Some Biological Characteristics Of *Cyprinus Carpio* (L., 1758) Inhabiting Apa Dam Lake (Konya-Turkey)

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Abstract

This study was carried out in Apa Dam Lake between January 2001 and December 2001. Characteristics of sexuality status, age groups, growth and reproduction as well as condition factor of *Cyprinus carpio* (L. 1758) population, which inhabits this dam lake and is of economic importance, was investigated. The age composition of *Cyprinus carpio* samples were determined to have ranged from I to VIII. Sexual distribution proved to be 41,83 % for females and 43,02 % for males. Minimum fork length of this species was found to be 138 (mm), minimum weight 51 (gr), maximum fork length 525 (mm), and maximum weight 2724 (gr). The highest age-specific number within the population was observed in age group III, whereas the lowest one was in age group VII. Minimum and maximum condition factors were found to be 1,69 in age group VI and 2,26 in age group III, respectively. As far as the seasons are concerned, minimum condition factor was observed 1,84 in July, whereas the maximum one was 2,17 in June. Sexual maturity age was found to be III in the males and IV in the females. Reproduction period was determined to be June and July. GSI values based on the months ranged from 1,64 to 18,78. Fecundity has increased, rising from the age group IV to VIII.

Key Words: Apa Dam Lake, *Cyprinus carpio*, reproduction, fecundity, sexual maturity age, sex ratio.

Apa Baraj Gölü (Konya)'nde Yaşayan Cyprinus carpio (L., 1758)'nun Bazı Biyolojik Özelliklerinin Belirlenmesi

Özet

Bu çalışma, Ocak-2001, Aralık-2001 tarihleri arasında Apa Baraj Gölü'nde yapılmıştır. Bu baraj gölünde yaşayan ve ekonomik öneme sahip *Cyprinus carpio* (L. 1758) populasyonunun eşey durumu ve yaş grupları, büyüme ve üreme özellikleri ile kondisyon faktörü araştırılmıştır. *Cyprinus carpio*'nun I-VIII yaşları arasında dağılım gösterdiği belirlenmiştir. Eşey dağılımı %41,83 dişi ve %43,02 erkek bireylerden oluşmuştur. Bu türe ait en küçük çatal boy uzunluğu 138 (mm), en küçük ağırlık 51 (gr), en büyük çatal boy uzunluğu 525 (mm), en büyük ağırlık 2724 (gr) olarak saptanmıştır. Populasyonda en fazla bireye III yaş grubunda, en az bireye ise VII yaş grubunda rastlanılmıştır. Kondisyon faktörü en düşük VI. yaşta 1,69, en yüksek III. yaşta 2,26 ve aylara göre en düşük Temmuz'da 1,84, en yüksek Haziran'da 2,17 olarak bulunmuştur. Eşeysel olgunluğa ulaşma yaşı erkeklerde III. ve dişilerde IV. yaş olarak belirlenmiştir. Üreme zamanı ise Haziran-Temmuz olarak belirlenmiştir. Aylara göre GSİ değerleri 1,64 -18,78 arasında değişim göstermiştir. Yumurta verimliliği (fekondite) artarak, IV yaştan VIII yaşa doğru yükselmiştir.

Anahtar Kelimeler: Apa Baraj Gölü, *Cyprinus carpio*, üreme, yumurta verimi, eşeysel olgunluk yaşı, eşey oranı

1. Introduction

The fishes are important sources of food for human beings and possess a crucial role in keeping a balanced nourishment as they are rich in protein and contain multiple unsaturated fatty acids. For that reason, fish consumption, which is low in our country, should be raised to the consumption level in developed countries. Fish consumption increasing, not only food sources in our waters will have been exploited in a better way, but also an important source of income will have been provided for those involved. Thus, we should benefit from our present water sources at an optimal level (Bulut, 2002; Geldiay and Balık, 1988; Lagler, 1966).

For a better exploitation of fish populations in water sources, some biological characteristics such as condition factors as well as growth and reproduction characteristics should be known very well. These characteristics of the fishes vary depending upon the physical, chemical, biological and hydrographic conditions of the same water ecosystem. Besides, differences are observed between the populations of the same fish species inhabiting different geographical regions with respect to condition factors as well as growth and reproduction characteristics (Nikolsky, 1963; Geldiay and Balık, 1988; Karataş, 2000; Ozyurt and Avşar, 2001).

In an effort to benefit from this species at an optimal level, commercial fishing of which is done in Apa Dam Lake, bio-ecological characteristics of the carp within its ecosystem should be known very well.

There are also many studies on the biology of Cyprinus carpio, which appears to be widely distributed in Turkey (Akyurt, 1987; Alpbaz and Hoşsucu, 1979; Atalay, 1985; Bircan, 1993; Cengizler and Erdem, 1989; Çetinkaya, 1992; Demirkalp, 1992; Erdem, 1982; Erdem, 1983; Alp and Balık, 2000; Yılmaz and Gül, 2002). A study relating to the carp population in the same research field had been carried out before. However, it had been realized within a limited time, and thus very few values had been investigated. In this study, on the other hand, many more values were obtained through a much longer period of time (Erdem, 1984). Thus, not only the deficiencies were completed, but also comparisons relevant to the bio-ecology of Cyprinus carpio in two different time periods could be made.

During this study based on the Cyprinus carpio, which inhabits Apa Dam Lake and is of significant economic value for those living in the settlement areas in the vicinity, biological characteristics of Cyprinus carpio such as growth in length, growth in weight, length-weight relationship, condition factor, sex ratios, sexual maturity age, reproduction period, fecundity were investigated.

2. Material and Methods

Situated within the borders of Cumra county and designed for the purposes of irrigating (90%) and preventing the floods (%10), Apa Lake was formed by a 29.83-meter high dam of rolled earthfill embankment over multifilament fishing nets (2-3 ply) with a mesh size of 18, 24, 32, 36, 44 and 60, which have a depth of 2,5-3 m and a length of 50, 100 and 200 m.

Carsamba Stream running between Apasaraycik village and Apa town having the longitude of central meridian at 22-23°E and the latitude at 37°N. The dam was inaugurated for use in 1963. Lake area is 12 km², whereas the irrigation area 59704 ha

Fish samples were caught at different stations located on the dam lake between January 2001 and December 2001 using multifilament fishing nets (2-3 ply) with a mesh size of 18, 24, 32, 36, 44 and 60, which have a depth of 2,5-3 m and a length of 50, 100 and 200 m.

Age determination of Cyprinus carpio samples was done using their scales because of their practicality and necessary preparations were made (Geldiay and Balık, 1988; Lagler, 1966).

Development of the carps in the dam lake were determined separately in terms of growth in length and growth in weight. Besides, growth in length and in weight were examined from two different points of view,

that is, relative growth (relative length, relative weight) and relative growth (relative length, relative weight), and were determined by the equations given by Chugunova (1963). Relative growth of the carps inhabiting the dam lake based on various age groups were also assessed through the mathematical analysis of the age-length and age-weight relationships. During this analysis, Von Bertalanffy growth equations were used (Bertalanaffy, 1957).

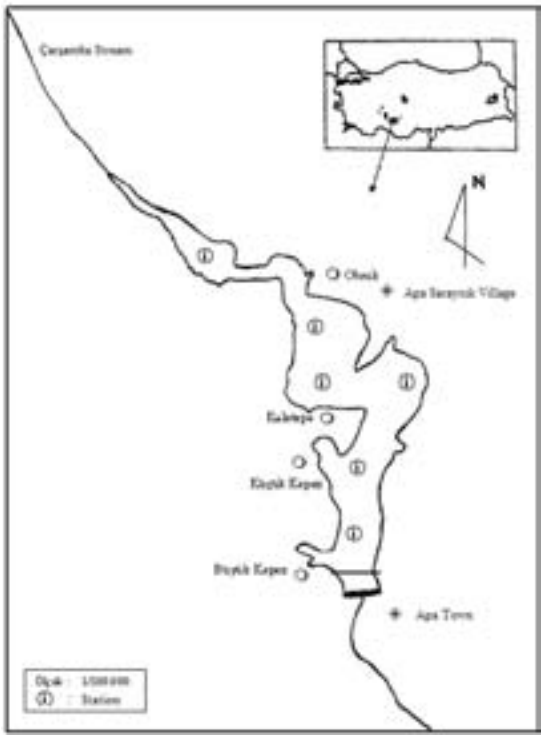

Figure 1. Drenage Area of Apa Dam Lake

The samples were classified according to their sex and the significance level of the difference observed between the fork lengths and weights of males and females in each age group were checked using ($p<0,05$) "t-test".

Relative length increase and relative weight increase of each group were calculated by the following equations ; (OL) ; OL = Lt - Lt-ı / Lt-ı, (OW); OW= Wt- Wt-w Wt-I, respectively (Chugunova, 1963).

Growth equations for males, females and combined sexes (male+female) were calculated by LogW = Log c+n . Log L using the formula of W = c.Ln by Le Cren (Le Cren, 1951;Geldiay and Balık,1988;Celikka, 1986).

Another correlation which marks the relationship between the length and the weight of the fish samples is the condition factor. Moreover, the condition factor is at the same time a measurement which shows the fact whether the fish is fed enough, and thus the water body which it inhabit is rich in foodstuff or not (Geldiay and Balık, 1988; Celikkale, 1986; Bagenal, 1978). This factor can be explained by the following equation;

$$K = (W/L^3). 10^5$$

K= Condition difference,
W= Mean weight (g),
L= Mean fork length (rnm)

Condition factor was calculated separately for each sex group according to the their age and then statistical significance control was

Fragments of 1 gram were taken from the head, middle and end parts of the ovary in an effort to ensure a balanced distribution and determination, and then an egg count was performed using "t-test" ($p<0,005$). Condition factor of each sample was evaluated separately and mean values of them were calculated in age and sex groups.

done under a binocular microscope. Total egg count in females was calculated by multiplying the egg count found in a one-gram ovary fragment by the ovary weight of the sample. (Nikolsky, 1963; Bagenal, 1978).

Gonadosomatic index values were obtained by the following equation;

GSI = [GW (g) / W (g)] . 100
GSI= Gonadosomatic index,
GW=Gonad weight, W=Weight of the sample.

To determine the diameter of the eggs, diameter of every each one of 25 eggs taken from the different parts of the ovary so as to ensure a balanced distribution and determination was measured by means of a micrometer. Then, mean values were obtained and subsequently

mean egg diameter for each female was calculated. Egg diameters were also calculated according to the months and their monthly changes could be obtained.

3.Results

251 samples of *Cyprinus carpio* caught in Apa Dam Lake have proved to be distributed between the ages I-VIII (Figure 2). Samples of *Cyprinus carpio* consisted of females (41,83 %) and males (43,02 %), which reveals that the number of male samples exceed that of female ones.

3.1.Growth in Length

Standard deviation (SD) and standard error (Sx) values were calculated by taking the mean values of the fork lengths of male and female carp samples according to their age. Following t-test, any significant difference could not be observed between male and female samples in all age groups regarding the growth in length. (Table 1; Figure 3).

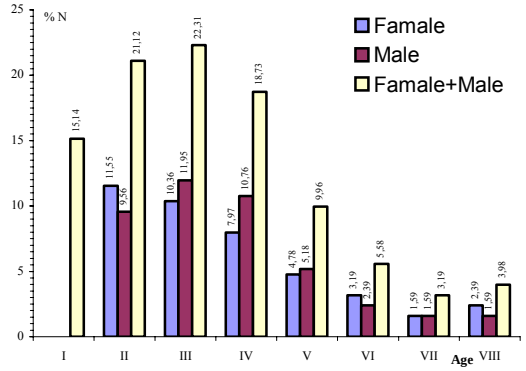

Figure 2. Distrubution graphic for the age and sexuality of *Cyprinus carpio* in Apa Dam Lake

Table 1. Length distrubution for the age and sexuality of *Cyprinus carpio* in Apa Dam Lake

Age	Female			Male			t-test	Female + Male		
	N	L(mm) ± SD (Min-Max)	S_X	N	L(mm) ± SD (Min-Max)	S_X	(p < 0.05)	N	L(mm) ± SD (Min-Max)	S_X
I	-	-		-	-	-	-	38	154,00±10,58 (138-168)	1,72
II	29	201,69 ± 25,70 (165-260)	4,77	24	192,67±30,60 (170-268)	6,25	0,129	53	197,60±28,12 (165-268)	3,86
III	26	294,38±26,95 (243-329)	5,28	30	302,80±22,87 (258-334)	4,18	0,054	56	298,89±24,97 (243-334)	3,34
IV	20	343,80±17,43 (312-362)	3,90	27	330,48±19,67 (296-370)	3,78	0,009	47	336,15±19,71 (296-370)	2,87
V	12	382,00±8,53 (370-396)	2,46	13	375,69±21,19 (350-410)	5,88	0,168	25	378,72±16,38 (350-410)	3,28
VI	8	440,50±22,19 (420-470)	7,84	6	435,67±3,61 (432-440)	1,48	0,281	14	438,43±16,62 (420-470)	4,44
VII	4	504,00±9,24 (496-512)	4,62	4	505,50±5,20 (501-510)	2,60	0,295	8	504,75±6,98 (496-512)	2,47
VIII	6	512,33±10,44 (502-525)	4,26	4	504,00±4,62 (500-508)	2,31	0,064	10	509,00±9,29 (500-525)	2,94

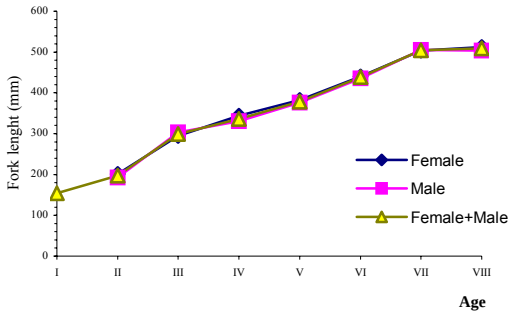

Figure 3. *Age-length relationship of Cyprinus carpio* in Apa Dam Lake

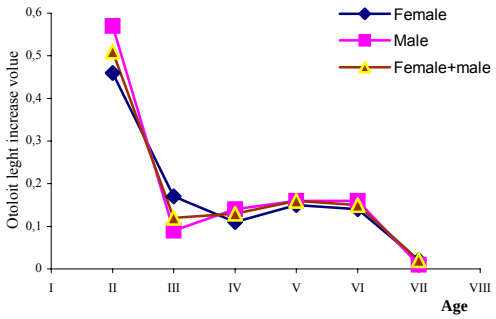

Figure 4. The lenght increase relationships in ratio according to age and sexualtiy of *Cyprinus carpio* in Apa Dam Lake

Table 2. The lenght increase in ratio according to age and sexualtiy of *Cyprinus carpio* in Apa Dam Lake

	Female			Male			Female + Male		
Age	N	L(mm)	O.L.	N	L(mm)	O.L.	N	L(mm)	O.L.
I	-	-		-	-	-	38	154,00	
									0,28
II	29	201,69		24	192,67		53	197,60	
			0,46			0,57			0,51
III	26	294,38		30	302,80		56	298,89	
			0,17			0,09			0,12
IV	20	343,80		27	330,48		47	336,15	
			0,11			0,14			0,13
V	12	382,00		13	375,69		25	378,72	
			0,15			0,16			0,16
VI	8	440,50		6	435,67		14	438,43	
			0,14			0,16			0,15
VII	4	504,00		4	505,50		8	504,75	
			0,02			0,01			0,02
VIII	6	512,33		4	504,00		10	509,00	

Relative length increase values which were calculated for each age and sex group (female, male, combined sex) are shown in Figure 4. This figure reveals that relative length increase value occurred the most rapidly in age group II and then slowed down by the ageing. Relative length increase value has proved to be at its lowest level in age VII.

When relative length increase values were examined, it was revealed that relative length increase values of females were higher than those of males in age group III and VII, whereas relative length increase values of males were higher than those of females in age groups II, IV, V and VI (Figure 4 and Table 2).

3.2. Growth in Weight

Cyprinus carpio samples classified by their mean weights according to their age and sex are shown in Table 3. In this table, mean weights for males, females and combined sexes were given separately. Standard deviations as well as standard errors were also calculated. Based on these calculated values, t-test was used to check whether the differences between the weight of males and females were statistically significant or not.

Table 3. The weight distribution according to age and sexualtiy of *Cyprinus carpio* in Apa Dam Lake

Age	Female N	Female W(g) ± SD (Min-Max)	Female S_X	Male N	Male W(g) ± SD (Min-Max)	Male S_X	t-test (p<0.05)	Female + Male N	Female + Male W(g) ± SD (Min-Max)	Female + Male S_X
I	-	-		-	-	-	-	38	75,26±15,47 (51-96)	2,51
II	29	191,10±84,07 (102-416)	15,61	24	167,42±97,53 (97-440)	19,91	0,177	53	180,38±90,30 (97-440)	12,40
III	26	560,38±104,55 (354-682)	20,50	30	588,13±88,08 (460-775)	16,08	0,079	56	575,25±96,20 (354-775)	12,86
IV	20	760,80±84,48 (589-880)	18,89	27	765,70±102,27 (534-896)	19,68	0,429	47	763,62±94,16 (534-896)	13,73
V	12	1065,83±62,90 (973,1160)	18,16	13	1058,31±150,27 (918-1320)	41,68	0,435	25	1061,92±114,53 (918-1320)	22,91
VI	8	1496,25±208,15 (1234-1692)	73,59	6	1394,00±49,61 (1360-1458)	20,25	0,109	14	1452,43±164,42 (1234-1692)	43,94
VII	4	2206,00±154,73 (2072,2340)	77,36	4	2242,50±44,46 (2204-2282)	22,23	0,338	8	2224,25±107,18 (2072-2340)	37,89
VIII	6	2673,00±55,45 (2604-2724)	22,64	4	2475,50±128,75 (2364-2587)	64,37	0,024	10	2594,00±132,80 (2364-2724)	41,99

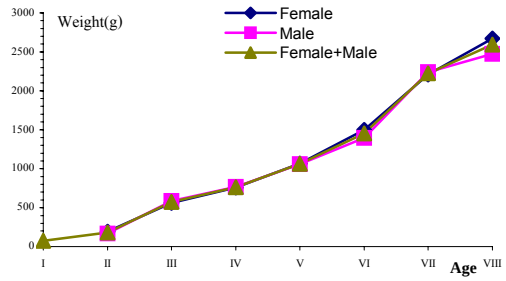

Figure 5. The age-weight relationships of *Cyprinus carpio* in Apa Dam Lake

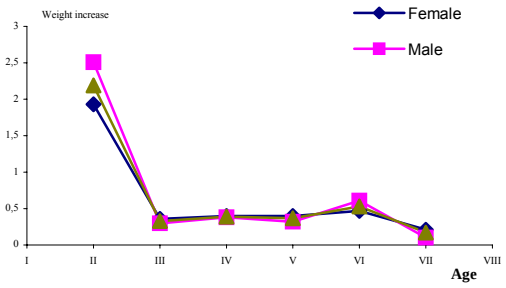

Figure 6. The relationships in ratio according to age and sexualtiy of *Cyprinus carpio* in Apa Dam Lake

Table 3 shows that differences in mean weights of males and females proved to have varied according to age groups. For instance, female samples were determined to be heavier in age groups II, V, VI and VIII, whereas male ones outweighed them in age groups III, IV and VII. However, the difference in weight is rather small between the age IV and V. These differences were checked by t- test. During t-test controls performed according to the results obtained, it was revealed that the difference between the mean weights found in age group VI and VIII was significant.

Taking relative length increase values calculated by mean weights into consideration, they were higher for males than females in age group II. As far as relative length increase is concerned, differences observed between the sexes in other age groups were rather small (Table 2; Figure 4). Relative length increase appeared to be fast in age group II; close to each other in III, IV and V. Yet, the one in age group VI turned out to be the slowest.

3.3.Length- Weight Relationship

Length-weight relationship of 251 samples of *Cyprinus carpio* caught in Apa Dam Lake was calculated for males, female and combined sexes separately using the equation of $W=c.L^n$. (Table 5). A higher correlation (0,93) was found between the fork length and the weight of the carp samples inhabiting Apa Dam Lake.

Table 4. The weight increase in ratio according to age and sexualtiy of *Cyprinus carpio* in Apa Dam Lake

Age	Female			Male			Female + Male		
	N	W (g)	O.W.	N	W (g)	O.W.	N	W (g)	O.W.
I							38	75,26	
									1,40
II	29	191,10		24	167,42		53	180,38	
			1,93			2,51			2,19
III	26	560,38		30	588,13		56	575,25	
			0,36			0,30			0,33
IV	20	760,80		27	765,70		47	763,62	
			0,40			0,38			0,39
V	12	1065,83		13	1058,31		25	1061,92	
			0,40			0,32			0,37
VI	8	1496,25		6	1394,00		14	1452,43	
			0,47			0,61			0,53
VII	4	2206,00		4	2242,50		8	2224,25	
			0,21			0,10			0,17
VIII	6	2673,00		4	2475,50		10	2594,00	

Table 5. The correlation coefficient (r) values and length-weight relationship equation of *Cyprinus carpio* in Apa Dam Lake

	$W=1,27 \times 10^{-4} \times L^{2,53}$	
Female	Log W= - 3,38 x 2,53 Log L	r =0,93
	$W=1,09 \times 10^{-4} \times L^{2,71}$	
Male	Log W= -3,96 + 2,71 Log L	r =0,93
	$W=5,4 \times 10^{-5} \times L^{2,83}$	
Female+Male	Log W= - 4,26 + 2,83 Log L	r =0,93

3.4.Condition Factor

Condition factor which was separately calculated for each sex in all age groups of the carp population and related statistical results are given in Table 6. During the calculation of condition factor, the total of the condition factor values of the samples in each age group was averaged. When Table 6 is studied, condition factor appears to be higher for females in age groups II, III and VIII; and for males in IV, V and VII. Condition factor values of males and females were observed to be equal in age group VI.

Differences between the condition factor values of males and females were checked using t-test and the difference between the sexes in age group IV was found significant. However, the differences among other age groups were evaluated insignificant.

Condition factor of female and male Cyprinus carpio samples proved to have ranged from 1,06 to 4,11 and 1,33 to 3,69, respectively. When age-based changes were examined, it was determined that condition factor had increased up to age III, decreased between the ages III and VI, and increased again beginning from the age VI (Figure 7).

Table 6. The condition factor and statistical results according to age and sexualtiy of *Cyprinus carpio* in Apa Dam Lake

Age	Female			Male			t-test	Female + Male		
	N	K ± SD (Min-max)	S_X	N	K± SD (Min-Max)	S_X	(p<0.05)	N	K ± SD (Min-Max)	S_X
I	-	-		-	-	-	-	38	2,06±0,35 (1,48-3,08)	0,06
II	29	2,21±0,15 (1,80,2,44)	0,03	24	2,14±0,14 (1,97-2,32)	0,14	0,094	53	2,19±0,14 (1,80-2,44)	0,02
III	26	2,33±0,95 (1,06-4,11)	0,19	30	2,20±0,65 (1,33-3,69)	0,12	0,278	56	2,26±0,80 (1,06-4,11)	0,11
IV	20	1,88±0,25 (1,45-2,37)	0,06	27	2,16±0,48 (1,43-3,39)	0,09	0,007	47	2,04±0,42 (1,43-3,39)	0,06
V	12	1,92±0,19 (1,67-2,15)	0,06	13	2,03±0,44 (1,35-2,61)	0,12	0,201	25	1,98±034 (1,35-2,61)	0,07
VI	8	1,69±0,18 (1,52-1,97)	0,06	6	1,69±0,03 (1,65-1,71)	0,01	0,476	14	1,69±0,13 (1,52-1,97)	0,04
VII	4	1,72±0,03 (1,70-1,74)	0,01	4	1,74±0,09 (1,66-1,81)	0,04	0,366	8	1,73±0,06 (1,66-181)	0,02
VIII	6	1,99±0,11 (1,88-2,13)	0,05	4	1,93±0,05 (1,89-1,97)	0,02	0,145	10	1,97±0,09 (1,88-2,13)	0,03

Table 7. The changes of condition factor values according to month of *Cyprinus carpio* in Apa Dam Lake

Monhts	Female			Male			Female+Male		
	N	K	S_x	N	K	S_x	N	K	S_x
January	5	2,04	0,024	8	1,99	0,025	13	2,02	0,016
February	6	1,98	0,013	6	1,92	0,021	12	1,95	0,031
March	10	2,00	0,014	9	1,95	0,015	19	1,98	0,012
April	9	2,06	0,021	11	2,01	0,020	20	2,04	0,013
May	13	2,12	0,019	10	2,10	0,011	23	2,11	0,032
June	12	2,18	0,030	13	2,15	0,017	25	2,17	0,023
July	7	1,80	0,017	8	1,88	0,032	15	1,84	0,019
August	8	1,83	0,012	7	1,90	0,012	15	1,87	0,010
September	9	1,92	0,033	6	1,95	0,016	19	1,94	0,020
October	7	1,96	0,016	6	1,92	0,032	13	1,94	0,015
November	11	1,99	0,020	9	1,97	0,023	20	1,98	0,027
December	8	2,01	0,019	11	2,01	0,018	19	2,01	0,016

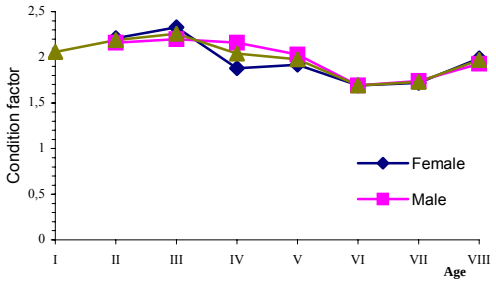

Figure 7. The changes of condition factor according to age and sexualtiy of *Cyprinus carpio* in Apa Dam Lake

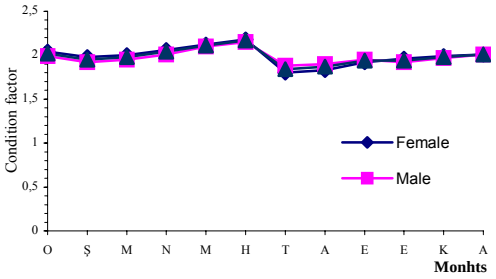

Figure 8. The changes of condition factor values according to month of *Cyprinus carpio* in Apa Dam Lake

Monthly changes relating to the condition factor of Cyprinus carpio population are given in Table 7 and Figure 8. The lowest condition value occurred in July, whereas the highest one was observed in June.

Reproduction

To determine the reproduction characteristics of *Cyprinus carpio* population inhabiting Apa Dam Lake; various characteristics such as sex ratio, sexual maturity age, reproduction period and fecundity were investigated.

Sex Ratio

251 samples of *Cyprinus carpio* population caught in dam lake consisted of 105 females and 108 males. Sex of the 38 samples (%15,17) in age group could not be determined. Sex of the rest was determined examining their gonads. Carp samples, which were examined, included females (%41,83) and males (% 43,02) (Table 8). Male/Female ratio was found 1,028:1.

Table 8. The sex disturbition and ratio according to the ages of *Cyprinus carpio* in Apa Dam Lake

	Female		Male		Male / Female
Age	N	%	N	%	Rate
I	-	-	-	-	-
II	29	11,55	24	9,56	0,827:1
III	26	10,36	30	11,95	1,153:1
IV	20	7,97	27	10,76	1,350:1
V	12	4,78	13	5,18	1,083:1
VI	8	3,19	6	2,39	0,750:1
VII	4	1,59	4	1,59	1,000:1
VIII	6	2,39	4	1,59	0,666:1
Total	105	41,83	108	43,02	1,028:1

Sexual Maturity Age

When *Cyprinus carpio* samples reached their first sexual maturity age was determined examining their gonad growth. The first maturity age for females was found IV and III for males. The smallest female sample was 343,8 mm, and male sample 302,8 mm.

Reproduction Period

To determine the reproduction period of *Cyprinus carpio,* gonadosomatic index was calculated. Changes related with the egg count and egg diameter in an ovary fragment of 1 g were examined on a monthly basis (Table 9). The highest gonadosomatic index value was obtained in June (18,78), and the lowest one in August

(1,64). A diagram in Figure 9 illustrates gonadosomatic index values and monthly varying mean temperature values of the dam lake's water.

Egg diameters of the fish samples, which have reached their maturity age, as well as the monthly variations in egg count in an ovary fragment of 1 g are shown in Table 10.

Table 9. The monthly changes of gonadosomatic index values of *Cyprinus carpio* in Apa Dam Lake

Months	J	F	M	A	M	J	J	A	S	O	N	D
GSI	4,82	6,85	7,51	10,82	11,93	18,78	1,23	1,64	2,02	2,73	3,31	395
Sx	0,951	0,723	0,467	0,980	1,19	1,56	1,04	0,12	0,151	0343	0,209	0,661

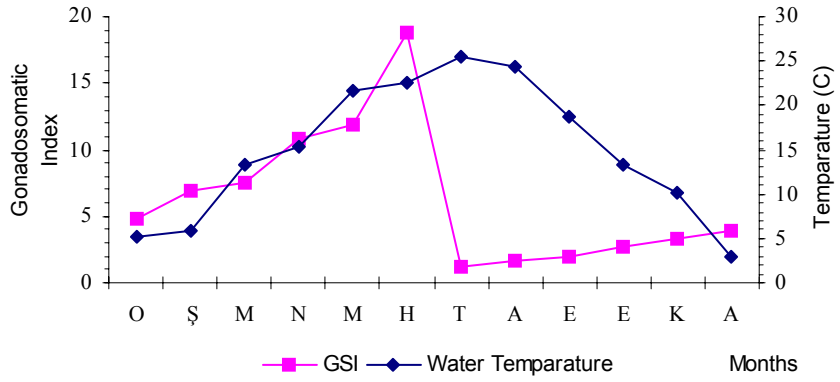

Figure 9. The monthly changes of gonadosomatic index and water temparature value means of *Cyprinus carpio* in Apa Dam Lake

Table 10. The monthly changes of egg count and diamater of *Cyprinus carpio* in Apa Dam Lake

Monhts	Average of Egg diameter (mm)	S_x	Egg count (In 1g. Ovary)	S_x
J	0,883	0,178	1314,28	82,36
F	0,997	0,091	1220,07	45,14
M	1,045	0,072	970,71	124,67
A	1,180	0,088	612,83	90,01
M	1,245	0,102	536,40	121,63
J	1,292	0,030	515,24	99,54
J*	-	-	-	-
A	0,457	0,047	457,35	22,74
S	0,593	0,031	1883,62	89,36
O	0,681	0,056	1694,91	111,30
N	0,774	0,043	1486,54	116,85
D	0,810	0,030	1398,81	123,44

*It could not be measured

Since the fish samples had no egg in their ovary in July, egg count could not be done. Monthly changes in egg diameter has showed a parallel development with gonadosomatic index values (Figure 10). On the other hand, a decrease was observed in egg count of an ovary fragment of 1 g. The highest mean value for the egg diameter was found in May and June. Besides, the highest egg count in an ovary fragment of 1 g was observed in September. The more the egg diameter enlarged, the more the egg count decreased. The decrease in egg count continued until June (Figure 10).

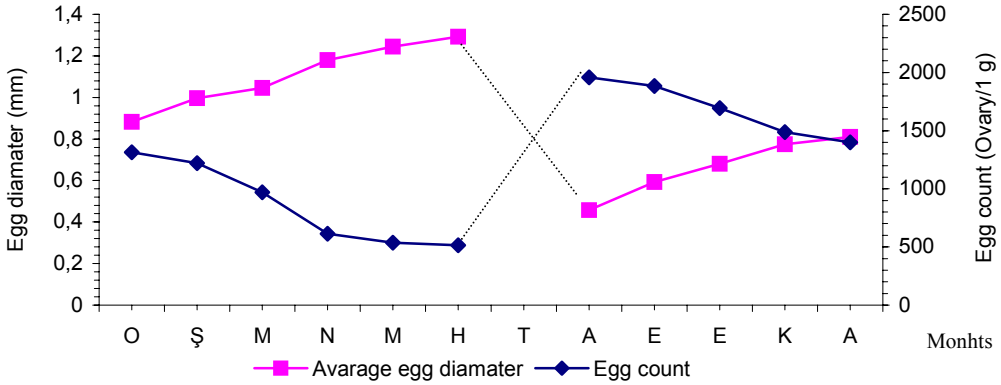

Figure 10. The monthly changes of egg count and diamater of *Cyprinus carpio* in Apa Dam Lake

Cyprinus carpio samples inhabiting Apa Dam Lake was observed to have had an egg growth which continued until June and immensely spawned in June and July. As a result, we concluded that reproduction of *Cyprinus carpio* samples occurred in June and July examining the gonadosomatic index, ovarian weight and egg diameter values

Fecundity

Egg count changes of *Cyprinus carpio* samples inhabiting Apa Dam Lake according to the age are given Table 11. The more the samples aged, the more the egg count increased.

Table 11. The changes of egg count according to the ages of *Cyprinus carpio* in Apa Dam Lake

Age	N	Fork leght (mm)	Weight (g)	Average of egg count
IV	20	343,80	760,80	16919±3457
V	12	382	1065,83	23525±4713
VI	8	440,5	1496,25	29760±6540
VII	4	504	2206	34684±3738
VIII	6	512,33	2673	42246±8251
Average				29 427

4. Discussion

The age composition of *Cyprinus carpio* samples inhabiting Apa Dam Lake ranged from I to VIII (Figure 2). While the number of the examined samples was much in the first IV age group, it decreased in following age groups, which shows that the samples consisted mostly of juvenile carps. The age composition of carp populations in previous studies was as follows: Almus Dam Lake, II - VIII (Akyurt, 1987), Lake Akşehir, I - XIV (Cetinkaya, 1992). The age composition of carp population inhabiting Apa Dam Lake had been found to have ranged from I to VIII (Erdem, 1984), which complies with the results of our study, as well. Other studies have yielded similar result, i.e. Lake Hafik, I -VII (Cengizler and Erdem, 1989), Lake Cavuşçu, I - IX (Erdem, 1983), Lake Eber, 0-X (Erdem, 1982), Bafra Lakes, II -VII (Bircan, 1993) and II—VIII (Demirkalp, 1992). Wide distribution of the fish population is directly related with whether the water body which it inhabit is rich in foodstuff or not. (Nikolsky, 1963; Richard, et al., 1969).

In this study, length of carp samples ranged from 138 to 525 mm(Table 1). Female samples

were determined to be longer than male ones in age groups II, IV, V and VI. However, these sexual differences are very small and of statistical insignifance. Length composition of *Cyprinus carpio* in Aslantas Dam Lake ranged from 109 mm to 445 mm. These values show similarity to the findings obtained in Apa Dam Lake (Erdem, 1984). Mean fork length was found to be 128 mm in age group I, and 366 mm in VII in Lake Hafik (Sivas) (Cengizler and Erdem, 1989). Mean fork length of *Cyprinus carpio* population inbating Lake Akşehir was 143 mm in age group I and 369 mm in VIII (Cetinkaya, 1992). As it can be seen, fork length values obtained in many other studies related with *Cyprinus carpio* population have proved to be lower than the ones determined in this study that was carried out Apa Dam Lake. These findings reveal that the carp population in Apa Dam Lake has enjoyed a better growth. The reason for this fact can be attributable to the favourable biotic and abiotic factors in the lake.

Cyprinus carpio samples have showed an relative length increase of 0,28 in age group I; 0,51 in II; 0,12, in III; 0,13 in IV, 0,16 in V; 0,15 in VI; 0,02 in VII. The highest and the lowest relative length increase ranged from in age group II (0,51) and VII, respectively (Table 2). The lowest relative length increase was observed in age group VII (0,01) for females and, in VII (0,01) for males. These findings show us the fact that relative length increase of juvenile samples is higher than that of older ones. Relative length increase of the samples in Aslantas Dam Lake was higher in age groups I and II. The relative length increase which was 0,5588 in age group I and 0,3658 in age group II. decreased gradually in the following years. These values show similarity to the findings obtained in Apa Dam Lake (Erdem, 1984).

In this study, the weight of the samples inhabiting Apa Dam Lake ranged from 51 g to 2724. The difference between the mean weights of females and males in age group IV was found to be significant. Males were heavier in age groups III, IV and VII, whereas females outweighed in other age groups. (Table 3). Mean weights obtained Apa Dam Lake were found higher than those determined in many other dam lakes except for a few exceptions, as it was the case with mean fork lengths (Akyurt, 1987; Alpbaz and Hoşsucu, 1979; Atalay, 1985; Bircan, 1993; Cengizler and Erdem, 1989; Cetinkaya, 1992; Demirkalp, 1992; Erdem, 1982; Erdem, 1983; Alp and Balık, 2000; Yılmaz and Gül, 2002). The comparisons we made reveal that growth of Cyprinus carpio population was faster in Apa Dam Lake.

While relative weight increases of *Cyprinus carpio* samples inhabiting Apa Dam Lake was high in the first age groups, they decreased in the following ones (Table 4 and Figure 6). Relative weight increase was higher in females beginning from the age 3, except for the age VI. This difference may be due to the reproduction age. The lowest relative weight increase in the overall population was observed in age VII (0,17). Low relative weight increase during the reproduction ages reveals the fact that the fish samples have used a large amount of food they consumed for the development of gonads.

To determine the length-weight relationship of *Cyprinus carpio* population using their measured mean lengths and weights, logarithmic growth equations were calculated as follows: Log W = -3,38 + 2,53 Log L, for females; Log W = -3,96 + 2,71 Log L for males and Log W = -4,26 + 2,83 Log L for combined sexes. The “n” value which was calculated for *Cyprinus carpio* population inhabiting Apa Dam Lake was found 2,53 for males; 2,71 for females and 2,83 for combined sexes, which are ideal (Table 5). The “n” values which were obtained in other carp-related studies showed parallelism to that of this study carried out in Apa Dam lake.The "n" value for the carp population was found 3,00 in Lake Mogan, 2,96 in Lake Eber, 2,56 in Lake Egirdir, and 2,51 in Lake Beysehir (Erdem, 1982; Erdem, 1983; Tanyolac, 1975).

Mean condition factor was found 1,96 for females, 1,98 for males 1,99 and for combined sexes (Table 6; Figure 7). Condition factor in

fish populations varies according to age, sex, season, place and time of fishing (Nikolsky, 1963; Richard, et al., 1969; Lagler, 1966). In this study carried out in Apa Dam Lake, the condition factor which was higher in the first age groups decreased in following ones, which is attributable to the fact that the samples were not fed well or they spent a large amount of their energy for the reproduction (Nikolsky, 1963). T-test results of the condition factor of male and female samples have proved to be significant for the age group 4, but not for the rest.

Condition factor (mm) of *Cyprinus carpio* population was found lower in other studies carried out in Turkey than the one we performed in Apa ; i.e., Lake Aksehir 1,54 (Cetinkaya, 1992); Beytepe Lagoon, 1,69 (Atalay,1985); Almus Dam Lake, 1,68 (Akyurt, 1987); Lake Cavuscu, 1,54 (Erdem, 1983). The results which were obtained in the studies formerly carried out in Lake Hafik and Apa Dam Lake were 1,99 (Cengizler and Erdem, 1989) and 1,82 (Erdem, 1984), respectively, showing parallelism to those in this study.

Samples of *Cyprinus carpio* population inhabiting Apa Dam Lake consisted of females (41,83 %) and males (43,02 %). Male/Female sex ratio in the population was found 1,028:1, which reveals that the samples were caught at random and by a good sampling. Reproduction age of *Cyprinus carpio* samples caught in Apa Dam Lake was determined to be IV for females and III for males.

In the studies which were carried out in Turkey, the reproduction age of *Cyprinus carpio* was determined to have ranged between II and IV. Due to the significant effect of the ecological factors on reproduction age, these different results which were obtained from different regions of different climatic conditions may be considered normal (Akyurt, 1987; Alpbaz and Hoşsucu, 1979; Atalay, 1985; Bircan, 1993; Cengizler and Erdem, 1989; Çetinkaya, 1992; Demirkalp, 1992; Erdem, 1982; Erdem, 1983; Alp and Balık, 2000; Yılmaz and Gül, 2002).

Gonadosomatic index of *Cyprinus carpio* population inhabiting Apa Dam Lake reached the peak in May (11,93) and June (18,78), and then decreased to the minimum value in August (1,64), which reveals that the eggs matured completely in June and the spawning took place in July (Table 9; Figure 9).

Egg count in a 1 g fragment of ovary of *Cyprinus carpio* samples, which increased inversely relative to the egg diameter according to age, decreased as the reproduction time approached (Table 10). Based on these results, we determined that *Cyprinus carpio* inhabiting Apa Dam Lake had spawned in June and July. If Table 3.12 and Figure 3.12 are studied, one can conclude that egg count increased as the samples got older and had an average of 29427 in the population (Table 11). Besides, during the study we hardly found few samples which were about to spawn in August.

As a result, the parameters, which determine the reproduction characteristics of *C. carpio* inhabiting Apa Dam Lake, such as gonadosomatic index, weight of the ovary, egg diameter, egg count in a 1 g fragment of ovary were examined and the reproduction period was concluded to take place between early June and late July.

Besides, during the discussions with the fishermen and joint catching of fish beginning from January 2000, they were observed to be ignorant of catching rules and prohibited catching period. So, they were made fully conscious of the issue.

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