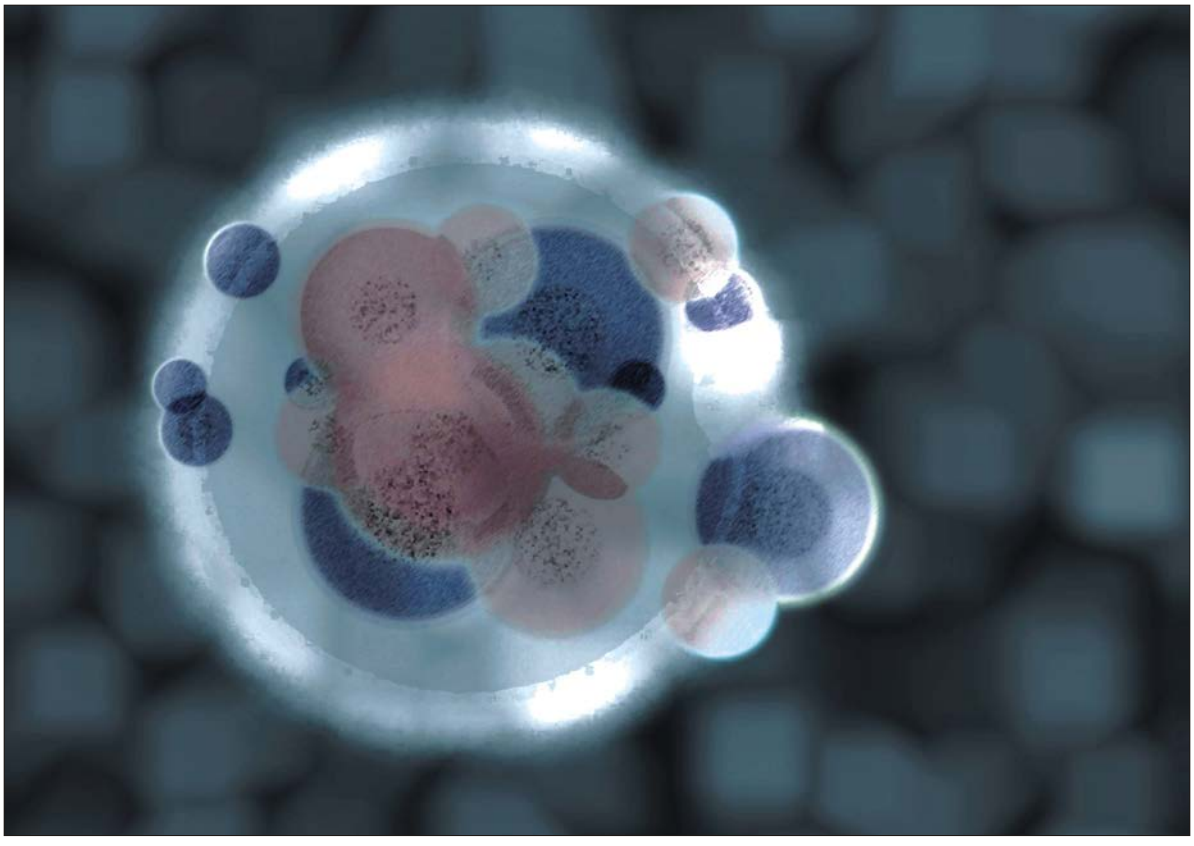

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Reproduction Characteristics of Population of Carp (*Cyprinus carpio*) Inhabiting in Almus Dam Lake, Turkey

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Abstract: The aim of this study was to establish the sex ratio, age of sexual maturity, spawning period and fecundity of common carps (*Cyprinus carpio*) in Almus Dam Lake from October 2002 to September 2003. The overall male to female ratio was 1:1.4. Females and males began to be mature at the age of 4 and 3. All of them were mature at the age of 5 and 4, respectively. Fork lengths at maturation were 22.88 and 27.48 cm for male and female, respectively. Maximum ages observed were 4 in males and 7 in females. Reproductive period started in June for males and July for females and continued until the beginning of August. Individual fecundity of the females was found between 2405-107089 for the population.

Key words: Fecundity, sex ratio, spawning time, sexual maturity, carp

INTRODUCTION

Common carp (*Cyprinus carpio*) is a member of the Cyprinidae family and native to Europe but found worldwide except for the poles and Northern Asia[1,2]. This frequently cultured species has a commercial value as a food fish throughout their native and introduced range. Common carp is an important freshwater species especially all of the branches of Yesilirmak River in Turkey.

There is some information about the life cycle of the common carp of Turkish waters[3-11]. Additionally, the growth characteristics of some cyprinid species of Almus Dam Lake were also investigated[3,12]. The aim of this study was to investigate the age composition and reproduction tactics of *Cyprinus carpio* inhabiting in Almus Dam Lake.

MATERIALS AND METHODS

The study was performed in Almus Dam Lake, which is located 3.5 km North-east of Almus town in the province of Tokat on Yeşilirmak River and has a surface area of 3130 ha. A total of 313 carps were captured by nets of various mesh sizes between October 2002 and September 2003. Environmental conditions were recorded during the survey (Table 1). Fork length (L) and wet weight (W) of the captured fish were recorded with 1 mm and 0.01 g sensitivity, respectively. Scales were used for age determination. Sex of the fish was determined by examination of the gonad tissue either by eye for larger fish or with the aid of a microscope for smaller fish. Then gonad tissue was weighted and ovaries preserved in Gilson's fluid. The age of sexual maturity was also estimated from the gonad development and monthly variations in egg diameters of the samples[13]. The stages of maturation were classified as: stage 0, immature; stage 1, resting; stage 2, developing; stage 3, ripe; stage 4, running; stage 5, spent; stage 6, recovering[14]. The spawning season determined following the monthly changes of the gonad-somatic index (GSI), calculated by the following formula[15]:

Table 1: Environmental conditions at the sampling sites

Characteristics	Minimum	Maximum	Mean
Temperature	3.0	25.50	17.4±6.47
Dissolved oxygen	7.4	10.50	8.9±0.72
Lake depth	7.0	43.00	16.0
pH	6.9	8.40	8.0±0.32
EC (mhos/cm)	1600.0	21000.00	14252.0±8500
Hardness (FS^0)	225.0	390.00	297.0±123
NH_3 (ppm)	0.0	0.00	0.0
NO_3 (ppm)	0.0	3.43	1.66±0.48

$$GSI = 100\frac{W_g}{W} \quad (1)$$

Where, W is total weight (g), W_g is gonad weight (g).

Fecundity was estimated gravimetrically[16,17]. Eggs from the front, middle and back parts of ovaries, taken from females captured just before the spawning period were measured under stereo-microscope with an ocular

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micrometer. The relationships between fecundity and fork length, weight and gonad weight were calculated by applying the exponential regression equation[18]:

$$F = aX^b \quad (2)$$

Where, F is fecundity; X could be fork length (L), total weight (W) or gonad weight (W_g) a and b are parameters to be estimated.

RESULTS

Age composition and sex ratio: The age of fish varied between I and VII. The third age group was dominant in the population. The numbers of fish in the younger age groups were more than that in the older age group (Table 2). The sex rate of the population was 1:1.4 (M/F). χ^2 analysis showed significant difference (χ^2 =8.97; p<0.01).

Table 2: Composition of the sex and age of *Cyprinus carpio* in Almus Dam Lake

	Female		Male		Female-Male	
Age	N	%	N	%	N	%
I	8	30.77	18	69.23	26	8.30
II	50	44.64	62	55.36	112	35.78
III	103	68.67	47	31.33	150	47.92
IV	10	76.92	3	23.08	13	4.15
V	8	100.00	--	0.00	8	2.55
VI	3	100.00	--	0.00	3	0.95
VII	1	100.00	--	0.00	1	0.31
Total	183	58.47	130	41.53	313	100.00

Sexual maturity: Maturation was started at the age of 3 and 4 for male and female, respectively (Table 3). Maturation fork length were 22.88±1.06 and 27.48±180 cm for males and females, respectively.

Gonad development and spawning period: The monthly variations of male and female Ganodosomatic Index (GSI) values of the population were presented in Table 4.

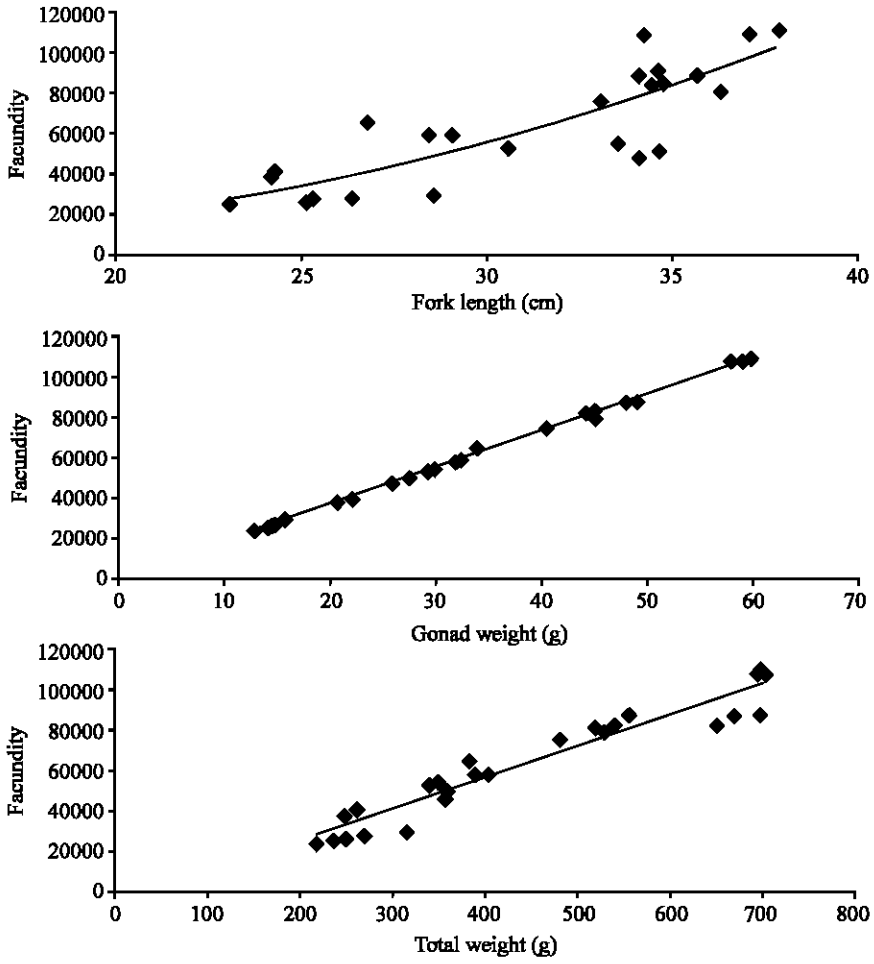

Fig. 1: Relationships between fecundity of fish and fork length (FL), weight (W) and gonad weight (Wg)

Table 3: The distribution of sexually mature individuals of *Cyprinus carpio* to age groups

	Female					Male				
Age	N	Mature	%	Immature	%	N	Mature	%	Immature	%
I	8	0	0.00	8.0	100.00	18	0	0.00	18	100.00
II	50	0	0.00	50.0	100.00	62	24	38.70	38	61.30
III	103	47	45.63	56.0	54.37	47	34	72.34	13	27.66
IV	10	10	100.00	0.0	0.00	3	3	100.00	0	0.00

Table 4: Ganodosomatic index values of the males and females

Month	N	Mean±SE (Female)	N	Mean±SE (Male)
October	17	2.09±0.22	12	1.90±0.17
November	13	3.32±0.25	9	2.39±0.26
December	22	4.51±0.27	17	3.61±0.12
January	11	5.01±0.32	28	4.78±0.13
February	19	5.71±0.73	19	5.92±0.54
March	25	6.62±0.75	14	6.91±0.07
April	14	7.74±0.08	29	6.94±0.72
May	24	8.06±0.84	30	7.4±0.38
June	26	9.01±1.03	33	8.96±0.44
July	37	10.97±1.14	22	7.42±0.51
August	18	1.61±0.42	8	1.06±0.13
September	15	1.88±0.27	15	1.50±0.023

Table 5: Egg diameters (mm) of *Cyprinus carpio* population in Almus Dam Lake

Month	N	Mean±SE	Min.	Max.
18 May 2003	21	0.81±0.03	0.74	0.95
15 June 2003	18	0.97±0.02	0.80	1.15
1 July 2003	14	1.04±0.09	0.92	1.23
15 July 2003	15	1.09±0.03	0.94	1.19

The maximum GSI values were observed in July for females and June for males.

Spawning time began in June and continued to the middle of July. However, small amount of individual was found spawning at the beginning of August. After the beginning of reproduction, GSI values decreased progressively towards the quiescent period.

The egg diameters for *Cyprinus carpio* inhabiting Almus Dam Lake are given in Table 5. Egg diameters changed between 0.74 and 1.19 mm. Maximum increment in egg diameters occurred in July 2003.

Fecundity: Fecundity was determined using 63 females caught just before the spawning period. Female carps produced 148617±9785 eggs for per kg of their body mass. Individual fecundity of the females was found between 2405-107089 for Almus Dam Lake population of *Cyprinus carpio*. Generally, diameters of carp eggs vary between 1.24 and 1.42 mm[19,20]. In this study, the egg diameters varied between 0.74 and 1.19 mm. Maximum increment in egg diameters occurred in July 2003. Fecundity was correlated with the length, weight and gonad weight of fish. Large and old fish showed a higher fecundity. In Fig. 1 the relationships and the estimated parameters between fecundity and fork length, weight and gonad weight are:

$$F = 99.46\ W^{1.059} \quad (R^2 = 0.92)$$

$$F = 5.67\ L^{2.69} \quad (R^2 = 0.71)$$

$$F = 1833.94\ W_g^{0.99} \quad (R^2 = 0.95)$$

DISCUSSION

The overall sex ratio is close to 1:1 in many species, but it may vary from species to species, even population to population of the same species and may change year to year in the same population[21]. The overall ratio of males to females was found 1:1.4 for *Cyprinus carpio* population of Almus Dam Lake and significantly different from the ratio 1:1.

Males typically become sexually mature at 3 to 5 years and females at 4 to 5 years[2,22]. On the other hand it was reported that carp populations in Kazova Kaz Lake became sexually mature at the age of 2 year[10]. The present study indicated that males and females in Almus Dam Lake began to mature at the age of 3 and 4, respectively. Male carp of Almus Dam Lake reached to sexual maturity at 22.88±1.06 cm of fork length whereas females were sexually mature at 27.48±180 cm of fork length. These sexual maturation lengths reported here were similar to the results reported by many investigators in carps[23-25] with slight differences. These variations in age, length and weight of sexual maturity could be explained by means of adaptive response of carps to different environmental conditions such as temperature, population density, growth properties, quantity and quality of food[13,26].

The spawning characteristics of fish vary in respect to their species and the ecological properties of the water system in which they live[13]. Wild carps are portional spawners[27], so they spawn two or three times over a 14-day interval. Spawning time began in June and continued to the middle of July for this population. However, a little number of individual was found spawning at the beginning of August. Şen[11] also determined the spawning period for this species as reported here.

Common carp has a relative fecundity of 100,000 to 300,000 eggs for per kilogram of weight and each female can produce up to 360,000 to 599,000 eggs[19,20,28]. Individual fecundity in this study was found between 2405 and 107089 for per female. Relative fecundity was

148617±9785 eggs for per kg of their body mass. This values for fecundity were similar to the most of the reports on carps of Turkey[7,10,11] but slightly higher than that reported by Çetinkaya[25] and Bircan *et al.*[9]. It is well known that fecundity is affected by age, size, species, season, feeding of fish and environmental conditions. Additionally, it differs between populations of the same species and does not remain constant from year to year. One of the major features of the fecundity is that it increases during the growth of fish[21].

In the light of this study, water of the lake used for agricultural irrigation should be regulated without damaging the spawning period of the population. The most critical season for spawning was between June and July. Fishing should be controlled and minimum catch size should not be lower than 28 cm fork length.

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