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The Growth Features of Tench (*Tinca tinca* L., 1758) in the Kesikköprü Dam Lake

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Abstract: In this study, the growth properties of tench (*Tinca tinca* L., 1758) in the Kesikköprü Dam Lake between April 1995 and March 1996 were studied. In the specimens examined, ages ranged from I-VI in both sexes. The population was 51.43% female and 48.57% male. The fork length and weight in ranged from 16.1 to 41.4 cm and from 85 to 1350 g, respectively, and in males from 15.8 to 40.3 cm and from 83 to 1127 g, respectively. Age-length and age-weight relations were calculated according to the von Bertalanffy growth equation. The following values were obtained for females and males, respectively. The condition factor of *T. tinca* was 1.99 for females, 1.92 for males and 1.95 for both sexes combined.

L_t = 41.76 (1 - e - 0. 2510 (t + 0.9830))
L_t = 36.97 (1 - e - 0.3767 (t + 0.3803))
W_t = 1397.47 (1 - e - 0. 2510 (t + 0.9830)) 3.2470
W_t = 957.91 (1 - e - 0. 3767 (t + 0.3803)) 3.0358

The following logaritmic equations for length-weight relations were found for females and males, respectively.

Log W = - 3.9315 + 3.2470 Log L
Log W = - 2.2294 + 3.0358 Log L

Key Words: Tench, *Tinca tinca*, Growth, Kesikköprü Dam Lake

Kesikköprü Baraj Gölündeki Kadife Balığının (*Tinca tinca* L., 1758) Büyüme Özellikleri

Özet: Nisan 1995 - Mart 1996 tarihleri arasında Kesikköprü Baraj Gölü'nde yapılan bu çalışmada *Tinca tinca* (L., 1758)'in büyüme özellikleri araştırılmıştır. İncelenen örneklerde dişi ve erkek bireylerin I-VI yaşları arasında dağılım gösterdiği tesbit edilmiştir. İncelenen balıkların % 51,43'ü dişi, % 48,57'si erkek bireylerden oluşmaktadır. Çatal boy dişi bireylerde 16,1 - 41,4 cm, ağırlık 85 - 1350 gr, erkek bireylerde 15,8 - 40,3 cm, ağırlık 83 - 1127 gr olarak bulunmuştur. Von Bertalanffy'e göre hesaplanan yaş-boy; yaş-ağırlık ilişkisi denklemleri dişi ve erkek bireyler için sırayla aşağıdaki şekilde hesaplanmıştır. *T. tinca* bireylerinin kondisyon faktörü, dişiler için 1.99, erkekler için 1.92 ve tüm populasyon için 1.95 olarak bulunmuştur.

L_t = 41,76 (1 - e - 0, 2510 (t + 0,9830))
L_t = 36,97 (1 - e - 0,3767 (t + 0,3803))
W_t = 1397,47 (1 - e - 0, 2510 (t + 0,9830)) 3,2470
W_t = 957,91 (1 - e - 0, 3767 (t + 0,3803)) 3,0358

Boy - ağırlık ilişkisi logaritmik olarak, dişi ve erkek bireyler için sırasıyla aşağıdaki şekilde bulunmuştur:

Log W = - 3,9315 + 3,2470 Log L
Log W = - 2,2294 + 3,0358 Log L

Anahtar Sözcükler: Kadife, *Tinca tinca*, Büyüme, Kesikköprü Baraj Gölü.

Introduction

The tench, *T. tinca* (L.), commonly inhabits relatively shallow weedy lakes and slow flowing rivers. *T. tinca* is wide-spread in Europe and is found also in anterior orient and western Siberia (1). In Turkey, these fish live in rivers flowing into the Black Sea from Thrace and Northern Anatolia (1, 2). Although t hey do not have great economical importance, they contribute considerably to the eutrophication process. They live on the floors of still waters or slow flowing waters. In winter, they burrow in the mud at the bottom until spring time and suffer lack of oxygen (2, 3). Since they mix the bottom mud continuously, they play an important role in mineralization (3). In eutrophic lakes, they also prevent the transition of inorganic nutrient salts, nitrogen and

phosphorus accumulated in sediment to the water because they feed on aquatic plants and have low growth rates. Since the 19th century, *T. tinca* has been bred as an important pool fish in Central Europe. In particular, these fish are used in cleaning carp pools and, lately, garden pools (4). Very few scientific studies on *T. tinca* in Turkey have been conducted, notably by Yiğit (5) on the nutrition biology of *T. tinca* in Lake Mogan. In Europe, Cerny (6) has studied growth, Weatherley (7) has studied certain biological features and Lukowicz and Proske (1) have studied aspects of reproduction and breeding. However, in this study, findings were obtained on the structure and growth of the *T. tinca* population in Kesikköprü Dam Lake, about which little scientific data existed previously.

Description of studying area

Kesikköprü Dam Lake, located on the Kızılırmak river 110 km southeast of Ankara (Figure 1), went into operation in 1966 for the purposes of irrigation and energy supply. The lake is freshwater and has a surface area of 8.45 km2 and a maximum depth of 30 m. Economic fish species living there include Cyprinus carpio, Leuciscus cephalus, Capoeta capoeta, Silurus glanis and Chondrostoma nasus. It is estimated that approximately 26 tons of fish are bred annually (9).

Material and Method

One hundred five fish caught between April 1995 and March 1996 at 5 stations at Kesikköprü Dam Lake (Fig 1) were examined. Specimens were caught with fanned and blind nets with mesh sizes ranging from 30 mm to 60 mm. The fork length of each specimen was measured in centimeters (L), body weight (W) was determined and sexual maturity was calculated according to external sexual characteristics and microscopic examination of gonads (A male *Tinca tinca* has pelvic fins approximately two times larger than the female has (1)). The ages of the specimens were calculated according to Lagler (10) by checking the scales. Bertalanffy's growth-model equations (11), which require measurement and weighing procedures to obtain averages of length-weight mathematically, were used to determine age-length and age-weight relationships among the age groups. The equation for age-length relationship:

$L_t = L\bullet (1\text{-}e\text{-}k\ (t\text{-}to))$

The equation for age-weight relationship:

$W_t = W\bullet(1\text{-}e\text{-}k\ (t\text{-}to))b$

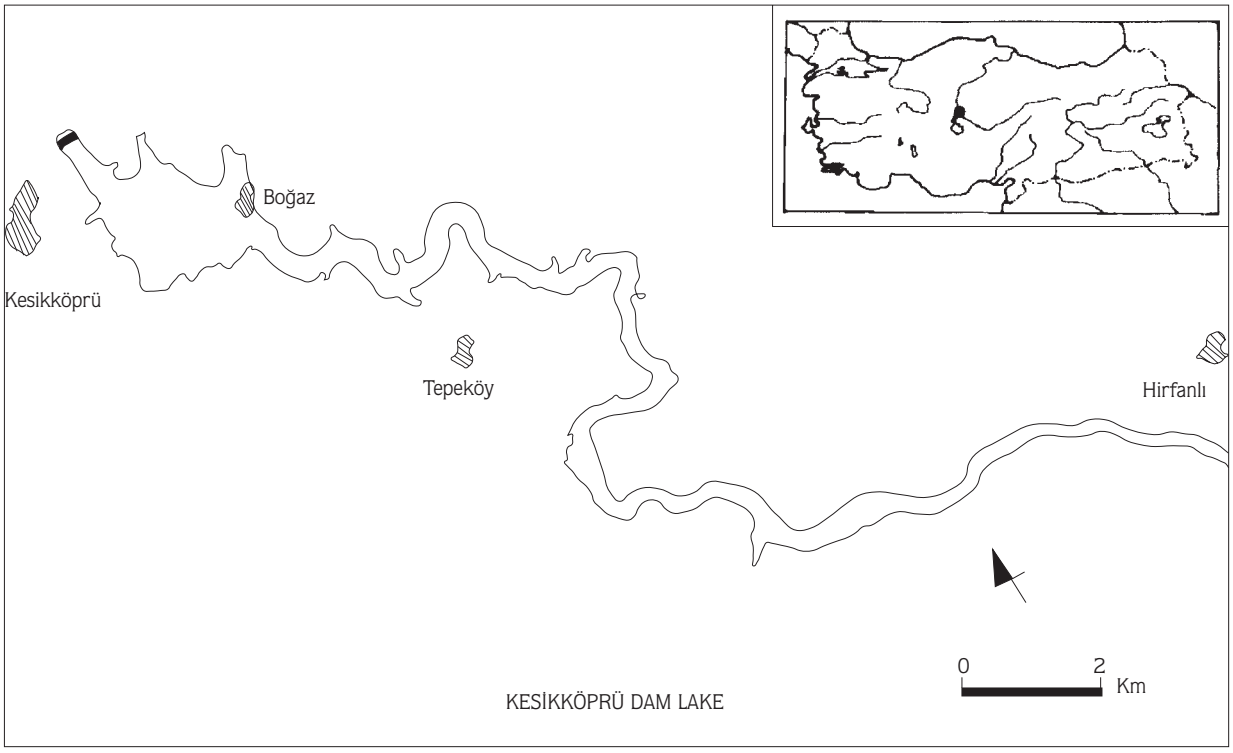

Figure 1. The location of Kesikköprü Dam Lake and sampling sites.

By using the average theoretical length and weight values calculated for each age group, the rational increases in length and weight were determined with the formulas given by Chugunova (12, 13).

$OL=(L_t - L_t - 1) \div L_t - 1$ and $OW=(W_t - W_t - 1) \div W_t-1$

By using the values for fork length (cm) and weight (g) as per individual the length-weight relationship was calculated according to Le Cren's (14) equation:

$W=aLb$

In calculation of condition factor (K), also known as fatness coefficient,

$K=(Wx100) \div L3$

the following equation was used (14):

The importance control of differences between growth and condition factors for the female and male groups within the same age groups and of differences between measured values and theoretical values for length were tested by t - test with e P of 0.05. The difference importance controls between measurement and theoretical length values are made by t-test $P \leq 0.05$.

Results

Population Structure

Aga-group and sex distribution of 105 *T. tinca* caught from Kesikköprü Dam Lake between April 1995 and March 1996, are shown in Table 1. It was determined that 51.43% of the samples were female and 48.57% male. Age variation ranged from groups I to VI, It was determined that fish in group IV were the most common, (28.57%), followed by group V (23.81%). The majority of the specimens (105 each) was made up by age groups IV, V and VI (73.33%).

Length and Weight Composition

Length and weight distributions of the 105 *T. tinca* specimens examined, were as follows: female individuals were 16.1 (I age group) -41.4 cm (VI age group), while male specimens were 15.8 cm (I age group) -40.3 cm (VI age group) in length. Weight varied as follows: females 85 g (I age group) -1350 g (VI age group) and males 83 g (I age group) -1127 g (VI age group).

Growth

Age-Length Relationship

Table 2 illustrates the growth equations for calculation of the theoretical length of an individual at any age by using the age-length relationship growth parameters according to sex. Table 3 shows the theoretical lengths, calculated according to the growth equations of von Bertalanffy, and the average length values, determined by measurements, of females, males and both sexes combined, according to age group. Table 4, shows the annual proportioned growth of sexes, while Figure 2 shows the age-length relationship curves.

Age-Weight Relationship

The growth (age-weight) parameters and equations of *T. tinca* according to Von Bertalanffy for both sexes are shown in Table 5. Theoretically and empirically obtained

Table 1. The age and sex ratio of the tench (*Tinca tinca*) in Kesikköprü Dam Lake.

	Female		Male		Female+Male	
Age	N	%	N	%	N	%
I	2	1.90	1	0.95	3	2.86
II	3	2.86	8	7.62	11	10.48
III	7	6.67	7	6.67	14	13.33
IV	16	15.24	14	13.33	30	28.57
V	16	15.24	9	8.57	25	23.81
VI	10	9.52	12	11.43	22	20.95
Total	54	51.43	51	48.57	105	100.0

Table 2. Calculated von Bertalanffy growth parameters and equations of tench (*Tinca tinca*).

	Growth Parameters			Growth Equations
Sex	L	k	to	
Females	41.76	0.2510	-0.9830	$L_t=41.76\ (1-e^{-0.2510\ (t+0.9830)})$
Males	36.97	0.3767	-0.3767	$L_t=36.97\ (1-e^{-0.3767\ (t+0.9803)})$
Female+Male	57.76	0.1262	-1.6838	$L_t=57.76\ (1-e^{-0.1262\ (t+1.6838)})$

Table 3. The actual and calculated values of fork lengths of *Tinca tinca* according to von Bertalanffy for both sex and age.

AGE		FEMALES			MALES			FEMALES+MALES	
Group	N	Actual lengths L(cm) ± SD (Min-Max)	Calculated L(cm)	N	Actual lengths L(cm) (Min-Max)	Calculated L (cm)	N	Actual lengths L(cm) ± SD (Min-Max)	Calculated L(cm)
I	2	16.40 ± 0.42 (16 - 17)	16.37	1	15.80	14.99	3	16.20 ± 0.46 (15 - 17)	16.98
II	3	22.93 ± 1.83 (20 - 23)	22.01	8	23.23 ± 1.46 (21 - 25)	21.89	11	22.83 ± 1.65 (20 - 25)	22.83
III	7	25.98 ± 2.91 (23 - 29)	26.39	7	26.20 ± 2.10 (23 - 29)	26.62	14	25.67 ± 2.51 (23 - 29)	26.85
IV	16	29.73 ± 2.43 (26 - 34)	29.80	14	28.35 ± 1.62 (25 - 31)	29.87	30	28.94 ± 2.03 (26 - 34)	29.62
V	16	31.41 ± 2.35 (27 - 35)	32.45	9	31.83 ± 1.73 (29 - 34)	32.10	25	31.57 ± 2.04 (27 - 35)	31.52
VI	10	35.14 ± 1.34 (35 - 38)	34.52	12	34.11 ± 2.82 (33 - 40)	33.63	22	36.89 ± 2.08 (33 - 40)	35.67

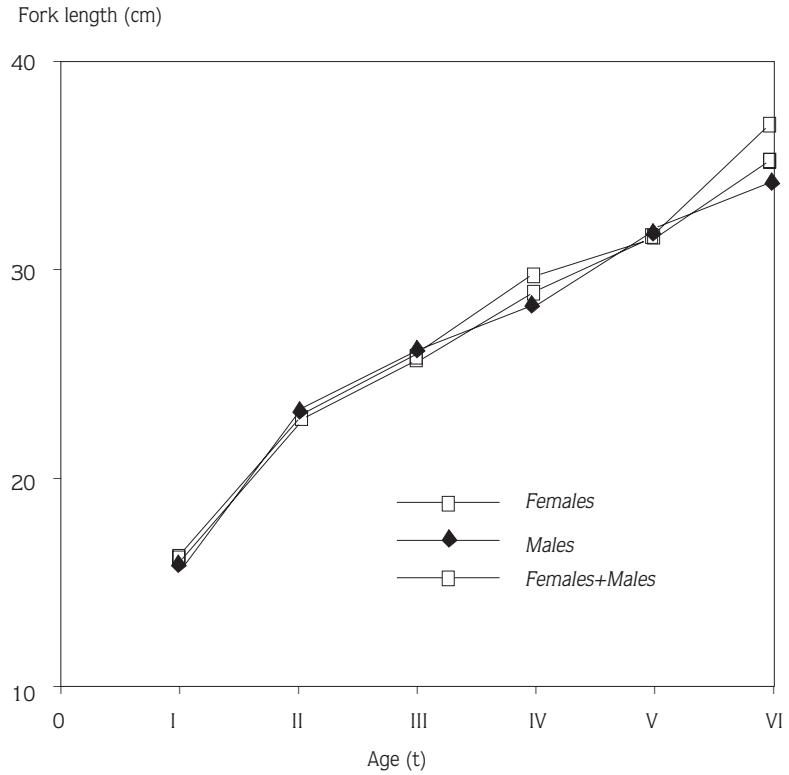

Figure 2. The curves of the age-length relationship of males and females, together and separately, for *Tinca tinca* samples.

weights for females, males and both sexes combined in the different age groups are shown in Table 6. Mean lengths calculated according to Von Bertalanffy and relative annual increases are shown in Table 7. The age-weight relationship of *T. tinca* is plotted in Figure 3.

Length-Weight Relationship

Table 8 shows the equations for logarithmic length-weight relationship, which enable calculation of the length of an individual whose weight is known and the weight of an individual whose length is known using the regression

Table 4. The relative annual increases in length of *Tinca tinca* for both sex and age.

AGE	FEMALES			MALES			FEMALES+MALES		
Group	N	L (cm)	RLF (cm)	N	L (cm)	RLF (cm)	N	L (cm)	RLF (cm)
I	2	16.40	0.398	1	15.80	0.470	3	16.20	0.409
II	3	22.93	0.133	8	23.23	0.128	11	22.83	0.124
III	7	25.98	0.144	7	26.20	0.082	14	25.67	0.127
IV	16	29.73	0.057	14	28.35	0.123	30	28.94	0.091
V	16	31.41	0.119	9	31.83	0.072	25	31.57	0.168
VI	10	35.14	-	12	34.11	-	22	36.89	-

Table 5. The growth parameters and equations of *Tinca tinca according to von Bertalanffy for sex.*

	Growth Parameters				Growth Equations
SEX	W∞	k	to	b	
Females	1397.47	0.2510	-0.9830	3.2470	W_t=1397.47 (1-$e^{-0.2510\ (t+0.9830)}$)3.2470
Males	957.91	0.3767	-0.3803	3.0358	W_t= 957.91 (1-$e^{-0.3767\ (t+0.3803)}$)3.0358
Females+Males	3820.12	0.1262	-1.6838	3.1743	W_t=3820.12 (1-$e^{-0.1262\ (t+1.6838)}$)3.1743

Table 6. The actual and calculated values of fork weight of *Tinca tinca* according to von Bertalanffy for both sex and age.

AGE		FEMALES			MALES			FEMALES+MALES	
Group	N	Actual lengths (W, g) ± SD (Min-Max)	Calculated (W, g)	N	Actual lengths (W, g) ± SD (Min-Max)	Calculated (W, g)	N	Actual lengths (W, g) ± SD (Min-Max)	Calculated (W, g)
I	2	86.00 ± 1.41 (85 - 87)	66.86	1	83.00	74.54	3	84.50 ± 2.08 (83 - 87)	72.90
II	3	186.00 ± 70.06 (110 - 248)	174.65	8	246.50 ± 66.99 (180- 340)	195.13	11	216.25 ± 68.53 (110 - 340)	164.84
III	7	360.40 ± 135.89 (220 - 500)	315.01	7	308.57 ± 89.83 (200 - 450)	353.53	14	334.29 ± 112.89 (200 - 500)	295.01
IV	16	535.80 ± 152.96 (370 - 800)	467.44	14	421.50 ± 92.06 (300 - 650)	501.40	30	478.25 ± 122.51 (300 - 800)	456.07
V	16	648.72 ± 144.76 (400 - 870)	616.61	9	647.78 ± 111.56 (550 - 840)	623.81	25	647.89 ± 128.16 (400 - 870)	640.72
VI	10	890.50 ± 99.23 (650 - 1000)	753.32	12	762.86 ± 198.06 (630 - 1127)	671.07	22	928.25 ± 148.65 (630 - 1127)	841.12

coefficients for length-weight relationship (W= aLb) established for 54 female and 51 male specimens. The length-weight relationship curves obtained are shown in Figure 4.

Condition Factor

The condition factor of *T. tinca* was found to be 1.99 for females, 1.92 for males and 1.95 for both sexes combined. Condition values showed a gradual increase with length.

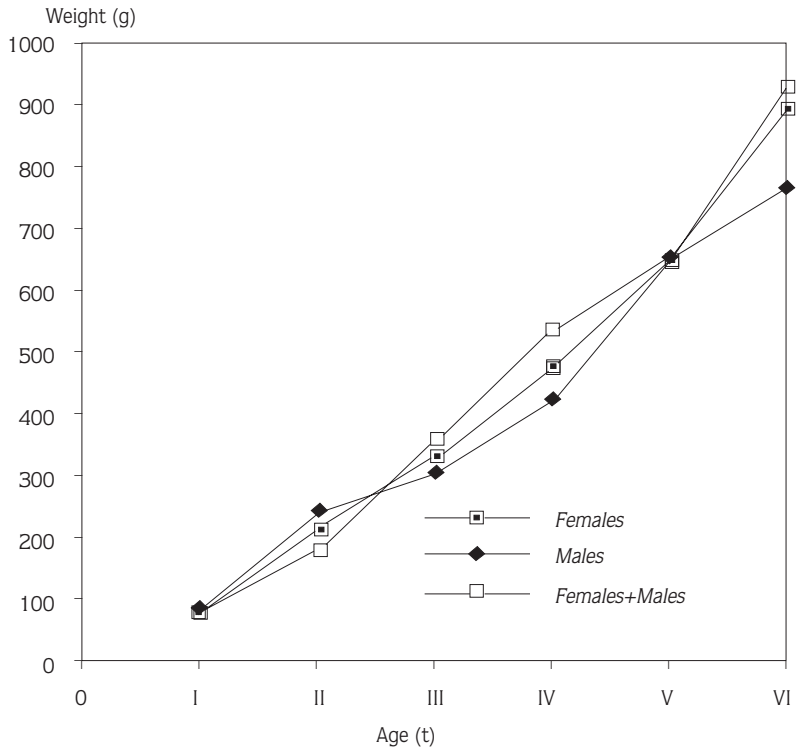

Figure 3. The curves of the age-length relationship of males and females, together and separately, for *Tinca tinca* samples.

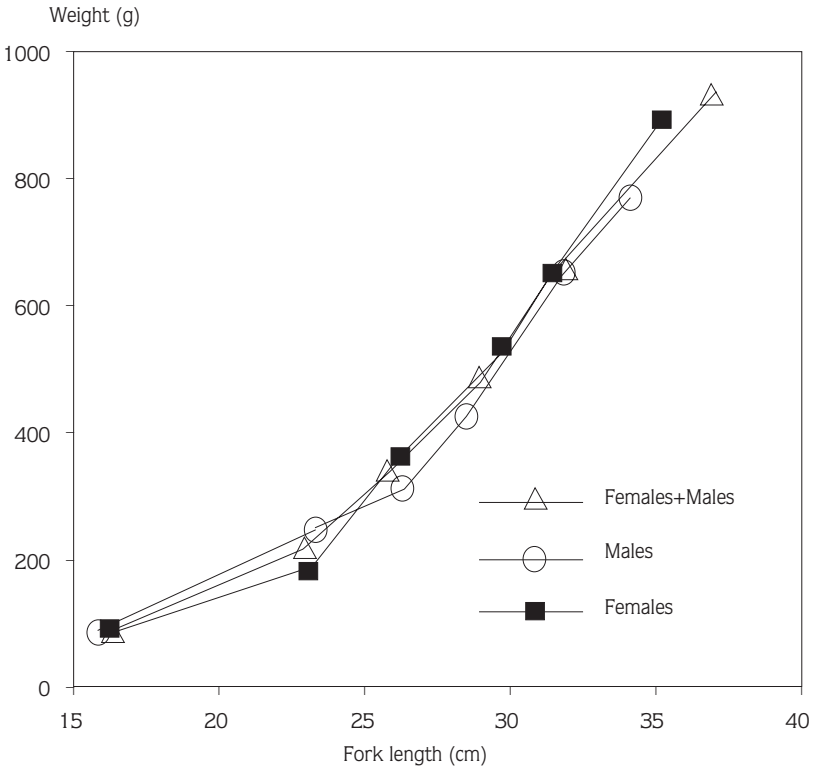

Figure 4. The curves of the length-weight relationship of *Tinca tinca* in Kesikköprü Dam Lake.

Table 7. The relative annual increases in weight of *Tinca tinca* for both sex and age.

AGE	FEMALES			MALES			FEMALES+MALES		
Group	N	W (g)	RW (g)	N	W (g)	RW (g)	N	W (g)	RW (g)
I	2	86.00	1.163	1	83.00	1.969	3	84.50	1.560
II	3	186.00	0.938	8	246.50	0.252	11	216.25	0.546
III	7	360.40	0.487	7	308.57	0.366	14	334.29	0.431
IV	16	535.80	0.211	14	421.50	0.537	30	478.25	0.355
V	16	648.72	0.373	9	647.78	0.151	25	647.89	0.433
VI	10	890.50	-	12	762.86	-	22	928.25	-

Table 8. The length-weight relationship equations and correlation coeficient of *Tinca tinca* for sex.

SEX	Log a	b	r	EQUATIONS
Females	-3.9315	3.2470	0.982	LogW=-3.9315 + 3.2470 Log L
Males	-2.2294	3.0358	0.970	LogW=-2.2294 + 3.0358 Log L
Females+Males	-2.0.343	3.1743	0.975	LogW=-2.0343 + 3.1743 Log L

Discussion

The age distribution for both sexes of the *T. tinca* population in Kesikköprü Dam Lake indicates a distribution between I and VI. Of the specimens examined, it was determined that age group IV was the largest, followed, in succession, by groups V, VI, III, II and I (Table 1). When the age composition of the *T. tinca* population was examined, it was noted that there was a significantly high ratio of aged individuals of both sexes (73.33%). Sigle (1958) and Linfield (1982) have stated that aged individuals existed in lakes where growth is slow and fishing activities are low while aged individuals are rare in lakes where the growth rate is normal (15). This observation fits the age distribution of the *T. tinca* population in the Kesikköprü Dam Lake. The fork length of samples examined during the research period ranged from 15.4 to 41.4 cm. 53.33% of examined specimens were 20 to 30 cm in length. Researchers have stated that the maximum length of *T. tinca* may be 65 - 70 cm. In a study by Yiğit (5) at Mogan Lake, the length of *T. tinca* was found to range from 21 - 35 cm. Weights of *T. tinca* individuals in this study ranged from 83 to 1350 grams. *T. tinca* has been said to have a maximum weight of up to 3 kilograms (2).

The ratio of males to females was 0.94/1 (51:54) (Table. 1). Male and female individuals had the fastest growth the highest annual proportioned length and weight in group I, while females had the lowest in group IV and males had the lowest in group V (Table. 4, 7). As seen in Table 3 and Table 6, the difference between length values calculated according to von Bertalanffy's model and the observed length values was not found important statistically ($P > 0.05$), and the weight values observed and calculated (excluding VI age group) were also found unimportant ($P = 0.05$).

The length-weight relationship in fish may vary according to the species, age and sexual maturity of the fish, and according to season, nutrition and sexuality (13, 16). It was determined that the length-weight relationship was LogW=-3.9315+3.2470LogL for females, LogW=-2.294+3.0358 LogL for males and LogW=-2.0343+3.1743 LogL for both sexes combined. The b value, showing the type (nature) of growth in fish, has been shown to range from 2 to 4 (13, 14, 17). When the b value for the length-weight relationship in a fish population is 3 or very close, it can be classified as isometric (in the case of proportional body growth and weight increase in cubic of the length); however, if this value is considerably less than 3, it can be classified as allometric (unsymmetrical growth of some or all organs of the body and failure of weight increase in cubic length). The b value in fish may vary according to age and sexual maturity (14, 16). The b value for individuals having reached sexual maturity is greater than that for those that have not reached sexual maturity yet, and the b value increases with age. The b value found for *T. tinca* individuals in the Kesikköprü Dam Lake was 3.0358 for males with isometric character, yet the b value for

females was 3.2470 with slight allometric character. The reason for the higher value in females may have been the high numbers of sexually mature and aged fish.

In particular, when *T. tinca* individuals reach sexual maturity, it has been noted that there are differences in growth between males and females (1). Mann (18) has observed that females have higher growth rates than males. Similar results have been reported by other researchers as well (1). This study has also shown that females have slightly better growth than males after reaching sexual maturity.

The condition factor in fish population has shown changes according to gonad development, ages, seasonal changes in growth, and net mesh size (13, 14). The condition factor in *Tinca tinca* in the Kesikköprü Dam Lake was determined to be an average of 1.99 for female individuals and 1.92 for male individuals and 1.95 for both sexes combined. It was found that tench of Kesikköprü Dam Lake had higher condition factors.

Consequently, as no studies have been done on the growth of the *T. tinca* population living in the Kesikköprü Dam Lake, no comparison has been made. Although *T. tinca* is not an economic fish due to low growth rate and laying speed and tasteless flesh, we believe that in the future, when their advantages are taken into account, (such as cleaning of carp pools, aiding mineralization, and their slow metabolisms), they will be used more in aquatic ecosystems.

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