The Length and Weight Relations of Some Reproduction Characteristics of Prussian carp, *Carassius gibelio* (Bloch, 1782) in the South Aegean Region (Aydın-Turkey)

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Abstract

In this study, the reproduction biology of 172 Prussian carp (*Carassius gibelio* (Bloch, 1782)) was studied from June 1999 to June 2000 monthly in Topçam Dam Lake. The sex and age composition of Prussian carp were determined. Individuals were composed of 1.16% males and 98.84% females. In this study, fully mature specimens were defined as those which were ready to reproduce at the third age. The spawning of Prussian carp took place between March and August, and suggesting that it is a multiple spawner. The mean fecundity of Prussian carp varies from 37,823 (August) – 85,159 (March) for female monthly. The average egg diameter was between 0.533 (January) – 1.099 (June) mm in months.

Key words: Prussian carp, *Carassius gibelio*, reproduction, length, weight, sex ratio, Topçam Dam Lake.

Introduction

The Prussian carp is the most common in East Asia and Siberia and introduced and widely distributed throughout European (Kottelat, 1997). The wild form of the goldfish is known in Eastern European, the Black Sea basin, the Caspian Sea basin, the Azov Sea basin and Thrace region of Turkey (Welcomme, 1988), and spread throughout in Anatolia (Sasi and Balık, 2003). Although the crucian carp, *Carasius carassius* (L), is showing similar characteristic of Prussian carp of genus *Carassius that* inhabits in Turkish inland waters (Geldiay and Balık, 1996). Prussian carp is a benthopelagic, non-migratory and omnivore fish living in fresh and brackish water. Prussian carp is minor commercial in Turkey.

There are some information on their reproduction and fecundity in natural habitats (Berg, 1964; Slastenenko, 1955-56). The Prussian carp is omnivore (Dulmaa, 1999) and is able to reproduce from unfertilized eggs (gynogenesis) (Spratte and Hartmann, 1997). The fish max length is published 45.0 cm TL and max weight 3,000 g (Muus and Dahlström, 1968). Lake dwelling individuals is moving into river mouths to avoid low oxygen water in winter (Kukuradze and Mariyash, 1975).

The present study was therefore determined in order to investigate the reproduction of the *C. gibelio* population in Topçam Dam Lake, south-western Anatolian region of Turkey. The clarification of the some biological parameters of each species is essential for management.

The Topçam Dam Lake, which is fed by Madran Stream and precipitation, was constructed in 1984 for irrigation and flood prevention. The Dam Lake is located in the Büyük Menderes River Basin, Southwestern Turkey. The water level decreases in the late spring and summer every year because of irrigational use. When the rainfall begins in winter, water level increases again.

This area was 49.5 m deep. This region has a warm climate. During the study, water temperatures varied from 7.42 to 28.90°C. Turbidity was between 65–300 cm, pH 7.20–7.98, dissolved oxygen 5.00–10.54, and conductivity 118.10–151.50 µmhos/cm.

Ecological factors affect the biological and the reproduction characteristics of fish population, and so these kinds of investigations should be carried out periodically. The main purpose of the present investigation was to study the reproduction biology of *C. gibelio*. This is the first study reproduction biology of *C. gibelio* in Turkey.

Material and Methods

The study was carried out on *C. gibelio* population from Topcam Dam Lake of South-western Anatolia. The study area was shown in Figure 1.

Specimens were captured monthly using gill-nets with various mesh sizes (18-55 mm) between June 1999 and June 2000. The captured fish were transported to the laboratory in 4% formalin solution. After fish samples were brought to the laboratory, the fork length (FL±1.0 mm), weight, gonad weight (W±0.1 g) were recorded. Sex was determined by examination of the gonad tissue either by eye or with the aid of a microscope (Nikolsky, 1963). Scales were used for age determination. For this purpose, ten to twelve scales were taken between the dorsal fin and lateral line region of the side of the body and read under a binocular microscope. Scales were kept in 4%
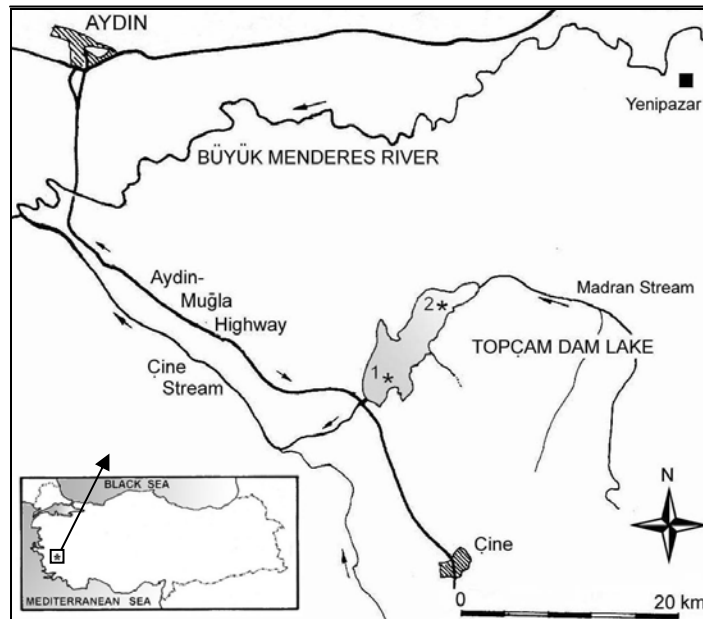
Figure 1. Study area.

NaOH solution for 16 hours, and than washed in distilled water and treated with 70% and 96% ethyl alcohol (Chugunova, 1963). After cleaning the scales were examined under a steromicroscope to allow age for determination.

The spawning period were estimated from the gonad development (Gonado-Somatic Index; GSI), direct observation of the gonads and monthly variations in egg diameters of samples (Lagler, 1966). GSI was calculated from the equation,

$$GSI \% = (Wg / Wt) \times 100;$$

where Wg and Wt are gonad weight and total weight in grams of fish respectively (Lagler, 1966; Bagenal, 1978).

Fecundity was studied by gravimetric method (Bagenal, 1978). The procedure is as follows; the sub-samples of 1 or 2 g according to the size of the eggs were taken from the front, middle and back parts of the ovaries. The number of the sub-samples was multiplied up to the weight of the ovary. The diameters of various eggs size from parts of ovarian were measured with object micrometer between January and August.

Sexual maturity was confirmed by noting macroscopically according with the presence of "yolked eggs" or sperm in the gonads (Nikolsky, 1963). On the other hand, Fecundity (F) - fork length (FL) and Fecundity - body weight (WT), were calculated with regressions analyses. Fecundity (F), was calculated from the equation (Nikolsky, 1969).

$$F = a.FL^{b} \text{ and } F = a.WT^{b}$$

Results

The Sex and Age Composition

The age and sex distribution of specimens caught during this study is given in Table 1. 98.84% fish found was female and 1.16% male. Females were more numerous than males in all age groups. This suggests that Prussian carp is able to reproduce from unfertilized eggs (gynogenesis).

The age of captured fish varies between III-VI years and 5th group was dominant in the population. 98.84% of fish found was female and 1.16% male.

Age at Sexual Maturity

In this study, specimens with fully mature were defined as those which were ready to reproduce. The captured fish had sexual maturity at three years of age. The minimum size of fish (FL) at sexual maturity and weight (W) were calculated as 23.80 cm and 350.30 g.
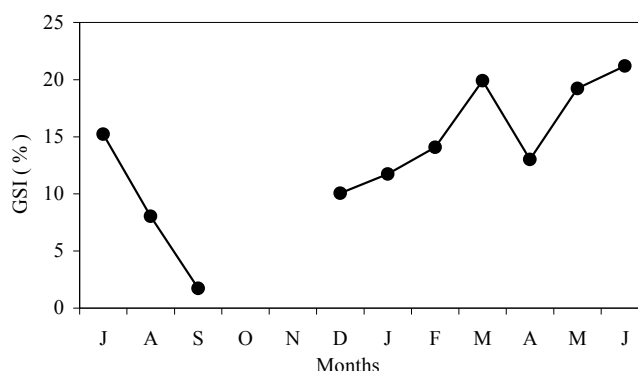
Spawning

Assessment of the spawning season for *C. gibelio* in Topçam Dam Lake was based on the GSI and analysis of seasonal development in mean egg diameter (Figure 2).

Ovary developments began in November. According to the averages, the highest GSI values were determined in the samples in March (19.897%) and in June (21.208). There was a decrease of the mean GSI values in September, when spawning was almost finished and the high temperature was 25.10°C

Table 1. The age and sex composition of *C. gibelio* in Topçam Dam Lake

Age	Female		Male		Female+Male	
	N	%N	N	%N	N	%N
III	1	0.58	-	-	1	0.58
IV	32	18.61	2	1.16	34	19.74
V	112	65.12	-	-	112	65.12
VI	25	14.53	-	-	25	14.53
Total	170	98.84	2	1.16	172	100.00

N= Number of fish

Figure 2. Monthly variations in the GSI of *Carassius gibelio*.

in water. Spawning occurred between March and August when water temperature was between 13.5 and 29.4°C.

We observed oocytes in ovaries in all seasons. Egg diameters were given in Table 2. The mean egg diameter was the highest in April (19.897 mm) and in June (21.208), while the smallest was measured in September (1.176). The maximum egg diameters in March and June were found to be as 1.525 and 1.500 mm respectively. Egg diameters increased along with the increase in fish length, weight and age and the larger fish had the larger eggs.

In Prussian carp population, spawning took place between March and August.

Fecundity

Fecundity was estimated in 88 females captured. The mean number of eggs ranged from 37,823 (August) to 85,159 (March). Fish had different egg sizes. Fecundity was the highest in populations with the smallest eggs. Female *Carassius gibelio* maturing at age III produced a mean of 53,100 numbers per female. At age VI, fecundity was 98,861 numbers per female.

In the spawning period, the fecundity of female Prussian carp was determined according to their age groups (Table 3).

As shown in Table 3, egg production increased along with increasing age. Fecundities was determined as 53,100, 65,874, 72,685 and 98,861 depending on the III-VI years of age in Prussian carp

population, respectively. Fecundity was correlated with fish length, weight, and fecundity increased as fish length, weight, gonad weight and age increased. The correlation was obtained; fecundity was increasing with increase of fish length, weight, gonad weight and age (Table 3)

The growth curve of egg diameter related with fecundity in some parts of ovaries for Prussian carp is given on Figure 3.

There were significant correlations between fish length (FL), fish weight (WT), and versus fecundity (F) (Figure 4 and 5). These relationships were:

$$F = 2.3523 \, FL^{3.133} \quad (r = 0.358)$$
$$F = 3.9860 \, WT^{1.588} \quad (r = 0.630)$$

Discussion

In this study, a total of 172 specimens of *C. gibelio* in Topcam Dam Lake were examined from June 1999 until June 2000. The age of captured fish ranged between III and VI. The groups were 98.84% female and 1.16% male.

There is some literature information regarding reproduction biology of *Carassius gibelio* from different habitats (Berg, 1964; Slastenenko, 1955-56).

In this study, fully mature specimens (maturity stage 6 and 7) were defined as those which were ready to reproduce. Berg (1964) reported the bulk attains maturity in the 4th year of life; individual specimens may mature in the 3rd or even in the 2nd year.

**Table 2.** The average egg diameters (Y), (mm) in *C. gibelio* during the year

Months	N	Min.	Max.	Y ± SD
January – 2000	166	0.125	1.150	0.533±0.260
February – 2000	29	0.150	1.175	0.668±0.305
March - 2000	421	0.150	1.525	0.955±0.286
April – 2000	345	0.200	1.400	0.800±0.292
May – 2000	178	0.250	1.500	0.996±0.256
June – 2000	151	0.600	1.450	1.099±0.133
July – 1999	103	0.200	1.400	0.816±0.349
August - 1999	31	0.150	1.150	0.523±0.328

N= Number of egg, SD= Standard Deviation.

Table 3. Mean fork length (FL) (cm), total weight (WT) (g), gonad weight (WG) and Fecundity (F) of 88 females Prussian carp, *C. gibelio* from different age groups

Age	N	FL (cm)±SD	WT (g)±SD	WG (g)	F±CI	F/FL	F/WT
III	1	23.80±	356.30±	30.00	53100±	2,203.32	149.03
IV	16	25.48±0.460	409.06±31.994	67.05	65,874±9,070	2,586.90	159.61
V	56	27.01±0.517	481.65±38.426	76.84	72,685±5,751	2,685.72	150.92
VI	15	28.38±0.577	572.02±51.015	111.80	98,861±13,876	3,462.73	170.08

N= Number of fish, SD= Standard Deviation.
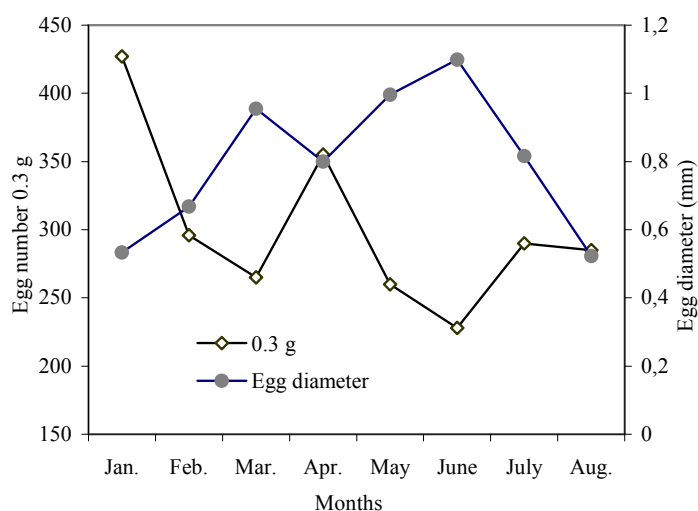
Figure 3. Relationships between fecundity and egg diameters monthly.

$$F = 2,3523.LF^{3,133}$$
$$r = 0,358$$
$$N = 88$$
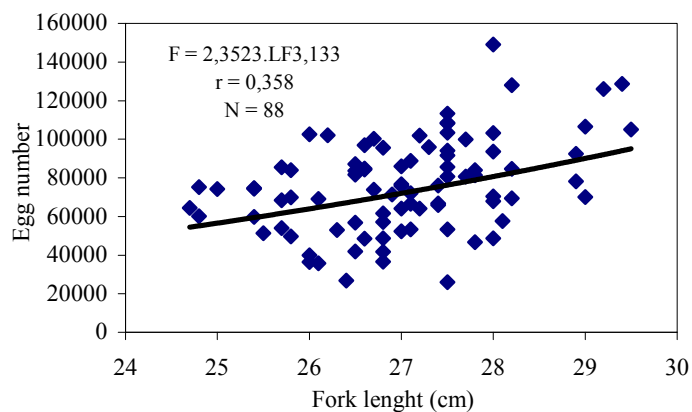
Figure 4. Relationships between fecundity and fork length of *C. gibelio* in Topçam Dam Lake.
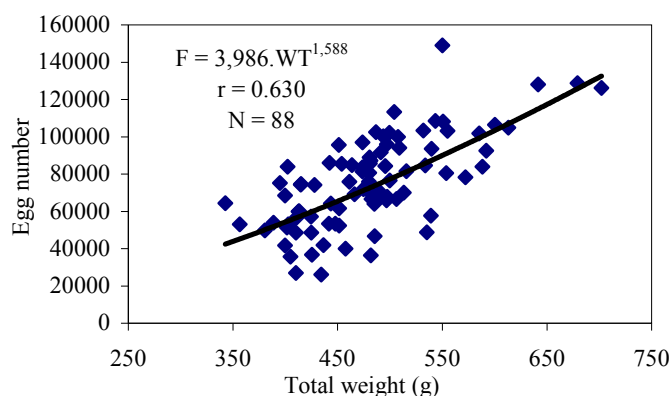
Figure 5. Relationships between fecundity and total weight of *C. gibelio.*

Sexual maturity was noticed 3 years old for *C. carassius* in Marmara Lake (Turkey) by Balik *et al.* (1991) and in Hamam Lake (Turkey) by Erdem *et al.* (1994).

In this study, according to GSI values, the investigation of egg diameters and direct observation of gonads of *C. gibelio* population in Topcam Dam Lake, it was revealed that spawning of this species took place in March and August suggesting that species is a multiple spawner (Figure 2). Many species of multiple spawning fish have a rhythmic periodicity of reproductive behaviour (McEnvoy and McEnvoy, 1992).

Berg (1964) defined that *C. gibelio* population is living in Kolyma basin (Russia) lay eggs together with *Phoxinus* sp. at the end of June or in the beginning of the July. *C. gibelio* in Lake Khanka spawn from mid-May till July.

Balik *et al.* (1991) determined that spawning period of *C. carassius* in Marmara Lake occurred from April to July.

Slastenenko (1955-56) found the spawning period time of the *C. carassius* population in the Black Sea basin in May, June, and July, at the end of May and in June. Although it was reported that the spawning period of *C. auratus gibelio* occurred during summer period the spawning time of Prussian carp population in Topçam Dam Lake began earlier than in the other basins, because of warm climatic factor in Southern part of Turkey.

In 1940, the catchment of 600 specimen of *C. a. gibelio* was examined from the oxbow lake of the Kuban. All the specimen were female. Nevertheless, in the ponds where wild carp were kept together with females of the Prussian carp, these spawned efficiently and produced young of their own kind. In a experimental study females of *C. a. gibelio* in the Amur basin were interbred with wild and domesticated *Cyprinus carpio* and *C. carassius* producing not hybrids but females of *C. a. gibelio*. This phenomenon has been called gynogenesis. When the ova of *C. gibelio* are fertilized by the spermatozoa of *C. carpio*, latter according to Golovinskaya and Romashow, merely stimulate cleavage, but no actual

fusion of the egg and sperm nuclei occurs (Berg, 1964). This phenomenon has been shown only for *C. gibelio* (Wheeler, 1969).

The number of eggs of *C. gibelio* living in Topcam Dam Lake ranged between 26,064 and 149,084. Fecundity varied from a mean of 53,100 eggs per female at the age of III to a mean of 98861 eggs per female at the age of VI. It was correlated significantly with age, fish length, body weight and gonad weight. It was increasing along with increase of fish length, weight, gonad weight and age and larger old fish had higher fecundity.

The biggest diameter of eggs of *C. gibelio* living in Topçam Dam Lake ranged between 1.525 mm in March and 1.500 mm in May. The diameter of eggs varied from a mean of 0.523 mm in August to a mean of 1.099 mm in June. It was significantly correlated with increase in fish length, weight, age and also gonad weight.

One of the most important parameters used for determination of the reproductive potential is the variation of egg diameter in ovarian. The egg diameter is maybe related to the amount of food that females can metabolize (Nikolsky, 1963).

Slastenenko (1955-1956) showed that the mean number of eggs of *C. carassius* in the Black Sea basin was 250,000, and found that egg diameter was 1 mm.

The fecundity of the Amur *C. gibelio*, according to study (Soldatov, 1928), varies from 160,000 to 383,000, averaging 254,000 eggs (Berg, 1964).

Although, Balık *et al.* (1991) reported that maximum of fecundity was 380,000 eggs/female, maximum egg diameter of *C. carassius* population living in Marmara Lake (Turkey) was 1.229 mm.

Investigations have given that fecundity increased as fish length, weight, age and gonad weight increased. Fecundity is affected by age, size, species, feeding of fish, season and environmental conditions (Nikolsky, 1969). It is also different between populations of the same species and does not remain constant from year to year.

Based on these results and evaluations, with the view of maintaining the population in equilibrium, it has a great importance to give each fish the chance of

reproduction at least once in its lifetime. Nevertheless, this species have to be caught all seasons. Because the transfer and introduction of *C. gibelio* had a considerable and negative impact on economically important species (e.g. *Cyprinus carpio*) and native species (*Acanthobrama mirabilis*, *Capoeta capoeta bergamae* and *Leuciscus cephalus*) due to competition for food resources (Sasi, 2004). It is recommended that fishing of Prussian carp does not have to be prohibited during the spawning seasons, which occurred between March and August.

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