AGE AND GROWTH OF BASSAN BARBEL, \textit{Barbus pectoralis} (Actinopterygii: Cypriniformes: Cyprinidae), UNDER CONDITIONS OF A DAM RESERVOIR

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**Background.** Bassan barbel, \textit{Barbus pectoralis} Heckel, 1843, is widely distributed in the lakes and river systems of Turkey and its neighbouring countries. Bassan barbel is a fish species of commercial value. The aim of this study was to provide necessary biological features of bassan population from Kemer Reservoir.

**Materials and Methods.** Biological aspects of Bassan barbel were studied based on a total of 206 specimens collected from Kemer Reservoir, during the period December 2004–November 2005. The fish age was determined from scales. Length–weight relation and Fulton’s condition factor were used to evaluate fish condition.

**Results.** The fish were from 1 to 6 year-old. Fork length (FL)–weight (W) relations were estimated as $W = 0.011 \cdot FL^{2.980}$ for all specimens studied. The estimated growth parameters of the von Bertalanffy equation were: $L_{\infty} = 34.8$ cm, $W_{\infty} = 549.58$ g, $K = 0.168 \cdot$ year $^{-1}$ and $t_0 = -1.590$ year for all specimens examined.

**Conclusion.** The fish from Kemer Reservoir were characterized by an average growth rate and it was observed that the specimen grew fast during the first two years of life. The reason why bassan barbel had low condition values is probably because the environmental conditions in the reservoir were poor.

**Keywords:** bassan barbel, \textit{Barbus pectoralis}, age, growth, dam reservoir, Kemer Reservoir, Turkey
tored in 4% formaldehyde solution. Specimens were measured in the laboratory to the nearest 1 mm fork length (FL), and weighed to the nearest 0.01 g total weight (W). Age was determined by macroscopic examination of scales. For this, scales of each specimen (10–15 scales) were removed from the posterior part of the body, cleaned in a 10% solution of NaOH and treated according to Chugunova (1963).

Sex of mature specimens was easily determined to the naked eye, while microscopic examination was done for immature specimen. Sex ratios were tested with Chi-squared analyses ($\chi^2$). Fulton’s equation was used to calculate the condition factor ($K$) for each individual: as $K = 100 \cdot \frac{W}{L^3}$, where $L$ is the fork length [cm] and $W$ is the body weight [g] (Le Cren 1951). The parameters $a$ and $b$ of the $L$–$W$ relations ($W = aL^b$) were estimated by the least squares regression method. Confidence intervals of 95% were calculated for each parameter. The length–weight relations were calculated for females ($W = 0.014L^{2.949}$) (Fig. 2), $W = 0.014L^{2.980}$ (Fig. 4), respectively. Isometric growth was observed for females ($t = 0.77 < t_{0.05, 87} = 1.99$), males ($t = 0.99 < t_{0.05, 115} = 1.98$) and the whole fish (males ($t = 0.41 < t_{0.05, 204} = 1.97$).

The von Bertalanffy growth equations were computed as $L_t = L_{\infty}(1 - e^{-K(t - t_0)})$ was used to describe growth in size (for FL), where $L_t$ is the length of fish in cm at age $t$; $K$ is the rate at which the growth curve approaches the asymptote; $L_{\infty}$ is the asymptotic length in cm; and $t_0$ is the theoretical time at which the fish length is zero (Erkoyuncu 1995). For the growth in weight, the same function was used: $W_t = W_{\infty}(1 - e^{-K(t - t_0)})$, where $W_t$ is the total weight and $b$ is the power constant of the length–weight relation. Growth performance index ($\eta'$) was estimated according to Pauly and Munic (1984).

**RESULTS**

*B. pectoralis* is found in reservoir with a conductivity of 82–603 µhos · cm$^{-1}$. Water temperature varied between 7.5 and 28.5°C in January and August, respectively. Dissolved oxygen content ranged between 6.5 mg · L$^{-1}$ (August) and 10.1 mg · L$^{-1}$ (January). pH values were close to neutral or slightly alkaline. Secchi disc transparency was found to be 1.20 m in April and 4.10 m in July.

In total 206 specimen were caught during the study period, in this number 117 males (56.8%) and 89 females (43.2%). The fork length of all individuals collected ranged from 9.8 to 27.2 cm FL (mean 18.5 ± 3.8 cm FL) and weight from 13.04 to 317.32 g (mean 96.06 ± 4.19 g W) (Table 1). Ages ranged from 1 to 6 years for both sexes. Since mesh size was large (12–45 mm), 0-group fish was not represented in the samples. According to the age-length key, second year class was dominant (31.6%) (Table 2).

The overall ratio of males to females was 1 : 0.76. A chi-square revealed significant departure from the theoretical 1 : 1 sex ratio ($X^2 = 7.61 > X^2_{0.05} = 3.84$). The chi-square test of sex ratios for *B. pectoralis*, divided into age classes, showed that males dominated the second ($X^2 = 19.23 > X^2_{0.05} = 3.84$), third ($X^2 = 3.85 > X^2_{0.10} = 3.84$) and sixth ($X^2 = 3.85 > X^2_{0.10} = 3.84$) age classes (Table 2).

Length–weight relations were calculated for females ($n = 89$), males ($n = 117$) and all specimens ($n = 206$) as: $W = 0.011FL^{3.068}$ ($r^2 = 0.928$) (Fig. 2), $W = 0.016FL^{2.949}$ ($r^2 = 0.966$) (Fig. 3), and $W = 0.014FL^{2.980}$ ($r^2 = 0.947$) (Fig. 4), respectively. Isometric growth was observed for females ($t = 0.77 < t_{0.05, 87} = 1.99$), males ($t = 0.99 < t_{0.05, 115} = 1.98$) and the whole fish (males ($t = 0.41 < t_{0.05, 204} = 1.97$).

The von Bertalanffy growth equations were computed for $L_\infty = 35.7$ (SE = 0.37 cm), $W_\infty = 238.0$ (SE = 35.42 g).

| Table 1 | Length and weight of *Barbus pectoralis* from Kemer Reservoir |
|---------|--------------------------------------------------------------|
| Sex     | Parameter        | 1+ | 2+ | 3+ | 4+ | 5+ | 6+ |
| Male    | fork length [cm] | 9.8–11.6 | 11.6–15.6 | 13.0–26.6 | 14.1–24.0 | 16.4–26.0 | 23.5–26.9 |
|         | mean ± SE       | 11.8 ± 0.52 | 15.1 ± 0.29 | 18.8 ± 0.46 | 20.9 ± 0.42 | 23.2 ± 0.71 | 25.1 ± 0.29 |
| Male    | weight [g]      | 27.6 ± 2.78 | 57.3 ± 3.14 | 85.0 ± 4.74 | 141.1 ± 8.64 | 159.4 ± 17.0 | 276.3 ± 31.32 |
| Male    | fork length [cm] | 10.8–11.6 | 12.6–16.3 | 14.0–25.0 | 14.9–24.4 | 16.3–26.3 | 23.1–27.2 |
| Female  | fork length [cm] | 11.2 ± 0.40 | 14.5 ± 0.31 | 17.9 ± 0.56 | 20.5 ± 0.47 | 23.7 ± 0.54 | 24.8 ± 0.91 |
| Female  | weight [g]      | 16.8 ± 4.26 | 29.06–85.34 | 56.63–158.43 | 75.10–178.72 | 92.43–233.55 | 179.32–534.13 |
| Female  | fork length [cm] | 29.11 ± 2.79 | 51.67 ± 3.79 | 84.09 ± 7.49 | 119.66 ± 7.07 | 174.75 ± 11.07 | 350.40 ± 42.83 |
| Both    | fork length [cm] | 9.8–11.6 | 11.6–16.3 | 13.0–26.6 | 14.1–24.4 | 16.3–26.3 | 23.1–27.2 |
| Both    | weight [g]      | 28.37 ± 1.92 | 55.54 ± 2.47 | 84.04 ± 4.09 | 128.94 ± 5.69 | 169.65 ± 9.19 | 225.62 ± 11.93 |

SE = standard error of the mean.
**Table 2**

| Fork length [cm] | 1+  | 2+  | 3+  | 4+  | 5+  | 6+  | Total |
|------------------|-----|-----|-----|-----|-----|-----|-------|
| 9                | 2   |     |     |     |     |     | 2     |
| 11               | 9   | 1   |     |     |     |     | 10    |
| 13               | 7   | 18  |     |     |     |     | 25    |
| 15               | 32  | 8   |     |     |     |     | 40    |
| 17               | 14  | 29  | 5   |     |     |     | 48    |
| 19               | 11  | 13  | 3   |     |     |     | 27    |
| 21               | 4   | 16  | 7   |     |     |     | 27    |
| 23               | 3   | 7   | 4   |     |     |     | 14    |
| 25               | 4   | 8   | 12  |     |     |     |       |
| 27               | 1   | 1   |     |     |     |     |       |
| n                | 18  | 65  | 52  | 37  | 21  | 13  | 206   |
| % n              | 8.7 | 31.6| 25.2| 18.0| 10.2| 6.3 | 100   |
| FL               | 11.5 ± 0.32 | 15.0 ± 0.19 | 18.4 ± 0.22 | 20.6 ± 0.30 | 23.5 ± 0.43 | 25.0 ± 0.35 | 18.5 ± 3.80 |
| W                | 28.37 ± 1.92 | 55.54 ± 2.47 | 84.63 ± 4.09 | 128.94 ± 5.69 | 169.65 ± 9.19 | 225.62 ± 11.93 | 96.06 ± 4.19 |
| Males            | 9   | 45  | 31  | 16  | 7   | 9   | 117   |
| Females          | 9   | 20  | 21  | 21  | 14  | 4   | 89    |
| M : F            | 1 : 1.00 | 1 : 0.44 | 1 : 0.68 | 1 : 1.31 | 1 : 2.00 | 1 : 0.44 | 1 : 0.76 |

Fig. 2. Relation between fork length and weight of female *Barbus pectoralis* \((n = 89)\) from Kemer Reservoir

![Graph showing the relationship between fork length and weight for female *Barbus pectoralis*.](image)

\[ W = 0.011 \times FL^{3.068} \]

\[ R^2 = 0.928 \]

Female

Fig. 3. Relation between fork length and weight of male *Barbus pectoralis* \((n = 117)\) from Kemer Reservoir

![Graph showing the relationship between fork length and weight for male *Barbus pectoralis*.](image)

\[ W = 0.016 \times FL^{2.964} \]

\[ R^2 = 0.966 \]

Male
Fig. 4. Relation between fork length and weight of combined sexes of Barbus pectoralis (n = 206) from Kemer Reservoir

\[ W = 0.014 FL^{2.980} \]
\[ R^2 = 0.947 \]

All

K = 0.161 year\(^{-1}\) and \( t_0 = -1.328 \) years for females (\( n = 5, r^2 = 0.886 \), \( L_\infty = 34.7 \) (SE = 0.26) cm, \( W_\infty = 225.28 \) (SE = 31.83) g, \( t_0 = -1.620 \) years for males (\( n = 5, r^2 = 0.817 \), \( L_\infty = 35.5 \) (SE = 0.17) cm, \( W_\infty = 232.15 \) (SE = 32.20) g, \( K = 0.163 \cdot \) year\(^{-1}\) and \( t_0 = -1.319 \) years for all specimens (\( n = 5, r^2 = 0.804 \) (Figs. 5, 6). The values of \( L_\infty \) and \( W_\infty \) of females was higher than those of males, but there was a no significant difference between the growth parameters of males and females (\( L_\infty \): \( t = 1.587 < t_{0.05, 204} = 1.97 \), \( W_\infty \): \( t = 0.189 < t_{0.05, 204} = 1.97 \)).

The growth performance index (\( \phi' \)) was found to be 2.32 for combined sexes and 2.29, and 2.31 for males and females, respectively.

The condition factor was calculated as 1.272–1.367 for males, and 1.337–1.423 for females.

**DISCUSSION**

The maximum estimated age was 6 years while Balık (1980) refers maximum age of 7 years in the Gediz River. Six and 8 years of age were reported from the Kean Reservoir in 1978 and 1979, respectively (Çolak 1982). Ergene (1998) reported a maximum age of 7 years in the Goksu River, while İkiz et al. (1998) found the maximum age of 5 years from the Aksu River. In the Avsar Reservoir the maximum age was 6 years (Topkara and Balık 2004). The age groups found for Kemer Reservoir population were consistent compared to other B. pectoralis populations described by Topkara and Balık (2004) and Çolak (1982; in first year).

In this study males were dominant. A similar situation has been reported by Balık (1980) (gill nets and cast nets) and İkiz et al. (1998) (electrofishing). However, Çolak (1982) (gill nets), Ergene (1998) (gill nets and cast nets), and Topkara and Balık (2004) (gill nets) found females to be more numerous than males. There tends to be a surplus of males on the spawning grounds in some species, because the males remain there longer or because the males shed mature sperm gradually. The females usually leave the spawning grounds more rapidly, which also may be considered as an adaptation facilitating preservation of the females or more rapid recovery of gonads, which results in an increased population. Males usually predominate in the younger groups because they mature earlier but live less long (Nikolsky 1969).

The growth of bassan barbel in Kemer reservoir was isometric (\( b = 2.98 \)) in contrast to similar to those inhabiting in Gediz River (\( b = 2.85 \)) (Balık 1980), Aksu River (\( b = 2.89 \)) (İkiz et al. 1998), Avsar reservoir (\( b = 2.81 \)) (Topkara and Balık 2004), and Kemer reservoir (\( b = 3.14, t\text{-test } = 2.375, P < 0.05 \) Özcan (2008). The \( b \) values of \( L–W \) relations is known to vary according to age, maturity, and sex (Dulčić and Kraljević 1996). Geographic location and associated environmental conditions, such as seasonality (date and time of capture), stomach fullness, disease and parasite loads (Le Cren 1951, Rickert 1975, Bagenal and Tesch 1978, Erkoyuncu 1995), can also affect the value of \( b \).

The \( L_\infty \) and \( W_\infty \) values were calculated as 34.7 cm and 225.28 g, respectively for males and 35.7 cm 238.00 g, respectively for females (Figs. 5, 6). The values of \( L_\infty \) and \( W_\infty \) of females was higher than those of males, but there was a no significant difference in the growth parameters between sexes (\( P > 0.05 \)). Topkara and Balık (2004) reported also similar differences. The \( L_\infty \) and \( W_\infty \) values for the whole population were 35.5 cm and 232.15 g, and these values were similar to the those reported by Topkara and Balık (2004), but different from those reported by İkiz et al. (1998) (Table 3). The differences in growth between regions can be attributed to the difference in the size of the largest individual sampled in each area.

Ergene (1998) and İkiz et al. (1998) report higher values for the condition coefficient (1.47–1.61 and 1.121–1.667 respectively), while Balık (1980) and
**Barbus pectoralis** from a dam reservoir

**Fig. 5.** Relation between fork length and age for combined sexes of *Barbus pectoralis* from Kemer Reservoir

**Fig. 6.** Relation between weight and age for combined sexes of *Barbus pectoralis* from Kemer Reservoir

| Length (FL) [cm] | Weight (W) [g] | Growth Constant (K) [year⁻¹] | Age at Maturation (Iₚ) [years] | L∞−FLmax | n | Sex | Author |
|------------------|----------------|-------------------------------|--------------------------------|-----------|---|-----|--------|
| 51.74            | 1623.38        | 0.055                         | -3.909                         | 6.4–22.5  | 364 | both | Ikiz et al. (1998) |
|                  |                |                               |                                |           |    |      | Aksu River       |
| 36.22            | 607.28         | 0.264                         | -1.121                         |           | 375 | both | Topkara and Balık (2004) |
| 27.03            | 562.80         | 0.534                         | -0.730                         | 12.7–28.6 | 247 | male | Avsar Reservoir |
| 35.33            | 232.15         | 0.300                         | -0.852                         |           | 128 | female | Presently reported study |
| 35.5             | 225.28         | 0.163                         | -1.319                         | 9.8–27.2  | 117 | male | Kemer Reservoir |
| 34.7             | 238.00         | 0.161                         | -1.328                         |           | 89  | female |                  |

**Table 3**

Various growth parameter estimates of *Barbus pectoralis* from Kemer Reservoir.
Topkara and Balık (2004) mention almost similar with the present study values (1.142–1.315 and 1.315–1.481, respectively). Variation in the condition factor of fish may be indicative of food abundance, adaptation to the environment and gonadal development (King 1995).

Our study provides some important information on the age and growth of *B. pectoralis* that would be useful for fishery biologist to propose adequate regulations for sustainable fishery management and conservation of this highly economic important fish species in Kemer Reservoir.

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