

## Biological Properties of Chub (*Leuciscus cephalus* L., 1758) in Karasu Stream (Mus/Turkey)

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**Abstract:** In this study, the age, growth and reproduction of chub (*L. cephalus*) population, living in Karasu Stream, was determined. Total 404 chub have sampled and investigated between April 2005 and October 2006. The ages, lengths and weights of individuals varied from 1-7 year, 7.3-40.5 cm and 4.8-1002.5 g, respectively. Length-weight relationship and Von Bertalanffy Growth Equations were calculated as  $W = 0.00844 \times L^{3.1558}$ , as  $L_t = 60.75 \times (1 - e^{-0.088(t+0.333)})$  and as  $W_t = 3588.04 \times (1 - e^{-0.088(t+0.333)})^{3.1558}$ , respectively. The mean condition factor was defined as  $1.297 \pm 0.010$ . It was established that females and males attained sexual maturity when they reached to 13 and 14 cm in length and third age, respectively and spawning was observed between May and July. The male:female ratio was calculated as 1.45:1. In the population, minimum catching size should be applied as IV age, 18 cm fork length and 70 g total weight.

**Key words:** Growth, reproduction, chub, population structure, karasu stream

### INTRODUCTION

Chub (*L. cephalus*) is a Cyprinid and a freshwater fish, widely distributed in Europe, The Black Sea, The Caspian Sea and The Sea of Azov Basins. It almost exists in all Anatolian inland waters. Maximum length and weight can be 80 cm and 4 kg. Body color is dark on dorsal and light yellow-whitish on ventral. There are large cycloid scales with dark spot on the body. Its head is large and wide. The mouth is terminal. It is generally omnivore, but, elderly individuals are carnivore (Geldiay and Balik, 1996).

Karasu Stream (37° 74' N, 42° 80' E) is important branch of Murat Stream in the Euphrates Basin, eastern Anatolia and, its altitude is 1288 m, total length is 98 km. There is an irrigation regulator on the region of up Stream. This region has terrestrial climatic. The surface water of the Stream is freeze every winter. Apart from *Leuciscus cephalus*, there are *Acanthobrama marmid*, *Alburnus alburnus*, *Barbus plebejus*, *Capoeta tinca*, *Capoeta trutta*, *Capoeta capoeta koswigi*, *Chalcalburnus chalcoides*, *Chondrostoma regium*, *Cyprinus carpio*, *Mastacembelus simack*, *Tinca tinca* and *Vimba vimba* in the Stream (Anonymous, 2005).

Population sustainability should be maintained in natural sources. Therefore, management of natural sources based on the scientific foundation is a necessity.

In this study, it is aiming to determine the growth and reproductive aspects of *L. cephalus* population living in Karasu Stream and arrange the fishing on the scientific basis.

### MATERIALS AND METHODS

In this study, a total 404 chub was sampled in five different region of Karasu Stream from April 2005 to October 2006. The samples were captured with electroshock, hand and trammel nets (18, 22 and 35 mm). A total 374 chub scales and opercula were used for age determination. The ages were determined on scale preparation with microfilm device (Türkmen *et al.*, 2005). The fork length (FL±0.1 cm) of 404 specimens and total weight (W±0.1 g) of 217 individuals were recorded. Age, length and weight frequencies were determined. The length-weight [ $W = a \cdot FL^b$ ], age-length [ $FL_t = FL_\infty (1 - e^{-K(t-t_0)})$ ] and age-weight [ $W_t = W_\infty (1 - e^{-K(t-t_0)})^b$ ] relationships, condition factor [ $CF = W/FL^3 \cdot 100$ ] and Munro's phi prime index [ $\phi' = \log K + 2 \cdot \log FL_\infty$ ] were calculated (Cetinkaya *et al.*, 2005, Avsar, 2005). Sex was determined by examination of the gonads of 289 specimens. Sexual maturation of chub was defined according to age, length and weight. Gonad somatic index were calculated via [ $GSI = (G_w/W) \cdot 100$ ] (Karatas *et al.*, 2005).

## RESULTS

The age of the specimens ranged from I to VIII and third age group was dominant in all samples (29.4%) and males (15.0%) and fourth age group in females (10.2%). So, 0 year old specimens could not captured in Karasu Stream (Table 1).

The largest and the heaviest specimen was 40.5 cm FL and 1002.5 g (Table 2) and it was estimated that the females were bigger than the males, statistically ( $p < 0.05$ ).

When fork length grouped into 2 cm bands, the largest group was found as 15.0-16.9 cm range (22.5%). According to the sex, the largest group of males was in 15.0-16.9 cm range (11.9%) and, of females was in 15.0-16.9 and 17.0-18.9 cm range (6.9%). Total weights were grouped into 50 g. The dominant weight group (49.3%) of all samples was determined as 0-49.9 g group. When weight frequencies was examined in relation to sex,

dominant weight group of males was 0-49.9 g group (23.0%) and, of females was in 50.0-99.9 g group (15.2%) (Table 3).

Length-weight relationship was analyzed depending on sex. It was found that males had  $W = 0.00828 \times L^{3.162}$  ( $r^2 = 0.973$ ), females had  $W = 0.00895 \times L^{3.138}$  ( $r^2 = 0.983$ ) and all samples had  $W = 0.00844 \times L^{3.156}$  ( $r^2 = 0.985$ ). The slope (b) values of length-weight relationship were analyzed depending on sex and the value of females (3.138) was lower than that of males (3.162). Age-length and age-weight relationships were determined depending on sex.  $\phi'$  was calculated as 2.510 in all samples, 2.138 in males and 2.535 in females (Table 4).

Condition factor was calculated as 1.297 in the overall samples, 1.296 in males and 1.332 in females. Maximum average condition value in overall samples was calculated in April 2006 (1.509) and it declined to lowest in October 2006 (1.196) (Table 5).

Table 1: Age composition of chub depending on sex in Karasu Stream

Age groups	Males		Females		All samples	
	n	n (%)	n	n (%)	N	N (%)
I	5	1.3	1	0.3	30	8.0
II	25	6.7	8	2.1	83	22.2
III	56	15.0	33	8.8	110	29.4
IV	44	11.8	38	10.2	93	24.9
V	17	4.6	20	5.4	41	10.9
VI	5	1.3	7	1.9	13	3.5
VII	1	0.3	2	0.5	3	0.8
VIII	0		1	0.3	1	0.3
Total	153	41.0	110	29.5	374	100.00

Table 2: According to age and sex, lengths (cm) and weights (g) of chub

Age	Males				Females				All samples			
	n	FL±SE	n	W±SE	n	FL±SE	n	W±SE	n	FL±SE	n	W±SE
I	5	10.2±0.4	3	13.2±1.6	1	10.3	0		30	10.0±0.2	11	12.7±0.9
II	25	12.5±0.4	14	25.7±4.3	8	11.8±0.7	3	13.3±3.0	83	11.1±0.2	38	18.8±2.2
III	56	14.8±0.3	37	43.5±3.2	33	15.8±0.4	22	53.5±4.2	110	14.9±0.2	68	46.6±2.5
IV	44	16.9±0.3	26	69.9±5.2	38	17.5±0.4	23	64.1±4.3	93	17.1±0.2	55	66.9±3.1
V	17	17.9±0.4	11	73.4±2.0	20	19.2±0.7	15	101.7±12.9	41	18.5±0.4	29	88.1±7.2
VI	5	21.9±1.2	4	151.2±31.8	7	23.8±1.1	5	230.6±34.6	13	22.8±0.8	9	195.3±26.4
VII	1	20.4	1	114.5	2	30.2±3.9	2	412.0±164.5	3	26.9±3.9	3	312.8±137.3
VIII					1	40.5	1	1002.5	1	40.5	1	1002.5

Table 3: Length and weight composition of chub in karasu stream

Length groups cm	Males		Females		All		Weight groups (g)	Males		Females		All	
	n	n (%)	n	n (%)	n	n (%)		n	n (%)	n	n (%)	n	n (%)
7.0-8.9					12	3.0	0-49.9	50	23.0	22	10.1	107	49.3
9.0-10.9					62	15.4	50-99.9	38	17.5	33	15.2	83	38.2
11.0-12.9	22	3.0	3	0.7	50	12.4	100-149.9	7	3.2	9	4.2	16	7.4
13.0-14.9	36	8.9	23	5.7	67	16.6	150-199.9	1	0.5	1	0.5	2	0.9
15.0-16.9	48	11.9	28	6.9	91	22.5	200-249.9	1	0.5	4	1.8	5	2.3
17.0-18.9	34	8.4	28	6.9	68	16.8	250-299.9	0		1	0.5	1	0.5
19.0-20.9	13	3.2	12	3.0	30	7.4	300-349.9	0		1	0.5	1	0.5
21.0-22.9	3	0.7	4	1.0	7	1.7	350<	0		2	0.9	2	0.9
23.0-24.9	3	0.7	6	1.5	9	2.2	Total	97	44.7	73	33.7	217	100.0
25.0-26.9	0		6	1.5	6	1.5							
27.0<	0		2	0.5	2	0.5							
Total	171	42.3	118	29.2	404	100.0							

Table 4: According to sex, age-length and age-weight relationships of cub

Sex	Age-length relationship	Age-weight relationship	r <sup>2</sup>	Ø
Male	$L_t = 32.93.(1-e^{-0.127(t+1.789)})$	$W_t = 520.96.(1-e^{-0.127(t+1.789)})^{3.162}$	0.966	2.138
Female	$L_t = 60.75.(1-e^{-0.093(t+0.328)})$	$W_t = 3529.39.(1-e^{-0.093(t+0.328)})^{3.138}$	0.847	2.535
All samples	$L_t = 60.75.(1-e^{-0.088(t+0.333)})$	$W_t = 3588.04.(1-e^{-0.088(t+0.333)})^{3.156}$	0.815	2.510

Table 5: Depending on sampling date and sex, condition factor of chub

Sampling date	Male		Female		All samples	
	n	CF±SE	n	CF±SE	n	CF±SE
April 2005	7	1.419±0.016	10	1.359±0.036	23	1.377±0.020
May 2005	6	1.313±0.081	4	1.361±0.087	11	1.350±0.054
July 2005	6	1.257±0.045	5	1.209±0.022	13	1.236±0.022
Nov. 2005	1	1.349	0		1	1.349
March 2006	0		1	1.467	1	1.467
April 2006	0		1	1.509	1	1.509
May 2006	23	1.352±0.029	10	1.345±0.073	37	1.332±0.028
June 2006	12	1.277±0.041	25	1.313±0.029	42	1.294±0.022
July 2006	10	1.372±0.022	3	1.332±0.035	22	1.375±0.024
Sept. 2006	19	1.237±0.024	4	1.401±0.027	30	1.252±0.020
Oct. 2006	13	1.182±0.030	10	1.329±0.036	36	1.196±0.021
All samples	97	1.296±0.014	73	1.332±0.017	217	1.297±0.010

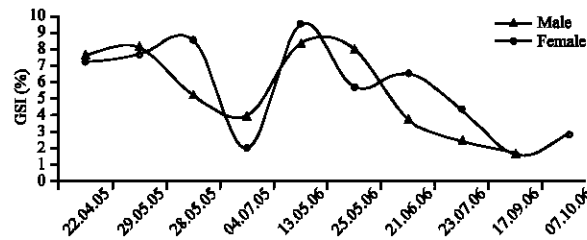


Fig. 1: Changes in GSI value of chub in karasu stream

Sex was determined on 289 samples and, while 171 (59.2%) individuals were male, 118 (40.8%) specimens were female. The male:female ratio was calculated as 1.45:1 and the difference was statistically significant ( $p < 0.05$ ). It was observed that the 56.5% of males and 80.6% of females in the third age group and, that 50.0% of males in 14 cm group and 66.6% of females in 13 cm group and that of 60% of males in 40 g group and 75% of females in 35 g group were sexually mature.

Spawning period was determined via GSI. The GSI values reached a maximum in the second week of May (8.066 in 2005 and 8.306 in 2006) in males and (7.583 in 2005 and 9.483 in 2006) in females and declined rapidly up to second half of July and reaching a minimum in September 2006 (1.709 in males and 1.565 in females). This showed that spawning of chub in Karasu Stream took place intensively from second half of May to second end of July (Fig. 1).

## DISCUSSION

Age, maximum length and weight are one of the main criteria in the determination of growth, so, they should be defined correctly. It is understood from the other researches in Turkey, the biological lifespan and

size of the chub in Turkey is similar to our findings (Türkmen *et al.*, 1999; Erdogan *et al.*, 2002; Sasi and Balik, 2003; Kara and Solak, 2004; Balik *et al.*, 2004; Sen *et al.*, 2005, 2007).

The b values of females (3.138) were found lower than that of males (3.162). This pattern has been reported by Kara and Solak (2004), Sen *et al.* (2005) and Koc *et al.* (2006). The b values are often 3.0 and generally between 2.5 and 3.5. If the b value is close or equal 3, the growth of fish is isometric and if it different 3, then it is allometric. The growth of specimens in Karasu Stream was found as isometric. As a fish grows, changes in weight are relatively greater than changes in length, due to the approximately cubic relationship between fish length and weight. The b values in fish differ according to species, different population of same species, life stages, sex and age, sexual maturity of fish, season and fish feeding (Cetinkaya *et al.*, 2005).

Von Bertalanffy Growth Equation parameters change within same species and between different species, different ecological condition, feeding and between sex. K value showing how fast fish reach to  $L_{\infty}$  value, is high (near to 1) in short living fish and is low (near to 0) in long living fish (Cetinkaya *et al.*, 2005). In this study, K value calculated as 0.127 in males, 0.093 in females and 0.088 in all samples. These show that the chub in Karasu Stream is a long living species. The theoretical maximum length ( $L_{\infty}$ ) and weight ( $W_{\infty}$ ) was estimated as 60.75 cm and 3588.04 g in this study. These values were bigger than reported values by Türkmen *et al.* (1999), Erdogan *et al.* (2002), Sasi and Balik (2003), Balik *et al.* (2004), Sen *et al.* (2005, 2007) and close to Kara and Solak (2004). The values can also be affected from geographic location, environmental conditions and feeding (Cetinkaya *et al.*, 2005). Munro's Index ( $\phi'$ ) was similar to Sen *et al.* (2005, 2007).

The condition values in this study were similar to some studies in Turkey (Türkmen *et al.*, 1999; Erdogan *et al.*, 2002; Kara and Solak, 2004) and were lower than Sasi and Balik (2003), Balik *et al.* (2004), Sen *et al.* (2005), Koc *et al.* (2006). Variations in condition coefficients may change within same species, age, season, sexual maturity, spawning season, feeding condition and environment (Cetinkaya *et al.*, 2005).

The sex ratio in the majority of fish species is close to 1:1, but, it may vary from species to species, population to population and year after year within the same species (Nikolsky, 1963). The males were found to be dominant in this study. Some researcher in Turkey reported the same situation (Erdogan *et al.*, 2002; Balik *et al.*, 2004; Sen *et al.*, 2005), but some of they reported conversely (Kara and Solak, 2004; Sasi, 2004, 2007; Koc *et al.*, 2006).

Sexual maturation age was reported in several studies in Turkey between II-IV age groups (Türkmen *et al.*, 1999; Erdogan *et al.*, 2002; Kara and Solak, 2004; Sasi, 2004, 2007). It was found as III age group in this study.

In this research, it was determined that spawning took place intensively from second half of May to second half of July. Spawning period of chub was reported between May and July in the study in East Anatolian (Türkmen *et al.*, 1999; Erdogan *et al.*, 2002; Sen *et al.*, 2007) and between March and May in the researches in West Anatolian (Sasi, 2004; Koc *et al.*, 2006). This situation is normal, because, in the west of Anatolian waters are warmed earlier than eastern.

As a result, in order to maintain the population in equilibrium, to give a chance for reproduction each fish at least one has great importance. Therefore, it may be suggested that fishing should be forbidden between 1 April and 15 July and minimum catching size must be IV age, 18 cm fork length and total weight 70 g.

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