

Age and Growth Characteristics of Carp (*Cyprinus carpio* L., 1758) in Mogan Lake, Ankara, Turkey

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Abstract.- The present study was carried out to assess the population structure, growth and condition factor of carp (*Cyprinus carpio* L., 1758), between June 2012 and June 2013 in Mogan Lake. The age of *Cyprinus carpio* caught from Mogan Lake ranged between I to VI years. The sex percentage was determined as 49.45 % males and 46.15% females. Fork length of fish ranged from 14.0 cm to 41.5 cm and body weight of fish ranged from 65 g to 1750 g. The von Bertalanffy growth equations were: $L_t = 49.603 [1 - e^{-0.241(t+1.74)}]$ for females and $L_t = 49.060 [1 - e^{-0.259(t+1.44)}]$ for males; $W_t = 2623.07 [1 - e^{-0.241(t+1.74)}]^{2.874}$ for females and $W_t = 2669.75 [1 - e^{-0.259(t+1.44)}]^{2.7529}$ for males. The condition factor was calculated as 1.98 and 1.99 for females and males, respectively.

Keywords: *Cyprinus carpio*, Growth, von Bertalanffy's parameters, Mogan Lake

INTRODUCTION

In Turkey, Cyprinidae are the richest and the most important family of fish, and its members are distributed world-wide. These family members are distributed widely in fresh water sources. Southeast Asia and China, the actual distribution of carp (*Cyprinus carpio* L., 1758), due to hold an important place in the production of artificial fish once it is spread all over Europe and even to America. In Turkey, natural lakes, ponds, dams lakes and rivers stagnant flowing parts of a large distributed carp, economic value is high due to the inland water fisheries in terms of our very important is a species (Geldiay and Balık, 2009). Therefore, the most studied species of fish on the tops.

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 (Karataş *et al.*, 2007).

The growth properties of *C. carpio* was investigated in Mogan Lake (Tanyolaç, 1975), Gölhisar Lake (Alp and Balık, 2000), Mediterranean Vransko Lake (Treer *et al.*, 2003), in the mid-Murray River and Barmah Forest Wetlands (Brown *et al.*, 2005), Waikato Region (Tempero *et al.*,

2006), Karamık Lake (Balık *et al.*, 2006), Almus Dam Lake (Karataş *et al.*, 2007), Işıklı Lake (Apaydın Yağcı *et al.*, 2008), Two Nebraska Sandhill Lakes (Coulter *et al.*, 2008), Small Island (Gheorghe *et al.*, 2011), Mangla Reservoir (Mirza *et al.*, 2012), Tödürge Lake (Ünver and Yıldırım, 2012), Bafra Fish Lake (Yılmaz *et al.*, 2012) and Damsa Dam Lake (Mert and Bulut, 2014)

Ecological factors affect the biological and reproduction characteristics of fish populations and so these kinds of investigations should be carried out periodically. The main purpose of the present investigation was to study growth in *C. carpio*.

MATERIALS AND METHODS

Mogan Lake is located about 20 km south of Ankara, capital of Turkey, and lies within the coordinates of 39°44'40" N and 39°47'45" N latitudes and 32°46'30" E and 32°49'30" E longitudes. It is near the Gölbaşı town which has undergone considerable development by the increased population and settlement in recent years. A large number of commercial establishments such as restaurants, social clubs, tea gardens as well as summer resorts have been built around the lake which became a popular site for sports, fishing, sailing, and rowing (Anonymous, 1992).

This study was carried out on 364 (168 females and 180 males) caught between June 2012 and June 2013 in Mogan Lake by using a gill nets (18 mm–55 mm mesh sizes). The fish samples were

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transported to the laboratory to record the fork length (FL) to the nearest 0.1 cm and body weight (BW) to the nearest 0.1 g. Scales were sampled from each specimen for age determination according to Lagler (1966).

Growth was estimated using the von Bertalanffy growth curve model (Sparre and Venema, 1992) $L_t = L_\infty [1 - e^{-K(t-t_0)}]$ and weight $W_t = W_\infty [1 - e^{-K(t-t_0)}]^b$ where L_t = the fork length (cm) at age t , L_∞ = the asymptotic length (theoretical maximum length), k = the Brody growth coefficient (proportional to rate at which L_∞ is reached), t = the age (years), t_0 = the age at zero length, e is the base of natural log (2.71828), W_t is the weight of the fish in g at age t , W_∞ is the asymptotic weight of (theoretical maximum weight) the fish in g and b is the constant in the length–weight relationship. The von Bertalanffy growth parameters were estimated for males and females separately as well as for both sexes combined. The relationship between FL and BW was calculated separately for each sex with \log_{10} -transformed data (Le Cren, 1951). The condition factors (CF) of fish was determined using the formula $(W / L^3) \times 100$ (Ricker, 1975), where W = body weight (g) and L = Fork length (cm).

Statistical analysis of data was carried out using SPSS statistical package program for Windows Ver. 18.

RESULTS

The age of 364 specimens of *C. carpio* caught from Mogan Lake ranged between I to VI years (Fig. 1) and III year class were dominant. There were about 46.15 % females and 49.45 % males (sex ratio 1:0.93), and differences among different age groups were not significant ($P > 0.05$).

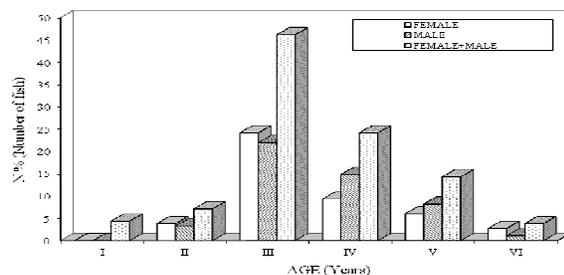


Fig. 1. The percent (%) distribution of *C. carpio* according to their age and sex.

The mean FL, mean BW and CF of male and female fish in different age groups is presented in Table I. In age groups II, III, IV and VI, females were longer than males. Males V age group was longer than females. The differences between the sexes only were significant in III age group ($P < 0.05$). Age–length relationships of females and males are plotted in Figure 2 with the respective equations indicated and differences between sexes were not significant in all age groups without III age group ($P > 0.05$). In male and female age–weight relationships were shown in Figure 2. While weight of females was higher than for males in age groups II, III, IV and VI weight of males was higher than for females in age group V. The differences between the sexes only were significant in III age group for age–weight relationships ($P < 0.05$). Males grew to a greater asymptotic (W_∞) weight than the females (Fig. 2).

The length–weight relationships were calculated as $W = 0.00004077 L^{2.8742}$ ($r^2 = 0.941$) for females and $W = 0.00008231 L^{2.7529}$ ($r^2 = 0.948$) for males. The b value for females was higher than for males. Length–weight curves for males and females are drawn in Figure. 2.

While CF of females was higher than for males in age groups IV, V and VI, CF of males was higher than for females in age group II and III. There was no significant difference in CF value between sexes ($P > 0.05$, t -test; Table I, Fig. 3). The condition factor was calculated as 1.98 and 1.99 for females and males, respectively.

DISCUSSION

The sex ratio (male female) of carp in Mogan Lake was 1:0.93, and similar to the 1:1 ratio expected for most fish species (Bagenal and Tesch, 1978). This ration is in agreement with the value reported for the same species in previous studies Mert *et al.* (2008), Apaydın Yağcı *et al.* (2008), Yılmaz *et al.* (2012) for Apa Dam Lake, Işıklı Lake and Bafra Fish Lake. However, Kirankaya and Ekmekçi (2004), Balık *et al.* (2006), Yılmaz *et al.* (2012) and Karataş *et al.* (2007) reported higher ratios for females:males (1:1.421, 1:1.242, 1.444 and 1.417). Although the sex ratio in most of the species was close to 1, this may vary from species to

Table I.- Mean fork length (FL, cm), and mean Body weight (BW, g), mean condition factor (CF), standard error (SE) for different age groups of *C. carpio* males and females in Mogan Lake (P>0.05).

Age (Years)	No. of fish	FL±SE (min.-max.)	BW±SE (min.-max.)	CF±SE (min.-max.)
Female				
I	-	-	-	-
II	14	23.97 ± 2.63 20.90 – 27.00	296.00 ± 82.15 220.00 – 390.00	2.12 ± 0.21 1.80 – 2.40
III	88	30.45 ± 1.01 28.00 – 31.30	545.10 ± 46.16 458.30 – 602.77	1.93 ± 0.13 1.76 – 2.19
IV	34	32.84 ± 2.44 30.00 – 38.80	726.53 ± 173.09 579.00 – 1200.00	2.03 ± 0.12 1.82 – 2.28
V	22	34.55 ± 3.21 32.50 – 43.00	824.88 ± 172.87 869.00 – 1245.00	1.99 ± 0.16 1.57 – 2.30
VI	10	40.40 ± 1.21 39.00 – 41.50	1410.00 ± 206.55 1200.00 – 1750.00	2.12 ± 0.17 2.02 – 2.44
Male				
I	-	-	-	-
II	12	22.96 ± 3.34 20.10 – 27.80	273.66 ± 120.21 170.00 – 440.00	2.14 ± 0.17 1.95 – 2.46
III	80	29.90 ± 1.46 27.00 – 32.50	525.89 ± 52.38 411.00 – 616.61	1.96 ± 0.14 1.77 – 2.23
IV	54	32.56 ± 1.36 30.00 – 36.10	699.92 ± 68.23 611.00 – 900.00	2.02 ± 0.16 1.76 – 2.31
V	30	35.04 ± 2.36 32.80 – 42.00	844.86 ± 136.30 752.00 – 1300.00	1.96 ± 0.16 1.75 – 2.34
VI	4	40.25 ± 2.88 40.00 – 40.50	1337.50 ± 43.30 1300.00 – 1375.00	2.05 ± 0.11 1.95 – 2.14

FL, BW and CF significance level (P value) is found P>0.05.

species, differing from one population to another of the same species, and may vary year after year within the same population.

At early life stages the ratio of males is higher, but at later stages the female ratio is higher (Nikolsky, 1963). This study determined at early stages the ratio of females is higher, but at later stages the males ratio is higher. Some of the researches are founded that the number of female is higher than males at early life stages ages group (Mert *et al.*, 2008; Apaydın Yağcı *et al.*, 2008; Yılmaz *et al.*, 2012).

Most of the samples studied in the present study belonged to III year age group. Karataş *et al.*, 2007; Mert *et al.*, 2008; Yılmaz *et al.*, 2012; reported a similar situation for Almus Dam Lake, Apa Dam Lake, Bafra Fish Lake populations. While Alp and Balık (2000) found that most of the samples were in the II year age group for Gölhisar Lake,

Balık *et al.*, 2006 found that most of the samples were in the I year age group for Karamık Lake.

Males were longer and heavier than females in V year ages groups in present research. II, III, IV and VI year ages group females were found heavier and longer than males. Females were longer and heavier than males in II, III, IV and VI year ages groups in present research. V year ages group males were found heavier and longer than males. Mert *et al.* (2008) reported that females longer than males in II, IV, V, VI and VIII age year ages groups and females heavier than males in II, V, VI in Apa Dam Lake. Females were longer at earlier life stages, while males were heavier at earlier life stages (Yılmaz *et al.*, 2012; Alp and Balık, 2000).

Variations in fish growth in terms of length and weight can be explained as an adaptive response to different ecological conditions (Nikolsky, 1963). The von Bertalanffy growth equations were:

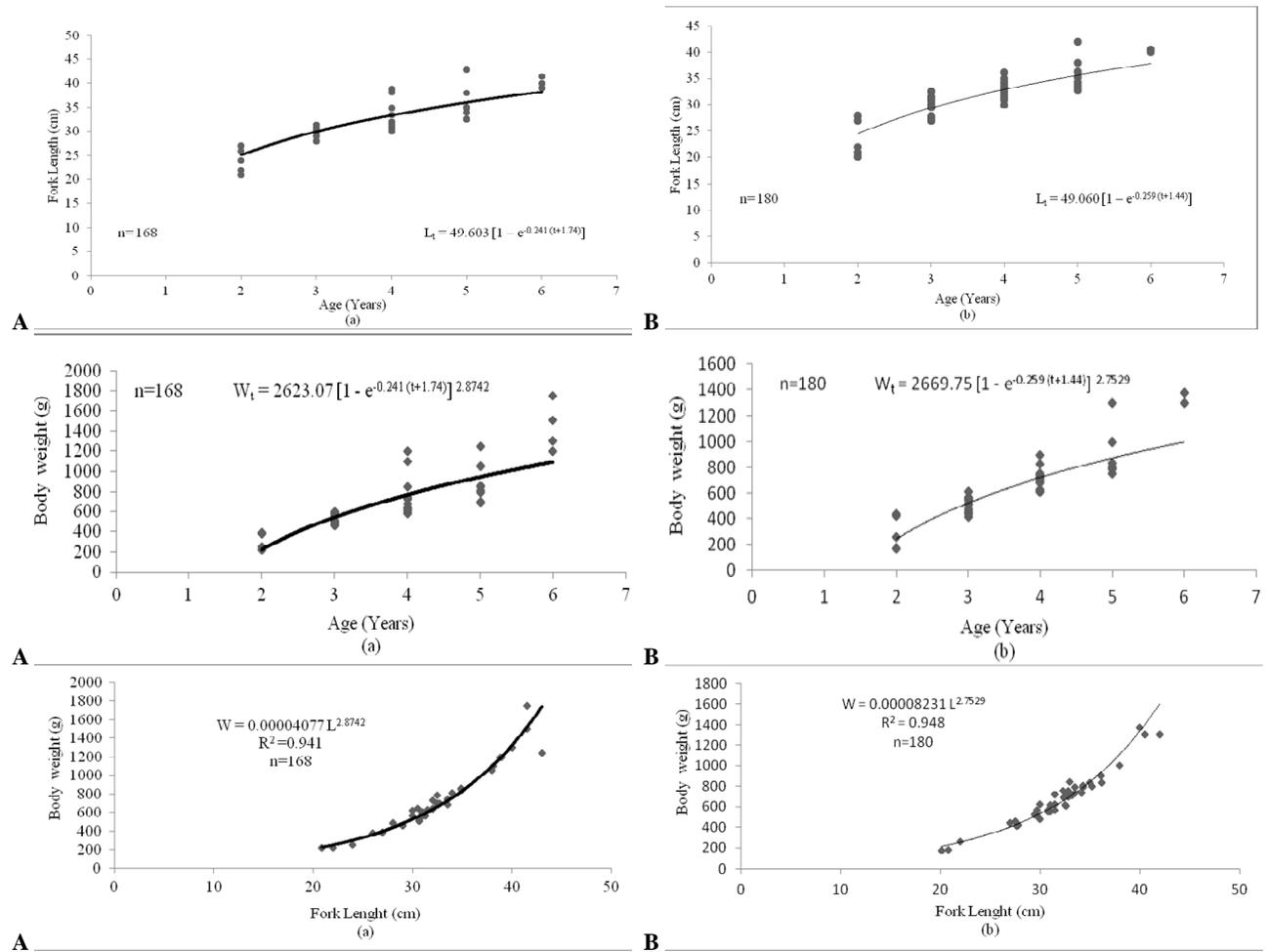


Fig. 2. Age-length (top panel), Age-weight (middle panel), and length weight (bottom panel) relationships in female (A) and male (B) *C. carpio*.

$L_t = 49.603 [1 - e^{-0.241(t+1.74)}]$ for females and $L_t = 49.060 [1 - e^{-0.259(t+1.44)}]$ for males; $W_t = 2623.07 [1 - e^{-0.241(t+1.74)}]^{2.874}$ for females and $W_t = 2669.75 [1 - e^{-0.259(t+1.44)}]^{2.7529}$ for males.

While some earlier studies have reported similar theoretical maximum length (Karataş *et al.*, 2007; Yılmaz *et al.*, 2012), other studies were different (Alp and Balık, 2000; Brown *et al.*, 2005; Balık *et al.*, 2006; Apaydın Yağcı *et al.*, 2008; Mirza *et al.*, 2012). Some studies have reported different theoretical maximum weight (Apaydın Yağcı *et al.*, 2008; Yılmaz *et al.*, 2012). This variation may be due to different stages in ontogenetic development, as well as differences in condition, length, age, sex and gonadal development

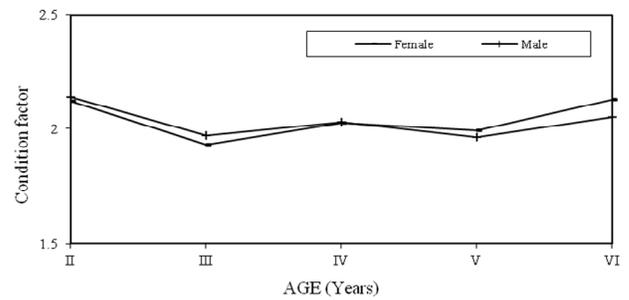


Fig. 3. Mean condition factor according to age and sex of *C. carpio*.

of fish (Ricker, 1975). Geographic location and some environmental conditions such as temperature, organic matter, quality of food, time of capture,

Table II.- Age structure, parameters of length–weight relationship (a and b), growth (L_{∞} , K, t_0) and CF of *C. carpio* in this and previous studies.

References area	Age	Weight range	Length range	N	a	b	r ²	L _∞	k	t ₀	CF
Alp and Balık, 2000	6	20.19-1922.2	10.5-49.4	287	0.0258 0.0243	2.867 2.887	-	68.09 76.72	0.199 0.149	-0.3174 ^a -0.6163 ^b	-
Göhlisar Lake Özyurt and Avşar, 2001 Seyhan Dam Lake	5	-	-	159 ^a 77 ^b 257 ^c	-	-	-	64.43	0.115	-1.862	-
Kırankaya and Ekmekçi, 2004 Gelingüllü Dam Lake	5	41.0-5998	11.7-63.8	407 ^c	0.0215	3.022	0.96	-	-	-	1.25-3.55
Brown <i>et al.</i> , 2005 mid-Murray River Barmah Forest Wetlands	-	-	-	-	-	-	-	48.9 59.4	0.249 0.177	-0.1519 ^a -0.6090 ^b	-
Balık <i>et al.</i> , 2006 Karamık Lake	10	16.0-8780	9.0-70.4	108 ^c	-	-	-	130	0.075	-0.245	2.022
Karataş <i>et al.</i> , 2007	7			180 ^a 127 ^b	0.0070 0.0053	3.21 3.28	0.98 0.98	47.24 47.39	0.198 0.183	-1.428 -1.982	1,34
Almus Dam Lake Apaydın Yağcı <i>et al.</i> , 2008	14	35.6-701.4 36.0-9700	14.0-21.5 11.8-80	307 ^c 158 ^c	0.0049 -	3.32 -	0.98 -	46.39 108.40	0.153 0.101	-1.922 -0.221	1.920
Işıklı Lake Mert <i>et al.</i> , 2008	8	51-2724	13.8-5.25	108 ^a 105 ^b 251 ^c	0.000013 0.000011 0.000005	2.53 2.71 2.83	0.93 0.93 0.93	-	-	-	1.69-2.26
Apa Dam Lake				367 ^c	0.0271	2.845	0.98	84.7	0.161	-0.810	-
Geheorge, 2011 Small Island	-	432.67-9000	23-86	-	-	-	-	80.30	0.60	-0.39 ^c	-
Mirza <i>et al.</i> , 2012 Mongla Lake	-	-	-	-	-	-	-	-	-	-	-
Yılmaz <i>et al.</i> , 2012 Bafra Fish Lake	4	193-2280	20.8-48.8	81 ^a 74 ^b 155 ^c	0.0328 0.0378 0.0349	2.839 2.802 2.822	0.98 0.98 0.98	54,07 45,67 60,96	0,359 0,544 0,274	-0,537 -0,238 -0,802	
Ünver and Yıldırım, 2012 Tödürge Lake	7	13.2-854.7 10.2-1049.8 10.2-1049.8	8.5-38.9 8.3-40.5 8.3-40.5	115 ^a 96 ^b 211 ^c	0.0085 0.0103 0.0096	2.834 2.897 2.852					1.16-2.37 1.41-2.39 1.16-2.39
This study 2013 Mogan Lake	6	170-1375 220-1750 65-1750	20.1-40.5 20.9-41.5 14.0-41.5	168 ^a 180 ^b 364 ^c	0.00005 0.00008 0.00006	2.87 2.75 2.80	0.94 0.94 0.93	49.60 49.06 49.71	0.241 0.259 0.245	-1.74 -1.44 -0.60	1.9848 1.9942 2.0040

^a male, ^b female, ^c male+female

stomach fullness, disease, parasitic loads (Bagenal and Tesch, 1978).

CF of *C. carpio* varied from 1.5659 to 2.4485 in female; from 1.7547 to 2.1397 in male. Maximum CF was found as 2.44485 (Table II, Fig. 3). The results are in agreement with some earlier reports (Apaydın Yağcı *et al.*, 2008; Mert *et al.*, 2012), while it differed from studies carried out by (Karataş *et al.*, 2007).

CF of *C. carpio* differed age and sex of fish

(Table I). CF values of *C. carpio* in the Mogan Lake was recorded to be lower than 3.

The slope (b) values of the length–weight relationship in both sex is found as a 2.8016. Similar b values for *C. carpio* were reported by Mert *et al.* (2012); Yılmaz *et al.* (2012); Apaydın Yağcı *et al.* (2008); Ünver and Yıldırım (2012), but it differed from those found by Demirkalp (2007); Kırankaya and Ekmekçi (2004). The b value is often 3.0 and generally between 2.5 and 3.5. As the fish grows,

changes in weight are relatively greater than changes in length, due to approximately cubic relationships between fish length and weight. The b values in fish is species specific and varies with sex, age, seasons, physiological conditions, growth increment and nutritional status of fish (Ricker, 1975; Bagenal and Tesch, 1978).

In conclusion this is the study presenting the biological features of *C. carpio* population living in Mogan Lake such as, growth, sex ratio and age distribution. It is recommended that the necessary steps should be taken asap to protect the *C. carpio* population in the lake after investigating its stock situation and breeding and feeding behaviors.

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REFERENCES

- ALP, A. AND BALIK, S., 2000. Growth Conditions and Stock Analysis of the Carp (*Cyprinus carpio*, Linnaeus 1758) Population in Gölhisar Lake. *Turk. J. Zool.*, **24**:291-304.
- ANONYMOUS, 1992. *Report on Lake Mogan*. General Directorate of State Hydraulic Works. Pp. 212, Ankara.
- APAYDIN YAĞCI, M., ALP, A., YEĞEN, V., UYSAL, R., YAĞCI, A. AND CEYLAN, M., 2008. The growth characteristics of (*Cyprinus carpio* L., 1758) Population in Lake Işıklı (Çivril- Denizli). *Ege J. Fish. Aquat. Sci.*, **25**:337-341.
- BAGENAL, T.B. AND TESCH, F.W., 1978. Age and growth. In: *Methods for assessment of fish production in fresh waters*. IBP Handbook No. 3. (ed. T. Bagenal). Blackwell Scientific Publications, Oxford, pp. 101-136.
- BALIK, İ., ÇUBUK, H., ÖZKÖK, R. AND UYSAL, R., 2006. Some characteristics and size of carp (*Cyprinus carpio* L., 1758) population in the lake Karamık (Afyonkarahisar / Turkey). *Turkish J. Fish. Aquat. Sci.*, **6**:117-122.
- BROWN, P., SIVAKUMARAN, K.P., STOESEL, D. AND GILES, A., 2005. Population biology of carp (*Cyprinus carpio* L.) in the mid-Murray River and Barmah Forest Wetlands, Australia. *Mar. Freshw. Res.*, **56**:1151-1164.
- COULTER, D.P., JOLLEY, J.C., EDWARDS, K.R. AND WILLIS, D.W., 2008. Common carp (*Cyprinus carpio*) population characteristics and recruitment in two Nebraska Sandhill Lakes. *Trans. Nebraska Acad. Sci.*, **31**:35-41.
- DEMİRKALP, F.Y., 2007. Some of the growth characteristics of carp (*Cyprinus carpio* L., 1758) in Çernek Lake (Samsun, Turkey). *Hacettepe J. biol. Chem.*, **35**:57-65.
- GELDİAY, R. AND BALIK, S., 2009. *The freshwater fishes of Turkey*. College of Fisheries Ege University Publications No:46.
- GHEORGHE, D.C., RAZLOG, G.P., CRISTEA, V. AND ENACHE, I., 2011. The growth characteristics of common carp (*Cyprinus carpio*) in the northern part of the Small Island of Brăila Natural Park. *AAEL Bioflux*, **4**:154-158.
- KARATAŞ, M., ÇİÇEK, E., BAŞUSTA, A. AND BAŞUSTA, N., 2007. Age, growth and mortality of common carp (*Cyprinus carpio* Linnaeus, 1758) population in almus Dam Lake (Tokat- Turkey). *J. appl. biol. Sci.*, **1**:81-85.
- KIRANKAYA, Ş.G. AND EKMEKÇİ, F.G., 2004. Growth properties of mirror carp (*Cyprinus carpio* L., 1758) introduced into Gelingüllü Dam Lake, (in Turkish). *Turk. J. Vet. Anim. Sci.*, **28**:1057-1064.
- LAGLER, K.F., 1966. *Freshwater fishery biology*. W.M.C. Brown Company, Dubuque, IA. pp. 421.
- LE CREN, E.D., 1951. The length-weight relationship and seasonal cycle in gonad weight and condition in Perch, *Perca fluviatilis*. *J. Anim. Ecol.*, **20**:201-219.
- MERT, R., BULUT, S. AND SOLAK, K., 2008. Some Biological Characteristics of *Cyprinus Carpio* (L., 1758) Inhabiting Apa Dam Lake (Konya-Turkey). *AKU J. Sci. Engin.*, **2**:47-60.
- MERT, R. AND BULUT, S., 2014. Some biological properties of carp (*Cyprinus Carpio* L., 1758) Introduced into Damsa Dam Lake Cappadocia Region, Turkey. *Pakistan J. Zool.*, **46**:337-346.
- MIRZA, Z.S., NADEEM, M.S., BEG, M.A. AND QAYYUM, M., 2012. Population Status and Biological Characteristics of Common Carp, *Cyprinus carpio*, in Mangla Reservoir (Pakistan). *J. Anim. Pl. Sci.*, **22**:933-938.
- NIKOLSKY, G.V., 1963. *The ecology of fishes* (translated by L. Birkett). Academic Press, London, pp 352.
- RICKER, W.E., 1975. *Computation and interpretation of biological statistics of fish populations*. Bulletin Fisheries Research Board of Canada, pp. 382.
- SPARRE, P. AND VENEMA, S.C., 1992. *Introduction to tropical fish stock assessment. Part 1. Manual*. FAO Fisheries Technical Paper no 306. (Rev. 1). FAO, Rome, pp 376.
- TANYOLAÇ, J., 1975. Length-weight relationship and condition of carp *Cyprinus carpio* Linnaeus in the Mogan, Ankara. *Commun. Facul. Sci. Univ. Ankara, Sei C3:Zool.*, **19**, ANNEE.
- TEMPERO, G. W., LING, N., HICKS, B.J. AND OSBORNE,

- M.W., 2006. Age composition, growth, and reproduction of koi carp (*Cyprinus carpio*) in the lower Waikato region, New Zealand. *N. Z. J. mar. Freshw. Res.*, **40**: 571-583.
- TREER, T., VARGA, B., SAFNER, R., ANICIC, I., PIRIA, M. AND ODAK, T., 2003. Growth of the common carp (*Cyprinus carpio*) introduced into the Mediterranean Vransko Lake. *J. appl. Ichthyol.*, **19**:383-386.
- ÜNVER, B. AND YILDIRIM, M., 2011. Population characteristics of carp from Tödürge Lake in 583 Sivas, Turkey. *Int. J. Agric. Biol.*, **13**:935-940.
- YILMAZ, S., YAZICIOĞLU, O. AND POLAT, N., 2012. Age and Growth Properties of Common Carp (*Cyprinus carpio* L., 1758) from Bafra Fish Lakes (Samsun, Turkey). *The Black Sea J. Sci.*, **2**:1-12.

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