

Some Biological Properties of Carp (*Cyprinus carpio* L., 1758) Living in Kockopru Dam Lake, Van-Turkey

Mahmut Elp, Fazil Sen and Osman Cetinkaya
Department of Fisheries, Faculty of Agricultural,
University of Yuzuncu Yil, 65080 Zeve Kampus, Van, Turkey

Abstract: This study was carried out to determine some biological parameters of carp populations introduced to the Kockopru Dam Lake on the Zilan River in Lake Van Basin and conducted between December 1999 and August 2001. Sampling was carried out monthly using hand nets and trammel nets. It was determined that carp become a sustainable population and is caught by fishermen. The maximum age was determined as VII; fork length as 61.7 cm and weight as 6002.6 g. Length-weight relationship was estimated as $\log W = -1.402 + 2.847 \log L$ and age-length relationship was determined as $L_t = 84.070 (1 - e^{-0.126(t+0.801)})$. It was also determined that male female ratio was 1:0.94 and maturity size was determined as more than 45 cm for female. Reproduction period was observed in June. It was also observed that commercial fishing could be a big threat for the future of the Kockopru Dam Lake population because of undersized catch.

Key words: Lake van Basin, Zilan, carp, growth, reproduction

INTRODUCTION

Carp is a species distributed natively in Asia and Europe and introduced to many regions of the world. Carp is distributed naturally in Anatolian freshwaters and introduced and stocked to many inland waters. The studies were made as new introductions or improvements for the present stocks (Cetinkaya, 2006).

Various studies were conducted on carp biology in Turkey. Some of them were on natural populations (Erdem, 1983; Duzgunes, 1985; Cetinkaya, 1992) and some of them were on introduced populations (Akyurt, 1987; Cetinkaya *et al.*, 2000; Sen, 2001).

Carp has not been naturally distributed in Lake Van Basin, it has been introduced to various water sources since, 1970s. Fish introduction to Kockopru Dam Lake was started with water collection in the dam (1992). There was no record or study on Kockopru Dam Lake carp after its introduction to show whether it constituted a sustainable population or not and what are its growing and reproduction characteristics. This study was carried out to investigate determine some biological traits of the carp population in Kockopru Dam Lake.

MATERIALS AND METHODS

The Kockopru Dam Lake was built on the Zilan River in the Lake Van Basin in the Eastern Anatolian Region of Turkey. It was mainly built for irrigation and electricity

production. Commercial fishing has also been carrying out there. The dam has an estimated surface area of 6.15 km², a storage capacity of 86 hm³ when it is full. 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 Stream) and the Ilica (Incesu), Komurcu and Kunduk streams and by rainwater and snowmelt.

The present research was conducted between December 1999 and August 2001 and 326 individual was sampled. Sampling was carried out monthly using hand nets and trammel nets. Fork length was used to measure fish lengths in the study (Geldiay and Balik, 2002). Weight measurements were carried out on fresh caught fish (Cetinkaya *et al.*, 2005). Age was determined by examining the scales (Turkmen *et al.*, 2005). To estimate the length-weight relationship, the logarithmic growth model equation, $\log W = \log a + b \log L$ proposed by Le Cren and length-age relationship $FL_t = FL_{\infty} (1 - e^{-K(t+0)})$ were used. The formula $K = (W/L^3) \times 100$ was used to calculate the condition factor (Cetinkaya *et al.*, 2005). Sex was determined by examining the gonads.

RESULTS AND DISCUSSION

Total 326 carp individuals were examined and their ages ranged from I to VII. Carp can live more than 40 years (Celikkale, 1994). Carp have been introduced to Kockopru Dam Lake in 1992, so the age results were in normal ranges.

The fork lengths varied from 8.2-61.7 cm (in male 18.3-50.4, in female 12.7-61.7 cm) (Table 1). The weights varied from 13.7-7697.3 g (in male 147.8-3362.5, in female 44.6-6002.6 g). The maximum length was 61.7 cm (Table 2). This value can be thought small because carp can grow about 100 cm (Geldiay and Balik, 2002; Celikkale, 1994). The maximum age in the population, which was comparatively new introduction, was VII, so this observed growth could be considered well enough. Carp population in the Kockopru Dam Lake was developed better than those of Bendimahi, Karasu, Dolutas-Degirmigol ve Donerdere populations (Cetinkaya *et al.*, 2000) and similar to that of Nazik Lake (Sen, 2001).

Length-weight relationship in the Kockopru Dam Lake population was examined in relation to season and sex. The results showed that the b constant reached its highest value (3.025) in the winter of 2000. The highest value for males (3.656) was in the spring of 2000 and for

females (3.376) in the autumn of 2000 (Table 3). The b values describe form of the body shape. If the value is smaller than 3, it means that body shape of the fish is thin down; if it is bigger than 3, it means that body shape of the fish is rotund (Cetinkaya *et al.*, 2005). In this research, b values were calculated for males as 2.892 and for female as 2.737. These values prove that body shape of the Kockopru Dam Lake population has changed to slightly thin down.

Age-length relationships and growth performance indices were calculated as $L_t = 84.070 (1 - e^{-0.126(t+0.801)})$ and ($r^2 = 0.953$) $\phi' = 2.949$, respectively in overall samples; in male $L_t = 75.600 (1 - e^{-0.123(t+1.622)})$ and ($r^2 = 0.947$), $\phi' = 2.846$, respectively and in female $L_t = 92.550 (1 - e^{-0.119(t+0.619)})$ and ($r^2 = 0.937$), $\phi' = 3.008$, respectively. In overall sample, L_∞ was calculated as 84.070 cm (in male $L_\infty = 75.600$ and in female 92.550 cm) (Fig. 1). These values were smaller than those of Nazik Lake (Sen, 2001). Because only L_∞ was not

Table 1: Fork length (cm) of *C. carpio* in relation to age and sex in kockopru dam lake

Age groups	Male		Female		Juvenile		All samples	
	n	FL±SE (min-max)	N	FL±SE (min-max)	n	FL±SE (min-max)	N	FL±SE (min-max)
I	2	21.0±1.9 (19.0-22.9)	12	18.2±0.7 (12.7-21.6)	22	16.7±0.6 (8.2-22.5)	36	17.4±0.5 (8.2-22.9)
II	42	28.1±1.0 (18.3-37.8)	44	26.0±1.0 (17.0-38.7)	7	19.6±1.7 (15.1-28.5)	93	26.5±0.7 (15.1-38.7)
III	50	33.3±0.9 (21.4-42.6)	43	30.2±1.1 (20.9-43.2)	1	22.4	94	31.7±0.7 (20.9-43.2)
IV	27	36.2±0.8 (25.2-44.3)	14	37.2±1.4 (25.7-43.3)			41	36.5±0.7 (25.2-44.3)
V	22	37.6±0.5 (33.9-43.7)	7	39.9±1.2 (34.8-43.9)			29	38.2±0.5 (33.9-43.9)
VI	2	49.5±0.5 (49.0-50.0)	6	50.6±1.3 (46.8-55.3)			8	50.4±1.0 (46.8-55.3)
VII	1	50.4 (50.4-61.7)	1	61.7			2	56.1±5.7
Total	146	33.2±0.6 (18.3-50.4)	127	30.1±0.9 (12.7-61.7)	30	17.6±0.6 (8.2-28.5)	303	30.4±0.5 (8.2-61.7)

Table 2: Weight (g) of *C. carpio* in relation to age and sex in kockopru dam lake

Age groups	Male		Female		Juvenile		All samples	
	n	W±SE (min-max)	N	W±SE (min-max)	n	W±SE (min-max)	N	W±SE (min-max)
I	2	208.6±42.5 (166.1-251.1)	16	143.5±12.9 (44.6-227.0)	22	127.9±12.6 (13.7-325.1)	40	138.1±9.1 (13.7-325.1)
II	44	614.5±53.9 (147.8-1255.0)	46	520.4±57.0 (112.8-1357.4)	9	218.7±63.2 (86.7-697.5)	99	534.8±37.6 (86.7-1357.4)
III	54	960.0±66.7 (278.4-1754.0)	50	728.0±77.5 (142.5-2209.0)	1	257.8	105	842.8±51.7 (142.5-2209.0)
IV	27	1169.0±80.6 (426.1-2263.7)	14	1277.2±119.5 (396.8-1973.7)			41	1205.9±66.6 (396.8-2263.7)
V	23	1265.3±56.5 (861.3-2175.8)	7	1531.3±109.8 (951.8-1778.0)			30	1327.4±53.6 (861.3-2175.8)
VI	3	2537.5±580.9 (1416.5-3362.5)	6	3118.5±381.1 (2069.0-4609.8)			9	2924.8±313.1 (1416.5-4609.8)
VII	1	3338.4	1	6002.6			2	4670.5±1332.1 (3338.4-6002.6)
Total	154	979.9±45.7 (147.8-3362.5)	140	828.2±73.8 (44.6-6002.6)	31	157.5±20.7 (13.7-697.5)	326	834.0±40.5 (13.7-6002.6)

Table 3: Length-weight relation of *C. carpio* in relation to season and sex in kockopru dam lake

Season	Male	Female	All sample
Winter 1999	log W = -1.499+2.951 log L r = 0.999 n = 3	log W = -0.727+2.470 log L r = 0.797 n = 3	log W = -1.440+2.937 log L r = 0.978 n = 9
Spring 2000	log W = -2.526+3.656 log L r = 0.958 n = 6	log W = -1.695+3.014 log L r = 0.742 n = 9	log W = -1.547+2.947 log L r = 0.823 n = 17
Summer 2000	log W = -1.948+3.221 log L r = 0.983 n = 7	log W = 1.607+0.755 log L r = 0.148 n = 11	log W = -0.837+2.381 log L r = 0.828 n = 25
Autumn 2000	log W = -1.959+3.210 log L r = 0.976 n = 15	log W = -2.305+3.376 log L r = 0.437 n = 12	log W = -1.697+3.023 log L r = 0.621 n = 28
Winter 2000	log W = -1.415+2.880 log L r = 0.942 n = 11	log W = -1.734+3.079 log L r = 0.989 n = 5	log W = -1.641+3.025 log L r = 0.983 n = 16
Spring 2001	log W = -1.515+2.937 log L r = 0.981 n = 54	log W = -1.486+2.935 log L r = 0.990 n = 20	log W = -1.496+2.929 log L r = 0.991 n = 79
Summer 2001	log W = -1.324+2.800 log L r = 0.987 n = 64	log W = -1.444+2.871 log L r = 0.989 n = 90	log W = -1.444+2.874 log L r = 0.990 n = 155
Total	log W = -1.449+2.892 log L r = 0.986 n = 152	log W = -1.264+2.737 log L r = 0.895 n = 139	log W = -1.402+2.847 log L r = 0.951 N = 328

Table 4: Condition factor of *C. carpio* in relation to date and sex in kockopru dam lake

Date	Male		Female		Juvenile		All samples	
	n	CF± SE (min-max)	n	CF± SE (min-max)	n	CF± SE (min-max)	n	CF± SE (min-max)
08.12.1999	3	2.670±0.014 (2.648- 2.696)	3	3.144±0.277 (2.618- 3.555)	3	2.881±0.070 (2.775- 3.013)	9	2.898±0.107 (2.618- 3.555)
23.04.2000	5	2.565±0.084 (2.326- 2.840)	9	2.747±0.102 (2.418- 3.391)	1	2.739	15	2.686±0.069 (2.326- 3.391)
13.05.2000	1	3.652			1	2.518	2	3.085±0.567 (2.518- 3.652)
24.06.2000	1	2.660	1	2.561	2	2.494±0.009 (2.485- 2.503)	4	2.552±0.039 (2.485- 2.660)
13.07.2000			4	2.440±0.092 (2.240- 2.681)	3	2.767±0.291 (2.300- 3.300)	7	2.580±0.137 (2.240- 3.300)
25.07.2000	6	2.434±0.146 (2.148- 3.043)	6	2.325±0.046 (2.176- 2.491)	2	2.506±0.004 (2.502- 2.509)	14	2.398±0.065 (2.148- 3.043)
07.09.2000	14	2.360±0.059 (2.025- 2.778)	11	2.359±0.071 (2.046- 2.922)			25	2.359±0.045 (2.025- 2.922)
18.10.2000	1	2.168	1	2.818			2	2.493±0.325 (2.168- 2.818)
22.11.2000	1	2.569					1	2.569
10.12.2000	10	2.517±0.070 (2.271- 3.081)	4	2.459±0.184 (2.055- 2.940)			14	2.500±0.068 (2.055- 3.081)
08.01.2001			1	2.556			1	2.556
12.05.2001	7	2.451±0.091 (2.076- 2.653)	8	2.667±0.058 (2.448- 3.003)	1	2.745	16	2.577±0.056 (2.076- 3.003)
25.05.2001	46	2.441±0.029 (2.011- 2.853)	13	2.554±0.098 (2.125- 3.516)	3	2.526±0.147 (2.294- 2.799)	62	2.468±0.031 (2.011- 3.516)
12.06.2001	23	2.418±0.062 (1.959- 2.976)	9	2.641±0.116 (2.232- 3.358)	2	2.370±0.048 (2.322- 2.418)	34	2.474±0.054 (1.959- 3.358)
28.06.2001	6	2.207±0.057 (2.065- 2.389)	8	2.423±0.076 (2.211- 2.777)			14	2.330±0.057 (2.065- 2.777)
13.07.2001	4	2.356±0.098 (2.191- 2.634)	21	2.320±0.042 (1.930- 2.626)	14	2.466±0.063 (2.064- 2.835)	39	2.376±0.034 (1.930- 2.835)
03.08.2001			1	2.048			1	2.048
22.08.2001	24	2.563±0.094 (2.091- 4.365)	39	2.370±0.055 (1.190- 3.269)			63	2.443±0.051 (1.190- 4.365)
Total	152	2.460±0.024 (1.959- 4.365)	139	2.464±0.028 (1.190- 3.555)	32	2.556±0.046 (2.064- 3.300)	323	2.471±0.017 (1.190- 4.365)

sufficient to comment of growth, ϕ' was evaluated and it was calculated as similar to the Nazik Lake's value. The reason of the smallness of L_{∞} in Kockopru Dam Lake was thought that there was insufficient time for the population to complete its biological life cycle after the introduction while this study was being conducted.

Condition factor was calculated as 2.471 ± 0.017 in overall samples (in male 2.460 ± 0.024 and in female

2.464 ± 0.028). The condition factor values were high in autumn and winter and were low in spring and summer (Table 4). When the values were compared with other populations of the Lake Van Basin, Nazik Lake population have similar value and the other populations had smaller values (Cetinkaya *et al.*, 2000; Sen, 2001). It is thought that the differences come from feeding capacity of the other sources; their results were lower than that of

Kockopru Dam Lake and their population masses were higher than that of Kockopru Dam Lake due to absence of commercial fishing.

Male female ratio was calculated as 1:0.94 (Table 5). The difference between the sexes was not significant ($p>0.05$). The observed 1:094 ratio was similar to 1:1 biological rule ratio. Male AND female ratio of Kockopru Dam Lake was parallel to those of Bendimahi and Karasu streams and Donerdere reservoir (Cetinkaya *et al.*, 2000) and different from Nazik Lake's result (Sen, 2001).

It was observed that in the 45-47.4 cm length group, more than 50% of samples were sexually mature (Table 6). These values showed that carp population in Kockopru Dam Lake reached to maturation after 45 cm fork length. This value was larger than that of Nazik Lake (43 cm) (Sen, 2001). It was also noticed that 50% of females began to mature when they were larger than 2000 g. Therefore, carp should not be fished smaller than 2000 g.

Carp population was distributed into the shallow areas near to mouths of Zilan and Ilıca streams in May. The bottoms of these regions were grassy. When a light pressure was applied to the abdomen of males caught in the second half of May and June, it was observed that they released milk. The specimens had reproduction nods on their heads and pectoral and pelvic fins. On the light of this knowledge, it can be said that carp has been reproduced in June in Kockopru Dam Lake. GSI values were not used to determine reproduction season because of insufficient mature females. Water temperature was

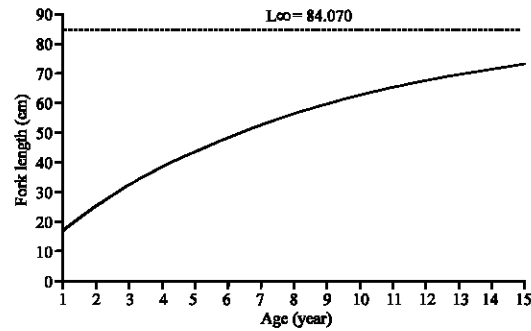


Fig. 1: Age length relationship of *C. carpio* in kockopru dam lake

Table 5: Sex ration of *C. carpio* in relation to sampling date in kockopru dam lake

Sampling date	Male		Female		Male: Female
	n	(%)	n	(%)	
08.12.1999	3	50	3	50	1:1.00
23.04.2000	5	35.7	9	64.3	1:1.8
13.05.2000	1	100	0	0	
24.06.2000	1	50	1	50	1:1.00
13.07.2000	0	0	4	100	
25.07.2000	6	50	6	50	1:1.00
07.09.2000	14	56.0	11	44.0	1:0.79
18.10.2000	1	50	1	50	1:1.00
22.11.2000	1	100	0	0	
10.12.2000	10	71.4	4	28.6	1:0.4
08.01.2001	0	0	1	100	
12.05.2001	7	46.7	8	53.3	1:1.14
25.05.2001	47	78.3	13	21.7	1:0.28
12.06.2001	23	71.9	9	28.1	1:0.39
28.06.2001	13	41.9	18	58.1	1:1.38
13.07.2001	4	14.8	23	85.2	1:5.75
03.08.2001	0	0	1	100	
22.08.2001	24	38.1	39	61.9	1:1.63
Total	160	51.4	151	48.6	1:0.94

Table 6: Maturity of *C. carpio* in relation to fork length and sex in kockopru dam lake

Length group (cm)	Male		Female		Juvenile n	All samples	
	Immature n (%)	Mature n (%)	Immature n (%)	Mature n (%)		Immature n (%)	Mature n (%)
7.5-9.9					1	1 (100)	
10-12.4							
12.5-14.9			1 (100)		2	3 (100)	
15-17.4			3 (100)		2	5 (100)	
17.5-19.9	1 (16.67)	5 (83.33)	16 (100)		1	18 (78.26)	5 (21.74)
20-22.4	3 (33.33)	6 (66.67)	15 (100)		1	19 (76.00)	6 (24.00)
22.5-24.9	3 (27.27)	8 (72.73)	11 (100)			14 (63.64)	8 (36.36)
25-27.4	4 (30.77)	9 (69.23)	16 (100)			21 (59.09)	9 (40.91)
27.5-29.9	1 (14.29)	6 (85.71)	8 (88.89)	1 (11.11)		9 (56.25)	7 (43.75)
30-32.4	1 (11.11)	8 (88.89)	10 (100)		1	12 (60.00)	8 (40.00)
32.5-34.9		24 (100)	7 (87.50)	1 (12.50)		7 (21.88)	25 (78.13)
35-37.4		29 (100)	10 (83.33)	2 (16.67)		10 (24.39)	31 (75.61)
37.5-39.9		24 (100)	8 (88.89)	1 (11.11)		8 (24.24)	25 (75.76)
40-42.4		10 (100)	8 (72.73)	3 (27.27)		8 (38.10)	13 (61.90)
42.5-44.9		4 (100)	5 (100)			5 (55.56)	4 (44.44)
45-47.4			1 (50.00)	1 (50.00)		1 (50.00)	1 (50.00)
47.5-49.9		1 (100)					1 (100)
50-52.4		2 (100)					2 (100)
52.5-54.9							1 (100)
55-57.4							1 (100)
57.5-59.9							1 (100)
60-62.4							2 (100)
Total	13 (8.72)	136 (91.28)	119 (88.15)	16 (11.85)	8	140 (47.95)	152 (52.05)

determined higher than 17°C in June. It was reported that the Nazik Lake population has reproduced from June to July (Sen, 2001).

CONCLUSION

The introduced carps to the Kockopru Dam Lake have made a sustainable population. The population orientated to the habitat can be said growing well and has an economic value. Current commercial fishing practice is dangerous for the future of population because immature specimens have been fished. The commercial fishing has to be regulated and controlled as soon as possible and some chance should be given to the population for at least one reproduction.

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