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AYHAN YILDIRIM

HALİL İBRAHİM HALİLOĞLU

MUSTAFA TÜRKMEN

ORHAN ERDOĞAN

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Age and Growth Characteristics of *Chalcalburnus mossulensis* (Heckel, 1843) Living in Karasu River (Erzurum-Turkey)

Ayhan YILDIRIM

Department of Fisheries, İspir Hamza Polat Vocational School, Atatürk University, İspir, Erzurum - TURKEY
ayhanyildirim@yahoo.com

Halil İbrahim HALILOĞLU

Department of Fisheries, Faculty of Agriculture, Atatürk University, Erzurum - TURKEY

Mustafa TÜRKMEN

Faculty of Fisheries, Mustafa Kemal University, İskenderun, Hatay - TURKEY
E-mail: mturkmen65@hotmail.com

Orhan ERDOĞAN

Department of Fisheries, Faculty of Agriculture, Atatürk University, Erzurum - TURKEY

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Abstract: The relationship of age, growth and length-weight was analyzed for *Chalcalburnus mossulensis* from the Aşkale region of Karasu River from November 1995 to October 1997. Fish in the sample groups were between 1 and 7 years and the ratio of males to females was 1:1.08. Von Bertalanffy equations were used to find the growth in length for both sexes. The growth parameters for males and females were estimated to be $L_{\infty} = 19.88869$ cm, $K = 0.1867795$ and $t_0 = -2.3$ and $L_{\infty} = 21.8742$ cm, $K = 0.168014$ and $t_0 = -2.1$, respectively. We also found that the length-weight relationships were $a = 0.0129$ and $b = 2.913$ for males and $a = 0.073$ and $b = 3.136$ for females

Key Words: *Chalcalburnus mossulensis*, age, growth, von Bertalanffy, length-weight relationship, Karasu River, Turkey.

Karasu Irmağında (Erzurum-Türkiye) Yaşayan *Chalcalburnus mossulensis* (Heckel, 1843)'in Yaş ve Büyüme Özellikleri

Özet: Karasu nehrinden (Aşkale bölgesi) Kasım 1995 ile Ekim 1997 tarihleri arasında yakalanan *Chalcalburnus mossulensis*'in yaş, büyüme ve boy-ağırlık ilişkisi araştırıldı. Toplanan örneklerde yaş dağılımının 1-7 arasında değiştiği ve erkek:dişi oranının 1:1,08 olduğu tespit edildi. Boyca büyüme her iki cinsiyet için von Bertalanffy denklemi ile ifade edildi. Büyüme parametreleri dişilerde; $L_{\infty} = 19,88869$ cm, $K = 0,1867795$, $t_0 = -2,3$, erkeklerde $L_{\infty} = 21,8742$ cm, $K = 0,168014$, $t_0 = -2,1$ olarak tespit edildi. Boy-ağırlık ilişkisi erkeklerde $a = 0,0129$, $b = 2,913$ ve dişilerde $a = 0,073$, $b = 3,136$ olarak tespit edildi.

Anahtar Sözcükler: *Chalcalburnus mossulensis*, yaş, büyüme, von Bertalanffy, boy-ağırlık ilişkisi, Karasu Nehri, Türkiye

Introduction

The genus *Chalcalburnus* is widely distributed in southern Iran, Lake Van and the Aral and Black Sea basins. Four species, *Chalcalburnus mossulensis*, *Chalcalburnus tarichi*, *Chalcalburnus chalcoides*, and *Chalcalburnus sellal*, have been recorded in the inland waters of Turkey (1). *Ch. mossulensis* is widely found in Karasu River, the upper parts of the Euphrates (Firat)

River in the east and southeast of Turkey (2). Although the information about their taxonomic and systematic features have been researched (2-4), there is very limited information available about their life histories (5-7).

The purpose of this study was to investigate the age, growth and the length-weight relationship of *Chalcalburnus mossulensis* collected from the Karasu River.

Study area

The study area, which is in the upper parts of the Karasu River in the East Anatolia region of Turkey, is about 15 km long, 10-30 m wide and 50-220 cm deep (39°56'16"N, 40°45'33"E) (Fig. 1). During this study, air and water temperatures varied from -25 to +29 °C and from -1.5 to +27 °C, respectively. The Karasu River starts to freeze in the middle of December and becomes ice-free by early March.

Materials and Methods

In this study, we analyzed 850 individuals of *Ch. mossulensis* obtained monthly by cast nets (12-24 mm in mesh size) from November 1995 to October 1997. The fork lengths (L) and total weights (W) of each sample were recorded to the nearest 1 mm and 0.01 g, respectively. The scales used for the age determination were taken from the back of the dorsal fin, above the lateral line. The first formation of annulus of the newborn fish started on the outer edge of the scale in February of the year following birth, i.e., in the 9th/10th month of its first year of life. The annulus was almost completed by April and fully completed by the end of May, i.e., the 12th month. Thus, this species up to its

9th/10th month is considered to belong to the 0 age group. From the 10th month up to the 21st month, when the second year-ring starts its formation on the outer edge of the scale, it is considered to belong to age group 1 and so on (Table 1). The relative ages recorded by Chugunova (8) are in agreement with this. Williams and Bedford (9) also consider fish of 0-9 months as belonging to age group 0, of 10-22 months to age group 1, of 22-34 months to age group 2 and so on. The relation of weight to length was calculated by applying the exponential regression equation, $W = aL^b$, where W is the total weight (g), L is the fork length (cm), and a and b are parameters to be estimated (10). The von Bertalanffy growth curve was fitted to the observed length at age data of resulting age-length key by means of Marquard's algorithm for non-linear least-squares parameter estimation. The form of the growth curve is $L_t = L_{\infty}(1 - e^{-K(t-t_0)})$, where L_{∞} is the average asymptotic length, K is the growth coefficient that determines how fast the fish approaches L_{∞} , and t_0 is the hypothetical age for $L_t = 0$. As the selectivity of the gear could not be corrected and since the lengths-at-ages may have biases for the first ages represented in the catch, first age groups were optionally removed from the sample (11,12). The statistical calculations used in our analyses were obtained from Düzgüneş et al. (13).

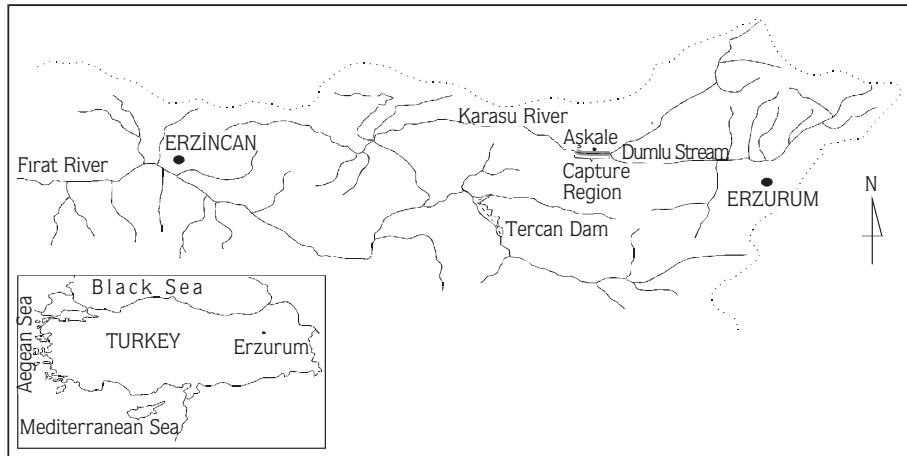


Figure 1. Map of the capture region.

Table 1. Correspondence between age groups, real age and numbers of rings in the scale of *Ch. mossulensis*.

Age groups	1	2	3	4	5	6
Months old	10-21	22-33	34-45	46-57	58-69	70-81
Year-rings	1	2	3	4	5	6

Results

Age

The ages of the fish ranged from 1 to 7 years (Table 2). Since the mesh size was large (12-24 mm), the 0 age

group fish was not represented in the samples. In this study, 409 males and 441 females (850 in total) were examined. The overall ratio of males to females was found to be 1:1.08 and χ^2 analysis showed that this was not significant ($\chi^2 = 1.205 < \chi^2_{1,0.05} = 3.84$). The males

Table 2. Age-length key based on scale readings of *Ch. mossulensis* from the Karasu River for males, females and for both combined.

Size (cm)	Age Groups (year)							Total
	1	2	3	4	5	6	7	
Male								
5	1							1
6	1							1
7	0							0
8	2							2
9	6							6
10	9	8	4					21
11	1	38	17					56
12		36	67					103
13		1	90	3				94
14			56	10				66
15			22	12	2			36
16			2	10	2			14
17				1	4	2		7
18					1	1		2
N	20	83	258	36	9	3		409
$\bar{L} \pm SH$ (cm)	9.48 \pm 0.35	11.79 \pm 0.07	13.37 \pm 0.07	15.23 \pm 0.16	16.80 \pm 0.34	17.97 \pm 0.47		
$\bar{W} \pm SH$ (g)	8.73 \pm 0.84	17.04 \pm 0.39	25.27 \pm 0.44	36.30 \pm 1.44	45.84 \pm 3.31	47.70 \pm 15.7		
Female								
5								
6	3							3
7	2							2
8	3							3
9	4							4
10	6	2	1					9
11	2	18	21					41
12		33	59					92
13			88	3				91
14			60	14				74
15			31	28	2			61
16			4	17	7	1		29
17				5	14	3	1	23
18					1	5	2	8
19							1	1
N	20	53	264	67	24	9	4	441
\bar{L} (cm) \pm SH	9.36 \pm 0.36	11.99 \pm 0.08	13.52 \pm 0.07	15.52 \pm 0.11	16.88 \pm 0.16	17.73 \pm 0.25	18.45 \pm 0.38	
\bar{W} (g) \pm SH	8.71 \pm 1.09	17.94 \pm 0.60	26.52 \pm 0.47	39.63 \pm 0.98	52.06 \pm 1.62	63.81 \pm 4.00	71.66 \pm 9.15	
Male+Female								
5	1							1
6	3							3
7	3							3
8	4							4
9	11							11
10	15	10	5					30
11	3	56	38					97
12		69	126					195
13		1	178	6				185
14			116	24				140
15			53	40	4			97
16			6	27	9	1		43
17				6	18	5	1	30
18					2	6	2	10
19							1	1
n	40	136	522	103	33	12	4	850
$\bar{L} \pm SH$ (cm)	9.42 \pm 0.25	11.87 \pm 0.05	13.44 \pm 0.05	15.42 \pm 0.09	16.86 \pm 0.15	17.79 \pm 0.21	18.45 \pm 0.38	
$\bar{W} \pm SH$ (g)	8.72 \pm 0.68	17.39 \pm 0.34	25.90 \pm 0.32	38.47 \pm 0.82	50.39 \pm 1.54	59.28 \pm 5.05	71.66 \pm 6.15	

were more numerous in the younger age groups, while females were present in greater numbers in the other age groups (Table 2).

Growth and von Bertalanffy

In the early life stages, males were longer and heavier than females, but in the later stages females were longer and heavier (Table 2). However, these differences between the individual lengths and weights of males and females at the same ages were not statistically significant (Table 3). The longest and heaviest captured male and female fish were 18.9 cm, 19.5 cm and 67.93 g, 86.50 g, respectively.

Von Bertalanffy growth equations were estimated to be $L_t = 19.588869(1-\exp(-0.1867745(t + 2.3)))$ for males and $L_t = 21.8742(1-\exp(-0.168014)(t + 2.1))$ for females. Females grew to a greater asymptotic length (L_∞) than males, but the rate at which this was achieved

(K) was less than in the males. The relationships between lengths at age data (observed lengths) and von Bertalanffy growth curves (expected lengths) are plotted in Figure 2.

Length-Weight Relationship

The length-weight relationships are calculated and plotted in Figure 3 by using the lengths and weights as follows: $W = 0.0129L^{2.913}$ (n = 409, r = 0.99) for males, and $W = 0.0073L^{3.136}$ (n = 441, r = 0.96) for females, respectively.

Discussion

In this study, a total of 850 specimens of *Ch. mossulensis* from the Karasu River were analyzed from November 1995 to October 1997. The overall male-to-female ratio (M:F) was found to be 1:1.08, not

Table 3. The differences between individual lengths and weights of males and females of *Ch. mossulensis* ($\alpha = 0.05$).

Age	Length \bar{L} (cm)			Weight \bar{W} (g)		
	Male	Female	p value	Male	Female	p value
1	9.48	9.36	0.804438	8.73	8.71	0.989026
2	11.79	11.99	0.59680	17.04	17.94	0.195594
3	13.37	13.52	0.123348	25.27	26.52	0.520060
4	15.23	15.52	0.135606	36.30	39.63	0.053242
5	16.80	16.88	0.804270	45.84	52.09	0.069047
6	17.97	17.73	0.653058	45.70	63.81	0.125030
7	-	18.45	-	-	71.66	-

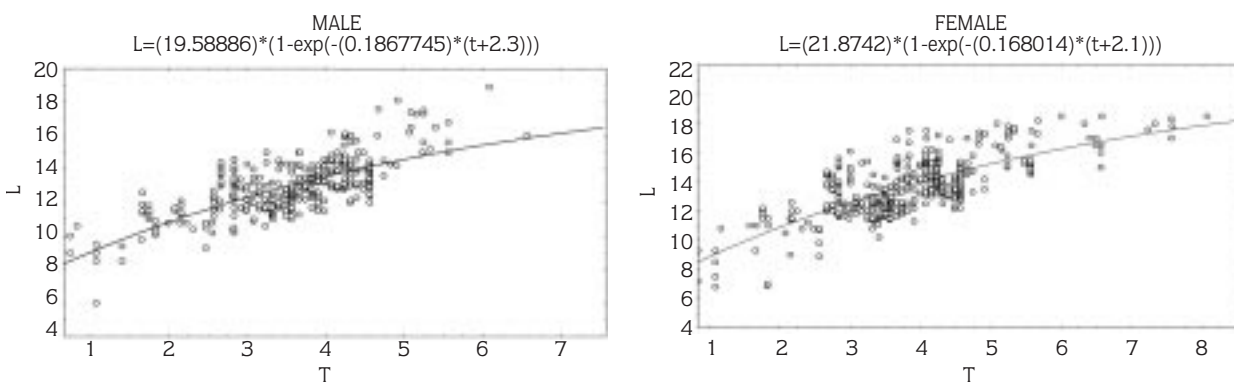


Figure 2. The relationships between lengths at age data (observed lengths) and von Bertalanffy growth curves (expected lengths) for both sexes.

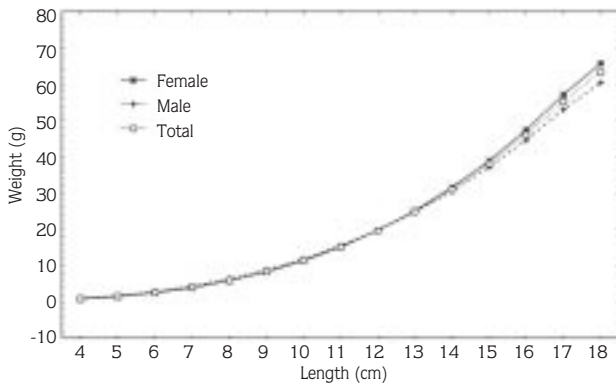


Figure 3. The length-weight relationships of *Ch. mossulensis* from the Karasu River

significantly different from 1:1. It is well known that the sex ratio for most species is close to 1:1, but this may vary from species to species, differing from one population to another of the same species and may vary year to year in the same population (14). In the early life stages, the males were found to be higher in number than the females, but in the later stages this case is reserved

for the females. Some researchers have also reported similar patterns in their studies (5,15,16). Although it has been reported that the ability of freshwater fish to hatch out is generally higher for males than females, in the upper age classes the proportion of males decreases, while females become dominant in a population (14).

The L_{∞} value of females was calculated to be higher than that of males. Türkmen and Akyurt (7) and Elp (17) in their studies pointed out similar situations. The reason for this may be that females grow faster than males and live longer (18). The findings showed that the theoretical maximal length values ($L_{\infty} = 19.58886$ cm for males and 21.8742 mm for females) were close to the size of the largest fish examined and the growth coefficient values ($K = 0.1867745$ year⁻¹ for males and 0.168014 year⁻¹ for females) indicated the relatively low attainment of maximal size. These parameters are similar to those reported by Türkmen and Akyurt (7) (Table 4).

The exponents of length-weight relationships (males: $b = 2.913$ and females: $b = 3.136$) of *Ch. Mossulensis* estimated in the Karasu River showed that growth is

Table 4. Parameters of the length-weight relationship (b) and the von Bertalanffy growth equation (L_{∞} , K , t_0) for different species of the genus *Chalcalburnus* in different areas (*Ch. mossulensis*: *Chalcalburnus mossulensis*, *Ch. tarichi*: *Chalcalburnus tarichi*, *Ch. chalcoides*: *Chalcalburnus chalcoides*).

Author	Species	Study area	Sex	Age (year)	b	L_{∞} (cm)	K (year ⁻¹)	t_0 (year)
Özdemir et al. (6)	<i>Ch. mossulensis</i>	Keban Dam Lake	M	1:2.3	2.04553			
			F		2-5			
Türkmen and Akyurt (7)	<i>Ch. mossulensis</i>	Karasu River	M	1-6	2.828	20.41	0.2485	-1.47
			F		3.082	21.59	0.1914	-2.13
Ergene (11)	<i>Ch. mossulensis</i>	Tercan Dam Lake (Karasu River)	M+F	1-4				
Akyurt and Sarı (15)	<i>Ch. calcoides</i>	Different Habitat	M+F	1-4				
Çetinkaya and Öksüz (16)	<i>Ch. tarichi</i>	Lake Van	M	1-7	2.9861			
			F		(M+F)	2-7		
Elp (17)	<i>Ch. tarichi</i>	Lake Van	M	1:1.8				
			F		1-8			
Akgül (19)	<i>Ch. tarichi</i>	Lake Van	M+F	1:1.3	3.16054			
Şen (20)	<i>Ch. mossulensis</i>	Karakoçan-Kalecik Dam Lake	M	1:8.7	2.885			
			F		1-5			
Present study	<i>Ch. mossulensis</i>	Karasu River	M	1:1.08	2.913	19.88	0.18677	-2.3
			F		3.136	21.87	0.168014	-2.1

allometric. These values were close to those found by Ergene (5), Akyurt and Sarı (15), Çetinkaya and Öksüz (16) and Akgül (19) but were different from those found by Özdemir et al. (6) and Şen (20) for the genus *Chalcalburnus* (Table 4). This variation in the exponents could also be attributed to the different stages of ontogenetic development, as well as to the differences in age, maturity, sex and species. Geographic location and

associated environmental conditions, such as seasonality (date and time of capture), stomach fullness, disease and parasite loads, can also affect the value of b (21,22).

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