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Some Biological Properties of Carp (*Cyprinus carpio* L., 1758) Introduced into Damsa Dam Lake, Cappadocia Region, Turkey

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Abstract.- Age composition, length–weight relationships, growth, and condition factors of the carp (*Cyprinus carpio* L.,1758) were determined using specimens (39.38% female and 60.62% male) collected from Damsa Dam Lake between May 2010 and April 2011. The age composition of the samples was from I to VIII. The length–weight relationship was calculated as $W = 0.0181\ TL^{2.9689}$ for females and $W = 0.0278\ TL^{2.8507}$ for males. The total lengths were between 17.1 and 69.2 cm, and the total weights were found to be between 86 and 5473 g. The majority of the individuals (48.12%) were between 46.0 and 55.0 cm length groups. The von Bertalanffy growth equation were found as $L_\infty = 86.80$ cm, K = 0.189, $t_0 = -0.396$ for females and $L_\infty = 85.34$ cm, K = 0.175, $t_0 = -0.468$ for males. The growth performance index was also estimated as $\Phi' = 7.260$ for females and $\Phi' = 7.151$ for males. The mean condition factor was found as 1.582 for females and 1.572 for males. The total mortality (Z) was calculated as 0.25 yıl^{-1}.

Keywords: Carp, *Cyprinus carpio*, age composition, condition factor, Damsa Dam Lake.

INTRODUCTION

The economic value of the common carp is increased by the growth speed in terms of length and weight, high meat yield, non-selective habitat use, tasty meat, and easy production availability in fish farms (Demirkalp, 1992). Therefore, common carp has been introduced into many water bodies throughout the world, including Europe, Australia, and North America. The wide distribution and successful introductions of common carp are mostly due to their tolerance to variable environmental conditions (Mills *et al*., 1993).

Common carp, the most common cyprinid species that creates an important part of inland freshwater fish production (Çetinkaya, 2006; Balık *et al*., 2006), is introduced to inland waters (lake, dam lake, stream) in different regions of Turkey. The common carp is one of the three economic fish species in Damsa Dam Lake. Other species are tench (*Tinca tinca* L. 1758) and perch (*Sander lucioperca* L. 1758). At first, carp, which is a non-native species in the Damsa Dam Lake was introduced in 1972, and followed periodically until 2012 by DSİ (General Directorate State of State Hydraulic Works).

The common carp is composed of 27% aquaculture production (37,000 tonnes) of Turkey in 2011 (www. tuik.gov.tr). In Turkey, the vast majority of aquaculture production is from unnatural sources. Increase in the production of aquaculture is important to the development of the existing food sources and also in terms of contributing to the country's economy. As aquaculture is used as a source of protein in diet, it should be managed and protected as well. The fish populations in wetlands are renewable sources if they are benefitted in a planned manner (Alp and Balık, 2000). But, fish populations in natural environments undergo constant change through several factors and so these studies must be carried out periodically.

Cappadocia region is located in plains and the rugged plateau region of eastern central Anatolia around the upper and middle reaches of the Kızılırmak River. Although Damsa Dam Lake is not the biggest freshwater source in this region, it is one of the most efficient sources in terms of fish production.

If these fish resources are determined and fisheries activities based on scientific activities are planned, these resources will be economically sustainable (Geldiay and Balık, 2007; Ünver and Kekilli, 2010). In Turkey, first studies on carp

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populations were started by Numann (1958) followed by several studies in the biological properties such as age, growth, length-weight relations, age-length and age-weight relations to the common carp population at freshwater resources in different parts of Turkey and other countries (Erdem, 1984; Özyurt and Avşar, 2001; Kırankaya and Ekmekçi, 2004; Karataş *et al*., 2007; Yılmaz *et al*., 2007, 2010; Mert *et al*., 2008; Ünver and Yıldırım, 2011; Qayyum *et al*., 2005; Kolaneci *et al*., 2010,).

However, there is no information available regarding the biological properties of the common carp population in Damsa Dam Lake. Therefore, we aimed to determine the total mortality and some biological parameters, such as age and sex distribution, age-length, age-weight, length–weight relationship, condition factor of common carp population and our data are compared with results from other populations.

MATERIALS AND METHODS

Study area and collection of samples

The Damsa Reservoir (38°32'54"N, 34°55'27"E), constructed on the Damsa Creek in Ürgüp-Nevşehir for irrigation and flood prevention purposes in 1971 also provides irrigation service for an area with 1330 hectares (Fig. 1). This reservoir is at a distance of 30 km from Nevşehir and 7 km from Ürgüp. Its height of the stream bed is 31.5 m, its volume is 712,000 m^3 on the normal water level, its extent is 0.82 km^2, and its altitude is 1223 m (Anonymous, 1992).

For this study, 160 specimens were captured monthly using gill nets (mesh size 24×24, 32×32, 40×40, 48×48, 60×60, 70×70, 80×80) between May 2010 and April 2011 in Damsa Reservoir. Fish samples were transported to the laboratory for the analysis of total length (TL) to nearest 0.1 cm and weight (W) to nearest 0.1 g. Sex was determined by macroscopic observation of the gonads. Scales were used for age determination according to Lagler (1966). The age–length relationship ($L_t = L_\infty[1–e^{-k(t–to)}]$) and the age–weight relationship ($W_t = W_\infty[1\text{-}e^{-k(t–to)}]^b$), were determined using the von Bertalanffy growth equations, where *Lt* is length of fish (cm) at age *t*, $L\infty$ is the asymptotic fish length (cm), W_t is the weight of fish (g) at age *t*, $W\infty$ is the asymptotic fish weight (g), *t* is the fish age (year), $t_o$is the hypothetical time at which the length of fish is zero, and *k* is the growth coefficient ($year^{-1}$) (Bertalanffy, 1938). The length–weight relationship was calculated using Le Creen (1951)'s allometric growth formula: $W = a.\ L^b$, which transformed into its logarithmic expression: Log*W*=log(*a)+b*log(L)*, where *L* is the total length (cm), *W* is the weight (g), *a* and *b* are constants. Condition coefficients were calculated for both sexes using the equation $K = (W/L^3) \times 100$, where *W:* gutted weight in grams, *L:* total length in cm (Bagenal and Tesch, 1978). The overall growth performance (Φ', phi prime) was calculated to compare the growth parameters to other growth parameters for the same species from different localities. This equation is Φ' = Log K + 2*Log L_∞ (Sparre and Venema, 1998). The total mortality rate which Beverton and Holt (1957)'s developed using the average length is calculated using this equation [$Z = K\times(L_\infty - \bar{L}) / (\bar{L} - L')$] where the von Bertalanffy growth parameters K and L∞, the so-called length of first capture (smallest size at which animals are fully vulnerable to the fishery and to the sampling gear), Lc, and the mean length of the animals ($\bar{L}$) above the length Lc.

Statistical analysis

To compare the growth and condition factor values between male and female specimens of the same age group, *t*-test was used and $P<0.05$ was accepted as the significant value (Düzgüneş, 1975). Sex ratios were tested with Chi-squared analyses (χ^2). Statistical analyses were carried out using SPSS software.

RESULTS

The age and sex distribution for *C. carpio* in the Damsa Dam Lake are given in Table I. The population was composed of 39.38% female and 60.62% male individuals. Male individuals were observed to be more dominant than females. The overall sex ratio of male and female was 1.54:1, which is different significantly from the theoretical 1:1 sex ratio ($\chi^2=27.37>\chi^2_{7,0.05}=14.07$). The age distribution of the carp population was observed between 1 and 8. Females were present in all age

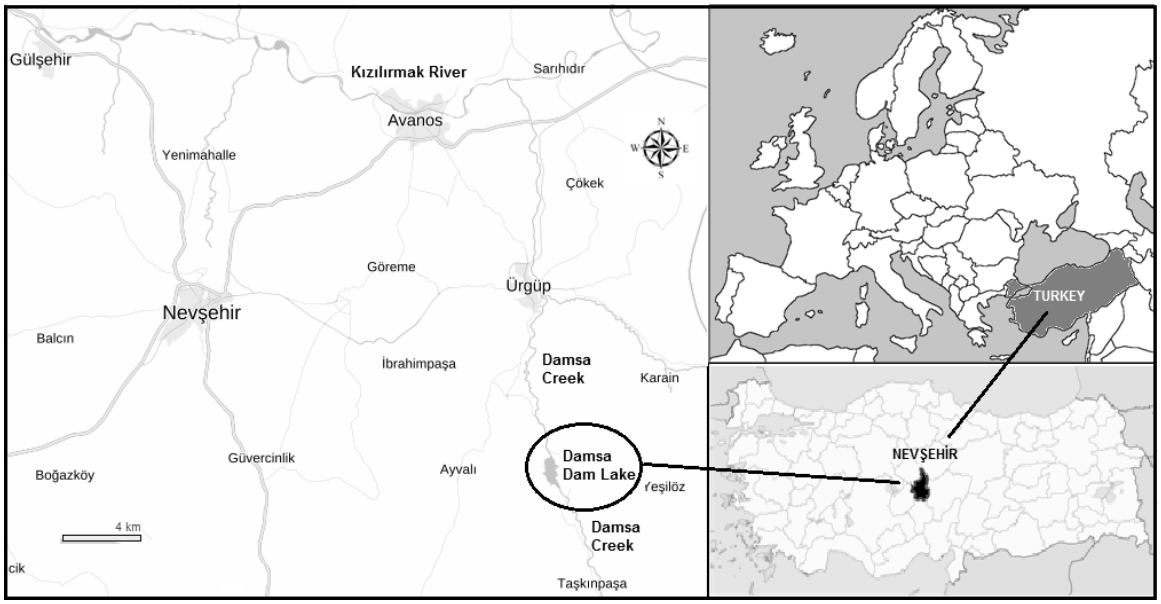

Fig. 1. Study area

Table I.- The mean fork length of different ages and significance levels of differences between sexes in the same ages of *C. carpio* in Damsa Dam Lake.

Age group	Female		Male		t-test	Female+Male	
	n (% of total)	Mean±SD (min-max)	n (% of total)	Mean±SD (min-max)		n (% of total)	Mean±SD (min-max)
I	2 (1.3)	17.95±0.64 (17.5-18.4)	5 (3.1)	20.3±2.38 (17.1-23.5)	p>0.05 (insignificant)	7 (9.8)	19.6±2.27 (17.1-23.5)
II	5 (3.1)	31.5±4.25 (26.8-35.8)	13 (8.1)	30.49±6.82 (21.0-38.5)	p>0.05 (insignificant)	18 (8.3)	30.8±6.11 (20.7-38.5)
III	3 (1.9)	37.86±2.05 (35.5-38.9)	15 (9.4)	39.53±2.52 (35.0-44.02)	p>0.05 (insignificant)	18 (11.3)	39.3±2.48 (35.0-44.0)
IV	20 (12.5)	47.63±2.41 (41.5-50.9)	36 (22.5)	47.99±1.6 (44.4-50.7)	p>0.05 (insignificant)	56 (35)	47.9±1.91 (41.5-50.9)
V	9 (5.6)	52.18±1.16 (50.0-53.5)	17 (10.6)	52.58±2.33 (45.5-55.0)	p>0.05 (insignificant)	26 (16.3)	52.4±1.99 (45.5-55.3)
VI	8 (5.0)	58.23±2.01 (56.4-65.5)	10 (6.3)	57.99±1.07 (56.1-59.4)	p>0.05 (insignificant)	18 (11.3)	58.1±1.51 (55.1-60.4)
VII	14 (8.8)	61.50±2.33 (56.4-65.5)	1 (0.6)	62.8	-	15 (9.4)	61.6±2.33 (57.8-65.5)
VIII	2 (1.3)	67.6±2.62 (66.4-69.2)	-	-	-	2 (1.3)	67.6±2.26 (66.0-69.2)

groups but there weren't any males in age group VIII. Except in VII and VIII age groups, males were more than females in the other age groups. The most dominant age group was IV (35%) followed by age group V (16.3%), II (11.3%), III (11.3%) and VI (11.3%), respectively (Table I).

The total length distribution of the captured *C. carpio* samples is given in Table I. Of the specimens examined, the total length ranges between 17.1 and 69.2 cm. In female and male samples, the minimum and maximum total length values were determined as 17.5–17.1 cm and 62.8–

69.2 cm, respectively. The differences between the total lengths of male and female individuals in the same age were not found statistically significant (P> 0.05) (Table I). The results show that the most abundant total length group (Fig. 2) is 46-55 cm for female and 56-65 cm group for male.

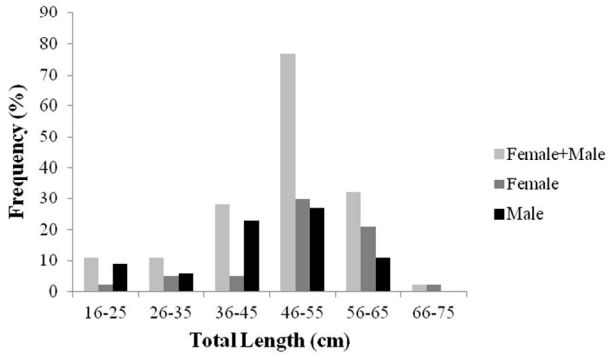

Fig. 2. Length-frequency distribution of *C. carpio* in Damsa Dam Lake.

As shown in the equations, the von Bertalanffy age-length relationship in female examined population grew to a greater asymptotic length (L_∞) than the males, but the value of K is lower than in males (Table II).

The weight of the individuals were examined and ranged from 86 g to 5473 g. In female and male samples, the minimum and maximum weight values were 86.51–91.79 g and 5573–3819 g, respectively. The difference between male and female individuals weight in the same age was not found statistically significant (P>0.05) (Table III).

As shown in the equations, the von Bertalanffy age-weight relationship in the examined population, females grew to a greater asymptotic length (W_∞) than the males but the value of K is lower than males (Table II).

The allometric growth parameters and growth equations that is used to calculate the length-weight relationship of *C. carpio* individuals were given in Table IV. The length-weight curves for males, females, and combined sexes are given in Figure 3.

On analyzing the condition factors, the highest condition factor was found to in the age group III for female and in age group II for male. The lowest condition factor was found to be in the age group V for female and in age group IV for male. The mean condition factor of females (1.582) was higher than that of males (1.572). The results of the *t*-test indicated that there were not a significant (P>0.05) difference in the mean values of condition factor between the two sexes of this species (Table VI).

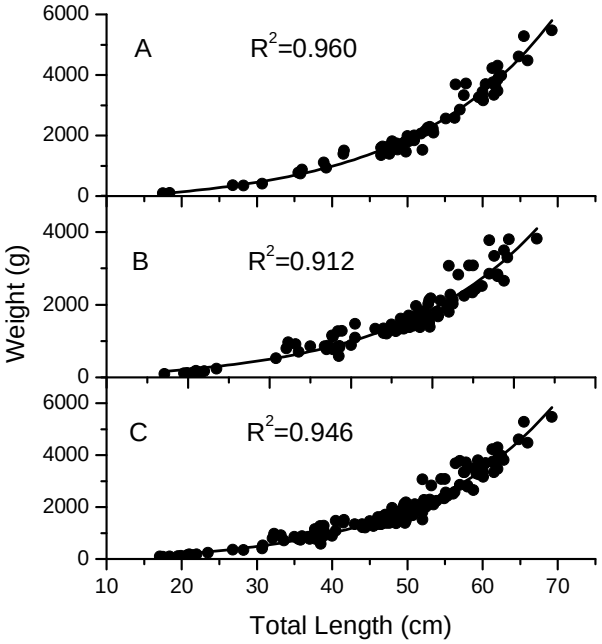

Fig. 3. The length-weight relationships of the female (A), male (B) and combined sex (C) of *C. carpio* in Damsa Dam Lake

The overall growth performance was determined on the basis of the phi prime values of female, male, and combined sexes were calculated as 7.26, 7.15, and 7.18, respectively.

DISCUSSION

The maximum age of *C. carpio* in Turkey was reported as 14 years old based on previous studies (Yağcı *et al.*, 2008a). The age composition of other carp populations in Turkey is as follows; Hirfanlı Dam Lake I-IX (Yılmaz *et al.*, 2007); Gelingüllü Dam Lake I-V (Kırankaya and Ekmekçi, 2004); Almus Dam Lake I-VII (Karataş *et al.*, 2007); Seyhan Dam Lake I-VI (Özyurt and Avşar, 2001); Karamık Lake I-X (Balık *et al.*, 2006); İznik Lake I-X (Yağcı *et al.*, 2008b). As a result of these studies that were done in different countries of the

Table II.- The von Bertalanffy growth parameters and equations of *C. carpio* in Damsa Dam Lake.

Sex	L_∞	W_∞	k	t_0	L_t	W_t
Female	86.80	10302.67	-0.189	0.396	$86.80[1-e^{0.189(t+0.396)}]$	$10302.67[1-e^{0.189(t+0.396)}]^{2.9689}$
Male	85.34	8868.06	-0.175	0.468	$85.34[1-e^{0.175(t+0.468)}]$	$8868.06[1-e^{0.175(t+0.468)}]^{2.8507}$
Female + Male	88.45	9854.95	-0.168	0.583	$88.45[1-e^{0.168(t+0.583)}]$	$9854.95[1-e^{0.168(t+0.583)}]^{2.9040}$

Table III.- The weight distribution and the importance control of *C. carpio* according to sex and age groups.

Age group	Female		Male		t-test	Female+Male	
	n	Mean±SD (min-max)	n	Mean±SD (min-max)		n	Mean±SD (min-max)
I	2	92.71±8.77 (86.51-98.92)	5	138.19±57.36 (91.79-236.19)	p>0.05 (insignificant)	7	125.2±51.95 (91.79-236.19)
II	5	542.36±247.61 (342.53-875)	13	586.69±320.74 (138-968)	p>0.05 (insignificant)	18	574.4±295.74 (138-968)
III	3	936.01±164.01 (775.15-1103)	15	1085.55±232.81 (737.7-1469)	p>0.05 (insignificant)	18	1060.6±226.03 (737.7-1469)
IV	20	1605.73±146.26 (1390-1834.39)	36	1584.78±229.12 (1271-2175)	p>0.05 (insignificant)	56	1592.3±202.23 (1271-2175)
V	9	2062.51±231.25 (1519-2286)	17	2287±487.51 (1382.3-3082)	p>0.05 (insignificant)	26	2209.9±425.65 (1382.3-3082)
VI	8	3096.47±399.83 (2560-3698)	10	3134.7±467.51 (2511-3800)	p>0.05 (insignificant)	18	3117.7±426.52 (2511-3800)
VII	14	3945.83±521 (3342-5278)	1	3819	-	15	3937.4±503.12 (3342-5278)
VIII	2	4973.5±706.39 (4474-5573)	-	-	-	2	4973.5±706.39 (4474-5573)

Table IV.- Length-weight relationship equations of *C. carpio* in Damsa Dam Lake

Sex	n	Log a	b	r^2	Log W=Log a+ b Log LF or $W = a L^b$
Female	63	-1.7423	2.9689	0.915	Log W= -1.7423 +2.3689 Log L or $W=0.0181 L^{2.9689}$
Male	97	-1.5559	2.8507	0.903	Log W= -1.5559 +2.8507 Log L or $W=0.0278 L^{2.8507}$
Female + Male	160	-1.6595	2.9040	0.900	Log W= -1.6595 +2.9040 Log L or $W=0.0219 L^{2.9040}$

world, the age distribution was seen as follows: Vransko Lake is III-XI (Treer *et al.*, 2003); Shkodra Lake is 0-VIII (Kolaneci *et al.*, 2010) and South Hazar Sea is I-VIII (Sedaghat *et al.*, 2013). The age distribution range of natural lakes is wider than dam lakes as seen in this study.

The age composition of *C. carpio* varied from I to VIII. The most dominant age group was IV (35%) followed by the age groups of V (16.3%), II, III, VI (11.3%), I (4.4%), and VIII (1.3), respectively except for 0 age groups (Table I). The reason for few numbers of young and old individuals may be due to gill net selectivity and fishing activity (Alp and Balık, 2000).The rates of male and female fish individuals give important data about the current situation and sustainability of the population. Usually, at early life stages, the ratio of males is higher, but in later stages, the female ratio is higher (Nikolsky, 1963).

The sex ratio was calculated as 1:1.53 (F:M). There was a significant difference in the sex ratio from the 1:1 ratio ($P<0.05$). The overall sex ratios in different localities of Turkey such as Gelingüllü Dam Lake (Kırankaya and Ekmekçi, 2004), Almus Dam Lake (Karataş *et al.*, 2007), İznik Lake (Yağcı *et al.*, 2008b), Gölhisar Lake (Alp and Balık, 2000)

Table V.- The condition values and the importance control of *C. carpio* according to sex and age groups.

Age group	Female		Male		t-test	Female+Male	
	n	Mean±SD (min-max)	n	Mean±SD (min-max)		n	Mean ±SD (min-max)
I	2	1.60±0.02 (1.58-1.61)	5	1.60±0.21 (1.39-1.83)	p>0.05 (insignificant)	7	1.60±0.17 (1.39-1.83)
II	5	1.64±0.20 (1.39-1.87)	13	1.85±0.49 (1.01-2.87)	p>0.05 (insignificant)	18	1.79±0.43 (1.01-2.87)
III	3	1.71±0.16 (1.54-1.87)	15	1.76±0.34 (1.38-2.24)	p>0.05 (insignificant)	18	1.75±0.31 (1.38-2.24)
IV	20	1.49±0.21 (1.18-2.08)	36	1.43±0.16 (1.13-1.77)	p>0.05 (insignificant)	56	1.45±0.18 (1.13-2.08)
V	9	1.45±0.15 (1.08-1.58)	17	1.56±0.25 (1.39-2.18)	p>0.05 (insignificant)	26	1.52±0.22 (1.08-2.18)
VI	8	1.56±0.11 (1.45-1.75)	10	1.61±0.22 (1.30-2.03)	p>0.05 (insignificant)	18	1.59±0.18 (1.30-2.03)
VII	14	1.69±0.18 (1.43-2.05)	1	1.54	-	15	1.69±0.18 (1.43-2.05)
VIII	2	1.60±0.07 (1.55-1.65)	-	-	-	2	1.60±0.07 (1.55-1.65)

Table VI.- Parameters of length-weight relationship (a and b), coefficient of determination (r^2), growth (L_∞, K, t_0), Condition Factor (CF), and phi prime (Φ') of *C. carpio* in this and previous studies.

Study area	a	b	r^2	L_∞	K	t_0	Φ'	CF
Mogan Lake (1975)	0.096	2.531	-	92.30	0.099	-0.651	6.74	1.77
Beyşehir Lake (1984)	0.063	2.610	-	109.76	0.100	-0.866	7.10	1.91
Mamasin Dam Lake (1988)	0.216	2.382	-	85.80	-	-	6.89	2.28
Marmara Lake (1997)	0.019	2.944	-	50.24	1.182	-1.622	8.00	-
Gölhisar Lake (2000)	0.025	2.874	-	72.76	0.172	-0.446	6.82	-
Seyhan Dam Lake (2001)	-	-	-	64.43	0.115	-1.862	6.19	1.55
Gelingüllü Dam Lake (2004)	0.022	3.023	0.956	-	-	-	-	2.34
Karamık Lake (2006)	0.024	2.952	0.996	130	0.075	-0.245	-	2.02
Almus Dam Lake (2007)	0.005	3.319	0.944	46.39	0.153	-1.922	5.80	1.34
Hirfanlı Dam Lake (2010)	0.022	2.967	0.992	-	-	-	-	1.97
Koçköprü Dam Lake (2008)	0.039	2.847	0.951	84.07	-	-0.801	2.95	2.47
Apa Dam Lake (2010)	0.005	2.830	0.993	-	-	-	-	1.99
Bafra Fish Lake (2012)	0.035	2.822	0.980	60.96	0.274	-0.802	-	1.87
Vransko Lake (2003)	-	2,860	-	81.97	0.122	-0.811	6.71	1.84
Shkodra Lake (2010)	-	-	-	101.3	0.310	-0.040	-	-
This Study	0.0219	2.904	0.900	88.45	0.168	-0.583	7.18	1.58

(- indicates absence of data)

were different to the present results and in these studies, the female ratio is higher. Similar results were obtained from the Mamasin Dam Lake (Cappadocia Region) (İkiz, 1988), Hirfanlı Dam Lake (Yılmaz *et al.*, 2007), Koçköprü Dam Lake (Elp *et al.*, 2008), Beyşehir Lake (Erdem, 1984) and in these studies, the male ratio is higher. The causes of these differences in sex ratios may be due to the temperature dependent sex determination (Conover and Kynard, 1981), the presence of hormone-like substances in the environment (Lye *et al.*, 1997), sex-selective mortality depending on predation (Schultz, 1996), or intersexual differences in life span or behavior (Purdom, 1993).

The value of "b" that expresses length–weight relationship in teleost fishes varies between

2.5 and 3.5 (Ricker, 1975). The "b" value of *C. carpio* populations living in different localities in Turkey and some other countries ranged from 2.531 to 3.319 (Table VI). The value of "b" differs between the same species according to the sex. So, the size of female *C. carpio* was bigger and the weight was heavier than males. In addition, the value of "b" differs under the influence of maturity, seasons, and at different times of day because of the changes in stomach fullness (Arshad *et al.*, 2012). In this study, when we look at the "b" value calculated for carp, we may say that allometric growth is negative.

The length–weight relationship (Fig. 3) demonstrated a negative allometric growth with a b-value of 2.96 for females, 2.85 for males, and 2.90 for both sexes. These values are similar to 2.86 for carp in Marmara Lake (Balık *et al.*, 1997), 2.87 for carp in Gölhisar Lake (Alp and Balık, 2000), and 2.86 for carp in the Vransko Lake (Treer *et al.*, 1993), but different from 3.32 for carp in Almus Dam Lake (Karataş *et al.*, 2007), 2.53 for carp in Mogan Lake (Tanyolaç, 1975), and 2.61 for carp in Beyşehir Lake (Erdem, 1984). These situations may be caused by several factors including the seasonal effect, habitat type, degree of stomach fullness, gonad maturity, sex, health, preservation techniques, food availability, and differences in the observed length ranges of the specimen caught (Tesch, 1971).

The $L\infty$, $W\infty$, K, and t_0 values were calculated as 88.45 cm, 9854.95 g, K=0.168 and t_0= -0.583, respectively (Table VI). The values of $L\infty$ and $W\infty$ of females were higher than those of males. These values were similar to the those reported by Karataş *et al.* (2007) and Yılmaz *et al.* (2010). These parameters were higher than those reported by Karataş *et al.* (2007), Özyurt and Avşar (2001) and Treer *et al.* (2003). On the other hand, these parameters were lower than those reported by Balık *et al.* (2006), Erdem (1984), Kolaneci *et al.* (2010), Arshad *et al.* (2012) and similar to those reported by İkiz (1988). The differences in growth may have resulted from differences in the environmental conditions, such as water, temperature, water quantity and food abundance.

C. carpio can significantly affect plant and animal communities in a direct or indirect way in shallow freshwater (Lougheed *et al.*, 1998). Mack and D'Antonio (1958) and Pimental *et al.* (2000) reported that *C. carpio* may negatively influence the native fish and aquatic plant communities and cause very high annual economic loss. In our study, we did not find native fish species. Therefore, we may assume that the presence of *C. carpio* is badly affected by native fish populations in the study area.

Condition values of fish population show changes according to the sex, gonad development, age, growth, seasonal changes, and feeding circumstances (Ricker, 1975). Significant statistical differences in the condition factors between age classes and sexes were not found in all groups (P>0.05, t-test). The mean condition factor for males was higher than that for females, but the differences between sexes were not significant (P>0.05, Table V). The Condition factor of individuals who make up population was calculated as 1.01 (min) and 2.87 (max).The minimum and maximum mean condition factor was calculated as 1.45 in the IV age group, 1.79 in II age group, respectively (Table V). The mean condition factor of the population was calculated as 1.58 (Table VI). The differences in the mean condition factor between female and male according to age groups were not statistically significant (P>0.05, Table V).

It is clear that the mean condition factor of the *C. carpio* population in Damsa Dam Lake is higher than Almus Dam Lake (Karataş *et al.*, 2007) and Seyhan Dam Lake (Özyurt and Avşar, 2001). It is lower than Beyşehir Lake (Erdem, 1984), Vransko Lake (Treer *et al.*, 2003), Koçköprü Dam Lake (Elp *et al.*, 2008), Mamasin Dam Lake (İkiz, 1988), Gelingüllü Dam Lake (Kırankaya and Ekmekçi, 2004) , Apa Dam Lake (Mert *et al.*, 2008) and Hirfanlı Dam Lake (Yılmaz *et al.*, 2007) (Table VI). The mean condition factor has been used as an indicator of health, growth, and feeding in intensity (Bagenal and Tesch, 1978; Froese, 2006). Therefore, it can be used to determine the feeding activity of carp and also to determine better usage of its feeding source (Lizama and Ambrósia, 2002). According to these results, we think that carp population is adequate in nutrition in Damsa Dam Lake.

In this study, the phi prime index of carp population was found to be 7.18 whereas in previous studies, it ranged from 2.95 to 8.00. These

values show that the species had higher growth performance relatively than most of the studies in the literature (Table VI). This difference in the phi prime index between the same species may be due to the differences in size of the largest individuals sampled (Balık *et al.,* 2004) and various exogenous and endogenous factors affecting fish growth performance and longevity (Wootton, 1990).

According to Nikolsky (1963) the mortality ratio in fish populations under the influence of age, a biotic factors, parasitic diseases, carnivorous fishes, lack of food and hunting. The total mortality (*Z*) was calculated as 0.25 $yıl^{-1}$ for the carp population sampled from Damsa Dam Lake, which is much lower than those obtained from other sites as Karamık Lake (0.40 $yıl^{-1}$) (Balık *et al.,* 2006) and Almus Dam Lake (0.64 $yıl^{-1}$) (Karataş *et al.,* 2007). When we compare these results, it can be said that carp population is well managed in Damsa Dam Lake.

In conclusion, on comparing our data with previous studies, it can be said that good development has happened in the carp population in Damsa Dam Lake. According to the length-frequency distribution and total mortality ratio, it can be said that there is no excessive hunting pressure. Tench, carp, and perch populations are sharing the same habitat. So, constantly monitoring of these populations using scientific methods can be beneficial for sustainable hunting opportunities and conserve fish faunas in Damsa Dam Lake.

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