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Some growth parameters of *Chondrostoma regium* (Heckel, 1843) inhabiting Karasu River (East Anatolia, Turkey)

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Abstract

The present study was carried out in order to determine age and some growth parameters of brond snout (Chondrostoma regium (Heckel, 1843)) caught in 14 different stations from Karasu River (East Anatolia, Turkey). For this purpose, a total of 236 fish specimen (124 females and 112 males) of C. regium were captured between 2014 and 2016 by electroshocker. Total length and weight of C. regium ranged from 11.0 to 33.0 cm, 33.0 to 324.0 g, respectively. Female:male ratio was estimated as 1:0.903 and the age groups of C. regium were 1-7. The parameters of von Bertalanffy growth parameter estimated as $L_t=40.17[1-e^{-0.154(t+2.14)}]$; $Wt=495.009[1-e^{-0.154(t+2.14)}]^{2.50}$ *for combined sexes and the growth performance index (Φ') value was calculated as 2.395. The length and weight relationships were as follows:* $W=0.0503L^{2.50}$ ($R^2 = 0.97$; *confidence intervals of b=2.41-2.70; p<0.001). The growth type was negative allometric.*

Keywords: *Age, von Bertalanffy growth parameters, brond snout, Karasu River, Turkey.*

Karasu Nehri'nde (Doğu Anadolu, Türkiye) yaşayan *Chondrostoma regium* (Heckel, 1843)'un bazı büyüme parametreleri

Özet

Bu çalışma, Karasu Nehri'nin 14 farklı istasyonunda yaşayan kababurun (Chondrostoma regium (Heckel, 1843))'un yaş tayini ve bazı büyüme özelliklerinin

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araştırılması ile ilgilidir. Bu amaçla, 2014 ve 2016 yılları arasında elektroşokerle toplam 236 C. regium balık örneği (124 dişi ve 112 erkek) yakalandı. Örneklenen C. regium bireylerinin total boy ve ağırlığı sırasıyla 11,0-33,0 cm ile 33,0-324,0 g arasında değiştiği görülmüştür. İncelenen bireylerin yaşlarının 1-7 arasında değiştiği görülmüş ve dişi:erkek oranı 1:0.903 olarak belirlenmiştir. von Bertalanffy büyüme parametreleri tüm bireyler için $Lt=40,17[1-e^{-0,154(t+2,14)}]$; $Wt=495,009[1-e^{-0,154(t+2,14)}]^{2,50}$ *ve büyüme performans indeks değeri (Φ') ise 2,395 olarak hesaplanmıştır. İncelenen populasyon için boy-ağırlık ilişkileri ise* $W=0,0503L^{2,50}$ (R^2 *= 0,97; b'nin güven aralıkları=2,41-2,70;* $p<0,001$) *şeklinde bulunmuştur. Bu değerlere göre, C. regium'un büyüme tipinin negatif allometrik özellik gösterdiği görülmüştür.*

Anahtar Kelimeler: *Yaş, von Bertalanffy büyüme parametreleri, kaba-burun, Karasu Nehri, Türkiye.*

1. Introduction

Cyprinidae is the largest of fish family in Turkey. *Chondrostoma regium* is widely distributed in Tigris-Euphrates basin and the Mediterranean basin of southeastern Turkey It is commonly known as "kababurun" in Turkey. It is a benthopelagic species inhabiting both lentic and lotic environment [1-2]. Although this species has not economical value as commercial fish, it is consumed as food by local people [2]. Some study conducted on the *C. regium* e.g. some population dynamical parameters (age, growth, length-weight and length-length relationships) and changes of in blood cells [2-8].

Age and growth studies are important for problems associated with management of fisheries [9]. It forms the basis for calculations leading to a knowledge of the growth, mortality, recruitment and other fundamental parameters of their populations. The age and growth of fish populations is important for the future preservation of stocks. Thus knowledge of biological characteristics is critically important in understanding, the future of the species due to environmental changes. In this study basic biological characteristics (age, growth, length-weight relationship) of *C. regium* are determined in Karasu River (14 different stations, Erzincan-Erzurum).

2. Material and methods

The study area, which is in the tributary of Karasu River (Yeşildağ Stream (40º08'13"N 41º25'49"E), Yeşildere Stream (40º08'21"N 41º24'25"E), Köşk Stream (40º05'45"N 41º24'48"E), Ağasuyu Stream (39º59'35'N 41º08'56"E), Sincan Stream (39º59'40"N 41º07'21"E), Çiğdemli Stream (39º58'18"N 41º01'23"E), Han Stream (39º56'53"N 40º46'08"E), Taşağıl Stream (39º57'44"N 40º34'40"E), Karataş Stream (39º56'13"N 40º07'51"E), Büyükgözenin Stream (39º56'39"N 40º15'03"E), Deliçay Stream (39º38'08"N 39º20'18"E), Karnı Stream (39º40'24"N 39º13'34"E), Eriç Stream (39º30'36"N 38º53'14"E), Kırık Stream (39º29'23"N 38º44'37"E) in the East Anatolia region of Turkey (Figure 1). A total of 236 specimens were caught between 2014 and 2016 by electroshocker. Sampled specimens were transported to the laboratory in fixed with 5% formaldehyde. Total length (TL, in cm) and weighted (W, in g) were measured

and sexes were determined with macroscopic care of gonads; Female/male ratios were checked by chi-square test according to 1:1 difference.

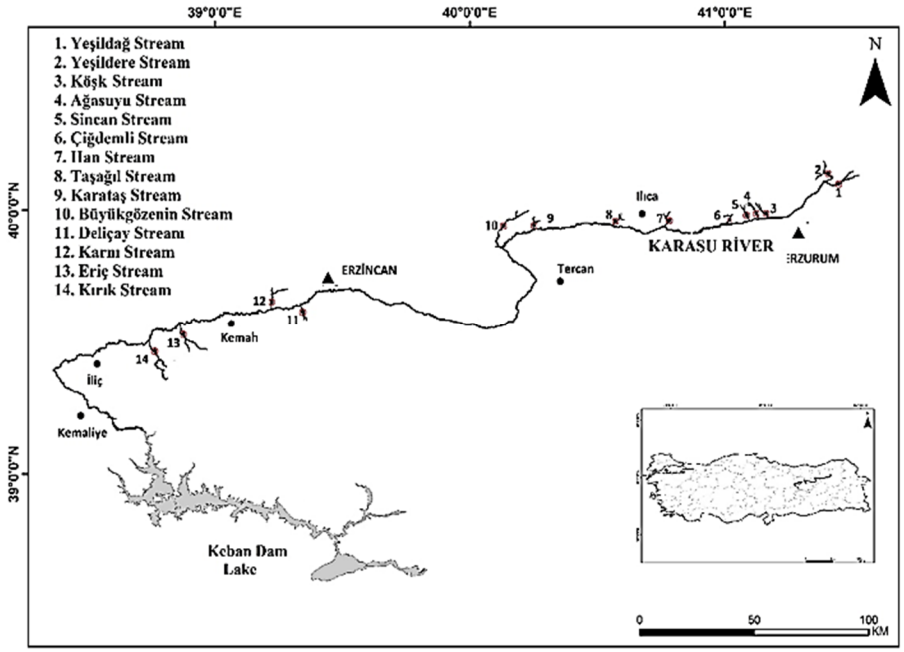

Figure 1. Stations where fish samples are taken from Karasu River.

The scales of fish species were used for age determination. Scale preparation for ageing was done according to method of Chugunova [10]. Age was read under a stereoscopic zoom microscope (OLYMPUS BX53). Each scale was read least two times by independent readers. The index of the average percentage error (IAPE) was assessed to utilize the accuracy of the age designates between readers. The equation is expressed as follows:

$$IAPE(\%) = \frac{100}{N}\sum_{i=1}^{N}\left[\frac{1}{R}\sum_{j=1}^{R}\frac{\left|X_{ij} - X_i\right|}{X_i}\right] \quad (1)$$

where N is the number of fish aged, *R* is the number of times each fish was aged, *xij* is the *ith* age determination of the *jth* fish, and *xj* is the mean age calculated for the *jth* fish [11].

The von Bertalanffy growth function (VBGF) was calculated with as;

$$L_t = L_\infty\,[1\text{-}e^{-k(t\text{-}to)}], \quad (2)$$

where L_t is the expected total length at age t years, L_∞ is the asymptotic average maximum total length, k is the growth coefficient, and t_0 is the theoretical age at zero length [12].

The growth performance index was calculated with as;

$$\Phi' = log_{10}(k) + 2log_{10}(L_\infty), \quad (3)$$

where k and L_∞ are the von Bertalanffy parameters [13].

Total length-weight relationships were determined using the equation:

$$W = a\ L^b, \quad (4)$$

where W is weight (W), L is total length (TL), a is the intercept, and b is the slope. The degree of association between the variables was calculated by the assess index, R^2 [14]. All data were formed with statistical analyses using the Excel 2013 and IBM SPSS package version 24 for Windows.

3. Results

The total length and weight of sampled specimens ranged from 11.0-33.0 cm to 33.0-324.0 g, respectively (Figure 2). The min, max and mean total length (cm), weight (gr) with standard error (SE) for female, male of the age groups of *C. regium* are given in Table 1. The ages of the captured specimens ranged from 1 to 7 years and Figure 3 showed the age determination by scale reading of *C. regium*. The 2rd group was dominant (Figure 4), 52.53% for female and 47.47% for male. The sex ratio (females/males) was 1:0.903; chi-square test showed that significantly different from the theoretical 1:1 ratio ($P < 0.05$).

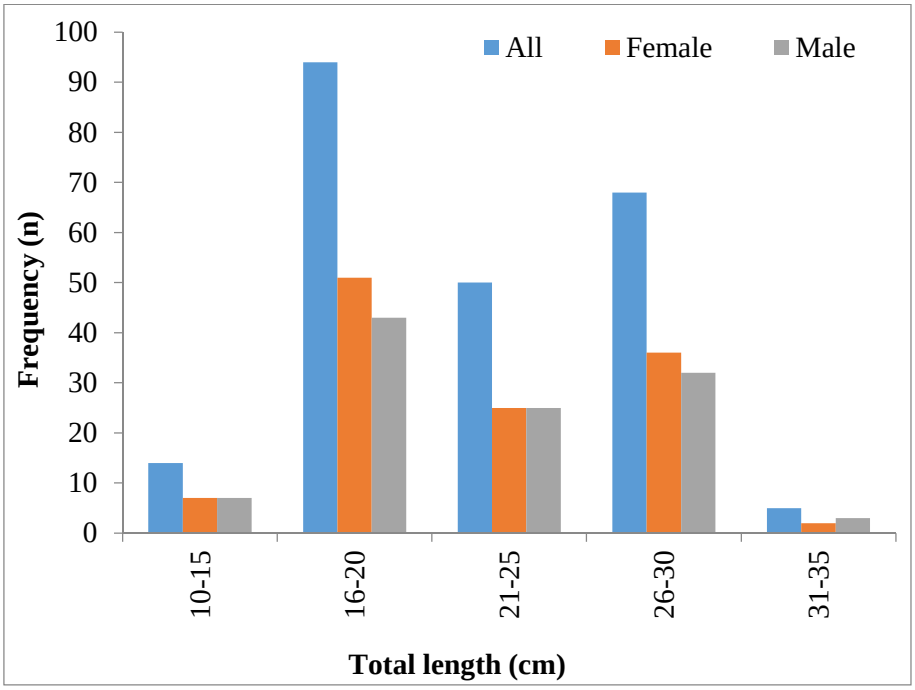

Figure 2. Total length-frequency analysis for *Chondrostoma regium* from Karasu River.

Table 1. Min, max and with standard error (SE) in TL (cm) and W (g) for female and male in each age groups of *Chondrostoma regium* from Karasu River.

Age	Sex	N	%N	TL±SE	TL(Min-Max)	W±SE	W (Min-Max)
1	♀	16	6.77	14.94±0.37	11.0-16.2	46.62±1.55	33.0-55.0
	♂	15	6.35	14.98±0.31	12.5-16.0	46.79±1.47	35.0-57.1
2	♀	47	19.91	17.99±0.20	16.9-21.9	67.11±3.14	50.0-129.1
	♂	40	6.9	18.21±0.21	16.9-21.5	71.85±3.16	46.3-128.4
3	♀	11	4.66	22.32±0.16	21.9-23.0	121.3±1.74	116.0-129.1
	♂	9	3.81	22.28±0.17	22.0-23.4	118.8±2.10	114.0-132.4
4	♀	5	2.12	24.14±0.12	24.0-24.7	132.4±3.16	128.0-145.8
	♂	5	2.12	24.24±0.18	23.8-24.9	136.5±4.11	127.3-148.9
5	♀	25	10.6	26.16±0.15	24.9-27.0	179.4±7.41	148.7-202.0
	♂	28	11.9	26.12±0.14	25.0-27.3	177.0±3.23	148.0-204.0
6	♀	17	7.20	28.56±0.21	27.2-30.0	224.2±4.95	189.0-268.0
	♂	12	5.08	28.65±0.21	27.8-30.0	228.0±4.85	205.0-254.0
7	♀	3	1.27	31.3±0.26	30.9-32.0	286.0±6.69	280.0-289.0
	♂	3	1.27	31.6±0.51	31.0-33.0	288.1±13.2	266.8-324.0
All groups	♀	12	52.5	21.67±0.47	11.0-32.0	121.9±6.52	33.0-298.0
	♂	4	47.5	21.84±0.47	12.5-33.0	124.1±6.61	35.0-324.0

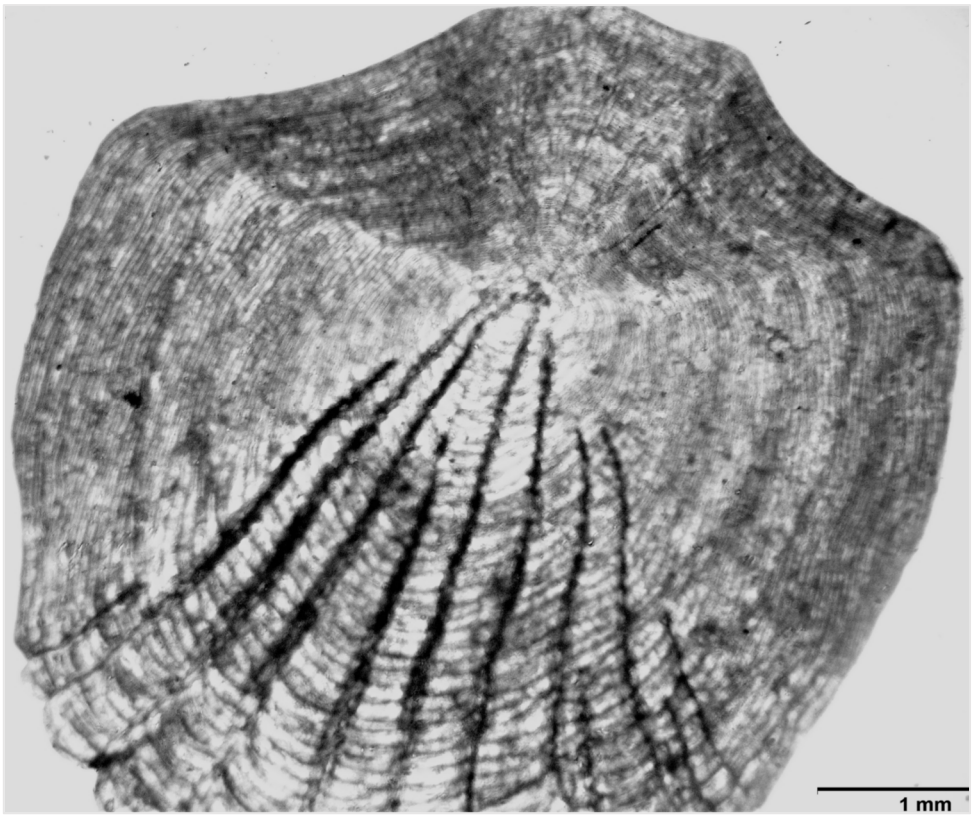

Figure 3. Appearance of age rings on scale of *Chondrostoma regium* from Karasu River.

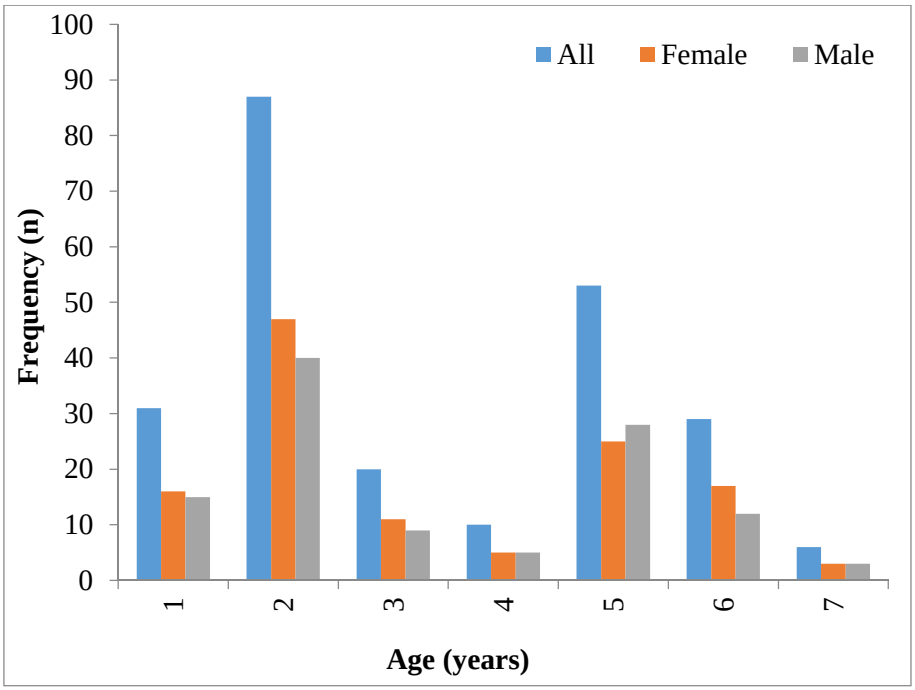

Figure 4. Age-frequency analysis for *Chondrostoma regium* from Karasu River.

According to the age estimations (IAPE), the index of the mean percentage error was found 8.21 by two independent readers. This means that the confidence interval for the reliability of estimations made are within 5 to 15%, indicating that our aging method represents a precision approach to the age determination [15]. The parameters of von Bertalanffy growth fitted to the mean observed total lengths-at-age for each species separately and estimated as $L_t=40.34[1-e^{-0.152(t+2.13)}]$ for female, $L_t=40.69[1-e^{-0.150(t+2.21)}]$ for male and $L_t=40.17[1-e^{-0.154(t+2.14)}]$ for combined sexes (Figure 5). The parameters of von Bertalanffy growth fitted to the mean observed weights-at-age for each species separately and estimated as $Wt=467.459[1-e^{-0.152(t+2.13)}]^{2.49}$ for female, $Wt=534.858[1-e^{-0.150(t+2.21)}]^{2.50}$ for male and $Wt=495.009[1-e^{-0.154(t+2.14)}]^{2.50}$ for combined sexes (Figure 6). The growth performance index (Φ') value was determined as 2.393 for female, 2.395 for male and 2.395 for combined sexes (Table 2).

Table 2. The parameters of the length-weight relationship and von Bertalanffy growth equation and growth performance index values for *Chondrostoma regium* from Karasu River.

		Growth parameters			**Age-length parameters**				
Sex	**N**	**a**	**b**	**R^2**	**L_∞ *(cm)***	**W_∞ *(g)***	**k (year^{-1})**	**to (year)**	**Φ'**
♀	124	0.0501	2.49	0.97	40.34	467.45	0.152	-2.13	2.393
♂	112	0.0506	2.50	0.96	40.69	534.85	0.150	-2.21	2.395
♀+♂	236	0.0503	2.50	0.97	40.17	495.00	0.154	-2.14	2.395

N, sample size; L_∞, asymptotic length; W_∞, asymptotic weight; t_0, theoretical age; k, body growth coefficient; Φ', growth performance index

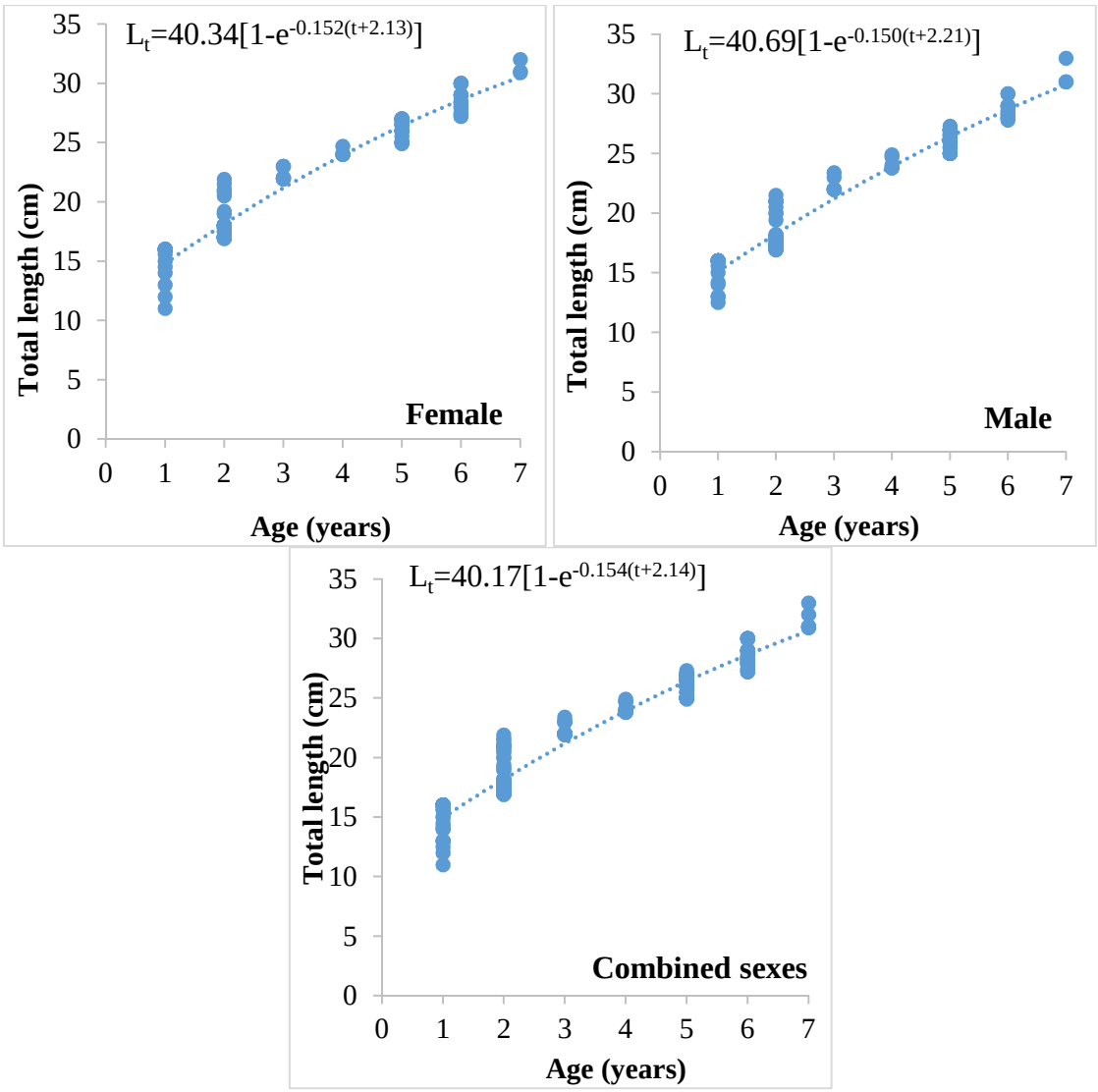

Figure 5. Age- total length relationship due to age groups for female, male and combined sexes of *Chondrostoma regium* from Karasu River.

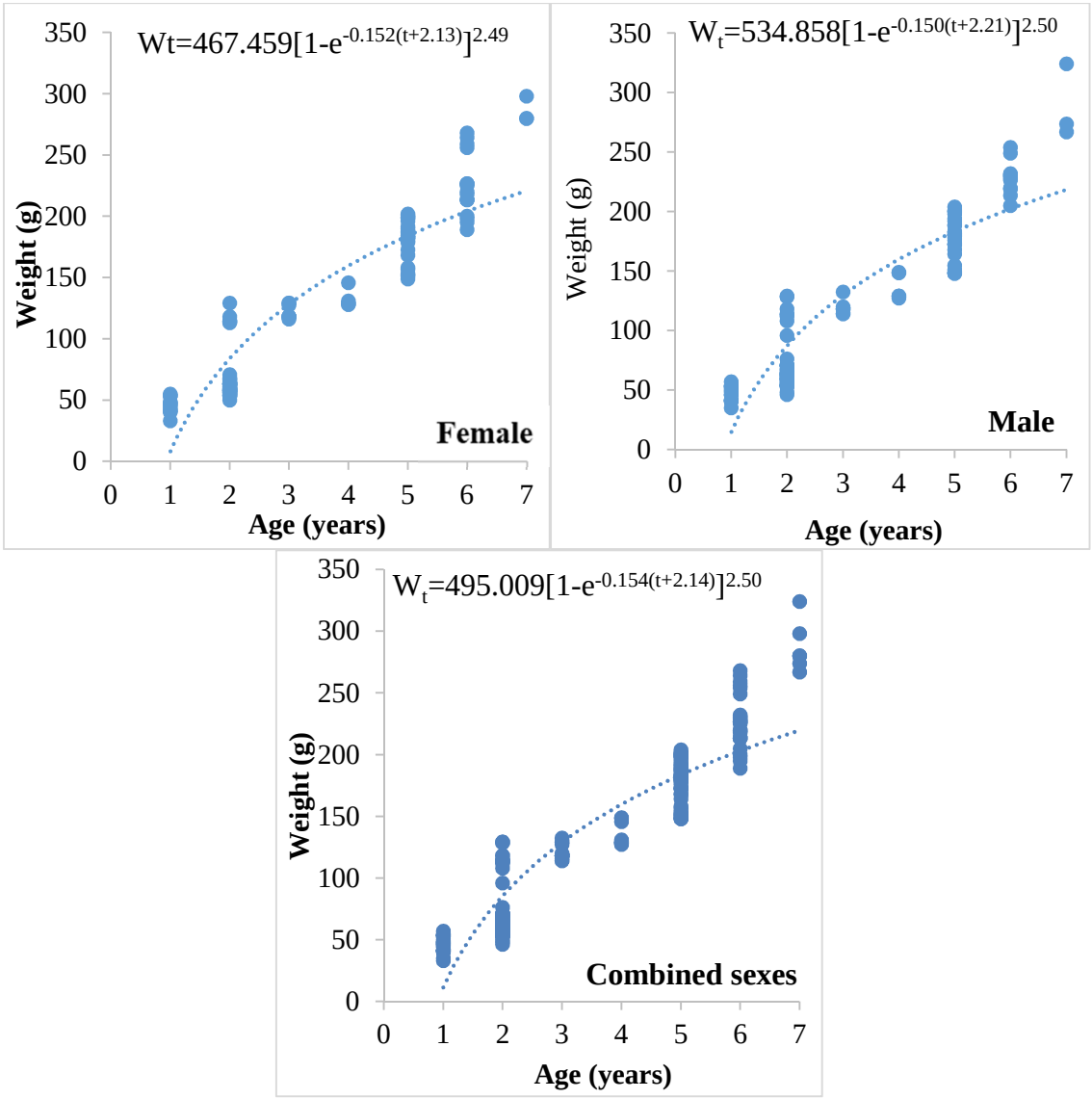

Figure 6. Age- weight relationship due to age groups for female, male and combined sexes of *Chondrostoma regium* from Karasu River.

The LWRs was expressed as $W= 0.0501L^{2.49}$ ($R^2 = 0.97$; confidence intervals of b=2.52-2.64; p<0.001) for females, $W= 0.0506L^{2.50}$ ($R^2 = 0.96$; confidence intervals of b=2.48-2.67; p<0.001) for males and $W= 0.0503L^{2.50}$ ($R^2 = 0.97$; confidence intervals of b=2.41-2.70; p<0.001) for combined sexes (Figure 7). According to these values, the growth type of *C. regium* was negative allometric growth.

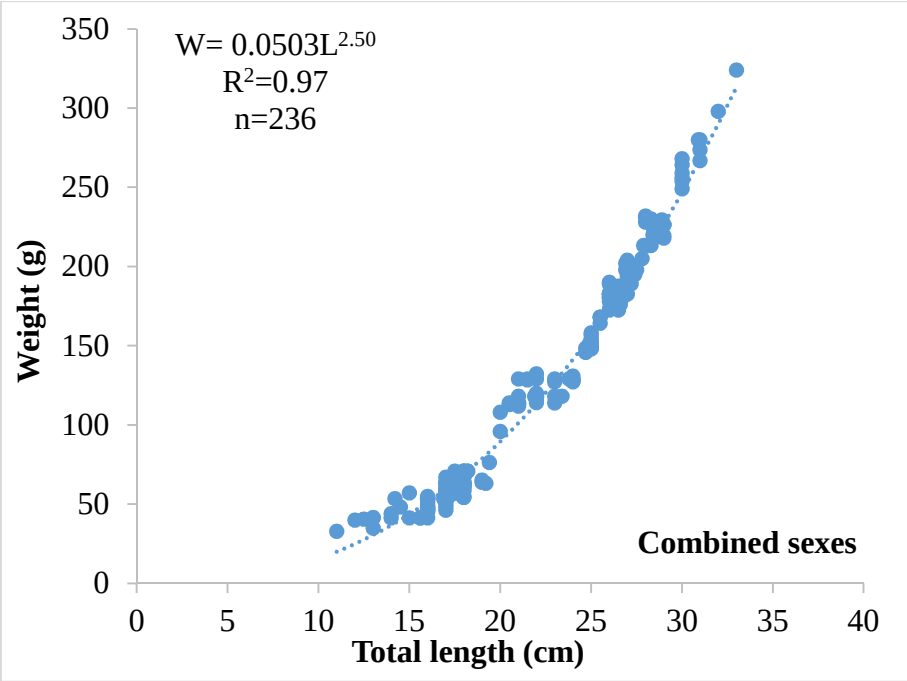

Figure 7. Length-weight relationships for *Chondrostoma regium* from Karasu River.

4. Discussion

In this study, the total length and weight of sampled specimens ranged from 11.0-33.0 cm to 33.0-324.0 g, respectively. Length and weight ranges of *C. regium* was reported as 13.7-28.1 cm and 19-240 g in Almus Dam Lake [2], 13.0-30.5 cm and 23-385 g in Ataturk Reservoir [4], 14.29-24.50 cm, 33.40-128.00 g in Seyhan River [6], 5.5-21.5 cm and 1.43-90.53 g in Bibi-Sayyedan River of Semirom (16). The variations in the length and weight compositions can be attributed to differences in sampling time and method, sample size, type of length measured, and the ecological properties of studied areas [2].

The age of *C. regium* was ranged from 1 to 7. The age composition in previous studies were as follows: Almus Dam Lake 1-6 [2], Lake Ladik 2-5 [7] and Bibi-Sayyedan River of Semirom 0-5 [16] (Table 3). Age group 2 was the dominant age group for *C. regium* from Karasu River. Age distributions give information about important population parameters (death, reproduction and development). Population parameters of same fish species change due to habitat variations, water quality, and nutrients [17].

Table 3. Population characteristics of *Chondrostoma regium* in the previous studies.

Habitat	Sex	n	a	b	R^2	L_∞	k	t_o	Φ'	Author
Almus Dam Lake	♀	194	0.0036	3.316	0.99	33.50	0.22	-2.36	2.391	[2]
	♂	128	0.0038	3.269	0.98	27.50	0.39	-1.45	2.477	
	♀+♂	359	0.0039	3.281	0.98	32.8	0.24	-1.57	2.40	
Atatürk Dam Lake*	♀	422	3.8432	3.197	0.92	35.01	0.168	-2.75	2.221	[4]
	♂	303	2.3922	3.278	0.94	38.67	0.136	-3.07	2.400	
	♀+♂	725	3.0067	3.240	0.93	34.81	0.169	-2.95	2.311	
Sır Dam Lake*	♀	252	0.0082	3.109	0.840	31.89	0.178	-3.44	2.55	[5]
	♂	209	0.0115	2.989	0.817	38.13	0.117	-4.03	2.23	
Seyhan Dam Lake	♀+♂	164	0.0327	2.64	0.93	28.06	0.25	-1.86	2.29	[6]
Lake Ladik*	♀	127	0.0035	3.36	0.97	-	-	-	-	[7]
	♂	37	0.0056	3.17	0.93	-	-	-	-	
	♀+♂	164	0.0029	3.41	0.97	28.15	0.30	-1.23	2.380	
Bibi-Sayyedan River of	♀	320	0.0070	3.08	0.98	23.85	0.19	-0.53	2.230	[16]
	♂	138	0.0070	3.09	0.98	18.97	0.28	-0.58	2.350	
	♀+♂	471	0.0070	3.07	0.98	-	-	-	-	
Zayandehrud River*	♀	134	0.023	2.768	0.93	24.6	0.206	-0.03	2.12	[18]
	♂	78	0.012	2.993	0.96	25.3	0.206	-0.17	2.09	
Keban Dam Lake	♀	164	0.0154	2.84	0.89	36.40	0.23	-2.01	2.483	[19]
	♂	130	0.0156	2.83	0.86	35.49	0.26	-1.74	2.515	
	♀+♂	294	0.0145	2.86	0.88	35.46	0.26	-1.73	2.515	
Zayandeh River**	♀+♂	54	0.0090	3.21	0.97	30.30	0.110	-0.34	-	[20]
Beheshtabad River	♀	185	0.0089	3.045	0.96	31	0.266	-0.24	2.18	[21]
	♂	145	0.0082	3.109	0.85	26	0.148	-0.42	3.84	
Karasu River (Erzurum-	♀	124	0.0501	2.49	0.97	40.34	0.152	-2.13	2.393	This study
	♂	112	0.0506	2.50	0.96	40.69	0.150	-2.21	2.395	
	♀+♂	236	0.0503	2.50	0.97	40.17	0.154	-2.14	2.395	

*fork length; **standard length

Asymptotic length of males was higher than that of females (L_∞ = 40.69 and 40.34) however there was no statistically significant differences. The reason for this is that males grow faster than females and live longer [22]. While the maximum L_∞ value 38.67 cm in Atatürk Dam Lake [4] and the minimum L_∞ values 18.97 cm in Bibi-Sayyedan River of Semirom [16] for *C. regium.* This may be associated with the variation in growth differences between females and males [23]. Population parameters (*a, b,* R^2, L_∞, *k,* t_o, *Φ'*) for all analysed material given in this paper were compared with the results of the other authors for *C. regium* (Table 3). Some species, most of them short-lived, have a high value of k [24]. In this study, generally k values were less than the same values observed other studies (Table 3). These differences may be due to the size of the largest individuals sampled from different areas. The Φ' values of present study are not significantly different from other studies (Table 3) ($p>0.05$).

The length-weight relationships (LWRs) exponent b values provide useful information on fish growth. It shows isometric growth when b=3, while it indicates positive allometry when b>3, and negative allometry when b<3. Positive or negative allometry indicates a rounder or slimmer body, respectively, whereas isometric growth shows that the body grows in the same proportion in all dimension. In this study, the b values of

combined sexes were determined as 2.50 for *C. regium* in Karasu River. The growth of *C. regium* was negative allometric growth. The LWRs were highly significant; all species were determined between length and weight very strong positive relationship in Karasu River (R^2>0.96). These high values of R^2 show that the length relationships are linear observed range of values. Regression analyses are shown that fish length have high significant correlation with weight (P <0.001). Furthermore, when the t-test results were analysed for the significance of regression coefficients (P <0.01).

This work gives the first information some growth parameters of *C. regium* from Karasu River. Fisheries managers should consider creation of freshwater protected areas with regional fisheries organizations. Further investigations are necessary to compare age and growth rates of four species from different areas.

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