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# Population Structure, Growth and Mortality of *Carassius gibelio* (Bloch, 1782) in Buldan Dam Lake

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**Abstract**

The present work was aimed at determining the population structure, growth and mortality of Crucian carp (*Carassius gibelio*) population in Buldan Dam Lake, in the Gediz River basin. Total of 2325 specimens were caught monthly by the trammel nets during September 1995-August 1996. The sex composition was 99.44% females and 0.56% males. Maximum age group was determined as VI. Fork length and total weight of the specimens ranged from 9.7 to 25.5 cm and from 23.6 to 269.1 g. The length-weight relationship was estimated as $W=0.031L^{2.87}$ for all individuals. von Bertalanffy growth parameters were computed as $L_\infty$=31.66 cm, $W_\infty$=635.91 g, k=0.146 year$^{-1}$ and $t_0$=-2.166 year. The ratios of total mortality, natural mortality and fishing mortality were calculated as 0.632 year$^{-1}$, 0.456 year$^{-1}$ and 0.176 year$^{-1}$, respectively.

*Key words:* Buldan Dam Lake, Crucian carp, *Carassius gibelio*, growth, mortality ratio.

## Introduction

According to Libosvarsky (1962), *Carassius* spp. are of warm water species and belong to the group of boreal fish (Holopainen *et al*., 1997). Thus, it has a wide geographic distribution especially in Eastern Europe and its distributional area is continuously increasing.

Impoundments which were built for such purposes as generating energy, irrigation and preventing floods and economically unproductive lakes are being filled by fish of economical interest in order to contribute to economy of the region in which they are located. It is known that undesired species may also be carried to the surroundings during such applications. *Carassius gibelio* is one of such species.

It is known that this species which was reported to exist in Meriç River in Western Thrace (Daget and Economidis, 1975) shows natural distribution in Thrace Region of Turkey (Özuluğ and Meriç, 1997; Özuluğ, 1997). It is also known that it has been carried into several lakes, reservoirs and ponds in Thrace and Anatolian regions of Turkey over the last 10 to 15 years. This species, also called "un-moustached carp" in the region is appreciated economically in this way.

Buldan Dam was built in 1967 within the boundaries of Buldan County (Denizli City, Turkey) in order to irrigate and prevent floods on the Derbent Brook branch of Gediz River. Following the construction of the Dam Lake, hybridization of scaled and mirror carp species has been done since 1976 (Geldiay and Balık, 1999). It is believed that *Carrasius gibelio*, a species which would not significantly contribute to the economy of the region and that may have negative impacts on fishing activities performed in the region, has been carried into the dam lake most likely via this undesired way.

No bio-ecological study exists currently on this species of which natural distribution is restricted to Thrace Region in Turkey. This species entered to the lakes and ponds in Anatolia together with *Carassius carassius* and gained importance because it became one of the most dominant species in the environment in a short time. Thus, bio-ecological studies were initiated especially on the *C. carassius* species. This study investigated the growth characteristics of *Carrasius gibelio,* a species that made a very big population in the Dam and that may have an economic potential to be exploited.

## Materials and Methods

A total of 630 m of different trammel nets with the mesh sizes of 36 (180 m), 40 (180 m), 50 (180 m), 56 (90 m) mm in inner nets and 110, 140 mm in outer nets were used. The samples were obtained through fishing between September 1995 and August 1996 during which the nets were cast on the same point each month in the nights and collected in the mornings. The samples fixed in 4% formalin were studied in the laboratory. Specimens were measured to the nearest 1 mm (fork length, FL) and weighed to the nearest 0.1 g (total weight, W). Scales were used for age estimation. For this purpose, scales were taken from the region of the fish between dorsal and ventral fins, the scales taken

were cleaned with a soft brush and prepared by applying into a series alcohol solutions (Geldiay and Balık, 1999). The preparations were read in aus JENA brand scale-reading instrument. Sex of fish was determined by macroscopic and microscopic investigations.

Sex ratio of the specimens was analyzed by age. Exponential regression was used to calculate the relationship between fork length and total weight (Ricker, 1975):

$$W = aL^b$$

where a and b are the regression constants. Von Bertalanffy's growth equation was calculated by the least squares method for length observed at each age (Ricker, 1975; Sparre *et al*., 1989; Erkoyuncu, 1995; Avşar, 1998):

$$L_t = L_\infty[(1-e^{-k(t-to)}]$$

where $L_t$ is the fish length at age t; $L_\infty$ represent the asymptotic length; k is a relative growth coefficient and $t_0$ theoretical age when fish length is zero. The equation may be added to the regression equation between length and weight when Von Bertalanffy's growth equation was transformed by weight (Sparre *et al*., 1989):

$$Wt=W_\infty[(1-e^{-k(t-to)}]^b$$

where $W_t$ is the fish length and weight at age t; $W_\infty$ is asymptotic weight of the fish which depends on slope of growth curve and b is regression co-efficient in the equation of the relationship between length and weight. Total mortality (Z) was calculated Z-equation based on Beverton's and Holt's length data (Sparre *et al*., 1989):

$$Z = K(L_\infty-L_c)/(L_c-L')$$

where *K* and $L_\infty$ are the parameters in von Bertalanffy's equation. $L_c$ defines the mean length of the fish used in calculating the co-efficients of growth equation and $L'$ defines the length of first capture for the species of interest and the catch method. Natural mortality (M) was calculated based on Pauly's empirical equation (Pauly, 1980).

$$LogM=-0,0066-0,279Log(L_\infty)+0,6543Log(K)+0,4634(T)$$

where $L_\infty$ and K are von Bertalanffy's growth parameters and *T* is yearly mean of temperature of surface water of the habitat. Following the calculation of Z and M, fishing mortality can be calculated through the formula F = Z – M; survival rate through the formula $S=e^{-Z}$ and exploitation rate through the formula E=F/Z (Ricker, W. E. 1975; Pauly, 1984).

It was necessary to compare the data obtained from the present study with those of international studies as no study has been performed on population biology of *Carassius gibelio* in Turkey. However, in international studies, according to which we made the comparison standard length was used, while in our country fork length is taked as basis. For this reason, linear regression relationship was determined between the fork length and standard length in order to resolve the difficulties in comparing two different length criteria.

Data were evaluated excluding the sex factor because 2312 (99.4%) of 2325 samples obtained were female.

## Results

It was found that 99.44% of the *C. gibelio* population in the Dam Lake consisted of females and remaining 0.56% of the population consisted of male (Table 1).

Six age groups were found from the *C.gibelio* population in the Dam Lake. Age groups I-VI were represented at the rates of 22.4%, 63.8%, 10.7%, 2.5%, 0.4% and 0.2%, respectively. According to the age frequency distribution, vast majority of the population consisted of age group II. specimens. Fork length of the samples ranged between 9.7 and 25.5 cm (Figure 1). About 90% of the population is consisted of the individuals less than 17 cm in length. The biggest group of fish was found 13 to 15 cm length groups.

Individuals less than 100 g in weight consisted of about 90% of the population. The biggest group in terms of weight consisted of the specimens of 50 to 70 g (51%). Weight distribution of the specimens ranged between 23.6 and 269.1 g (Figure 2).

**Table 1.** The age-sex distribution of *C. gibelio*

| Age | Female | | Male | | Female+Male | |
|---|---|---|---|---|---|---|
| | N | %N | N | %N | N | %N |
| I | 519 | 22.32 | 2 | 0.09 | 521 | 22.41 |
| II | 1,474 | 63.40 | 9 | 0.39 | 1,483 | 63.79 |
| III | 249 | 10.71 | 1 | 0.04 | 250 | 10.75 |
| IV | 57 | 2.45 | 1 | 0.04 | 58 | 2.49 |
| V | 9 | 0.39 | - | - | 9 | 0.39 |
| VI | 4 | 0.17 | - | - | 4 | 0.17 |
| Total | 2,312 | 99.44 | 13 | 0.56 | 2,325 | 100.00 |

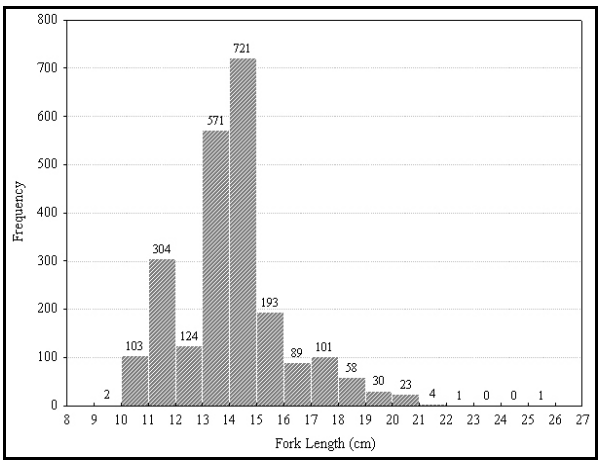


**Figure 1.** The distribution of fork length (cm).

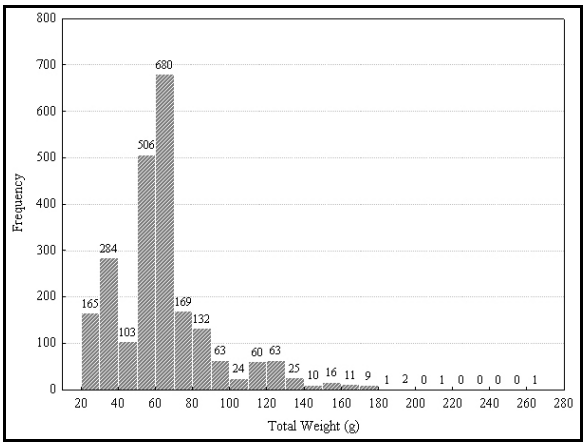


**Figure 2.** The distribution of total weight (g).

With regard to the length and weight, the individuals 13 to 15 cm in length and 50 to 70 g in weight which makes them the biggest length and weight group, were found in the age groups of I-III, while most of them were found in the age group of II.

In the present study, length and weight values by age were evaluated considering all individuals because of gynogenesis observed in the entire group. Mean lengths of each age group were given in Table 2.

It is seen that weight as evaluated according to age was close in each group at the early ages (in the age groups I and II) (Table 3). This similarity in weight values was not observed in other age groups.

Based on considering all of 2325 samples obtained from the lake, the equation of length-weight relationship was $W= 0.031*L^{2.87}$. Correlation co-efficient (r) was calculated as 0.985. A negative allometric growth was observed for all individuals as a consequence of the statistical analyses (Student's t-test, $t_c= 13.00$ d$f= 2323$; $P<0.05$). Scarcity of food may have caused because weight of the specimens decreases from the age of IV. Condition factors values also support type of relationship (Table 4).

Von Bertalanffy's growth equation was calculated for all specimens, because almost all of the population consisted of females. Equations calculated for both length and weight were given below.

$$L_t=31.66\ (1-e^{-0.146\ (t+2.146)})$$
$$W_t=627.18\ (1-e^{-0.146\ (t+2.146)})^{2.87}$$

Maximum length and weight was observed as 25.5 cm and 269.1 g.

Linear regression relationship between the standard length and fork length was found as

$$LS=0.876\ LF-0.361$$

Condition factor, expressing the feeding activity during the year, was calculated separately for males and females, although the males were scarce (Table 4). According to the age, the condition factor of the females, which better represents the

**Table 2.** Fork length at age values (cm) of *C. gibelio*

| Age | N | Min | Max | Mean±SE |
|---|---|---|---|---|
| I | 521 | 9.70 | 14.50 | 11.66±0.041 |
| II | 1483 | 11.00 | 19.50 | 14.13±0.023 |
| III | 250 | 13.90 | 20.40 | 16.98±0.080 |
| IV | 58 | 16.40 | 21.60 | 18.89±0.157 |
| V | 9 | 18.50 | 21.10 | 20.26±0.268 |
| VI | 4 | 19.90 | 25.50 | 22.03±1.099 |

SE: Standart Error

**Table 3.** Total weight at age values (g) of *C. gibelio*

| Age | N | Min. | Max. | Mean±SE |
|---|---|---|---|---|
| I | 521 | 23.80 | 68.80 | 36.16±0.444 |
| II | 1483 | 23.60 | 136.70 | 63.26±0.316 |
| III | 250 | 60.30 | 164.60 | 106.13±1.420 |
| IV | 58 | 83.10 | 211.30 | 138.67±3.445 |
| V | 9 | 130.80 | 186.30 | 158.11±5.089 |
| VI | 4 | 160.80 | 269.10 | 193.93±21.910 |

SE: Standart Error

**Table 4.** Average condition factor values for different ages of *C. gibelio* females and males

| Age | N | Min. | Max. | Mean±SE |
|---|---|---|---|---|
| Female | | | | |
| I | 519 | 1.659 | 4.555 | 2.232±0.009 |
| II | 1474 | 1.074 | 3.007 | 2.222±0.004 |
| III | 249 | 1.751 | 2.578 | 2.141±0.008 |
| IV | 57 | 1.715 | 2.453 | 2.041±0.021 |
| V | 9 | 1.662 | 2.067 | 1.904±0.048 |
| VI | 4 | 1.603 | 3.007 | 1.811±0.100 |
| Male | | | | |
| I | 2 | 2.114 | 2.185 | 2.149±0.025 |
| II | 9 | 2.066 | 2.342 | 2.204±0.033 |
| III | 1 | 1.885 | 1.885 | 1.885± |
| IV | 1 | 2.030 | 2.030 | 2.030± |

SE: Standart Error

population, decreases inversely proportional to age. However, such a trend was not observed in condition factor of males. This might be due to small size of the sample.

For the *Carassius gibelio* the biggest fish population in Buldan Dam Lake, mortality rate was calculated as 0.632 $year^{-1}$, natural mortality rate as 0.456 $year^{-1}$, fishing mortality rate as 0,176 $year^{-1}$ and exploitation rate as 0.279 $year^{-1}$. Additionally, survival rate of the population was found as 53.12%.

## Discussion

It was found that almost all (99.44%) of the specimens obtained in the study were female. F.I. Vork (1933) also reported that most of the individuals obtained in the study on Tandovo Lake in Western Siberia were female whereas Anishchenko (1940) informed that all of specimens were female in his study on Oxbow Lake on Labinskaya location of Kuban River (Berg, 1964). The fact that female individuals dominate the population can be explained by gynogenesis (Buth *et al*., 1991). This is especially due to the carp population reproducing in the same periods. Individuals in the age groups of I through VI were encountered in the present study. Berg (1964) reported on the individuals between ages of VI–VIII.

In the present study, maximum standard length and weight were 27.37 cm and 627 g. These values were reported as 31 cm and 1100 g in Amur Basin (Berg, 1964). According to Slastenenko (1956), standard length reaches to 40 cm and weight reaches up to 1000 g. In the present study, average standard length values for age groups of I-VI were calculated as 9.85, 12.02, 14.51, 16.19, 17.39 and 18.94 cm,

respectively. Berg (1964) reported that individuals up to age of VII were encountered in Golodovka Lake (Irtysh River Basin) on Northwest Kazakhstan and that standard lengths in this population for each age group were 3.7, 7.8, 10.2, 12.9, 14.9, 18.1 and 22.8 cm, respectively; and standard length of the individuals up to age of VI, he could obtained from Khanka Lake was 4.2, 10.1, 14.9, 19.2, 22.5 and 25.0 cm respectively; and standard length of the individuals up to age of V, he could obtained from Sudoch Lake in Aral Lake Basin was 6.6, 11.4, 15.2, 18.2 and 20.4 cm, respectively. Individuals up to age of IV were found from the pounds in Vinnits region of Ukraine. The standard lengths of these specimens were reported as 4.5-8.9, 8.7-14.5, 11.9-16.9 and 19.7 cm, respectively (Slastenenko, 1956). According to studies carried out in the different areas, growth was slower in the first two years of life in the habitats on more Northern locations than Turkey whereas it reaches to nearly same levels in almost all habitats in other age groups.

In the present study, average total weights for age groups of I-VI were calculated as 36.16, 63.26, 106.13, 138.67, 158.11 and 193.93 g, respectively. Slastenenko (1956) reported as 64.0 to 86.0 g for age of II, 101.5 to 138.0 g for age of III and 243.0 g for age of IV. When we compares these data with those of Buldan Dam Lake, the individuals developed better in the older ages. It can be said that this may be partly due to the fact that the fish on the northern latitudes reach to sexual maturity later than the populations of southern latitudes. The condition factor values of females decrease inversely proportional to age.

Overall mortality rate was estimated as 0.632 $year^{-1}$, natural mortality rate as 0.456 $year^{-1}$, and fishing mortality rate as 0.176 $year^{-1}$ and exploitation rate as 0.279 $year^{-1}$. Additionally, survival rate of the population was calculated as 53%. It is concluded that, there is no fishing pressure on the population. However, no fish species exist to compete with this species in the lake. Thus, the population exhibits a natural developmental process.

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