



GROWTH AND CONDITION OF INVASIVE SPECIES PRUSSIAN CARP, CARASSIUS GIBELIO (BLOCH, 1782) IN A DAM LAKES FROM BUYUK MENDERES BASIN (TURKEY)

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Abstract

In this research, some biological characters as growth compositions, mortality, age-length, age-weight, condition factors of prussian carp, *Carassius gibelio* (Bloch, 1782) were determined from 172 specimens caught in the southwest of Turkey during the one year. The age compositions of specimens were between III-VI years, and sex percentages were found as 98.84% for females and 1.16% for males.

The fork length varied between 23.80 and 29.50 cm, while weight ranged from 356.30 to 702.00 g. Growth of population was the most rapid at the first years of life afterwards growth ratio was slower. Growth were expressed in length and weight, and the von Bertalanffy growth equations were found as $L_t = 41.46 (1 - \exp -0.101(t + 5.523))$ and $W_t = 1579.54 (1 - \exp -0.101(t + 5.523))^2.74$. The following equation is for length-weight relationship, $W = 0.03622 LF 2.88$, $R^2 = 0.996$.

Keywords: Prussian carp, Invasive, *Carassius gibelio*, Growth, Condition, Buyuk Menderes, Turkey

BÜYÜK MENDERES HAVZASI'NDAKİ (TÜRKİYE) İSTİLACI TÜR KARAS BALIĞI, CARASSIUS GIBELIO (BLOCH, 1782)'NUN BÜYÜME VE KONDÜSYONU

Özet

Bu çalışmada, Türkiye'nin güney batısında bulunan bir baraj gölü'nden 1 yıl boyunca yakalanan 172 karas balığının, *Carassius gibelio* (Bloch, 1782) büyüme, ölüm oranları, yaş-boy, yaş ağırlık ve kondisyon faktörleri gibi bazı biyolojik özellikleri belirlenmiştir. Yaş kompozisyonu III-VI yaşları arasında dağılım göstermiş olup, eşey oranları dişilerde %98.84 ve erkeklerde %1.16 oranlarında olmuştur.

Karas balığının çatal boyu 23.80-29.50 cm arasındayken, ağırlıkları 356.30-702.00 g arasında değişmiştir. Populasyonun büyümesi ilk yıllarda daha hızlı olurken, sonraki yıllarda büyüme oranları daha yavaşlamıştır. Büyümeleri Boy ve Ağırlık olarak, von Bertalanffy büyüme denklemleriyle bulunmuştur. $L_t = 41.46 (1 - \exp -0.101(t + 5.523))$ ve $W_t = 1579.54 (1 - \exp -0.101(t + 5.523))^2.74$. Boy-Ağırlık ilişkisi aşağıdaki şekilde olmuştur. $W = 0.03622 LF 2.88$, $R^2 = 0.996$.

Anahtar Kelimeler: Karas balığı, İstilacı, *Carassius gibelio*, Büyüme, Kondisyon, Büyük Menderes, Türkiye

1 Introduction

Prussian carp, *Carassius gibelio* (Bloch, 1782), known as gibel carp, is a very common freshwater fish that can also thrive in slightly brackish water. Prussian carp is common fish in Eastern Asia, Siberia, which also introduced and widely distributed throughout Europe [1]. The wild form of the gibel carp is known to occur in Eastern Europe, Black Sea basin, Caspian Sea basin, Azov Sea basin and Thrace region of Turkey [2], in the last two decades spread throughout in Anatolia [3] [4], and invasive in Turkey [5]. Although characteristic of the crucian carp, *Carasius carassius* of the genus *Carassius* inhabiting European and Turkish inland waters [6].

The biological characteristic such as growth, distribution and taxonomy of *C. gibelio* were given in Russia and surrounding areas [7,8]. Prussian carp is able to reproduce from unfertilized eggs (gynogenesis) [9]. Invading gibel populations in the freshwater are often triploid and composed of almost females, which show gynogenetic reproduction [7,10]. The fish was introduced 45.0 cm TL and max weight 3.000 g [11].

After the dam lake constructed, the Prussian carp was transferred with restocking activities as common carp, *Cyprinus*

carpio for randomly. Topcam Reservoir, fed by Madran Stream and precipitation, was constructed in 1984 for irrigation and flood prevention. The reservoir is located in the Buyuk Menderes River basin, in the South-western of Turkey. The water level usually decreases in the late spring and summer because of irrigational use. When the rainfalls begin in winter and spring, water level increases again.

The maximum deep point of Topcam Dam Lake is approximately 49.5 m. This region has a warm climate. During the study period, water temperatures varied from 7.42 to 28.90 °C. Turbidity secchi disc was between 65 and 300 cm, pH 7.20-7.98, dissolved oxygen 5.00-10.54 mg/l, and conductivity 118.10-151.50 µmhos/cm.

Prussian carp is ecological and a little commercially important species throughout much of its range. In South-western Anatolia, this is not a highly valuable resource and only marketed in local area, usually fresh on ice [3].

There is limited information of growth parameters, mortality rates, and population characteristics of *C. gibelio* from Anatolia. This study was carried out to investigate its some biological and ecological characters of prussian carp as growth, condition of prussian carp from Topcam Dam lake, in Buyuk Menderes

basin. The comparison of some biological parameters is given for this species from different ecosystems.

2 Material and Method

The study purposed to determine prussian carp, *C. gibelio* population characters in a Dam Lake of Southwestern Anatolia in Buyuk Menderes basin. The study was conducted in a man-made dam lake of Topcam in Aydin, Turkey. Specimens were captured monthly during the year using gill nets (18-45 mm mesh sizes). Fish were fixed in a 4% formalin solution immediately and carried to the laboratory. We measured fork length (FL), total weight (WT) and recorded sex. Age was determined from microscopic examination of scales. Ten or twelve scales from the left side of the body between the lateral line and dorsal fin were taken and mounted dry between two slides for binocular microscopic study after they are prepared with some process [12].

The ratio of males and females was given. Length-weight relations were calculated by applying regression analysis by taking in of fork length (FL) to total weights (WT) of each fish and the equations were as follows Eq. (1):

$$W_T = q \times FL^b \quad (1)$$

Where q and b are the parameters to be estimated (13).

Growth parameters, L_∞ , K and t_0 , were found to get even with Excel software program and the von Bertalanffy growth equations for all of the fish were as follows Eq. (2);

$$L_t = L_\infty(1 - \exp^{-K(t-t_0)}) \quad (2)$$

$$W_t = W_\infty(1 - \exp^{-K(t-t_0)})^n$$

Where " L_t " and " W_t " are total length and total weight at age t; " L_∞ " and " W_∞ " are the asymptotic fork length and total weight, respectively; "K" is Brody growth coefficient, which determines how fast the fish approaches L_∞ and W_∞ ; "t" the age (years); and " t_0 " the hypothetical age at zero length [14].

The condition factor of *C. gibelio* was estimated using the equation $CF = (WT/FL^3) \times 100$ employing body weights (WT, g) and fork lengths (FL, cm) [13].

The total instantaneous mortality (Z) was estimated in Topcam Dam Lake of Anatolia from Prussian carp numbers-age data by using equation,

$Z = F + M$; where F is fishing mortality and M is natural mortality. Natural mortality for prussian carp was estimated by using a multiple regression equation relating M to L_∞ (LT in cm) and k (per yr) of the von Bertalanffy equation, and to mean annual water temperature [15].

3 Results

The age distribution of *C. gibelio* specimens caught is shown for female and males (Fig. 1). The ages of captured fish was composed of III-VI years and five-year-old group was dominant in the population. Females were more numerous than males in all age groups. The fish were not found 0+, 1+, and 2+ years-old-groups. This probably resulted from the selectivity of the gill nets (18-45 mm mesh size). The fish were 98.84% with female and 1.16% with male. It is suggest that prussian carp is able to reproduce from unfertilized eggs (gynogenesis) in the reservoir [16].

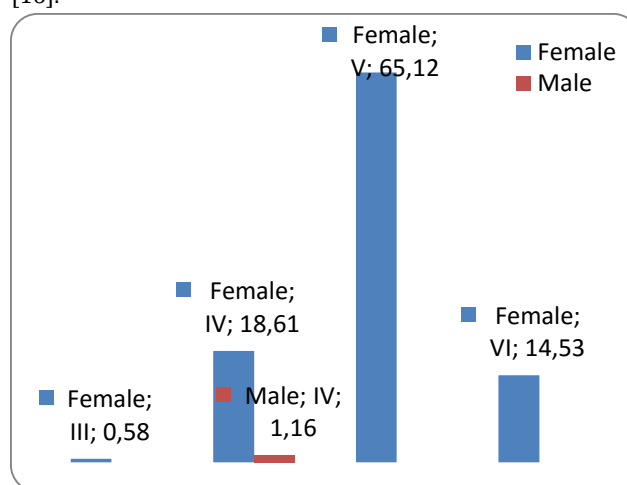


Figure. 1. The percentage of age composition (%) for *Carassius gibelio* in Buyuk Menderes Basin, (N= 172, Number of fish)

C. gibelio was ranged from 23.80 to 29.50 cm and the majority of the samples were composed of 27.0 - 29.0 cm length groups. The mean fork lengths and total weights and standard deviation of all groups of *C. gibelio* were calculated (Table 1).

Table 1. The Fork Length (FL) and the Total Weight (WT) of *C. gibelio* (SD= Standart Deviation)

Age groups	N	FL (cm) mean	Range (min.-max.)	SD	WT (g) mean	Range (min.-max)	SD
3	1	23.80	-	-	356.30	-	-
4	34	25.48	24.0-26.1	0.448	409.06	336.5-486.6	31.994
5	112	27.01	25.8-28.4	0.524	481.65	399.9-587.5	38.425
6	25	28.38	27.4-29.5	0.577	572.02	488.1-702.0	51.015

The growth parameters were found as $L_\infty = 41.46$, $W_\infty = 1579.54$, $k = 0.101$, $t_0 = -5.523$. von Bertalanffy growth model of the *C. gibelio* population of Buyuk Menderes basin was described as;

$$L_t = 41.46 (1 - \exp^{-0.101(t + 5.523)})$$

$$W_t = 1579.54 (1 - \exp^{-0.101(t + 5.523)})^{2.74}$$

The mean weights in the age groups of the prussian carp are presented in Table 1. Also, the diagram of weight growth in all individuals of *C. gibelio* is given Fig. 2.

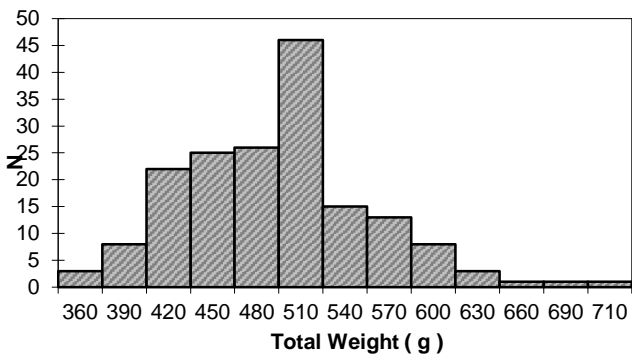


Figure 2. Weight distribution of *C. gibelio* in Buyuk Menderes Basin

The length-weight relationship of the *C. gibelio* was estimated using 172 fish specimens. The exponent (b) was estimated $b=2.88$. The relationship was found as (Fig. 3);
 $W = 0.03622 L^{2.88}$ $R^2 = 0.996$

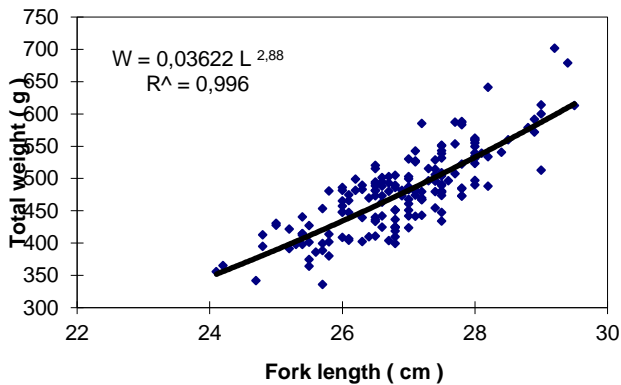


Figure 3. Length-Weight relationship of both sexes for *C. gibelio* in Buyuk Menderes Basin

The condition factors of 172 *C. gibelio* were investigated for age groups and ranged from 1.98 to 2.91. The condition factors, calculated from lengths and weights, are given according to the months (Fig. 4).

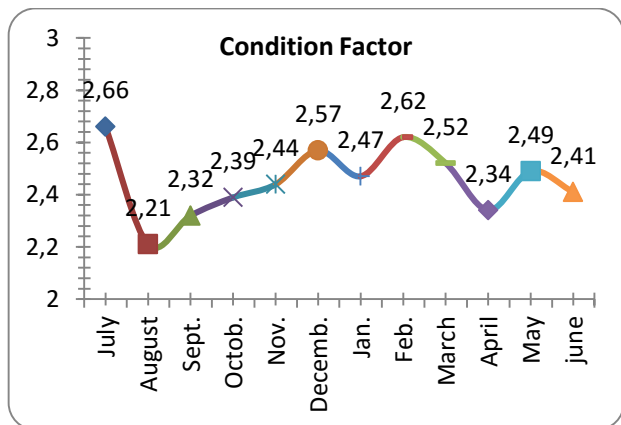


Figure 4. The seasonal Conditions variations of *C. gibelio* in Buyuk Menderes Basin

Estimate of Z was 0.38/yr for prussian carp in Topcam Dam Lake. The estimate of M was 0.21/yr from Pauly's (1980) multiple regression equation by using $L_{\infty}=41.46$, $k=0.32/\text{yr}$, and mean annual temperature of 18,0 °C. Also, exploitation ratio (E) of *C. gibelio* population was found 0.40 which it means that the population exploited less than optimum level.

The averages of GSI of *C. gibelio*, the highest values in March (19.897 %) and the lowest values of September (1.732%) and spawning time between March and August is given (16), when water temperature was between 13.50 and 29.40 °C (Fig. 5).

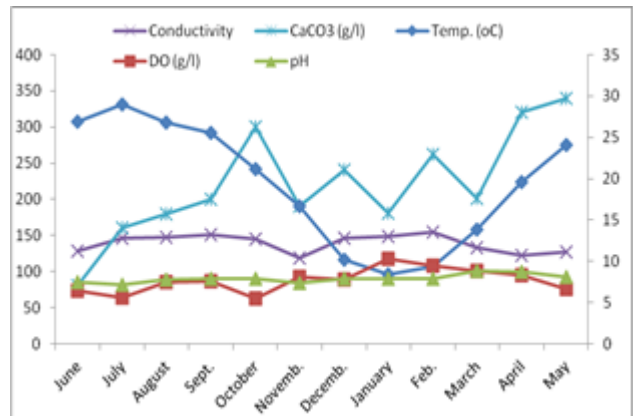


Figure 5. The Men of some Physical and Chemical characteristics

4 Discussion and Conclusion

Prussian carp was previously recorded in Thrace region of Turkey [17]. While transporting the economically important fish, that is, common carp (*Cyprinus carpio*) juveniles, the prussian carp was also transported randomly to the Western part of Turkey. It appears that prussian carp had spread towards to the Anatolian inland waters [3].

On the other hand, the native crucian carp, *Carassius carassius* in Thrace, having the same physical similarity with prussian carp, was inhabited in subsequent years many lakes and dam lakes in Turkey [6,18,19]. Crucian carp, which is a common Eurasian cyprinids fish, has shown strikingly dichotomies in several aspects of its physiology and ecology, at both the individual and population levels [20].

In this study, age determination was based on scales of Prussian carp and the age of specimens ranged between 3 and 6 years. The younger fish was not catch, because mesh sizes (18-45 mm) and water depth affected. The groups were composed of 98.84% females and 1.16% males. Similar situation of our result for less percentage of males was reported for Estonian freshwater populations, and where the proportion of males was very low (8,0%). It is also given a similarity result from Bafra Balik Lake with 97.11% Females and 2.89% Males [3]. However, the Baltic Sea (Estonian coastal water) population is gonochoristic form with a nearly equal proportion of females and males, both with normally developed gonads to present a normal sex ratio [10].

The sex ratio of Prussian carp showed that females was predominant in our study area. The invasion populations are often triploid and composed of usually females, which exhibit gynogenetic reproduction - using the sperm of the other species (e.g. *Cyprinus carpio*) to activate but not fertilize their

own eggs [7, 10]. This phenomenon has been shown in *C. gibelio* [21]. It is concluded that our population is gynogenetic reproduction.

The population of Prussian carp in Southwestern part of Turkey is gynogenetic (showing high dominance of females). Moreover, the presence of males does not mean that they participate in spawning, because of their gonads could not be developed enough to render milt. In addition to this, European freshwater populations seem to be predominantly gynogenetic [22]. The percentage of Prussian carp ranged from 79 to 97% in the three Mongolian populations [23]. In Greece, for the eight of the lakes populations consisted of only females, with exception of three lakes where the small population males (2,6-7,8%) were given [24].

In the present study, the exponent (b) in the length-weight relationships among the all (b=2.74) indicated that weight growth of Prussian carp was isometric. In the study, von Bertalanffy growth population parameters (L_{∞} =41.46 cm, W_{∞} =1579.54 g, k=0.101 and t_0 =-5.523) were determined. The length-weight relationships are shown in Fig. 3. We compared that our finding growing parameters, L_{∞} and k values with the other habitats were seen different from each other's. Growth performance of Prussian carp in Balaton Lake from Hungary is given L_{∞} = 47.80 cm, W_{∞} = 3801.0 g and k= 0.129 [25]. The Danube Delta population from Romania were L_{∞} = 47.10 cm, W_{∞} = 2010 g and k= 0.179 [26]. These fish populations (Hungary and Romania) inhabiting to standing waters have shown a better growth performance than our result, despite the fact that Buyuk Menderes basin has warm climate, due to lack of the food.

The total length (TL) of *C. gibelio* from 12 Greek lakes showed 14.5-37.7 cm and the value of the exponent b of the length-weight relationship ranged from 2.33 to 3.38. The higher values of b parameters were given in lake which is eutrophic, and relatively shallow [24].

In the present study, condition factors ranged from 1.98 to 2.91. It was determined that condition factors increased gradually with ages, and the highest at the age of 4 year, and then decreased the older ages. In our locality condition of Prussian carp population is less than in Bafra Balik Lake condition of population, which was reported with 1.97-3.77 from Northern part of Turkey [27].

Many species of multiple spawning fish have a rhythmic periodicity of reproductive behavior [28]. Slstenenko (1955-56) found out the spawning period time of the *C. carassius* population in Black Sea basin in May, June, and July. Also, it was reported that the spawning period of *C. gibelio* is during summer period. The spawning time of Prussian carp population in southwestern part of Anatolia was earlier than the other basins, because of warm climate.

Estimates of the annual instantaneous rate of natural mortality (M) were found 0.21. Mortality estimates of *C. gibelio* population of Buyuk Menderes basin population is considered to be exploited less than optimum levels. *C. gibelio* has faster growth and low fishing mortality rates. *C. gibelio* population from Buyuk Menderes with Exploitation ratio, E= 0.40 indicated that the population exploited very rarely. It is recommend that fishing not to be prohibited for prussian carp from Topcam Reservoir during the spawning seasons, which occur between March and August.

The objectives of this kind of study maintained the population caught with equilibrium, it is importance to give each fish the chance of reproduction at least once in its life, but this species

should be caught all seasons. The invasive of Prussian carp population of Topcam Lake in Buyuk Menderes basin was formed important population. Transferring and introduction of Prussian carp have been considerable negative influence to growth of the others native fish (*Acanthobrama mirabilis* and *Capoeta bergamae*) and economical important species (*Cyprinus carpio*) due to competition for food resources [3, 29].

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