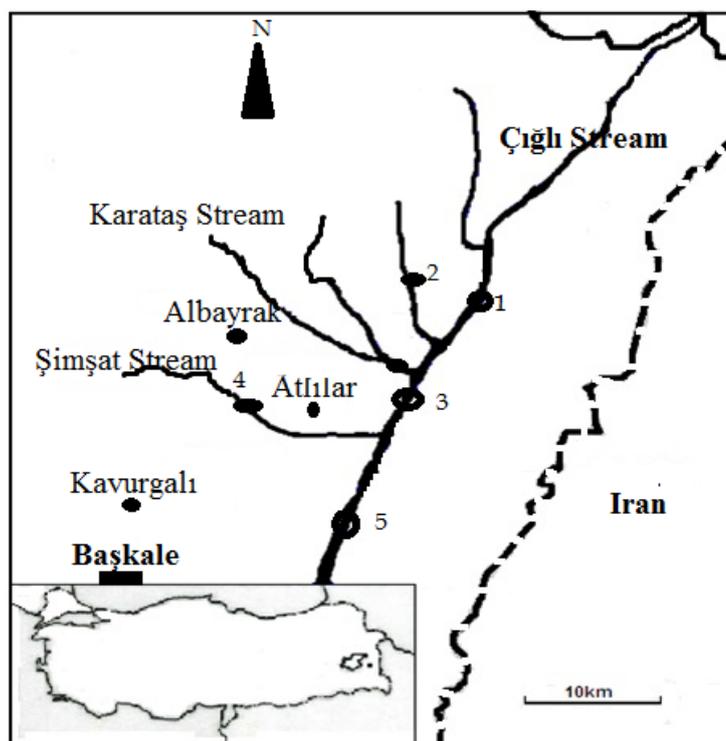


Figure 1: Çiğli Stream and sampling points (1-5) (Its coordinates are between 38°10'58.51" N-44°15'09.89" E and 37°59'56.371" N-44°06'48.53" E).

“K” and “ L_{∞} ” values in the formulae are estimated from “a” and “b” constants obtained from regression ($K = \log_e (1/b)$ and $L_{\infty} = a/(1-b)$). The formula $CF = (W/FL^3) \times 100$ was used in calculating the condition factor (CF) (Çetinkaya *et al.*, 2005). Age determination was made using scales (Türkmen *et al.*, 2005). Sex was determined by examining the gonads. First spawning age, length and weight of samples were determined according to gonad maturity of their gonads. Determination of spawning season was attempted by field observations and Gonad somatic index ($GSI = G_w/W \times 100$) values. Individual and relative fecundities were determined. In IV, (matured stage) and V (spawning stage)

stage eggs, in which maturity stage was determined according to Nikolsky (1963), and eggs were counted by gravimetric method (Nikolsky, 1963; Bagenal and Braum, 1978; Karataş *et al.*, 2005).

Population parameters in this study such as mean, standard error mean (SE) and other estimations were made by common statistical methods (Yıldız *et al.*, 2011).

Results

Population structure of Çiğli stream barbel population

Age of the samples was found between I and VI years. While maximum age of males was IV years, in the females, it was found to be VI years. Male and

females at 0+ ages couldn't catch. According to age groups, all samples (41.61%) and males (63.09%) were concentrated in second ages, but females were in third ages (48.65%).

According to 1 cm length groups, while males accumulated in the 8.0-8.9 cm group (30.25%), females were in 11.0-11.9 cm group (23.68%) and all samples concentrated in three groups that were in 9.0-9.9 cm group (21.21%), in 10.0-10.9 cm group (20.71%), and 8.0-8.9 cm group (18.69%).

According to 5 g weight groups, males concentrated in the 0.0-4.9 g group (59.17%) and 5.0-9.9 g group (38.33%), females in and 5.0-9.9 g group (36.84%) and 10.0-14.9 g group (31.58%), and all fish belonged to the 0.0-4.9 g group (39.39%) and 5.0-9.9 g group (37.88%).

Growth properties in Çığlı barbel population

Fork length and total weight values of samples were determined according to age and sex; the smallest individual sampled was 4.3 cm and 1.2 g, and the largest individual found was 16.6 cm and 65.8 g (Tables 1 and 2).

Length-weight, Von Bertalanffy Growth Equations (age-length and age-weight relationships), and growth performance index (\emptyset') were calculated in males, females and all samples (Table 3 and 4).

Average \pm SE (minimum-maximum) condition factor values were calculated as 1.260 \pm 0.008 (0.954-1.632) in overall samples, as 1.254 \pm 0.011 (0.954-1.632) in males and as 1.260 \pm 0.010 (1.041-

1.585) in females.

Reproduction properties of Çığlı stream barbel population

119 samples (60.71%) were male, 76 samples (38.78%) were female and also 1 individual (0.51%) was a juvenile. The male:female ratio was calculated as 1.566:1.

Sexual maturity of barbel sampled from Çığlı stream was observed according to age, fork length and total weight of samples. According to age, matured males were firstly seen in stage I age group (83.33%) and matured females was seen in stage II age group (75.00%), with regard to 1 cm fork length, matured males were firstly in the 6.0-6.9 cm group (100.00%) and matured females were in the 10.0-10.9 cm group (76.92%), and in accordance with 5 g total weight, matured males were firstly found in the 0.0-4.9 g group and matured females in the 15.0-19.9 g group as 100 %both of them.

The GSI values calculated were maximum in the second half of May in males (10.03 \pm 0.87), and in females (7.02 \pm 0.53), and determined as minimum in the end of August in both sexes (1.88 \pm 0.41 in males and 1.71 \pm 0.64 in females). The findings of GSI values and field observations showed that spawning took place intensively from the second half of May to the end of August (Fig. 2).

Table 1: According age and sex, fork lengths of barbel living in Çıgılı stream (cm).

Age	Male		Female		All samples	
	N	FL±SE (min-max)	n	FL±SE (min-max)	N	FL±SE (min-max)
I	12	7.79±0.23 (6.4-9.0)	6	6.80±0.17 (6.0-7.1)	19	7.30±0.25 (4.3-9.0)
II	53	9.45±0.14 (7.0-11.4)	12	10.83±0.38 (8.8-12.4)	67	9.72±0.14 (7.0-12.4)
III	18	10.80±0.21 (9.2-12.1)	36	11.57±0.19 (9.2-14.5)	54	11.31±0.15 (9.20-14.5)
IV	1	12.10	12	13.36±0.44 (10.1-15.3)	13	13.26±0.42 (10.10-15.3)
V			7	15.51±0.38 (14.0-16.6)	7	15.51±0.38 (14.0-16.6)
VI			1	16.30	1	16.30
Total	84	9.54±0.15 (6.4-12.1)	74	11.79±0.27 (6.0-16.6)	161	10.55±0.18 (4.3-16.6)

Table 2: According to age and sex, total weight of barbel living in Çıgılı stream (g).

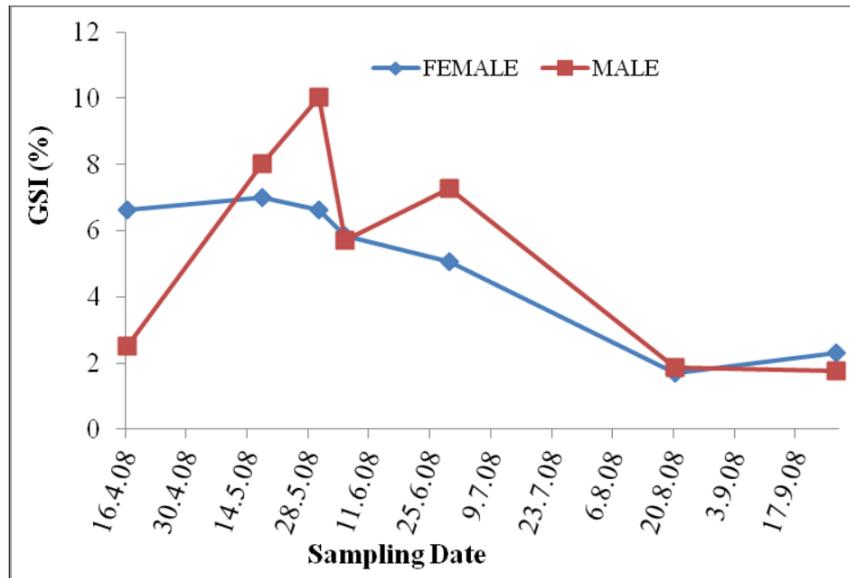
Age	Male		Female		All samples	
	N	W±SE (min-max)	n	W±SE (min-max)	N	W±SE (min-max)
I	12	6.58±0.70 (3.1-10.9)	6	3.88±0.23 (2.8-4.4)	19	5.45±0.58 (1.2-10.9)
II	53	10.95±0.46 (4.0-19.4)	12	17.12±1.59 (10.3-25.5)	67	12.11±0.54 (4.0-25.5)
III	18	15.89±0.90 (8.6-22.0)	36	19.93±0.98 (10.8-36.6)	54	18.58±0.76 (8.6-36.6)
IV	1	22.10	12	31.13±2.70 (12.1-45.8)	13	30.43±2.58 (12.1-45.8)
V			7	46.44±3.86 (35.4-65.8)	7	46.44±3.86 (35.4-65.8)
VI			1	47.00	1	47.00
Total	84	11.51±0.49 (3.1-22.1)	74	22.86±1.44 (2.8-65.8)	161	16.68±0.84 (1.2-65.8)

Table 3: Length-weight relationship in barbel population of Çıgılı stream.

Sex	r^2				Equations
Male	119	0.016	2.887	0.943	$W=0.016 \times L^{2.887}$ (LogW= -1.794+2.887×LogL)
Female	76	0.015	2.936	0.978	$W=0.015 \times L^{2.936}$ (LogW= -1.833+2.936×LogL)
All samples	198	0.015	2.934	0.976	$W=0.015 \times L^{2.934}$ (LogW= -1.836+2.934×LogL)

Table 4: Von Bertalanffy equations and growth performance index (Θ') of barbel population in Çığlı stream.

Sex	L_{∞}	W_{∞}	K	t_0	Θ'	Von Bertalanffy Equations
Male	21.24	109.22	0.13	-2.51	1.76	$L_t=21.24x(1-e^{-0.13(t+2.51)})$ $W_t=109.22 x (1-e^{-0.13(t+2.51)})^{2.887}$
Female	17.56	66.26	0.38	0.01	2.06	$L_t=17.56x(1-e^{-0.38(t+0.01)})$ $W_t= 66.26 x(1-e^{-0.38(t+0.01)})^{2.936}$
All samples	26.42	216.92	0.13	-1.46	1.95	$L_t=26.42x(1-e^{-0.13(t+1.46)})$ $W_t= 216.92 x(1-e^{-0.13(t+1.46)})^{2.934}$

**Figure 2: GSI values in barbel population in Çığlı stream.**

Eggs were counted in 11 adult samples and individual fecundity per female was found to be between 568 and 4171, and average individual fecundity was calculated as 1996.18 ± 309.20 per female. Relative fecundity was calculated between 38378 and 89669 eggs/kg female barbels, and average fecundity was estimated as 64964.55 ± 5855.49 eggs/kg female.

Discussion

Çığlı stream is one of the main tributaries of the Tigris which is one of Turkey's largest rivers and it has a very

high potential for electricity generation (Bakış, 2007) and also for fisheries. It was also recognized for its potential by Urartian 3000 years ago and they have made many channels and dams for drinking and irrigation on Çığlı stream (Belli, 2005; Bildirici, 2008).

It was shown that the overall samples consisted of small individuals. The reason for this may be fast flowing water, and there is no meander for fish to take cover and nutrients are very poor. Also, intensive fishing was seen in sampling areas. The samples have a maximum age of IV years, 16.6 cm fork

length and 65.8 g total weight. These values are very low in other studies (Yıldırım *et al.*, 2001; Geldiay and Balık, 2002; Karataş and Can, 2005; Elp *et al.*, 2006a). Because individuals of barbel population living in Çığlı stream are very small in size and younger, we believe that the population is not a healthy and sustainable population. Additionally, the growth performance index is lower (1.95) than in other studies (2.71 in Karataş and Can, 2005; 2.535 in Elp *et al.*, 2006a)

The b value was reported as 2.843 in males and 2.911 in females in Oltu stream (Yıldırım *et al.*, 2001), 2.60 in Almus dam lake (Karataş and Can, 2005), and 2.934 in Koçköprü dam lake (Elp *et al.*, 2006a). In this study, it was calculated as 2.934 and the value is similar to other values. According to the b value in Çığlı stream population, growth in the population is isometric. The b value may be used as an indicator of food intake and growth regime and many differ according to some biotic and abiotic factors like water temperature, food availability and habitat type (Wootton, 1992).

Condition coefficient was calculated as 1.260 ± 0.008 and the values changed between 0.954 and 1.632. Variations in the coefficient may change within same species, age, season, sexual maturity, spawning season, feeding condition and environment. In other studies, the values were reported as 1.221 (Yıldırım *et al.*, 2001) and 1.242 (Elp *et al.*, 2006a).

The male:female ratio was calculated as 1.566:1 (males 60.71% and females

38.78%). The males were found to be dominant. In most species, sex ratio is close to 1:1, but this situation may vary from species to species. It also may differ from one population to another in the same species. It also may change from year to year in the same population (Nikolsky, 1963). It was reported that males were dominant in Oltu stream at 1.824:1 (Yıldırım *et al.*, 2001) and female was dominant in Koçköprü dam lake at 0.61:1 (Elp *et al.*, 2006b) and in Almus dam lake at 1:1.83 (Karataş and Akyurt, 1997; Karataş and Can 2005).

First sexual maturation was observed in the 6.0-6.9 cm group in males and second sexual maturity was in the 10.0-10.9 cm group in females in this study. Females of barbel in Çığlı stream that matured were smaller than that in other studies. It was reported as 1st age, 7.0-7.9 cm in males; 2nd age, 15.0-15.9 cm group in females from Koçköprü dam lake (Elp *et al.*, 2006b), as 2nd or 3rd age, 11.45-13.76 cm in males; 3rd or 4th age, 13.65-15.95 cm group in females from Oltu stream (Yıldırım *et al.*, 2001), and as 2nd or 3rd age, 19.21 cm in males and 19.73 cm in females from Almus dam lake (Karataş and Akyurt, 1997).

Spawning took place intensively from the second half of May to the end of August. Spawning season was reported between May and July by Yıldırım *et al.* (2001), between April and July by Karataş and Akyurt (1997), and between June and August by in Elp *et al.* (2006b).

It is evident that barbel does not have

good growth performance in Çıgılı stream, because of fishing pressure, fast flowing and no meander for fish to take cover. So, barbel in the stream could be endangered. Therefore, fishing should be prohibited between April and August and minimum fishing size should be 14 cm fork length and 32 g total weight.

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