Age, Growth and Mortality of Common Carp (*Cyprinus carpio* Linneaus, 1758) Population in Almus Dam Lake (Tokat- Turkey)

Mehmet KARATAŞ[1*]   Erdoğan ÇİÇEK[2]   Asiye BAŞUSTA[3]   Nuri BAŞUSTA[3]

[1] Gaziosmanpaşa University, Faculty of Agriculture Tokat-TURKEY

[2] Gaziantep University, Faculty of Arts and Sciences, Department of Biology, 27310 Şahinbey, Gaziantep-TURKEY

[3] Fırat University, Fisheries Faculty, 23119, Elazığ-TURKEY

Abstract

This study was carried out between October 2002 to September 2003 in Almus Dam Lake. A total of 308 Common Carp were fished by monthly sampling and examined. Age composition varied from I to V, and they were composed of 48.3% females, 50.7% males. Mean total length and weight values for females, males and their pooled data were calculated as follows 22.45±2.57cm-150.12±56.05 g, 24.33±3.27cm-213.67±107.82 g and 23.55±3.14 cm-187.38±95.27 g respectively. In addition to this, the calculated length-weight relationships were estimated as $W=0.0070L^{3.2136}$ for females, $W=0.0053*L^{3.2771}$ for males and $W=0.0049*L^{3.3191}$ for their pooled data. Growth parameters of the population: L_∞=46.39 cm, K=0.153 year^{-1} and t_o=-1,922. The relationship between fork length and total length were calculated as TL=1.0439*FL+0.1626 for females, TL=1.0256*FL+0.6261 for males and TL=1.035*FL+0.3917 for pooled data. Fulton's Condition Factor and Phiprime values were estimated as K=1.338 and Φ′=5.80 respectively. Total mortality (Z) and natural mortality (M) rates were estimated as 0.64 year and 0.32 year respectively. Exploitation rate (E) was calculated as 0.50.

Key words: Age, Growth, Mortality, Carp

INTRODUCTION

Almus dam lake was constructed on Yeşilırmak river in 1966 (Almus, Tokat). Total area of the lake 3130 km^2. The dam is using for agricultural irrigation and energy production. General climatic characteristics of the region is cold in winter, hot and dry in summer. Surface water temperature is 3°C in winter, 10°C in spring and autumn, 25,5^{o}C in summer and mean temperature were calculated as 17.4 ±6.47 ^{o}C [1].

Common carp *(Cyprinus carpio)* prefers water bodies with stagnant and slowly flowing waters with sand and/ or silt bottoms with shell incorporations [2]. Common carp are frequently cultured and are of great commercial value as a food fish both over their native and introduced range [3].

Common carp is stocked into natural waters, reservoirs, and temporarily inundated areas, in order to utilize the natural food production of these waters for enhanced capture fisheries and this is also done by DSI in Turkey.

Common carp production in Turkey was nearly 38 percent of the total freshwater capture production in 2004 (14 134 tonnes). While production in 1954 2 010 t and only increasing in subsequent decades to 3 150 t in 1964, 5 980 t in 1974 and peaked up in 1984 with 18 655 t. Fishery yield appears to be gradually declining from 16 188 t in 1994 to 14 134 t in 2004 [4]. The majority of the carp are consumed domestically as fresh fish.

There are several studies are given detailed information about age and growth of common carp population in different water bodies of Turkey [5, 6, 7-14, 15-17, 18, 19, 20, 21].

Some population parameters of *Barbus plebeius, Capoeta tinca, Copoeta capoeta, Leuciscus cephalus* inhabiting Almus Dam Lake were studied previous studies [22, 23-24]. Pabucçu

[25] were studied hydrographical characteristics and algae of the dam lake. But there were no study related about common carp population of Almus Dam Lake in the last decade. Therefore, the aim of this study is the identification of the age, growth and mortality parameters of common carp.

MATERIALS AND METHODS

This study was carried out between October 2002 to September 2003 in Almus Dam Lake. Fishes were obtained by monthly sampling using nets of various mesh sizes from the different stations. Fish samples were transferred from field to the laboratory immediately, and then total length and total weight were measured and weighted to the nearest 1mm and 0.01g respectively. The scales were taken from above the lateral line, behind the pectoral fin. Scales were cleaned by water and examined under the stereo binocular microscope for the age determination. Sex was macroscopically identified by using gonads of the specimens. Sex ratio was determined and chi-square test (χ^2 test) was used to determine whether the sex ratio varied from 1:1.

The length-weight relationships were determined according to the allometric equation given by Ricker [28]; $W=a*L^b$ where W: weight in grams, L: total length in centimeter, *a* and *b* are constants. The growth parameters K, L_∞ and t_o were estimated using the Least Squares Method recommended by Sparre and Venema [26].

The von Bertalanffy growth function (vBGF) was used to fit the values of growth in length and Phiprime (Φ′) was used to study overall growth performance [26].

$L_t= L_\infty(1-e^{-K(t-to)})$ where L_t: length at age t, L_∞: infinity length, K: growth coefficient, t_o: hypothetical age at birth.

$Φ'=lnK+2ln\,L_∞$ where $Φ'$: overall growth performance.

Fulton's Condition Factor was calculated using the equation as follows; $CF = \dfrac{\overline{W}}{\overline{L}^3}*100$ where $\overline{W}$: mean total weight in g

and $\overline{L}$: mean total length in cm.

Total mortality rate (Z) were estimated using following equation [26-27]; $Z = K*\dfrac{(L∞-\overline{Lc})}{(\overline{Lc}-Lc)}$ where $\overline{Lc}$ is average

length of the entire catch and Lc: length at which 50% of the fish entering the gear are retained. Natural mortality (M) were estimated using Pauly's empirical formula [26];

$\ln M = -0.0152 - 0.279*\ln L∞ + 0.6543*\ln K + 0.463*\ln T$ where T is average annual temperature at surface in degrees centigrade).

The exploitation rate was estimated using this equation [26]; $E = \dfrac{F}{Z}$ where F: fishing mortality.

Because of fork length were used for growth studies in carp, like as other freshwater fish species, the relationship between regression method for transformation between fork length and total length.

RESULTS AND DISCUSSION

A total of 307 common carp were sampled, 127 males and 180 females. Overall sex ratio between females and males ratio was 1:1.42, which is significantly different from 1:1 ($χ^2$=9.14 at P<0.01). The percentage of females (58.6% of the samples) is different from Erdem [13] (46.6%), but there is close similarity with Kırankaya and Ekmekçi [26] (58.70%). Overall sex ratio between females and males ratio was 1:1.42, which is significantly different from 1:1 ($χ^2$=9.14 at P<0.01).

In previous studies, some population parameters of carp were listed in Table 1. All of the previous studies, fork length were used to estimate growth parameters of common carp. So it cannot be easy to comparison between this study and previous studies. All of the comparisons were done ignoring this situation.

The total length of all individual varied from 14.0 to 36.0 cm and mean total length calculated as 23.55±3.14 cm for pooled data, 24.33±3.27 cm for females and 22.45±2.57cm for males (Table 2). There were no significant differences between lengths of the sexes, so all fo the calculation were made using total length and fork length were calculated using linear

Table 1. Mean fork length in each age (cm), growth parameters, condition factor and Phi Prime ($Φ'$) values of *Cyprinus carpio* in the previous studies.

Author/s	Mean Fork Length in each Age (cm)					a	b	r^2	$L_∞$ (cm)	K (year^{-1})	t_0 (year)	$Φ'$	CF
	I	II	III	IV	V								
Karabatak, 1973	18.1	27.1	31.8	35.0	38.6	0.096	2.531		92.30	0.099	-0.651	6.74	1.769
Erdem, 1980	-	-	33.2	40.1	47.0	-	-	-	-	-	-	-	1.670
Erdem, 1982	16.3	25.1	34.1	38.0	44.9	-	-	-	-	-	-	-	1.889
Erdem, 1983a	16.3	24.0	30.1	36.9	41.5	0.019	2.938	-	-	-	-	-	1.548
Erdem, 1983b	16.3	23.9	30.1	36.5	41.5	0.077	2.568	-	-	-	-	-	
Erdem, 1984a	14.2	23.2	32.2	36.5	42.2	0.040	2.674	-	-	-	-	-	1.827
Erdem, 1984b	15.3	23.2	31.8	35.9	41.3	0.063	2.610	-	109.76	0.100	-0.866	7.10	1.910
Balık and Ustaoğlu, 1987	7.7	10.3	13.6	16.3	17.2	0.028	2.989	0.990	-	-	-	-	1.487
Erdem, 1988	11.3	17.8	23.9	28.2	30.8	0.151	2.489	-	80.71	0.110	-0.616	6.57	1.836
Cengizler and Erdem, 1989	12.8	18.5	23.9	26.9	30.5	-	2.713	-	54.53	0.140	-0.753	6.03	
Balık and Ustaoğlu, 1990	6.5	9.6	12.6	15.5	18.2	0.00001	2.687	0.994		0.039	-0.989	-	2.322
Erdem et al., 1992	11.4	17.7	24.2	27.8	31.4	0.019	2.944	-	50.24	1.182	-1.622	8.00	
Balık et al., 1997	10.6	14.4	17.5	20.5	-	-	-	-	-	-	-	-	2.69
Alp and Balık, 2000	16.8	25.7	31.8	40.0	45.7	0.025	2.874	-	72.76	0.172	-0.446	6.82	
Özyurt and Avşar, 2001	17.3	25.2	29.4	32.5	35.9	-	-	-	64.43	0.115	-1.862	6.19	1.55
Kırankaya and Ekmekçi, 2004	20.8	26.5	34.3	43.3	53.5	0.022	3.023	0.956	-	-	-	-	2.34
This study (total length)	18.1	22.0	24.5	29.4	31.2	0.005	3.319	0.944	46.39	0.153	-1.922	5.80	1,34

Table 2. *Cyprinus carpio* in Almus Dam Lake, Age, Growth in Length and Weight (n: Number of Samples; Min: Minimum; Max: Maximum Mean: SE: Standard Error)

Age Group	n	Total Length (cm)			Total Weight (g)		
		Min	Max	Mean	Min	Max	Mean
I	26	14.0	21.5	18.10±1.95	35.6	115.2	72.18±23.33
II	109	19.5	23.7	22.01±0.95	100.6	180.0	137.052±19.45
III	148	22.1	28.7	24.48±1.28	129.2	258.5	204.19±37.55
IV	13	27.2	33.5	29.39±1.71	247.0	612.3	356.87±93.54
V	8	28.4	35.2	31.15±2.25	383.8	538.9	475.23±59.66
VI	-	-	-	-	-	-	-
VII	3	35.0	36.0	35.67±0.58	629.7	701.4	666.63±35.90
Total	307	14.0	21.5	23.55±3.14	35.6	701.4	187.38±95.27

combined data (females+males). Dominant length groups were 23 cm (%20.52), and follows 22 cm (%16.61) and 24 cm (%14.66) respectively (Figure 1). As summarized in Table 1, the total weight was ranged from 35.6 to 701.4 g, and mean total weight were calculated as 187.38±95.25 g.

Age composition of common carp varied from I to VII (Table 1). According to the percentage occurrence, age group III was dominant (48.2%), nearly half of the sample were III years old, and it was followed by the age groups II (35.5%), I

(8.5%), IV (4.2%) and V (2.6%) respectively any species of age VI and only 3 specimens of age VII years were found.

The exponential relationship between length and weight were plotted for combined sexes in Figure 2. The regression constants *a* and *b* were estimated as 0.00486 and 3.3191 respectively. Type of growth shows a positive allometric (A+) growth because of the *b* value over to 3.

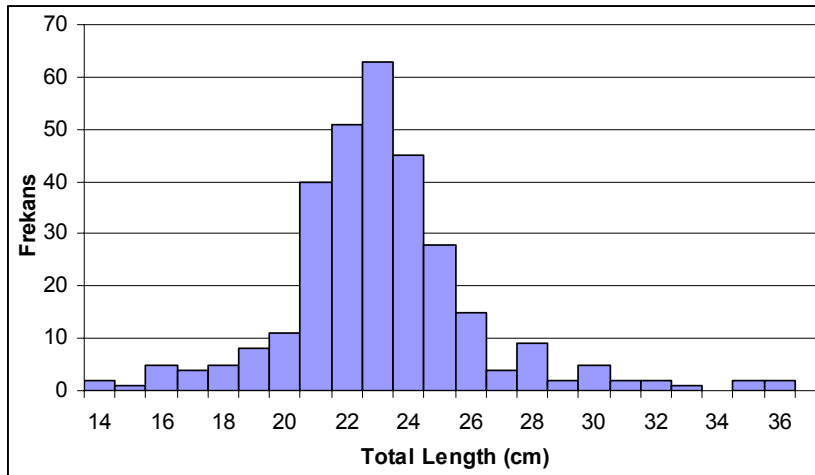Mean Fulton's condition factor (CF) of common carp population was calculated as 1.338±0.15. According to

Figure 1. Length-frequency distribution of *Cyprinus carpio* in Almus Dam Lake
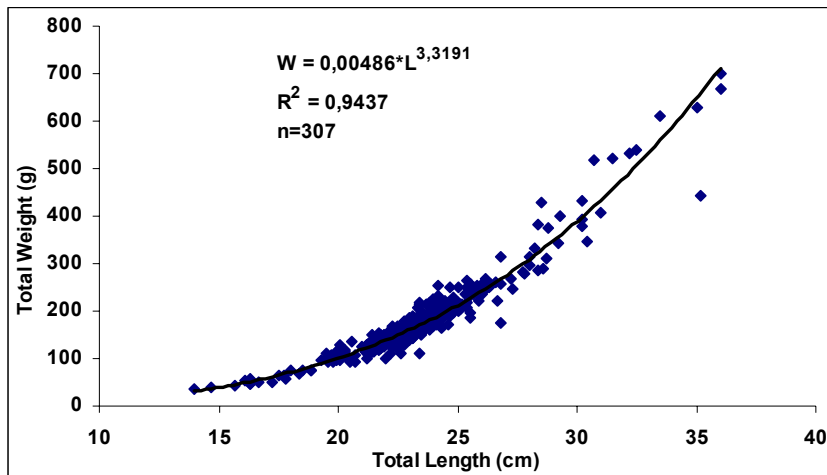

Figure 2. Length-weight relationship of *Cyprinus carpio* in Almus Dam Lake

individual condition factor, the value varied from 0.87 to 1.86. Mean condition factor was calculated as 1.39±0.13 (varied from 1.01 to 1.86) for felames, and 1.27±0.14 (varied from 0.87 to 1.64) for males. Mean condition factor of males was smaller than females. Condition factor were varied from 1.49 to 2.69 year^{-1} [13]. In order to determine overall growth performance, Phiprime (Φ′)were calculated for females, males and combined sexes as 6.01, 5.84 and 5.80 respectively.

The previous studies value of the Phi Prime varied from 6,03 [18] to 8,00 [14]. All of these studies Phi Prime value were higher than in this study. Both condition factor and Phi Prime of males were smaller than that of females. In this case, it can be claim that growth performance of the females were higher than males in Almus Dam Lake population.

The von Bertalanffy growth parameters were estimated as: L_∞=47.24 cm K=0.183 year^{-1}, t_o=-1.982 year for females; L_∞=41.61 cm K=0.198 year^{-1}, t_o=-1.428 year for males, and L_∞=46.39 cm K=0.153 year^{-1}, t_o=-1.922 year for combined

sexes. L_∞ value varied from 50.24 [14] to 109.76 [12]. L_∞ was estimated as 46.39 cm in this study, and this value is smaller than even observed length in Erdem et al. [14].

The back-calculated total length and weight-at-age was calculated using growth parameters in each age group (Table 3). A significant correlation (r=0.99) was determined between observed and back-calculated length and weight values. But the mean back-calculated lengths of each age group were smaller than (except age group III) the observed length.

The relationship between total length (TL) and fork length (FL) was described by the linear equations TL=1.0439*FL+0.1626 (r^2: 0.98, n: 180) for females, TL=1.0256*FL+0.6261 (r^2: 0.98, n: 127) for males, and TL=1.035*FL+0.3917 (r^2: 0.98, n: 307) for combined sexes.

Mortality Rates

Total mortality for combined sexes was Z=0.64 year^{-1}. Both of natural mortality (M) and fishing mortality (F) were estimated as 0.32 year^{-1} respectively. Exploitation rate of the population was calculated as E=0.50.

Total mortality rate was estimated as 0.64 year^{-1}. Both of natural and fishing mortalities were 0.32. So there were no differences between natural and fishing mortality. Exploitation rate were calculated as 0.50 using mortality rates. The exploitation rate indicates that, there is not any fishing pressure on the carp population in Almus Dam Lake. It can be claim that, carp population of the Almus Dam Lake is managed ideally.

Table 3. Observed and calculated total length and weight of *Cyprinus carpio* in Almus Dam Lake

Age Group	Measured		Calculated	
	Total Length (cm)	Weight (g)	Total Length (cm)	Weight (g)
I	18.10	71.18	16.72	55.84
II	22.01	137.52	20.93	117.64
III	24.48	204.19	24.54	199.53
IV	29.39	356.87	27.64	296.09
V	31.15	475.23	30.30	401.63
VI	---	---	32.59	511.10
VII	35.67	666.63	34.54	620.35

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