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Some of The Growth Characteristics of Carp (C*yprinus carpio* L., 1758) in Çernek Lake (Samsun, Turkey)

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Abstract

A total of 364 *Cyprinus carpio* were caught in the Çernek Lake from December 1999 to November 2000. The age composition of *C. carpio* specimens were between I-VI years. The observed sex ratio was 1.007 female: 1 male in the studied samples. An allometric growth pattern was proved from length-weight relationships. The mean condition factor for *C. carpio* in the study area was 1.767. The data obtained from this study were compared with those of the other populations of the same species in other regions of Turkey.

Keywords: Çernek Lake, carp, growth, condition factor, weight-length relationship

Introduction

Cyprinus carpio belonging to the family Cyprinidae has a common distribution in Turkey and in all over the world. *C. carpio* has a significant position in Turkey in terms of fisihing activities. It is found in many natural lakes and also in ponds and dam lakes. The amount of the domestic aquaculture is a total of 44.698 tones/year and 13.820 tones of this amount is composed of *Cyprinus carpio* which equals to 32% of the total production in a year (1). Since it has a important economic value, *C. carpio* is one of the most studied species in the world and in Turkey. There are many studies on various characteristics of *C. carpio* in Turkey (2-22).

However, there is no study on the growth properties of *C. carpio* in Çernek Lake. Therefore, the aim of the study is to examine the age composition, sex ratio, length and weight growth, length-weight correlation and codition factor of *C. carpio* sample which is eligible for fishing in Çernek Lake.

Study Site

Çernek Lake is located in the Kızılırmak Delta (41º40' N and 35º 46' E) in the Northern Turkey. Çernek Lake, located at the sea level, is a typical lagoon lake which is separeted from Black Sea by dune barrier. The surface area is 370 hectare and maximum depth is 1.95 meters. The lake water is slightly saline (average 0.75-1.28 ppt) and the lake is also non-stratified as a result of continous mixtures. In rainy seasons, natural channels that connect Çernek Lake to Balık Lake and other small temporal marshes are established.

Despite its small size, Çernek Lake is one of the most valuable wetlands in Turkey, because the lake and surrounding wetlands are characterized by a high degree of biodiversity with reference to the species and natural habitats, so it has been recognized as a “Ramsar Site” (23). Major fish species in the lake are *Cyprinus carpio, Mugil cephalus, Sander lucioperca, Scardinus erythrophthalmus, Leuciscus cephalus, Carassius carassius* and *Aphanius* sp.

Materials and Methods

All fish samples were caught from December 1999 to November 2000 by using gill nets of various mesh size ranging between 40-70 mm. Fork lenghts and weights of 364 specimens were measured to the nearest 0.1 cm and 0.1 g respectively. Scales were used for age determination according to Lagler (24), Crag-Hine and

Jones (25), Philipart (26). During the scale readings for age determination, Euromex-Arnhem binocular microscope and Ken-A Vision x100 Model microprojection were used.

The formulas OL = $(L_t-L_{t-1})/(L_{t-1}).100$ and OW = $(W_t-W_{t-1})/(W_{t-1})$ .100 were employed for relative length increment (RLI) and relative weigth increment (RWI), respectively, (27), where Lt = fork length at age t, L_{t-1}= fork length at t-1 age, W_t = weight at age t and W_{t-1}= weight at age t-1. Condition factor was calculated from the equation of $K=W/L^3$ of Lagler (1966). The length-weight relationship was computed separately for all female and male specimens by the equation; $W=aL^n$. Determining of growth (length and weight) and condition factor differences at same age between female and male specimens were statistically calculated with "t-test" in the %95 confidence interval (28). Statistical analyses were carried out using SPSS 11.0 programme.

Results

364 *Cyprinus carpio* samples caught in Çernek lake are found to have the age distribution of one year to six year. In terms of age composition, III (38.74%) and IV(32.42%) age groups appear to be dominant groups (71.16 %). For the samples of which sex is identified, the age distribution is similar to the overall distribution (Figure 1). For female samples, age composition ranges between II and VI age groups, whereas for male samples, it is between III and VI age groups. The sex of 273 samples is determined, of them 137 are female and 136 male. Thus, the sex ratio is found to be 1.007:1.

Length distribution of *C. carpio* samples is found to range between 130-880 mm and 84.64 % of the sample have the length of 242-447 mm (Figure 2). In female samples, minimum and maximum length values are 195 mm and 880 mm, respectively. These values are 235 mm and 525 mm in male samples (Table 1).

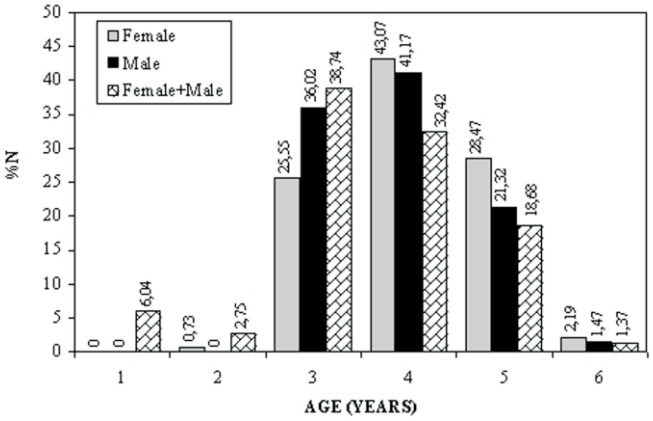

Figure 1. Frequency of age groups and sex ratio of *Cyprinus carpio* caught in Çernek Lake.

Table 1. Fork lenght (mm) and relative lenght increment (RLI) of *Cyprinus carpio* caught in Çernek Lake.

	Female			Male				Female+Male		
AGE	N	FL ± SD (Min-Max)	RLI %	N	FL ± SD (Min-Max)	RLI %	t-test	N	FL ± SD (Min-Max)	RLI %
I		-	-		-	-		22	152.3 ± 18.3 (130-185)	34.6%
II	1	195 (195-195)	-		-	-		10	205.0 ± 14.5 (180-235)	28.0%
III	35	267.6 ± 36.9 (225-395)	28.0%	49	273.6 ± 35.5 (235-395)	24.0%	p<0.05	141	262.4 ± 30.6 (220-395)	29.0%
IV	59	342.6 ± 25.7 (270-405)	17.5%	56	339.2 ± 18.9 (300-405)	14.7%	p<0.05	118	340.5 ± 22.5 (270-405)	16.5%
V	39	402.5 ± 86.0 (325-880)	21.7%	29	388.9 ± 38.9 (340-490)	27.9%	p<0.05	68	396.7 ± 69.8 (325-880)	24.3%
VI	3	490±13.2 (475-500)		2	497.5±38.9 (470-525)			5	493.0 ± 21.9 (470-525)	

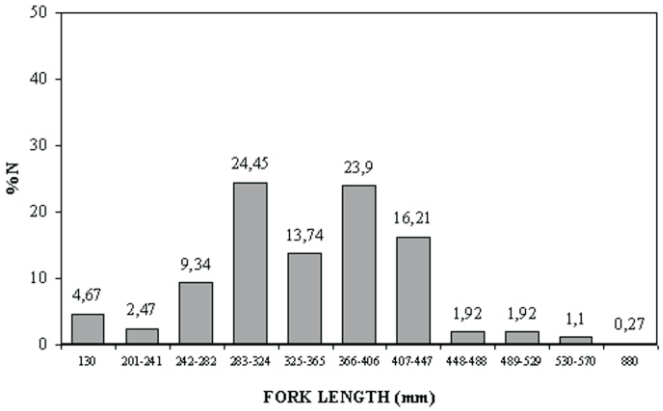

Figure 2. Fork Length (mm) frequency distribution of *Cyprinus carpio* living in Çernek Lake.

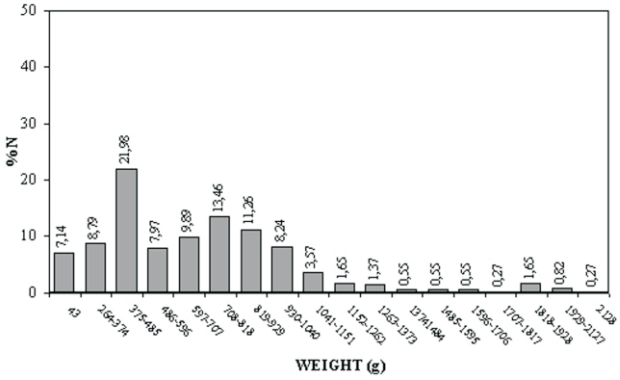

Figure 3. Weight (g) frequency distribution of Cyprinus carpio living in Çernek Lake.

In all the *C. carpio* samples (female+male), minimum weight is found to be 43 g and maximum is found to be 2128 g (Figure 3). Regarding to weight distribution, 80.49% of the samples have lower weight than 930 g. Only 19.51% of the samples have higher weight than 930 g. The minimum and maximum weight values for female samples are 154 g and 1870 g, and for male samples are 232 g. and 2128 g. Respectively (Table 2).

Table 1 shows the minimum, maximum and mean fork length values and relative length increases for overall populatin and both sex together with t-test results. Regarding absolute growth, it is found that length values iincrease depending on increase in age. In female and male samples, the value of absolute growth increases based on age. Mean values of length are found to be higher in females in contrast to males specially in IV and V ages. But it is not observed in the third year age group. The results of t-test indicate that length differences between two sexes are statistically significant ($P<0.05$).

Relative length increase (RLI) is found to be at the lowest level in the IV. age group and at the highest level in the I. age group. These values in both sexes are as follows: for females; the highest relative length increase is observed in the III. age group, whereas for males, in the V. age group. The lowest relative length increase for both sexes

Table 2. Weight (g) and relative weight increment (RWI) of *Cyprinus carpio* caught in Çernek Lake

	Female			Male				Female+Male		
AGE	N	W ± SD (Min-Max)	RWI %	N	W ± SD (Min-Max)	RWI %	t-test	N	W ± SD (Min-Max)	RWI %
I		-	-		-	-		22	71.7 ± 25.6 (43-121)	124.5%
II	1	154 (154-154)	-		-	-		10	161 ± 39.4 (99-257)	110.8%
III	35	350.8 ± 87.5 (224-579)	96.6%	49	388 ± 116.2 (232-724)	73.5%	p<0.05	141	339.4 ± 96.4 (193-724)	100.1%
IV	59	690.0 ± 148.3 (374-1130)	48.8%	56	673.2 ± 120 (490-1213)	49.8%	p<0.05	118	679.1 ± 134 (374-1213)	50.0%
V	39	1027 ± 308 (587-1825)	74.9%	29	1008 ± 320 (595-1790)	100.3%	p<0.05	68	1019.2 ± 311 (587-1825)	85.0%
VI	3	1796±65 (1744-170)		2	2019±154.2 (1910-2128)			5	1885.6 ± 151 (1744-2128)	

is observed in the IV. age group (Table 1).

Table 2 provides the minimum, maximum and mean weight values and relative weight increase for overall population and both sexes together with t-test results. As seen in Table 2, absolute weight increases based on age in ovellall population. Except for the III. age group, mean weight values of females are higher than those of males. It is found that absolute weight growth is statistically significant in all age groups of two sexes ($p<0.05$). Relative weight increase for overall population (female+male) is the highest in the first year of life and the lowest in the forth age group (Table 2).

Regression curve identifying the length-weight correlation for *C. carpio* samples caught in Çernek Lake reveals that length growth occurs more rapidly during the early years of life (Figure 4). It also indicates that length increase is faster than weight increase in early years of life and that later stage of life weight growth becomes faster in contrast to length growth. Besides, there is a positive curvial relationship between length growth and weight growth. The values of length-weight correlation for overall population, female and male samples are found as follows:

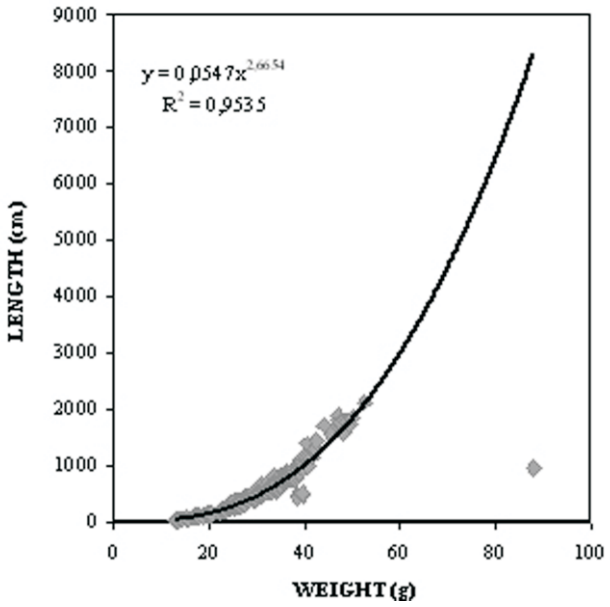

Figure 4. Length and weight relationship of Cyprinus carpio (female+male) caught in Çernek Lake.

$W = 0.0547\ L^{2.6654}$ for overall population (male+female)

$W = 0.2218\ L^{2.2674}$ for females

$W = 0.0745\ L^{2.5837}$ for males

Table 3. Condition factor results for female, male and combined sexes of *Cyprinus carpio* from The Çernek Lake.

	FEMALE			MALE				FEMALE+MALE	
Age	N	K ± SD (Min-Max)	SH	N	K ± SD (Min-Max)	SH	T testi	N	K ± SD (Min-Max)
I								22	1.965 ± 0.140 (1.665-2.276)
II	1							10	1.839 ± 0.130 (1.671-2.076)
III	35	1.855 ± 0.280 (0.780-2.118)	4,87	49	1.888 ± 0.260 (0.782-2.226)	3.749	p<0.05	141	1.866 ± 0.230 (0.779-2.547)
IV	59	1.696 ± 0.120 (1.396-2.072)	1,69	56	1.712 ± 0.110 (1.464-2.208)	1.541	p<0.05	118	1.704 ± 0.120 (1.396-2.207)
V	39	1.655 ± 0.270 (0.141-2.108)	4,48	29	1.866 ± 0.230 (1.396-2.207)	2.171	p<0.05	68	1.660 ± 0.220 (0.141-2.108)
VI	3			2				5	1.580 ± 0.160 (1.437 ± 1.839)
		K=1.724			K=1.765				K=1.776

Table 3 provides the minimum, maximum and mean condition factor values as well as t-test results for overall population and sexes. Mean condition factor value for overall population is found to be 1.776, for female K= 1.724, for males K= 1.765. The results of t-test indicate that difference in terms of K values between two sexes is statistically significant ($p<0.05$).

Discussion

In the study which aims at uncovering the growth characteristics of *C. carpio* population living in Çernek Lake, scales which are one of the significant parameters are used for age identification. Since its scale is very big and there are many fake age rings on the scale body, binocular microscope was employed and age identification was checked by micro-projection. The analysis shows that 364 *C. carpio* samples have age distribution ranging from one to six year (Table 1). Any samples belonging to 0 age was not found and those older than six year were not also collected. Beside, the most dominant age groups appear as III, IV and V age groups. The reason for the less number of samples to early and late age groups may be the selectivity of fishing net.

The rate of the fish sampled which belongs to the age groups IV and V age groups that are the most reproductive groups are 51.11%. These rates seem to indicate that there is a heavy fishing pressure in the lake. The other indicator of fishing pressure and natural mortality is that the number samples of after the V age group exhibits an immediate decrease and that there is no older samples rather than VI year old. On the other hand fishing of the samples at the age of active reproduction is one of the treating factors for the future of *C. carpio* population in Çernek Lake.

The sex ratio for *C. carpio* in Çernek Lake is found to be 1.007:1. This ratio is very close to one that is observed in natural populations. Similarly, Nikolskii (29) argues that sex ratio for many species in natural populations should be close to the ratio of 1:1. Therefore, the sex ratio found in the study is consistent with Nikolskii's assumption and it states that *C. carpio* population has an ideal sex ratio.

Length distribution of *C. carpio* sample varies between 130 mm and 880 mm. It is found that fishing activities are directed towards the samples with 242 mm-447 mm length interval and that such samples have higher reproduction capacity (Figure 2). Given that fishing of *C. carpio* having less length of 300 mm is prohibited in Turkey (30) and the rate of the fish with less than 300 mm length but hunted in Çernek Lake is 40.9%. It clearly shows that fishing prohibition is violated. Thus, the future of *C. carpio* population in Çernek Lake is under serious threat. Length differences between sexes is statistically significant for all age groups ($p<0.05$). However, since the number of the samples belonging to II and VI age groups is seldom, these samples were not analyzed in terms of length. It is determined that relative length increase is higher during the early years of life for both sexes and that it decreases once sexual maturity takes place (Table 1). This finding is consistent with the prediction of Wooton (31) who states that relative length growth being fast during the first years of life becomes slower at later periods of life because nutrition and energy is mostly used for gonad development and for the formation of sex cells. Values of length growth presented in Table 1 for overall population (female+male), male samples and female samples show consistency with the prediction of Nikolskii (29) who point out that length growth increases in parallel to age and that there is a linear relationship between age and length.

The minimum and maximum weight values for *C. carpio* population in Çernek Lake which is hunted are found to be 43 g. and 2128 g., respectively. 80.5 % of the sample has less weight values than 1000 g. which is stated to be the ideal fishing weight (21) (Table 2 and Figure 3). Like length values, weight values also indicate that the samples hunted have lower levels than ideal values. It also indicates misuse of fishing in the lake. Weight

differences between sexes appear to be statistically significant. Except for III age group, absolute weight means are higher for female samples in contrast to male samples. It may be due to the gonad weight of females who are sexually mature.

Similar to the mean absolute weight values, the values of relative weight increase are higher for female samples in contrast to male ones. As seen Table 2, weight growth is in parallel to age increase and that this growth is higher during the later ages in contrast to the early years.

Regression curves showing length-weight correlation indicate that there is a positive relationship between length and weight for overall population, female and male samples. It is also found that b value for the hunted population is 2.6654 (Figure 4). This finding shows that *C. carpio* population in Çernek Lake has allometric growth property. Correlation coefficient is found to be 0.9535. It indicates a strong and significant relationship between length and weight.

The value of condition factor which is calculated from weight and length parameters provides an understanding about nutrition features of habitat and it also provides a comparison about the same species living in distinct habitats. The values of condition factor for hunted *C. carpio* population are found as follows: 1.77 for allover population, 1.72 fro female samples and 1.76 for male samples. It is also seen that the value of condition factor decreases for *C. carpio* population in Çernek Lake (Table 3). However, for natural fish populations, the values of condition factors are expected to increase in parallel to the increase in age. As the reason of this result, it may be due to the fact that weight values are more effective on the condition factors and K value has linear proportional with weight and has reverse proportional with length.

Table 4 provides a comparison of growth values of *C. carpio* population living in different locations. As seen in Table 4, the values of growth for *C. carpio* living in Çernek Lake are close to those for *C. carpio* population found in Eğirdir, Beyşehir, Çavuşçu, Balık, Çıldır, Yeniçağa, İznik and Liman Lakes. The growth values of *C. carpio* sampled in Çernek Lake are higher than those of *C. carpio* observed in Gölcük, Hafik and Akşehir Lakes, and appear to be lower than those found in Gölmarmara, Köyceğiz Lagoon Lake. Such differences in growth values of *C. carpio* population is thought to be due to such factors as climate, ecological and limnological structure of the locations as well as nutrition differences, density of population, inter- and intra species competition and fishing techniques employed.

In conclusion, the growth characteristics of *C. carpio* population living in Çernek Lake reflect those characteristics that are observed and expected for natural fish populations. Because of fishing devoted to the active reproductive specimens and violation of hunting prohibition, *C. carpio* population in Çernek Lake is in dangerous condition and next generation is under the threat. Thus, it is necessary conform to minimum hunting length-weight and it should be inspected hunting techniques in the lake.

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Table 4. Comparing length, weight and condition factor values of Cyprinus carpio living in Liman Lake with the other studies results.

		Fork Length (mm)											Weight										K
		Age Groups											Age Groups										Value
	Study Area	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	
Alpbaz and Hoşsucu (1979) (32)	Göl Marmara	252	416	513	578	645	800						340	650	2892	4083	5900	9750						**1,6**
Erdem (1983a) (8)	Eğridir Lake	141	231	314	361	400	440	501	545	588	639	660	77	233	457	716	976	1313	1886	2228	2660	3320	3987	**1,6**
Erdem (1983a, 1984a) (8, 10)	Beyşehir Lake	150	231	310	355	404	458	499	556	609	651	679	97	276	567	782	1191	1548	2114	2605	3090	3664	4182	**1,6**
Erdem (1983a, b) (8, 9)	Çavuşçu Lake	141	220	288	349	411	455	501	560	611	680		69	193	417	674	1078	1377	1890	2522	3108	3767		**1,8**
Balık and Ustaoğlu (1987) (14)	Gölcük Lake	77	103	136	163	172	192	209	232	256	274	314	8	19	38	64	76	98	125	178	238	288	451	**1,5**
Cengizler and Erdem (1988)(33)	Hafik Lake	128	185	238	269	305	332	365					52	134	263	372	500	655	940					-
Yerli (1992) (15)	Köyceğiz Lagoon	224	308	356	414	475	547	600		662	712		217	496	742	1180	1764	2474	3442					-
Demirkalp (1992) (16)	Bafra Balık Lakes	165	268	319	365	442	516	535	630				116	382	628	905	1625	2561	2824	4050				**1,8**
Çetinkaya (1992) (17)	Akşehir Lake	143	181	215	239	258	290	322	369	430	465	533	51	98	157	217	271	374	499					-
Yerli (1997) (34)	Çıldır Lake		216	266	297	331	384	469	471	500				206	342	486	715	1028	1431	2073	2180			-
Demirkalp and Saygı (2001) (19)	Yeniçağa Lake	238	229	266	299	313	404	475	577	568	632		222	229	386	572	652	1260	2093	3135	3503	4875		**1,9**
Ozeren (2004) (21)	Iznik Lake	61	122	174	248	392	653	810					5	42	110	320	1141	4572	8422					**1,9**
Demirkalp et al. (2006)(22)	Liman Lake	192	221	247	293	339	407						148	218	296	448	739	1274						1,8
This Study	Çernek Lake	152	205	262	340	396	493						71	161	339	679	1019	1985						-

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