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A Study of the Some Growth Parameters of Barbel (*Barbus plebejus ercisianus*, Karaman, 1971) Living in the Koçköprü Dam Lake Basin-Turkey

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Abstract: This study was carried out to determine some growth parameters of barbel populations living in the Koçköprü Dam Lake and its inlets between April 2000 and October 2001. The barbel species are shown a widespread distribution in Turkey. The species is native in study area, has economic value and is fished local fishermen. A total of 324 individuals were sampled. The maximum age of individuals was determined as VII, fork length was 33.8 cm and weight was 428.0 g. Females were found larger than males in size. Condition factor values were determined as 1.210 ± 0.009 for males, 1.266 ± 0.017 for females and 1.293 ± 0.030 for juveniles. In overall, condition factor of females was higher than males. Length-weight relationship was determined for whole samples as $\log W = -1.841 + 2.934 \log L$.

Key words: Koçköprü Dam Lake, barbel, age, growth, condition factor

INTRODUCTION

Barbel species generally prefer running water with a sandy-gravelly bottom and they are occasionally seen in clean still water. They particularly like cold water and are seen in the oxygen-rich upper reaches of streams. In the spawning season, they can be seen separately, but in their feeding period they go around in large groups (Geldiay and Balık, 1996)

Barbus plebejus is distributed in many of the catchment areas of Turkey (Karaman, 1971; Geldiay and Balık, 1973, 1975, 1988, 1985, Kuru 1975; Erk'akan and Kuru, 1982; Erdemli and Kalkan, 1996; Barlas *et al.*, 2000). The species prefers the shallow areas of streams (Geldiay and Balık, 1973). Various studies have been carried out in Turkey on the species bio-ecology (Erk'akan and Akgül, 1986; Solak 1989; Baysal and Kutrup, 1990, 1994; Ekmekçi, 1990; Ünlü *et al.*, 1990; Bircan and Ergün, 1997)

In a study carried out in the Koçköprü Dam Lake (KDL) in 1992 to determine the species which could be fished, only the subspecies *C. capoeta umbra* was reported (Anonymous, 2000a). In that study, *Chalcalburnus tarichi* and *Barbus plebejus* were not mentioned. Maybe missed due to gear selectivity. However, *B. plebejus* is fished commercially in the KDL.

B. plebejus, *C. tarichi*, *C. capoeta* and *N. angorae angorae* show a natural distribution in the Zilan river upon which the KDL is built. In 1992, *C. carpio* and *O. mykiss* were introduced into the reservoir (Anonymous, 2000a).

Only one systematic study had been carried out on *B. plebejus*, which shows a natural distribution in the Zilan River, when KDL is not built (Karaman, 1971; Kuru, 1975) and no studies of population's characteristics were encountered. The present study describes the growth of the species in the habitat. It is hoped that these data can make a contribution to knowledge of growth and population management

MATERIALS AND METHODS

This study was carried out in the KDL and its inlets between April 2000 and October 2001. The KDL was built on the Zilan River in the Lake Van catchment area in Turkey's East Anatolian region. It was built for irrigation and electricity production, but commercial fishing is also carried on there. The dam has an estimated surface area when full of 6.15 km², a storage capacity of 86 hm³. It is 48.5 m deep at its deepest point. Altitude is 1778.50 m at maximum water level. It is fed by the Zilan river (Hacidiri Suyu) and the Ilica (Incesu), Kömürcü and Kündük streams and by rainwater and snowmelt (Anonymous, 2000b).

Samples of *B. plebejus* were caught from the reservoir and streams (Fig. 1). This fish, which is from the *Cyprinidae* family, is known in Turkey as biyikli balik and barbus and regionally as kaya balığı. In the Lake Van basin, it has been reported only in the Ercis area (Karaman, 1971; Kuru, 1975).

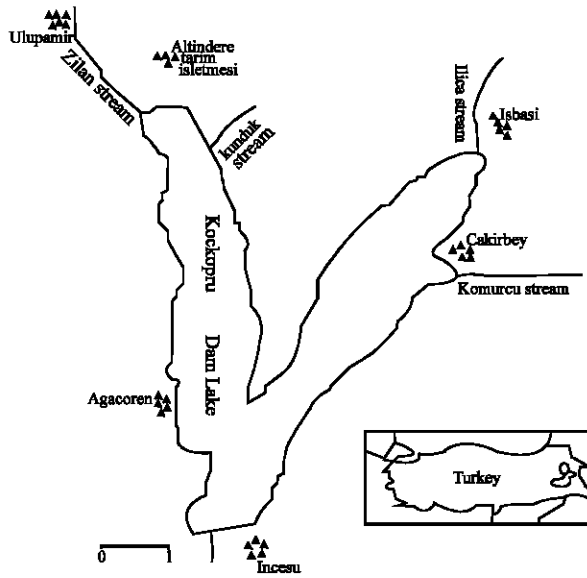


Fig. 1: Koçköprü Dam Lake, its inlets and sampling points

Research was conducted between April 2000 and October 2001. Sampling was carried out monthly using 15-18 mm mesh hand nets and 1.5 kW h electroshock equipment in running water and 25-35 mm mesh size 1.8 m high polyfilament trammel nets and beach seine nets with 30 m arms and a cod-end bag of 12 mm mesh size in the lake. In the measurement of length, fork length was used (Geldiay and Balık, 1996). Weight measurements were carried out fresh caught fish (Çetinkaya *et al.*, 2005). Age determination was made using scales (Gümüş and Polat, 1999). In estimation the length-weight relationship, the allometric growth model equation proposed by Le Cren $W = \log a + b \log L$ was used. The formula $K = (W/L^3) \times 100$ was used in calculating the condition factor (Busacker *et al.*, 1990, Çetinkaya *et al.*, 2005). Sex was determined by examining the gonads. Statistical analyses were made by common statistical methods (Yıldız and Bircan, 1994).

RESULTS

Age was determined in 204 *B. plebejus* individuals. The maximum age for males was found to be three and for females seven. Among females, only one individual of age seven was observed and no individuals aged five or six were found. The majority of individuals in the sample were found to be in the first year age group.

In 324 individuals whose sex was determined and whose length was measured, fork length varied between 2.4 and 33.8 cm. When they were grouped into 1 cm bands, it was observed that the largest group (10.8%) was in the 13-13.9 cm range. When length frequency was examined in relation to sex, it was determined that the largest group

of males (10.8%) was in the 13-13.9 cm range and of females in the ranges 8-8.9 cm and 23-23.9 cm (3.1%).

It was determined that the weight of individuals sampled varied from 0.1 to 428.0 g. Grouping by 10 g bands showed that the majority of individuals (29.5%) fell into the 0-9.9 g weight range. When weight frequency was examined in relation to sex, it was observed that males varied from 4.6 to 119.7 g, with the greatest proportion of individuals (17.4%) in the 20-29.9 g range. Females varied from 3.9 to 428 g and the largest weight grouping (7.5%) was in the 0-9.9 g range.

When fork length values were examined in relation to age and sexes separately, it was calculated that first-year males and third-year females were larger and the difference between them was statistically significant ($p < 0.05$). Growth differences between the sexes was examined in the sample overall and it was determined that female individuals were larger than males ($p < 0.05$) (Table 1).

When weight was examined in relation to sex and age, it was calculated that first-year males and second and third-year females were heavier ($p < 0.05$). In analysis of the sample overall, it was observed that females were heavier ($p < 0.05$) (Table 2).

Von Bertalanffy growth constants were found to be $L_{\infty} = 50.690$, $\varnothing = 2.535$ in the sample overall. Proportional growth of length and weight was calculated in relation to sex and it was determined that females grew faster than males.

Condition factor in the overall sample was calculated as 1.242 ± 0.009 . Condition factor reached a peak (1.365 ± 0.101) in the second half of October and declined its lowest point (0.906 ± 0.065) in May. Condition factor for males was found to be 1.210 ± 0.009 (0.944-1.644), for females 1.266 ± 0.017 (0.926-1.882) and for juveniles 1.293 ± 0.030 (0.790-2.226) (Table 3).

Condition factor was higher for females than for males. This difference between the sexes was found to be significant ($p < 0.05$) in the sample overall and in the first-year age group (Table 4).

Length-weight relationship in the population was examined in relation to season and sex. Results showed that the "b" constant reached its highest value (3.289) in spring 2001, but all individuals sampled were juveniles. The highest value for males (2.846) was in autumn 2000 and for females (2.994) in spring 2000 (Table 5).

C. carpio, *C. capoeta*, *C. tarichi* and *B. plebejus ercisianus* are fished commercially in the KDL using 15-70 mm mesh trammel nets. Fishing is carried on between September and April. In spring, fishing is concentrated in the mouths of the streams, the other months fishing is separate all part of the dame lake. In spring and summer, sport fishing takes place on the reservoir.

Table 1: Fork length values of barbel in relation to age and sex (cm) in KDL and its inlets

Age	Male		Female		p = 0.05	Juvenile		General	
	n	L±SE (min-max)	n	L±SE (min-max)		n	L±SE (min-max)	N	L±SE (min-max)
0						7	3.87±0.20 (3.0-4.4)	7	3.87±0.20 (3.0-4.4)
I	15	10.31±0.53 (6.9-3.4)	22	7.93±0.28 (6.3-11.4)	p<0.05	42	6.41±0.17 (3.7-8.3)	79	7.58±0.23 (3.7-13.4)
II	52	12.77±0.24 (8.3-16.3)	14	13.69±1.30 (8.5-24.6)	p>0.05	2	9.70±2.10 (7.6-11.8)	68	12.87±0.33 (7.6-24.6)
III	18	14.13±0.63 (10.4-21.1)	20	20.32±0.55 (16.1-23.6)	p<0.05			38	17.38±0.65 (10.4-23.6)
IV			11	21.32±0.83 (17.6-27.4)				11	21.32±0.83 (17.6-27.4)
VII			1	33.80				1	33.80
Total	85	12.62±0.25 (6.9-21.1)	68	15.30±0.81 (6.3-33.8)	p<0.05	51	6.19±0.22 (3.0-11.8)	204	11.91±0.38 (3.0-33.8)

Table 2: Weight of barbel in relation to sex and age (g) in KDL and its inlets

Age	Male		Female		p = 0.05	Juvenile		General	
	n	W±SE (min-max)	n	W±SE (min-max)		n	W±SE (min-max)	N	W±SE (min-max)
0						7	0.80±0.09 (0.4-1.1)	7	0.80±0.09 (0.4-1.1)
I	15	14.89±2.01 (4.6-26.3)	22	7.80±0.91 (3.9-21.8)	p<0.05	42	3.79±0.29 (0.4-8.1)	79	7.02±0.67 (0.4-26.3)
II	52	26.22±1.20 (8.7-45.4)	14	45.27±14.37 (8.2-201.1)	p<0.05	2	12.85±6.95 (5.9-19.8)	68	29.75±3.18 (5.9-201.1)
III	18	37.94±6.02 (16.6-119.7)	20	107.67±8.83 (54.0-171.1)	p<0.05			38	74.64±7.86 (16.6-171.1)
IV			11	124.00±14.13 (80.0-235.5)				11	124.00±14.13 (80.0-235.5)
VII			1	428.00				1	428.00
Total	85	26.70±1.68 (4.6-119.7)	68	69.86±9.03 (3.9-428.0)	p<0.05	51	3.74±0.43 (0.4-19.8)	204	35.35±3.58 (0.4-428.0)

Table 3: Condition factors of barbel in relation to sex and time in KDL and its inlets

Date	Male		Female		Juvenile		General	
	n	K±SE (min-max)	n	K±SE (min-max)	n	K±SE (min-max)	N	K±SE (min-max)
23.04.2000			11	1.046±0.026 (0.926-1.151)			11	1.046±0.026 (0.926-1.151)
07.05.2000					3	0.906±0.065 (0.790-1.016)	3	0.906±0.065 (0.790-1.016)
24.06.2000	14	1.161±0.021 (1.021-1.290)	7	1.199±0.032 (1.088-1.311)			21	1.174±0.018 (1.021-1.290)
13.07.2000	1	1.123			2	1.020±0.154 (0.867-1.174)	3	1.055±0.095 (0.867-1.174)
25.07.2000	10	1.183±0.037 (0.988-1.320)	7	1.222±0.028 (1.113-1.335)	2	1.181±0.023 (1.157-1.204)	19	1.197±0.022 (0.988-1.335)
05.08.2000	44	1.240±0.015 (0.944-1.476)	11	1.269±0.037 (1.116-1.583)	19	1.282±0.029 (1.120-1.505)	74	1.255±0.013 (0.944-1.583)
07.09.2000	15	1.304±0.026 (1.100-1.522)	29	1.402±0.030 (1.108-1.882)	23	1.345±0.025 (1.094-1.581)	67	1.361±0.017 (1.094-1.882)
18.10.2000			8	1.242±0.030 (1.097-1.351)	2	1.854±0.372 (1.481-2.226)	10	1.365±0.101 (1.097-2.226)
22.11.2000	1	1.168	6	1.294±0.030 (1.206-1.414)			7	1.276±0.031 (1.168-1.414)
19.04.2001			1	1.185	1	1.097	2	1.141±0.044 (1.097-1.185)
12.06.2001	9	1.328±0.050 (1.141-1.644)	7	1.290±0.035 (1.155-1.380)			16	1.311±0.031 (1.141-1.644)
28.06.2001	30	1.201±0.013 (1.092-1.349)					30	1.201±0.013 (1.092-1.349)

Table 3: Continued

Date	Male		Female		Juvenile		General	
	n	K±SE (min-max)	n	K±SE (min-max)	n	K±SE (min-max)	N	K±SE (min-max)
13.07.2001	21	1.123±0.019 (0.985-1.383)	1	1.209			22	1.127±0.019 (0.985-1.383)
03.08.2001	5	1.086±0.040 (0.974-1.201)	2	1.163±0.026 (1.137-1.190)			7	1.108±0.032 (0.974-1.201)
22.08.2001	2	1.217±0.001 (1.216-1.219)	3	1.078±0.054 (0.978-1.163)			5	1.133±0.045 (0.978-1.219)
Total	152	1.210±0.009 (0.944-1.644)	93	1.266±0.017 (0.926-1.882)	52	1.293±0.030 (0.790-2.226)	297	1.242±0.009 (0.790-2.226)

Table 4: Condition factors of barbel in relation to sex and age in KDL and its inlets

Age	Male		Female		p = 0.05	Juvenile		General	
	n	K±SE (min-max)	n	K±SE (min-max)		n	K±SE (min-max)	N	K±SE (min-max)
0						7	1.39±0.15 (1.09-2.23)	7	1.39±0.15 (1.09-2.23)
I	15	1.25±0.03 (1.07-1.40)	22	1.46±0.03 (1.20-1.88)	p<0.05	42	1.28±0.03 (0.79-1.58)	79	1.32±0.02 (0.79-1.88)
II	52	1.22±0.02 (0.94-1.52)	14	1.27±0.02 (1.10-1.40)	p>0.05	2	1.27±0.07 (1.21-1.34)	68	1.23±0.01 (0.94-1.52)
III	18	1.23±0.03 (1.05-1.48)	20	1.23±0.02 (1.09-1.41)	p>0.05			38	1.23±0.01 (1.05-1.48)
IV			11	1.24±0.04 (1.10-1.58)				11	1.24±0.04 (1.10-1.58)
VII			1	1.11				1	1.11
Total	85	1.23±0.01 (0.94-1.52)	68	1.31±0.02 (1.09-1.88)	p<0.05	51	1.30±0.03 (0.79-2.23)	204	1.27±0.01 (0.79-2.23)

Table 5: Length-weight relationships of barbel in relation to season and sex in KDL and its inlets

Season	Male	Female	General
Spring 2000		$W = 0.011 \times L^{2.994}$ (r = 0.949 n = 11)	$W = 0.008 \times L^{3.086}$ (r = 0.998 n = 14)
Summer 2000	$W = 0.028 \times L^{2.685}$ (r = 0.965 n = 69)	$W = 0.015 \times L^{2.925}$ (r = 0.993 n = 25)	$W = 0.014 \times L^{2.957}$ (r = 0.993 n = 117)
Autumn 2000	$W = 0.019 \times L^{2.846}$ (r = 0.995 n = 16)	$W = 0.020 \times L^{2.830}$ (r = 0.998 n = 43)	$W = 0.017 \times L^{2.901}$ (r = 0.996 n = 84)
Spring 2001			$W = 0.007 \times L^{3.289}$ (r = 0.981 n = 7)
Summer 2001	$W = 0.023 \times L^{2.736}$ (r = 0.971 n = 67)	$W = 0.017 \times L^{2.881}$ (r = 0.997 n = 13)	$W = 0.018 \times L^{2.834}$ (r = 0.987 n = 80)
Total	$W = 0.023 \times L^{2.745}$ (r = 0.975 n = 152)	$W = 0.020 \times L^{2.828}$ (r = 0.995 n = 93)	$W = 0.014 \times L^{2.934}$ (r = 0.992 n = 305)

Observations showed that 25 mm mesh trammel gill nets were used in catching barbel by one fisherman. However, this net was only used at certain times of the year and as a single 100 m length. It was noticeable that the great majority of individuals in the commercial catch were females. Only one individual of 31 samples was male.

DISCUSSION

In order to keep selectivity to a minimum, 15-18 mm mesh hand nets and 1.5 kw h⁻¹ electroshock equipment was used in the streams, while 25 and 35 mm mesh sized trammel nets and beach seine nets were used in the KDL.

The maximum age of *B. plebejus* in the Kizilirmak basin was determined as V (Erk'akan and Akgül, 1986) and in the şana stream it was IV (Baysal and Kutrup, 1990, 1994). The maximum age of *B.p. lacerta* in the Kura and Arax rivers was found to be V (Solak, 1989) and in the Savur stream it was VI (Ünlü *et al.*, 1990). The maximum

age for *B.p. escherichi* in the Sartyar dam was determined as VIII (Ekmekçi, 1990; Baysal and Kutrup, 1994), in the Kara stream V (Kutrup and Baysal, 1994) and in the Bafra-Altinkaya dam it was found to be VI (Bircan and Ergün, 1997). In this study, maximum age was found to be VII this suggests a similarity in fishing and predation on *B. plebejus* in our study area and in the environments mentioned.

It was reported that in *B.p. escherichi* living in the Kara stream, the females were longer than males in the same age group. At an early age, weight and length growth were similar, but at a later age females showed proportionately higher growth rates than males. Length increase in relation to sex in the third year showed a significant difference in favour of females (p<0.05) (Kutrup and Baysal, 1994). In this study it was found that differences between the sexes in length increase in relation to age favored males in the first year and females in the third year (p<0.05).

It was reported that maximum length of *B.p. lacerta* in the Kura and Arax rivers was 31.3 cm (Solak, 1989) and that of *B.p. escherichi* in Yuvarlak stream was 23 cm (Barlas *et al.*, 2000). In this study, maximum fork lengths were measured as 33.8 cm. The fact that the values determined were higher than those of Yuvarlak stream stem from overfishing as reported in the works cited.

The maximum weight of *B. p. lacerta* in the Kura and Arax rivers was reported as 297.1 g (Solak, 1989) and that of *B.p. escherichi* in Yuvarlak stream as 160.3 g (Barlas *et al.*, 2000). In this study, maximum weight was 428.0 g. The fact that this value is higher than those reported in previous studies may derive from the lack of intensive commercial fishing in the Kocköprü Reservoir.

Length-weight relationship of *B.p. escherichi* in Kara stream was calculated as $W = 0.0756 \times L^{2.494}$ (Kutrup and Baysal, 1994). In this study it was determined as $W = 0.014 \times L^{2.934}$. Our "b" values were higher than those reported from Kara stream and this is evidence that while in Kara stream specimens plumpness decreases as length increases, in specimens in our study area length increase does not involve any change in body shape. This shows that the habitat supports small and large individuals to the same extent.

Condition factors were reported as follows: 1.007-1.441 for *B. plebejus* in the Kizilirmak basin (Erk'akan and Akgül, 1986); an average of 1.925 for *B. plebejus* in the Şana stream (Baysal and Kutrup, 1990); an average of 1.960 for *B. plebejus* in the Şana stream (Baysal and Kutrup, 1994); and an average of 1.3 for *B.p. escherichi* in Yuvarlak stream (Barlas *et al.*, 2000). In this study, it was determined that the condition factor varied between 0.790 and 2.226 (1.242±0.009). In this study the high variability between individuals stems from the insufficient sensitivity of the scales for weighing small individuals. Although the averages determined accord with the values found in the Kizilirmak basin (Erk'akan and Akgül, 1986) and Yuvarlak stream (Barlas *et al.*, 2000), they are lower than those of Şana stream (Baysal and Kutrup, 1990; Baysal and Kutrup, 1994). These different averages may arise from differences in nutrition.

Condition factor of *B.p. escherichi* in Sariyar reservoir showed a significant increase in spring, a maximum in June and a minimum in January (Ekmekeçi, 1990). In this study, calculations showed that condition factor reached its highest value in the second half of October (1.365±0.101) and its lowest value in May (0.906±0.065).

It is reported that *B.p. escherichi* is fished commercially in the Trakya region (Balik, 1985). It was noticed that young individuals formed the dominant group of *B.p. pectoralis* and *B.p. escherichi* in Nif stream and its tributaries and that this arose from overfishing

(Geldiay and Balik, 1973). Similar data are reported concerning *B.p. lacerta* in the Kura and Arax rivers and *B. plebejus* in the Şana stream (Solak, 1989; Baysal and Kutrup, 1990). In this study it was seen that there was no pressure from intensive fishing on barbel in the area under study.

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