GROWTH FEATURES OF AN ENDEMIC POPULATION OF *CHONDROSTOMA HOLMWOODII* (ACTINOPTERYGII: CYPRINIFORMES: CYPRINIDAE) IN WESTERN ANATOLIA

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Background. The Izmir nase, *Chondrostoma holmwoodii* (Boulenger, 1896), an endemic species for the inland waters of Turkey, is in the category of DD "Data Deficient" in the list of IUCN Red Data Book. There are insufficient data on the biological characteristics of the species in the literature. The aim of this study was to obtain the growth characteristics of Izmir nase population from Western Anatolia and compare them with the previous data reported in literature.

Materials and Methods. Biological features of Izmir nase were examined based on a total of 1208 specimens collected from Tahtalı Dam Lake during the period May 2006–April 2007. Age of fish was determined by reading scales. Length–weight relation and the von Bertalanffy equation were used to evaluate the fish growth.

Results. Scales reading indicated the presence of 5 age classes. The computed growth parameters were: $L_\infty = 29.19$ cm, $k = 0.177 \cdot$ year^{-1} and $t_0 = -3.258$ year^{-1} for both sexes. The length-weight relations were estimated as $W = 0.019 L^{2.97}$, $W = 0.012 L^{3.11}$ and $W = 0.011 L^{3.13}$ for females, males, and both sexes combined, respectively.

Conclusion. The Izmir nase from Tahtalı Dam Lake was characterized by linear growth and it was observed that the fish grew faster during the first two years. Many endemic fish species in inland waters of Turkey are under the threat of extinction due to human activities (pollution, drought, dam construction, habitat degradation, and overfishing) but the species is not threatened by these factors in the study area.

Keywords: growth, population structure, *Chondrostoma holmwoodii*, Izmir nase, Tahtalı Dam Lake

INTRODUCTION

The Tahtalı Dam, located in the city of İzmir and Menderes town, receives its waters from the Şaşal and Bulgurca streams (Fig. 1). The dam was constructed to provide water for domestic and industrial purposes for İzmir, and was commissioned in 1999. Its area and volume are 24 km^2 and 0.307 km^3, respectively (Anonymous 2007).

All the previous studies on Tahtalı Reservoir were carried out before the construction of the dam on the Gümüldür Brook, on which the dam lake is located. This study reported, information about the fish, reptile, and amphibian faunas in the Gümüldür Brook and its tributaries. Studies on the fish from the Tahtalı Dam Basin were initiated when "*Leucalburnus kosswigi*" [=*Squalius cephalus* (Linnaeus, 1758)] was first introduced from the Gümüldür Brook (Karaman 1972). Balık (1979) and Sarsu (unpublished[**]) reported the taxonomical and ecological features of freshwater fishes in West Anatolia freshwaters and the Gümüldür Brook, respectively. Balık et al. (1995) studied the vertebrate fauna of the same area.

The first record of *Chondrostoma holmwoodii* from the inland waters of Turkey was reported by Boulenger (1896) as *Capoeta holmwoodii*. Later, the species was stated as *Varicorhinus holmwoodi* by Pellegrin (1928), as *Chondrostoma nasus* by Kosswig and Battalgil (1943), as *Chondrostoma nasus, Chondrostoma regium*, and *Chondrostoma knerii* by Ladiges (1960, 1966), as *Chondrostoma nasus holmwoodi* by Karaman (1969), respectively. Elvira (1987) divided the species into two subspecies, which are *Chondrostoma holmwoodii holmwoodii* from the Bakırçay and Gediz River basins and *Chondrostoma holmwoodii meandrensis* from the Büyük Menderes River Basin. At present, the Bakırçay and Gediz rivers populations of the species is determined as *Chondrostoma holmwoodii* while the Büyük Menderes River population as *Chondrostoma meandrense* (see Froese and Pauly 2009).

The biology of the species was also investigated in the Gediz River by Mermer and Balık (1991) *Chondrostoma holmwoodii*, is endemic to the inland waters of Turkey, and is classified as DD "Data Deficient" in the list of IUCN Red Data Book (Crivelli 2006). Pollution and water extraction are the main factors that negatively affect the fish populations (Crivelli 2006).

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[**] Sarsu M. 1981. Gümüldür deresi ve ona bağlı kaynaklarda yaşayan tatlısu balıklarının taksonomisi ve ekolojik özellikleri üzerine ön çalışmalar. [A preliminary study on the taxonomical and ecological features of freshwater fishes in Gümüldür Stream and its tributaries.] Ege Üniversitesi Fen Fakültesi Biyolojik Oseanografi Bölümü (Diploma Tezi). [In Turkish].

MATERIALS AND METHODS

Specimens of *Chondrostoma holmwoodi* were caught monthly during May 2006–April 2007 by 20, 25, 30, and 32 mm mesh trammel nets. Sampling was done between sunset and dawn every month in the same area.

A total of 1208 Izmir nase specimens were examined during the study period. Fish samples were fixed in 4% formaldehyde solution in the field and were measured in mm (fork length, FL), weighed to the nearest 0.01 g (total weight, W), and dissected in the laboratory.

Age was determined by reading scales. Some 15–20 scales from the left side of the body between the lateral line and dorsal fin were removed (Tesch 1970). Scales were prepared by applying a series of alcohol dilutives, and read under a binocular microscope.To minimize reading errors, the number of opaque rings outside the nucleus was evaluated by two readers.

Sex and maturity stages were determined by visual and microscopic examination of gonads.

The commonly used Ricker (1975) length–weight relation model was applied:

$$W = aL^b$$

where W is the total weight (mass) [g], L is the fork length [cm], a and b are the regression constants. Growth type was identified using the test (2-sided) (Sparre et al. 1989).

The generalized von Bertalanffy growth equations were used to describe the growth of the species (Sparre et al. 1989).

$$L_t = L_\infty (1 - e^{-k(t - t_0)})$$

and

$$W_t = W_\infty \left[(1 - e^{-k(t - t_0)}) \right]^b$$

where L_t and W_t are the fish length and weight at age t; L_∞ and W_∞ represent the asymptotic length and weight; k is a relative growth coefficient and t_0 theoretical age when fish length is zero.

Natural mortality was calculated by using the formula of Pauly (1980):

$$\text{Log}M = -0.0066 - 0.279 \log L_\infty + 0.6543 \log k + 0.4634 \log T$$

where M is the natural mortality, k is the relative growth coefficient ,and T is the average annual water temperature. T is the mean value of the measured temperature values during the field study (12 months).

RESULTS

The sex composition for the 1208 specimens of *Chondrostoma holmwoodii* was 72.10% : 27.90% (871 females : 337 males). According to the Chi-square test (c^2) there was a significant difference in the female : male ratio of sampled fishes ($c^2 = 236.06 < c^2_{t\ 0.05} = 3.841$, $P \leq 0.05$), whereby females significantly outnumbered males by a female : male ratio of 1 : 0.39. The age of the fish ranged from 1 to 5 years. Determination of the fish age showed that 39.49% of all samples belonged to age group IV. Age group I was represented by only 2.24% (Table 1).

The 1208 specimens ranged in length from 13.60 to 24.70 cm FL. FL of the males ranged from 13.60 to 24.00 cm and females from 14.40 to 24.70 cm. An F test showed that there were significant differences between the length frequency distributions of female and male fish ($F = 164.652$, $P < 0.05$, df = 1208 − 1). For this reason, the population analysis was carried out separately for females and males and for the two sexes combined. According to the length frequency distribution, specimens of >20 cm (69.45%) were abundant for both sexes (Fig. 2).

When we compared the mean fork length of specimens, overall mean FL values of females were significantly higher than that of males (Table 2).

The weight distribution of specimens varied between 44.30 and 260.80 g for females, and 38.00 g and 237.00 g for males. According to this data, the mean weight values were higher for females than for males in all age groups (Table 2).

The von Bertallanffy growth equations of the population were computed as $L_\infty = 29.19$ cm and $W_\infty = 438.80$ g (Table 3).

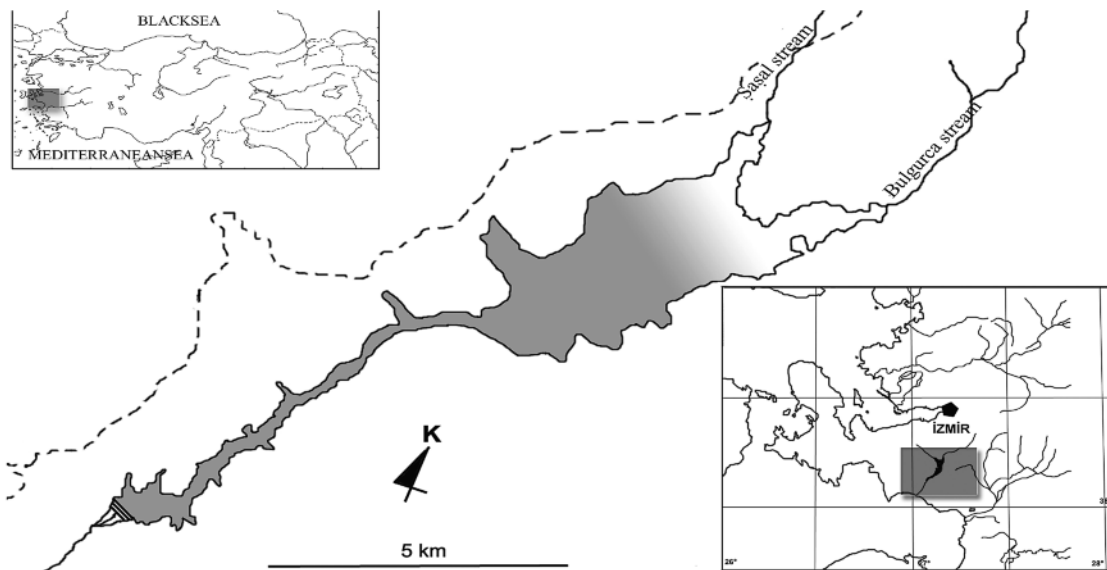Length-weight regression parameters for females, males and all individuals are presented in Table 4.

Fig. 1. Map of the study area (Tahtalı Dam Lake)

Significant difference in the allometric coefficient was found between females and males. According to Student's *t*-test, there were an isometric growth for females (b = 2.971; ±SE (b) = 0.0424; P > 0.05), and males (b = 3.111; ±SE (b) = 0.0706; P > 0.05). Positive allometric growth was observed for all specimens combined (b = 3.128; ±SE (b) = 0.0355; P < 0.05) (Table 4). Correlation coefficients computed for the length–weight
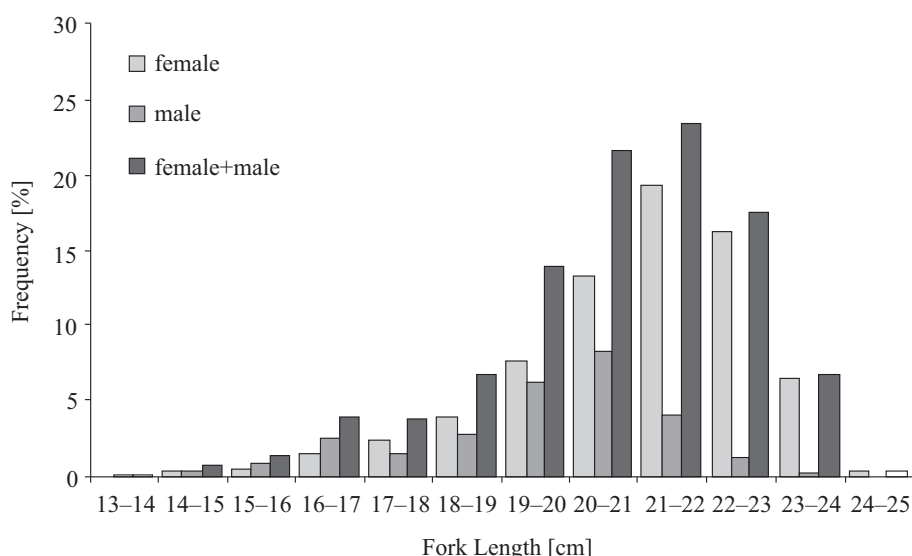

Fig. 2. Fork length frequency of *Chondrostoma holmwoodii* population of Tahtalı Dam Lake

Table 1

The age and sex ratio of *Chondrostoma holmwoodii* population of Tahtalı Dam Lake

Age group	Female		Male		Female + Male		Female : Male
	n	%	*n*	%	*n*	%	
I	14	1.16	13	1.08	27	2.24	1 : 0.93
II	69	5.71	62	5.13	131	10.84	1 : 0.90
III	124	10.26	100	8.28	224	18.54	1 : 0.81
IV	345	28.56	132	10.93	477	39.49	1 : 0.38
V	319	26.41	30	2.48	349	28.89	1 : 0.09
Total	871	72.10	337	27.90	1208	100.00	1 : 0.39

Table 2

Length and weight at age of *Chondrostoma holmwoodii* population of Tahtalı Dam Lake

Sex	Age group	*n*	Fork length [cm]				Weight [g]			
			Min	Max	Mean ± CI	SD	Min	Max	Mean ± CI	SD
Female	I	14	14.40	16.20	15.49 ± 0.344	0.596	44.30	79.80	59.48 ± 5.319	9.214
	II	69	16.30	19.20	17.81 ± 0.187	0.778	61.30	118.90	93.11 ± 3.655	15.182
	III	124	17.90	21.20	19.64 ± 0.123	0.693	91.40	185.00	128.82 ± 3.750	21.088
	IV	345	19.50	24.00	21.37 ± 0.086	0.815	109.80	250.30	170.63 ± 2.462	23.240
	V	319	20.50	24.70	22.48 ± 0.095	0.866	123.90	260.80	195.63 ± 2.610	23.683
Male	I	13	13.60	16.20	15.45 ± 0.439	0.726	38.00	66.50	52.98 ± 5.313	8.791
	II	62	16.00	19.20	17.34 ± 0.229	0.903	53.50	130.80	80.04 ± 4.055	15.966
	III	100	17.90	21.20	19.61 ± 0.135	0.681	71.70	166.70	123.03 ± 3.660	18.419
	IV	132	19.50	23.40	20.83 ± 0.115	0.665	112.70	202.10	147.61 ± 3.052	17.712
	V	30	20.50	24.00	21.85 ± 0.330	0.883	128.00	237.00	166.81 ± 9.027	24.176
Female + Male	I	27	13.60	16.20	15.47 ± 0.262	0.662	38.00	79.80	56.35 ± 3.791	9.580
	II	131	16.00	19.20	17.59 ± 0.151	0.873	53.50	130.80	86.92 ± 2.919	16.871
	III	224	17.90	21.20	19.63 ± 0.091	0.688	71.70	185.00	126.23 ± 2.655	20.148
	IV	477	19.50	24.00	21.22 ± 0.073	0.814	109.80	250.30	164.26 ± 2.175	24.157
	V	349	20.50	24.70	22.43 ± 0.093	0.885	123.90	260.80	193.15 ± 2.640	25.063

The von Bertalanffy growth equations of the population were computed as L_∞ = 29.19 cm and W_∞ = 438.80 g (Table 3).

relation were estimated as significant ($t = 115.63$, $P < 0.05$ for females, $t = 71.78$, $P < 0.05$ for males and $t = 144.00$, $P < 0.05$ for sex combined). These values suggested that growth in the population was regular.

The instantaneous natural mortality coefficient (M) was calculated as 0.44 when the both sexes are carried out. This value can be accepted as the total mortality ratio because there is no fisheries activity in the study area.

individual was sampled in the area. Therefore, our L_∞ and W_∞ values are also higher than those of reported by Mermer and Balık (1991) (Table 5). We think that absence of fisheries activities in the area can be one of the main reasons for the higher L_∞ and W_∞ values in our study. Similarly, the lake form of the species is generally bigger than the riverine forms, and our results also support this statement.

Table 3

The von Bertalanffy growth parameters of *Chondrostoma holmwoodii* population of Tahtalı Dam Lake

	n	k (year^{-1})	t_0 (year)	L_∞ [cm]	W_∞ [g]
Female	871	0.211	−2.865	27.75	364.56
Male	337	0.223	−2.965	26.30	301.38
Female + Male	1208	0.177	−3.258	29.19	438.80

Table 4

Parameters of the length-weight relation ($W = aL^b$) of *Chondrostoma holmwoodii* population of Tahtalı Dam Lake

Sex	a	b	SE (b)	n	r^2	t-test
Females	0.01878	2.97112	0.042428	871	0.939	0.681[a]
Males	0.01154	3.11062	0.070609	337	0.939	1.558[b]
All fish	0.01144	3.12845	0.035459	1208	0.945	3.606[c]

a (t-test, $t > t$ 0.05, 871 = 1.65); b (t-test, $t > t$ 0.05, 337 = 1.65); c (t-test, $t > t$ 0.05, 1208 = 1.65).

Table 5

Age-length and Age-weight values in different studies about *Chondrostoma holmwoodii* populations

Locality	n		I	II	III	IV	V	L_∞ / W_∞	Reference
Gediz River (♀♀)	47	L	11.83	15.59	17.77	20.20	—	26.40	Mermer and Balık (1991)
		W	20.22	40.44	59.60	86.71	—	161.98	
Gediz River (♂♂)	43	L	11.45	15.34	17.23	18.30	—	19.20	Mermer and Balık (1991)
		W	17.08	39.15	53.00	84.88	—	71.47	
Tahtalı Dam L (♀♀)	871	L	15.49	17.81	19.64	21.37	22.48	27.75	This study
		W	59.48	93.11	128.82	170.63	195.63	364.56	
Tahtalı Dam L (♂♂)	337	L	15.45	17.34	19.61	20.83	21.85	26.30	This study
		W	52.98	80.04	123.03	147.61	166.81	301.38	

DISCUSSION

In the presently reported study, the sex composition for the *Chondrostoma holmwoodii* specimens sampled from the Tahtalı Reservoir was 72.10% females and 27.90% males, which were distributed among the age groups I–V for both sexes. The female : male ratio was 1 : 0.39. A few specimens belonging to age group I were found in the sampling period. This may be attributed to predation by European perch (*Perca fluviatilis*) and the mesh size of the nets used in sampling. Mermer and Balık (1991) reported a sex ratio of 1 : 0.91 for age groups between I and IV in the Gediz River

In comparison of the mean lengths and weight values pertaining to age group, our results are higher than Mermer and Balık (1991) in Gediz River, The asymptotic length value (L_∞) is related to the size of the largest

Consequently, prohibition of fisheries activity can be a chance for persistence of the stock. As an endemic species confined to a limited geographical area *Chondrostoma holmwoodii* is potentially at risk of extinction due to pollution, drought, dam construction, habitat degradation, and overfishing. However, at present it appears that this species is not threatened by these factors in the surveyed area.

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