J. Black Sea/Mediterranean Environment
Vol. 17(1): 67- 77 (2011)

Age and growth of *Chondrostoma meandrense* in Kemer Reservoir, Turkey

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Abstract

Age and growth of *Chondrostoma meandrense* Elvira 1987, were determined based on specimens collected from Kemer Reservoir, during the period from December 2004 to November 2005. Fork length ranged from 12.3 to 18.3 cm. The overall ratio of males to females was 1:2.38. The length-weight relationship for all samples was described by the following parameters: estimated as a=0.030 and b=2.706. Fish aged 2-6 years were found. The von Bertalanffy growth parameters for the whole population were: $L\infty$:23.2 cm, $W\infty$:148.19 g, k=0.118 $year^{-1}$ and t_0=-6.480 year. Growth performance index (Φ) was 1.80.

Keywords: *Chondrostoma meandrense*, Age, Growth, Kemer Reservoir

Introduction

The cyprinid genus *Chondrostoma* Agassiz 1835, with 17-20 species, is widely distributed in Europe from Iberian Peninsula to the Ural and Emba Rivers, the Caucasus and the Middle East. The southeastern part of its range includes Asia Minor with both the Mediterranean and the Black Sea drainages, the Orentes River system, the Tigris-Euphrates basin and the Kor River in South Iran (Bogutskaya 1997a).

Chondrostoma meandrense Elvira 1987, locally called Menderes kababurun balığı, is an endemic Turkish species distributed in the Büyük Menderes River system, Işıklı Lake and Kemer Reservoir (Elvira 1987; Elvira 1997; Özcan 2007). Menderes nase is considered closely related to the Gediz nase, *Chondrostoma holmwoodii* (Boulenger 1896), in the genus *Chondrostoma* (Doadrio and Carmona 2004). The genus *Chondrostoma* is represented in Turkey by eleven species (Elvira 1987; Elvira 1997; Bogustkaya 1997b).

In the Büyük Menderes River, *C. meandrense* coexist with the cyprinids *Acanthobrama mirabilis*, *Capoeta bergamae* and *Barbus pectoralis* which are characterised by their adaptability. Population declines of Menderes nase has been threatened by pollution (domestic and agriculture) and by the introduction of alien fish species. Some major predators, such as *Lepomis gibbosus*, *Carassius gibelio* and *Pseudorasbora parva* are currently widespread in the the Büyük Menderes River basin (Şaşı and Balık 2003; Özcan 2007). Summer drought and irragation water cause continuous habitat degration or loss. It is also threatened due to destruction of their habitats; in shallow water the construction of Çine, Karacasu and İkizdere Reservoirs on the Menderes River branches has been continuing since 1995, followed by other reservoir that have a big impact on the water regime.

Materials and Methods

The study was carried out in the Kemer Reservoir (37° 32' N and 28° 32' E), on the Akçay Stream which is one of the important branches of the Büyük Menderes River in west Anatolia, Turkey (Figure 1).

Monthly samples of *C. meandrense* were collected between December 2004 and November 2005 inclusive, by means of 1000 m of gill nets of 18–45 mm mesh sizes and cast nets 12-22 mm mesh sizes. Due to the vulnerable status of Menderes nase, collections were kept at the minimum. 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). They were dissected and sexed by examination of gonads. Age determination was carried out from microscopic examination of scales.

The scales of each sample were prepared for age determinations and age readings were performed according to Chugunova (1963).

Fulton's equation was employed to calculated the condition coefficient (K) for each individual fish: $K=100\ W/FL^3$, where FL is the fork length (cm) and W is the body weight (g) (Le Cren 1951).

The L–W relationships were determined using the equations: $W = a\ L^b$ (Le Cren 1951). The parameters *a* and *b* of the L-W relationships were estimated by the least squares regression method. The significance of the regression was assessed by ANOVA, and different from the predictions for isometric growth (b=3). Growth performance index (Φ) was calculated using the equation, $\Phi = \log (K) + 2\text{Log} (L_\infty)$ (Pauly and Munro 1984).

The von Bertalanffy function $L_t = L_\infty(1-e^{-K(t-to)})$ was used to describe growth in size and weight, where L_t is the fork length at time t; k is a growth constant; L_∞ is the asymptotic length; and t_0 the theoretical age at length 0. the values of L_∞, K and t_0 were estimated by plotting L_{t+1} on L_t, using the Ford-Walford procedure (Erkoyuncu 1995). For the growth in weight, the same function was used: $W_t = W_\infty(1-e^{-K(t-to)})^b$, where W_t is the total weight and b is the power constant of the length-weight relationship.

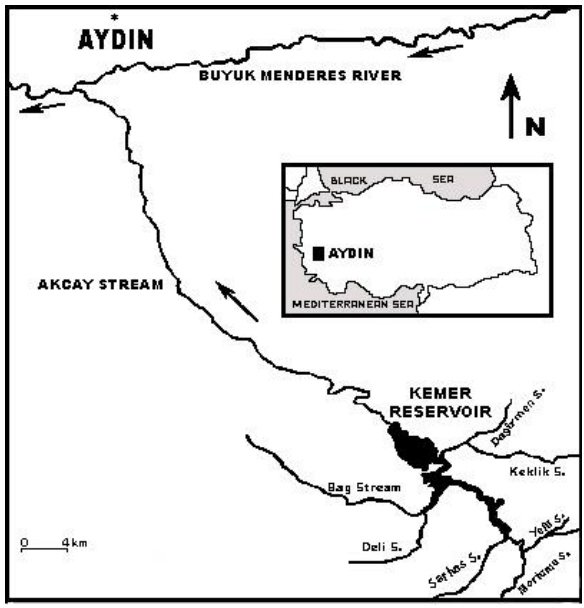

Figure 1. Map of study area

Results

From the total of 135 specimens of Menderes nase collected during the study period, 95 (70.4%) were females and 40 (29.6%) were males. The overall ratio of males to females was 1:2.38 and χ^2 analysis showed this to be significantly different from 1:1 (χ^2=22.41> $\chi^2_{1,\ 0.05}$ = 3.84). Females dominant in all length groups. Sex-ratios between males and females by age groups had significant departures from 1:1 ratio (χ^2> $\chi^2_{1,\ 0.05}$ = 3.84) for most age categories, except for the second age groups (χ^2< $\chi^2_{1,\ 0.05}$ = 3.84).

Fish size ranged from 12.3 to 18.3 cm (FL) and weighed between 24.84 and 76.74 g. Fork length of males ranged between 12.3 and 17.1 cm and weight between 24.84 and 68.50 g. Females ranged from 13.4 to 18.3 cm (FL) in length and from 31.87 to 76.74 g in weight.

The length-weight relationship was calculated separately for both sexes and all fish (Table 1). A significant relationship with the high regression coefficient (r=0.966) was found between the length and weight of Menderes nase. Negative allometric growth was observed for male, female and all samples because the b value was significantly greater than 3 ($p<0.05$).

The von Bertalanffy growth equatios were computed for males, females and all samples as L∞:17.5 cm, W∞:65.52, K=0.343 $year^{-1}$ and t_0=-3.228 year, L∞:23.3 cm, W∞:153.83, K=0.114 $year^{-1}$ and t_0=-6.790 year and L∞:23.2 cm, W∞:148.19, K=0.118 $year^{-1}$ and t_0=-6.480 year, respectively. The growth performance index (Φ) was found for females, males and all samples as 2.02, 1.79 and 1.80, respectively. There were statistical differences between the observed and calculated mean lengths ($p<0.05$) of females and males, except for the sixth age groups in females ($p>0.05$) and the fourth and fifth age groups in males ($p>0.05$ Table 2).

Condition coefficient of Menderes nase for sexes increases up to age-group 5, but there is a trend towards a decrease in the condition coefficient in age-group 6 for females (Figure 2).

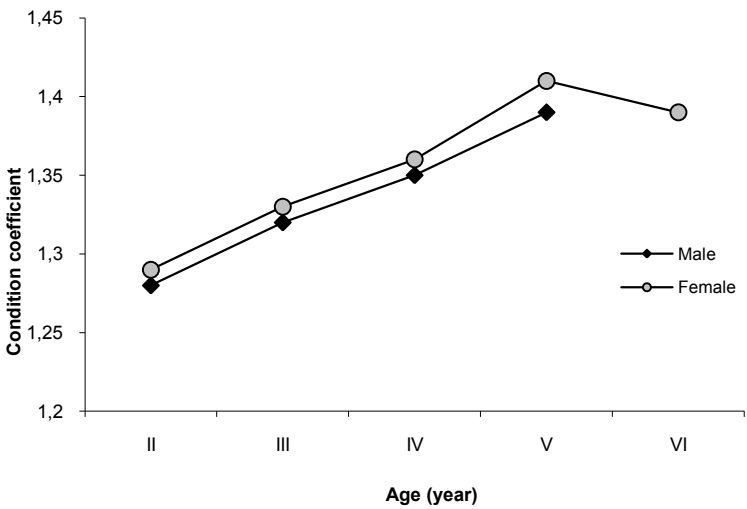

Figure 2. Condition coefficient of each age group of Menderes nase in Kemer Reservoir.

Table 1. Length (L)(cm)-weight (g) relationships for *Chondrostoma meandrense* in Kemer Reservoir, based on $W=aL^b$

Sex	**N**	**L_{min}-L_{max}**	**A**	**b**	**r^2**
Male	40	12.3-17.1	0.047	2.529	0.989
Female	95	13.4-18.3	0.025	2.773	0.975
All samples	135	12.3-18.3	0.030	2.706	0.966

Table 2. Observed and calculated mean lengths (FL, cm) of the Menderes nase for each age group of females and males

	Age groups (year)				
	2	**3**	**4**	**5**	**6**
Females					
$L_{observed}$	13.72	14.47	15.88	16.04	17.25
$L_{calculated}$	14.72	15.65	16.46	17.19	17.84
P=0.05	p<0.05	p<0.05	p<0.05	p<0.05	p>0.05
Males					
$L_{observed}$	13.50	14.51	15.67	16.07	-
$L_{calculated}$	14.60	15.44	16.04	16.47	-
P=0.05	p<0.05	p<0.05	p>0.05	p>0.05	

Table 3. Parameters of the length-weight relationship and von Bertalanffy growth equation for different species of genus *Chondrostoma* in different areas (C.: *Chondrostoma*).

	C. meandrense	***C. nasus***	***C. regium***
Locality	Kemer Reservoir[a] Yayla Gölü[g]	Bafa Gölü[b] Isıkli Lake[c]	Atatürk Reservoir[d] Sır Reservoir[e] Fırat River[f]
M:F	1:2.38[a] 1:1.73[g]	1:3.10[b] 1:2.51[c]	1:1.39[d] 1:1.21[e] 1:1.48[f]
Age	2-6[a] (A) 1-5[g] (A)	1-4[b] (A) 2-5[c] (A)	1-8[d] (A) 1-5[e] (A) 2-8[f] (A)
L_{min}-L_{max} (cm)	12.3-18.3[a] (FL) 9.4-17.7[g] (FL)	8.4-19.0[b] (FL) 13.3-22.3[c] (FL)	15.5-26.0[e] (FL)
L∞	23.2[a] (A) 19.6[g] (A)	23.7[b] (A) 25.4[c] (A)	34.8[d] (A) 31.9[e] (A)
W∞	148.12[a] (A) 105.05[g] (A)	210.38[b] (A) 208.48[c] (A)	517.59[d] (A) 372.47[e] (A)
K	0.118[a] 0.588[g]	0.279[b] 0.241[c]	0.169[d] 0.177[e]
Φ	1.80[a] (A) 2.35[g] (A)	2.20[b] (A) 2.19[c] (A)	2.31[d] (A) 2.26[e] (A)
B	2.706[a] (A) 2.65[g] (A)	3.08[b] (A) 2.86[c] (A)	3.07[e] (A) 2.84[f] (A)

a: This study
b: Balık *et al*. (1992)
c: Sarı *et al*. (2003)
d: Oymak (2000)
e: Kara and Solak (2004)
f: Şevik (1993)
g: Balık *et al*. (2007)

Discussion

C. meandrense, is an endemic freshwater fish species in the Büyük Menderes River basin in Turkey. Given the vulnurable status of the Menderes nase, the number of specimens captured was not sufficient desirable for a definitive study. The ratio of sexes in the population in the Kemer Reservoir is similar to Balık *et al*. (1992); Sarı *et al*. (2003) and Balık *et al*. (2007), while sex ratio in *C. meandrense* is very different from *C. regium* (Table 2). The overall sex ratio is close to 1:1 in many species, but may vary from species to species, may change from year to year in the same population (Nikolsky 1963).

The age groups found for the Menderes nase are consistent with those in other nase populations described by Balık *et al*. (1992); Sarı *et al*. (2003); Kara and Solak (2004) and Balık *et al*. (2007). On the other hand, Şevik (1993) and Oymak (2000) reported that the oldest *Chondrostoma* was 8 years (Table 3). Most studies have shown that genus *Chondrostoma* commonly only live for five to six years, and there is little reason to suspect that the habitat of the Fırat River and Atatürk Reservoir differs greatly from other localities.

The exponents of length-weight relationships (b= 2.706) of the Menderes nase in Kemer Reservoir show that growth is negative allometric. "*b*" values were close to estimations by Şevik (1993); Sarı *et al*. (2003) and Balık *et al*. (2007), but also different from those found by Balık *et al*. (1992) and Kara and Solak (2004) (Table 2). The b values are often 3.0 and generally between 2.0 and 4.0. As the fish grows, changes in weight are relatively greater than changes in length due to approximately cubic relationships between fish length and weight. The *b* values in fish vary according to species, sex, age, seasons and feeding. In addition, changes in fish shape, physiological conditions, different amounts of food available, life span or growth increment can all affect the b growth exponent (Le Cren 1951; Bagenal and Tesch 1978).

The theoretical maximal length value ($L\infty$) was close to the size of the largest fish examined. This parameter is similar to those reported by Balık *et al*. (1992); Sarı *et al*. (2003) and Balık *et al*. (2007) (Table 3).

However, this parameter differs in Oymak (2000) as well as in Kara and Solak (2004) (Table 3).

The condition coefficient were calculated as 1.28-1.39 for males, and 1.29-1.41 for females. Our values are similar to those given for the Işıklı Lake (1.29-1.39) and Atatürk Reservoir (0.90-1.38). Kara & Solak (2004) calculated lower condition coefficients (1.12-1.29) than those in this study. Condition coefficient values in fish population may vary according to age, sex, fat reserve level, species, season, locality and year (Le Cren 1951).

Acknowledgements

The present study was financially supported by Mustafa Kemal University (Project No: 04 M 1704).

Kemer rezervuarında yaşayan *Chondrostoma meandrense'nin* yaş ve büyüme özellikleri

Özet

Aralık 2004 ile Kasım 2005 tarihleri arasında Kemer Baraj Gölü'nden toplanılan *Chondrostoma meandrense* Elvira 1987'in yaş ve büyümesi belirlendi. Çatal boyu 12,3 ile 18,3 cm arasındadır. Erkek:dişi oranı 1:2.38. Örneklerin boy-ağırlık ilişkisi a=0,030 and b=2,706 olarak belirlendi. Yaş dağlımı 2 ile 6 yıldır. von Bertalanffy büyüme parametresi $L\infty$:23,2 cm, $W\infty$:148,19 g, k=0,118 $yıl^{-1}$ ve t_0=-6.480 yıl olarak bulunmuştur. Büyüme performans indeksi (Φ) 1,80 olarak bulunmuştur.

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