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Growth and Reproduction Properties of *Capoeta capoeta* (Guldenstaedt, 1772) in Zernek Dam Lake, Van, Turkey

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Abstract: This study was carried out in Zernek Dam Lake, Van, Turkey. In this study, 586 individuals have sampled and investigated between June 2006 and October 2007. The ages, lengths and weights of individuals varied from 1-7 years, 4.0-41.0 cm and 0.7-1060.4 g, respectively. Age-length and length-weight relationships were calculated as $L_t = 48.927 \times (1-e^{-0.2038 \times (t+0.2028)})$, as $W = 0.0137 \times L^{2.992}$, respectively. The mean condition factor was defined as 1.339±0.005. The male: female ratio was estimated as 1:1.72. It was established that females and males attained sexual maturity when they reached to 23 and 15 cm in length, 180 and 60 g and 4th and 2nd age, respectively, spawning was observed between beginning of June and 2nd week of July. It may be suggested that fishing should be forbidden between 1 May and 1 August and minimum catching size must be 5th age, 26 cm fork length and 220 g total weight.

Key words: Growth, reproduction, *Capoeta capoeta*, Zernek Dam Lake

INTRODUCTION

Zernek Dam Lake (38°21′N, 43°39′E) is in the Lake Van Basin, eastern Anatolia and situated on the eastern part of the Lake Van, its surface area is about 516 km^2, its altitude is 1927 m and its deepest area is 63 m. The dam lake was constructed in 1988. The dam lake has been built in consequence of irrigation and electrical energy (Anonymous, 2007). There has been *Capoeta capoeta*, *Cyprinus carpio* in the dam lake. Although, it says that there has been *Oncorhynchus mykiss*, it was not caught throughout this study. There has commercial fishing in the dam lake and *C. capoeta* is important economically. Lake water is freeze every winter. The vegetation of the lake bank is very poor. This region has terrestrial climatic.

Fish species of the *Capoeta* genus (Cyprinidae) are widely disturbed throughout northern India to Anatolian waters. There are 5 species and 6 subspecies in Anatolian inland waters. *C. capoeta* may be 70 cm length; its body shape is fusiform and it has a pair of barbell on the edge of its mouth. Body color is dark on the dorsal and light on ventral. The tubercles are seen on head in the reproduction period (Geldiay and Balik, 2002).

We studied *C. capoeta* in Zernek Dam Lake for 17 months to describe its population structure and reproduction characteristics. An investigation in the Zernek Dam Lake was not carried out before. It is hoped that this article can make a contribution to knowledge of growth, reproduction and population structure and population management.

MATERIALS AND METHODS

A total of 586 *Capoeta capoeta* was sampled in the Zernek Dam Lake from June 2006 to October 2007. The samples were captured with seines, hand and trammel nets of various mesh sizes (18-45 mm) and electroshock. The fork length (L±0.1 cm) of 586 specimens and total weight (W±0.1 g) of 585 individuals were recorded. The scales of 430 individuals were used for age determination. The age were determined with microfilm device (Turkmen *et al*., 2005). Age, length and weight frequencies were determined. The length-weight ($W = a \times L^b$) and age-length [$L_t = L\infty \times (1-e^{-K \times (t-to)})$] relationships, condition factor ($CF = W/L^3 \times 100$) and Munro's phi prime index ($Ø' = LogK + 2 \times LogL\infty$) were calculated (Avsar 2005; Cetinkaya *et al*., 2005). Sex was determined by examination of the gonads of 456 specimens. Sexual maturation of *Capoeta capoeta* was defined according to age, length and weight on 456 samples. Tubercles on body, fins and head were recorded as secondary sexual character. Gonadosomatic index (GSI) values were calculated as [$GSI = (G_w/W) \times 100$] and the eggs were counted by the gravimetric method. Egg diameters were measured with an ocular micrometer (Karatas *et al*., 2005).

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RESULTS

Age was determined on 430 *C. capoeta* specimens. The age of the samples of Zernek Dam Lake ranged from 1-7. The maximum age for males was 5 and for females were 7. Second age group was dominant in males (15.8%) and 4th age group in females (20.9%). In all samples, dominant group was also 4th (23.5%), but 3rd age group (22.1%) and 4th age group (23.0%) was near to 2nd age group. Zero year old specimens couldn't captured in the Dam Lake (Table 1).

In all samples, fork length varied from 4.0-41.0 cm, in males from 10.1-29 cm, in females from 9.5-41.0 cm (Table 2). The total weight ranged between 0.7-1060.4 g in all samples, 13.5-323.5 g in males and 13.1-1060.4 g in females (Table 3) and it was estimated that the females were bigger than the males, statistically ($p<0.05$).

When the lengths were grouped into 2 cm bands, the largest group was found as 26.0-27.9 cm range (15.2%). When length frequencies were examined in relation to sex, it was determined that the dominant group of females (6.8%) was in the 16.0-17.9 cm range and of females in the 30.0-31.9 cm range (7.8%). Total weights were grouped into 50 g. The dominant weight group (19.5%) of all samples was determined as 50.0-99.9 g group. When weight frequencies was examined in relation to sex, dominant weight group of males was 50.0-99.9 g group (14.0%) and of females was in 350.0-399.9 g group (5.8%) (Table 4).

Length-weight relationship was analyzed depending on sex. It was found that males had $W = 0.0167 \times L^{2.920}$ ($r^2 = 0.978$), females had $W = 0.0187 \times L^{2.903}$ ($r^2 = 0.980$) and all samples had $W = 0.0137 \times L^{2.992}$ ($r^2 = 0.990$). The slope (b) values of length-weight relationship were analyzed depending on sex and the value of females (2.903) was near to that of males (2.920).

Condition factor in overall samples was calculated as 1.314±0.019 (0.997-1.793). It reached a peak (1.456±0.027) in the middle of the June 2007 and it declined to lowest point (1.241±0.014) in the middle of the August 2006. Average condition factor was calculated as 1.323±0.009 (1.004-1.726) for males, as 1.366±0.007 (1.098-1.750) for females and as 1.309±0.025 (1.045-1.624) for juveniles (Table 5). The values of the condition factors of males and females were near to each other.

Age-length relationship were determined (Fig. 1) as $L_t = 48.927 \times (1-e^{-0.2038 \times (t+0.2028)})$. Munro's phi prime index was calculated as 2.688 in the *C. capoeta* population of the Dam Lake.

Sex was determined on 456 specimens. Total 158 (34.7%) individuals were male, 272 (59.6%) specimens were female and 26 samples (5.7%) were juvenile. The male:female ratio was estimated as 1:1.72 and the difference was statistically significant ($p<0.05$).

Sexual maturity was determined on 456 samples. Total 318 of the overall samples was mature and 138 was immature. Of the 158 males, 135 were identified as mature; of the 272 females, 183 were mature. It was observed that the 82.4% of males in the 2nd age group and 72.2% of females in the 4th age group and that 60.0% of males in 14-15 cm group and 88.9% of females in 22-23 cm group and that of 70% of males in 40-60 g group and 70% of females in 160-180 g group were sexually mature.

Table 1: Age composition of *C. capoeta* depending on sex in Zernek Dam Lake

	Male		Female		All samples	
Age groups	n	(%)	n	(%)	n	(%)
I	9	2.1	1	0.2	26	6.0
II	68	15.8	24	5.6	101	23.5
III	46	10.7	49	11.4	95	22.1
IV	9	2.1	90	20.9	99	23.0
V	6	1.4	68	15.8	74	17.2
VI	0	0.0	33	7.7	33	7.7
VII	0	0.0	2	0.5	2	0.5
Total	138	32.1	267	62.1	430	100.00

Table 2: According to age and sex, lengths (cm) of *C. Capoeta* in Zernek Dam Lake

	Male		Female		Juvenile		All samples
Age groups	n	L±SE (Min-Max)	n	L±SE (Min-Max)	n	L±SE (Min-Max)	n	L±SE (Min-Max)
1	9	13.4±0.74 (10.1-16.8)	1	9.5	16	8.0±0.83 (4.0-13.6)	26	9.9±0.76 (4.0-16.8)
2	68	17.7±0.26 (12.4-24.4)	24	19.2±0.49 (14.9-25.1)	5	15.9±0.60 (14.7-18.1)	101	18.0±0.22 (12.4-25.1)
3	46	21.7±0.44 (16.2-27.6)	49	24.7±0.43 (17.8-30.8)	0		95	23.3±0.34 (16.2-30.8)
4	9	25.2±0.75 (22.0-28.9)	90	27.4±0.35 (21.0-34.4)	0		99	27.2±0.33 (21.0-34.4)
5	6	26.4±0.56 (25.3-29.0)	68	30.8±0.34 (21.3-36.8)	0		74	30.4±0.35 (21.3-36.3)
6	0		33	32.9±0.50 (27.2-41.0)	0		33	32.9±0.50 (27.2-41.0)
7	0		2	37.9±2.80 (35.1-40.7)	0		2	37.9±2.80 (35.1-40.7)
Total	158	(10.1-29.0)	272	(9.5-41.0)	26	(4.0-18.1)	586	(4.0-41.0)

Table 3: According to age and sex, weights (g) of *C. Capoeta* in Zernek Dam Lake

	Male		Female		Juvenile		All samples	
Age groups	n	W±SE (Min-Max)	n	W±SE (Min-Max)	n	W±SE (Min-Max)	n	W±SE (Min-Max)
1	9	35.7±5.23 (13.5-60.9)	1	13.1	16	10.4±2.68 (0.7-35.6)	26	19.3±3.38 (0.7-60.9)
2	68	76.1±3.13 (29.4-171.9)	24	101.6±8.74 (50.0-242.4)	5	50.5±6.16 (41.4-74.8)	101	80.7±3.23 (29.4-242.4)
3	46	140.6±9.04 (57.7-306.0)	49	214.8±9.90 (71.7-363.9)	0		95	178.9±7.71 (57.7-363.9)
4	9	221.6±18.51 (159.4-323.5)	90	289.2±10.08 (138.8-536.2)	0		99	283.1±9.50 (138.8-536.2)
5	6	255.7±16.1 (212.1-310.5)	68	397.7±11.70 (141.3-636.8)	0		74	386.2±11.73 (141.3-636.8)
6	0		33	498.4±20.60 (318.7-795.8)	0		33	498.4±20.60 (318.7-795.8)
7	0		2	822.9±237.55 (585.3-1060.4)	0		2	822.9±237.55 (585.3-1060.4)
Total	158	(13.5-323.5)	272	(13.1-1060.4)	26	(0.7-74.8)	585	(0.7-1060.4)

Table 4: Length and weight frequencies of *C. capoeta* in Zernek Dam Lake

Length groups	Male		Female		All		Weight groups	Male		Female		All	
(cm)	n	(%)	n	(%)	N	(%)	(g)	n	(%)	n	(%)	N	(%)
4.0-9.9	0	0.0	1	0.2	12	2.0	0.0-49.9	21	3.6	1	0.2	45	7.7
10.0-11.9	2	0.3	0	0.0	4	0.6	50.0-99.9	82	14.0	21	3.6	114	19.5
12.0-13.9	5	0.9	0	0.0	9	1.5	100.0-149.9	23	3.9	23	3.9	50	8.5
14.0-15.9	21	3.6	1	0.2	28	4.8	150.0-199.9	14	2.4	24	4.1	62	10.6
16.0-17.9	40	6.8	8	1.4	54	9.2	200.0-249.9	8	1.4	31	5.3	98	16.8
18.0-19.9	36	6.2	15	2.6	58	9.9	250.0-299.9	7	1.2	32	5.5	63	10.8
20.0-21.9	18	3.1	18	3.1	42	7.2	300.0-349.9	3	0.5	33	5.6	42	7.2
22.0-23.9	12	2.0	23	3.9	48	8.2	350.0-399.9	0	0.0	34	5.8	37	6.3
24.0-25.9	10	1.7	30	5.1	80	13.7	400.0-449.9	0	0.0	27	4.6	28	4.8
26.0-27.9	12	2.0	35	5.9	89	15.2	450.0-499.9	0	0.0	21	3.6	21	3.6
28.0-29.9	2	0.3	43	7.3	58	9.9	500<	0	0.0	25	4.3	25	4.2
30.0-31.9	0	0.0	46	7.8	51	8.7	Total	158	27.0	272	46.5	585	100.0
32.0-33.9	0	0.0	30	5.1	31	5.3							
34<	0	0	22	3.8	22	3.8							
Total	158	26.9	272	46.4	586	100.0							

Table 5: Condition factor of *C. capoeta* in the Dam Lake depending on sampling date

	Male		Female		Juvenile		All samples	
Sampling date	n	CF±SE	n	CF±SE	n	CF±SE	n	CF±SE
01.06.06	34	1.355±0.019	18	1.420±0.021	17	1.317±0.024	69	1.363±0.013
15.06.06	49	1.315±0.019	9	1.496±0.029	3	1.425±0.100	62	1.347±0.018
11.07.06	6	1.426±0.064	30	1.408±0.011	0		36	1.411±0.013
15.08.06	22	1.258±0.016	14	1.256±0.020	5	1.192±0.062	44	1.241±0.014
22.09.06	3	1.329±0.058	24	1.296±0.021	0		27	1.299±0.020
20.11.06	6	1.344±0.027	30	1.327±0.019	0		121	1.293±0.009
25.04.07	2	1.339±0.002	11	1.324±0.023	0		53	1.364±0.017
17.05.07	0		15	1.340±0.027	0		15	1.340±0.027
30.05.07	0		29	1.347±0.024	0		29	1.347±0.024
05.06.07	0		20	1.365±0.022	0		20	1.365±0.022
14.06.07	8	1.469±0.045	20	1.450±0.034	0		28	1.456±0.027
04.07.07	23	1.273±0.019	14	1.413±0.027	1	1.397	38	1.327±0.019
26.07.07	0		21	1.415±0.025	0		21	1.415±0.025
25.10.07	5	1.320±0.040	17	1.312±0.023	0		22	1.314±0.019
Total (min-max)	158	1.323±0.009 (1.004-1.726)	272	1.366±0.007 (1.098-1.750)	26	1.309±0.025 (1.045-1.624)	585	1.339±0.005 (0.997-1.793)

The youngest matured male was one year old and the female was 2 years old. The smallest matured individual 13.4 cm and 33.4 g for males and 18.7 cm and 84.8 g for females.

Spawning period was determined via GSI and field observation. When a light pressure was applied to the abdomen of samples caught in June, it was showed that mature males and females released eggs or milk. Moreover, in June and July, reproduction tubercles were observed on mature males. These tubercles were seen on anal fin, head and body of mature males. Of the 101 mature males observed, 69 had tubercles. The GSI values reached

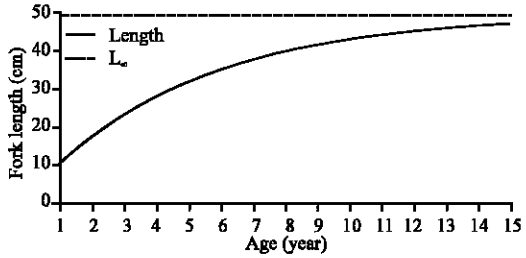

Fig. 1: Age-length relationship of *C. capoeta* in Zernek Dam Lake

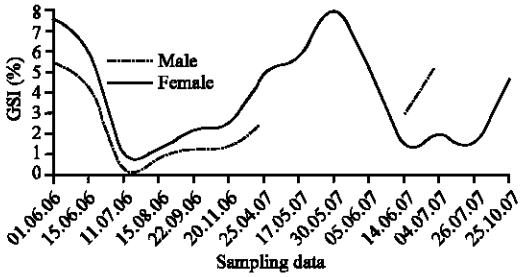

Fig. 2: GSI value of *C. capoeta* in Zernek Dam Lake

a maximum at the beginning of June (5.375 in 2006) in males and at the end of May (7.847 in 2007) in females and declined rapidly up to 2nd week of July and reaching a minimum in July 2006 (0.233 in males and 0.966 in females). This showed that spawning of *C. capoeta* in Zernek Dam Lake took place intensively from beginning of June to 2nd week of July (Fig. 2). In the lake, water temperature was above 15°C at the end of May.

In order to, determinate of fecundity and egg diameters, the eggs of 16 individuals were sampled in April and May. Average individual fecundity was defined as 9668±1198 and it ranged between 4072 and 23595. Relative fecundity was between 11120 and 37343 number kg^{-1} fish (average 21640±1748).

Egg diameters were measured with an ocular micrometer on 13 specimens. The diameters ranged from 1.612-2.292 mm (average as 1.915±0.061 mm). It was different among the different individuals.

DISCUSSION

Age is one of the main criteria in the determination of growth, so, it should be defined correctly. Age was determined on 430 individuals. The age of the samples ranged from 1-7 and the 2nd age group was dominant in all samples (23.5%). In this study, 0 year old individual could not capture (Table 1). The reason why 0 age group could not catch might be of the nets'selectivity. Similar age class was reported by Elp and Karabatak (2007) from Kockopru Dam Lake, but Cetinkaya *et al.* (1995), Evci (1997) and Sen *et al.* (1999) was reported older age class form Karasu and Bendimahi streams and Donerdere and Kockopru dam lakes and Nazik lake in Lake Van Basin.

The largest and the heaviest specimen was 41.0 cm fork length and 1060.4 g (Table 2 and 3) and it was estimated that the females were bigger than the males, statistically ($p<0.05$). It compares to the maximum lengths reported as 32.5 cm and 580 g by Cetinkaya *et al.* (1995), 47 cm, 1273 g by Evci (1997), 48.3 cm and 1379.5 g by Sen *et al.* (1999) and 39.8 cm and 755.6 g by Elp and Karabatak (2007). It is understood from the other researches in Lake Van Basin, size of the *C. capoeta* determined in our study is close to Evci (1997) and Sen *et al.* (1999) and bigger than the other studies.

Age-length relationship was calculated as $L_t = 48.927 \times (1-e^{-0.2038\times(t+0.2028)})$ ($r^2 = 0.982$). Von Bertalanffy Growth Equation parameters change within same species and between different species, different ecological condition, feeding and between sex. K value showing how fast fish reach to $L\infty$ value, is high (near to 1) in short living fish and is low (near to 0) in long living fish (Cetinkaya *et al.*, 2005). In this study, K value calculated as 0.2038 in all samples. These show that *C. capoeta* in Zernek dam Lake is a long living species (Cetinkaya *et al.*, 2005).

The theoretical maximum length ($L\infty$) was estimated as 48.927 cm in this study. It is raported as 69.75 cm by Sen *et al.* (1999) and 58.24 cm by Elp and Karabatak (2007). The values can also be affected from geographic location, environmental conditions and feeding (Cetinkaya *et al.*, 2005). Munro's phi prime index (Ø') was calculated as 2.643 in Nazik Lake by Sen *et al.* (1999) and 2.713 in Kockopru Dam Lake by Elp and Karabatak (2007). We estimated as 2.688 in Zernek Dam Lake.

Length-weight relationship was found that males had $W = 0.0167\times L^{2.920}$ ($r^2 = 0.978$), females had $W = 0.0187\times L^{2.903}$ ($r^2 = 0.980$) and all samples had $W = 0.0137\times L^{2.992}$ ($r^2 = 0.990$). The slope (b) values of length-weight relationship were analyzed depending on sex and the value of females (2.903) was near to that of males (2.920). The b values that of all samples, males and females were isometric in Zernek Dam Lake. The b value can be used as an indicator of food intake and growth regime and may differ according to some biotic and abiotic factors like water temperature, food availability and habitat type (Wootton, 1992).

Condition faktor was reported as 1.230 in Nazik Lake by Sen *et al.* (1999), 1.275 in Kockopru Dam Lake by Elp and Karabatak (2007). In this study, it in overall samples was estimated as 1.339 (Table 5). Our findings were higher than that of Nazik and Kockopru. Variations in condition coefficients may change within same species, age, season, sexual maturity, spawning season, feeding condition and environment (Cetinkaya *et al.*, 2005).

Of the 456 individuals, 158 (34.7%) were identified as males, 272 (59.6%) as females and 26 (5.7%) as juveniles. The male:female ratio was estimated as 1:1.72 and the difference was statistically significant ($p<0.05$). In the examined samples, females were found to be dominant. It is well known that the sex ratio for most species is close to 1:1, but it may vary from species to species. It also may differ from one population to another of same species and may vary from year to year in the same population (Nikolsky, 1963). The ratio was reported as 1.18:1 by Evci (1997), 1.3:1 by Sen *et al.* (1999), 1:1.43 by Elp and Karabatak (2007).

In June and July, reproduction tubercles were observed on mature males. These tubercles were seen on anal fin, head and body of mature males. Of the 101 mature males observed, 69 had tubercles. In the reproduction period of *C. capoeta*, reproduction tubercles were observed on the samples. These tubercles were seen on anal fin, head and body of the mature males but were not seen on females. Of the 101 mature males observed, 69 had tubercles. Geldiay and Balik (2002) reported reproduction tubercles in mature males of *C. capoeta* on the head and nose. In Lake Nazik population, the tubercles appeared on the anal fin, body and head between June and August (Sen *et al.*, 1999). In Kockopru population, those were seen on head, anal fin and tail stalk between April and July (Elp and Karabatak, 2007).

Of 456 individuals observed for sexual maturation, 318 specimens were mature and 138 specimens were immature. Of the 158 males, 135 were identified as mature; of the 272 females, 183 were mature. It was observed that the 82.4% of males in the 2nd age group and 72.2% of females in the 4th age group and that 60.0% of males in 14-15 cm group and 88.9% of females in 22-23 cm group and that of 70% of males in 40-60 g group and 70% of females in 160-180 g group were sexually mature. The youngest matured male was 1 year old and the female was 2 years old. The smallest matured individual 13.4 cm and 33.4 g for males and 18.7 cm and 84.8 g for females. In Nazik Lake, *C. capoeta* was sexually matured in 14.0-14.9 cm length group of males and in 20.0-20.9 cm length group of females (Sen *et al.*, 1999). In Kockopru Dam Lake, that was become in 3rd age group and 23.0-24.9 cm length-group of males, in 4th age group and 33.0-34.9 cm length-group of females (Elp and Karabatak, 2007).

The GSI values reached a maximum at the beginning of June (5.375 in 2006) in males and at the end of May (7.847 in 2007) in females and declined rapidly up to 2nd week of July and reaching a minimum in July 2006 (0.233 in males and 0.966 in females). This showed that spawning of *C. capoeta* in Zernek Dam Lake took place intensively from beginning of June to 2nd week of July. In the lake, water temperature was above 17°C at that time. In Nazik lake, spawning period was determined between 2nd half of May and at the beginning of August (Sen *et al.* 1999); in Zernek, it was between 15 May and 15 June (Elp and Karabatak, 2007).

Individual fecundity was determined between 4072 and 23595 number/fish. Relative fecundity was estimated 21640±1748 number kg^{-1} fish. Nazik's value (Sen *et al.*, 1999) was higher than our data, but Kockopru's (Elp and Karabatak, 2007) was close to ours. The eggs diameters ranged from 1.612-2.292 mm (average as 1.915±0.061 mm). It was different among the different individuals. It reported as 1.82 mm by Sen *et al.* (1999), as 1.85 mm by Elp and Karabatak (2007). Our value was higher than they.

As a result, in order to maintain in equilibrium the *Capoeta capoeta* population in Zernek Dam Lake, to give a chance for reproduction each fish at least one has great importance. Therefore, it may be suggested that fishing should be forbidden between 1 May and 1 August and minimum catching size must be 5th age, 26 cm fork length and 220 g total weight.

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