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Investigation of Some Population Parameters of the Tench (*Tinca tinca* L., 1758) Inhabiting Beyşehir Lake (Konya-Turkey)

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Abstract

This study was carried out between April, 2004 and March, 2005 in Beyşehir Lake in the Central Anatolian Region of Turkey. The present study of 210 *Tinca tinca* from Beyşehir Lake shows that 52.38 % are female and 47.62 % male ranging between I^+-VIII age groups. The sex ratio was 1.10 female:1 male in the studied samples. Specimens ranged from 14.9 to 38.5 cm in fork length, and 48.5 to 967.10 g in weight. At the same time, fork length and weight distributions of *Tinca tinca* were also given in this study.

Age-length and age-weight relations were calculated by the von Bertalanffy growth formula. The following equations were found for males and females, respectively. $L_t=41.36[1- e^{1-0.152(t+3.1396)}]$, $L_t=44.23[1- e^{1-0.1176(t+3.6745)}]$, $W_t= 1202.16 (1- e^{-0.52(t+3.1396)})^{3.0993}$, $W_t=1458.30 (1- e^{-0.1176 (t+3.6745)})^{3.0718}$.

Key words: *Tinca tinca*, Population structure, Beyşehir Lake, Turkey.

Introduction

In Turkey, Cyprinidae are the richest and the most important family of fish, and its members are distributed world-wide. These family members are distributed widely in fresh water sources (Demirsoy, 1988; Geldiay and Balık, 1998). There are about 236 species and subspecies belonging to 26 families in inland water of Turkey. One hundred eight of these fish species belong to Cyprinidae and tench have also a member of this family (Kuru, 2004). Recently, it has been implanted in various inland waters in Turkey (Geldiay and Balık, 1998; Çelikklae, 1988). They can be found from Thrace (Trakya) and Northern Anatolia in lakes with ample plants and slow-flowing streams with abundant aquatic vegetation (Lucowicz, 1979; Demirsoy, 1988). Since they mix the bottom mud continuously, they play an important role in mineralization (Demirsoy, 1988). 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 (Michaels, 1988). They feed on a variety of animals and vegetables including a wide variety of invertebrates, mollusks, zooplankton, detritus, algae and vascular plants (Kennedy and Fitzmaurice, 1970; Petridis, 1990).

Although much more studies have already been on tench by Horoszewicz (1983), Morawska (1984), Pimpicka (1990; 1991), Neophitou (1993), Linhard and Billard (1995) Weatherley (1999), Gonzales *et al.* (2000) etc., there are few studies about *Tinca tinca* in Turkey such as Göktaş (1987), Atasagun and Karabatak (1995), Alaş *et al*. (1998), Yılmaz (1997), Altındağ *et al*. (1998; 2002), Alaş and Solak (2004), Balık *et al*. (2004) and Ergönül and Altındağ (2005).

The present study was conducted to investigate the population structure of *Tinca tinca* in Beyşehir Lake.

Materials and Methods

Beyşehir Lake is located on the boundary of Konya and Isparta provinces (37°45′ N-31°36′ E) It is the greatest natural fresh water lake in the Central Anatolian Region of Turkey (Figure 1). The lake has a surface area of 690 km^2 and average depth of 6 m. Its altitude is 1150 m (Balık *et al*., 1997). Beyşehir Lake is fed by streams (Hanboğazı stream, Söğütlü stream, Çarıksaray Deresi, Eflatun Pınarı, Ozan and Termiye Çayı) mainly coming from the Anamas Mountains in the west and the Sultan Mountains in the east. There are 24 islands which are of different sizes in the lake. Among them, only Mada is inhabited and farmed. Extensive reedbeds (*Phragmites australis* and *Typha angustifolia*) are found only in bays in the east and south-west parts. In addition, 7 fish, 2 amphibia and 2 reptilia species are presently living. The natural outlet of the lake of is in the south-east where water formerly flowed via the Beyşehir stream into Suğla Lake, 40 km south-east of Beyşehir (TÇV., 1993; Yarar and Magnin, 1997).

Because of its ecological importance, Beyşehir Lake was declared as a National Park by The Directorate of Nature Conservation and National Parks, The Ministry of Environment and Forestry of Turkey, on 11.01.1993 (Yarar and Magnin, 1997). While the east and north of the lake are eutrophic, the

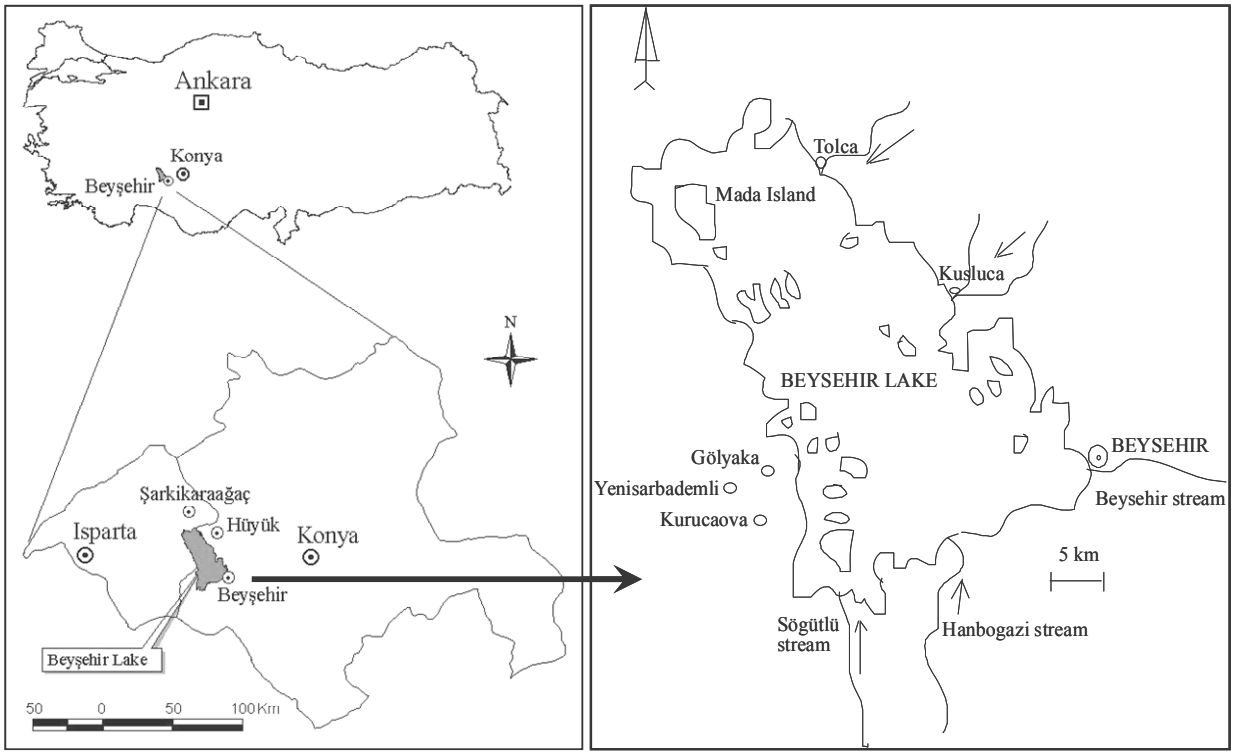

Figure 1. Map of Beyşehir Lake.

other areas are mesotrophic (Saraçoğlu, 1990; Erdem, 1995).

The tench was implanted to this lake by fishermen in 1990's. It has been caught commercially by fishermen (Balık *et al*., 1997).

Two hundred and ten fish were caught between April, 2004 and March, 2005 in Beyşehir Lake. Sampling was performed with gills and gill nets of various mesh sizes (18x18, 24x24, 36x36, 44x44 and 60x60 mm). In the laboratory, the body weight and fork length of each individuals were measured with a sensitivity of 0.01 g and 0.1 cm, respectively. Scales were used for age determination (Lagler, 1966). The sexual characteristics were determined by examining the gonadal tissue with eye or with the aid of a lens (x10) (Horoszewicz, 1983). In addition, morphological characteristics of ventral fin of males were used to determine sexual position (Blasco *et al*., 1993).

The significance of the differences for the female and male groups with the same age groups values for length was tested by a t-test. The least significant was $p \leq 0.05$.

The length and weight was calculated following the Le Cren's equation: $W = aL^b$ (Le Cren, 1951). Bertalanffy's growth equations were used to determine age-length and age-weight relationships among the age groups (Bertalanffy, 1957; Ricker, 1975).

Results

Age Structure

The age group and sex distribution of all specimens examined are shown in Table 1 and Figure 2. Overall, 52.38 % were female and 47.62% were male. Ages varied between I^+ to VIII and the most common group was II (39.05%). Age groups I^+, II and III were comprised of 82.39% of all specimens studied (Table 1).

Sex Ratio

The sex ratio obtained for each group is given in Table 1. A greater sex ratio at males was shown only in the age group IV (0.53 female: 1 male). The observed sex ratio was 1.10 females for 1 male.

Length and Weight Composition

Length distribution was found to be ranging from15.0 to 38.5 cm in females and this range for weight varied from 14.9 cm to 33.0 cm in males (Table 2). Fork length distribution of *Tinca tinca* is given in Table 3 and Figure 3.

Weight composition was found to be ranging from 56.0 to 967.10 g in females and this range for weight was changing from 48.5 to 592.0 g in males

Table 1. Sex ratio of *Tinca tinca* inhabiting Beyşehir Lake. N: Number of samples

Age Groups	Female		Male		Female + Male		Female:Male
	N	%	N	%	N	%	
I^+	29	13.81	30	14.29	59	28.10	0.97:1
II	51	24.29	31	14.76	82	39.05	1.65:1
III	14	6.67	18	8.57	32	15.24	0.78:1
IV	9	4.29	17	8.10	26	12.38	0.53:1
V	3	1.43	2	0.95	5	2.38	1.50:1
VI	3	1.43	2	0.95	5	2.38	1.50:1
VII	*	-	*	-	*	-	-
VIII	1	0.48	0	0	1	0.48	-
Total	110	52.38	100	47.62	210	100.00	1.10:1

*There wasn't found

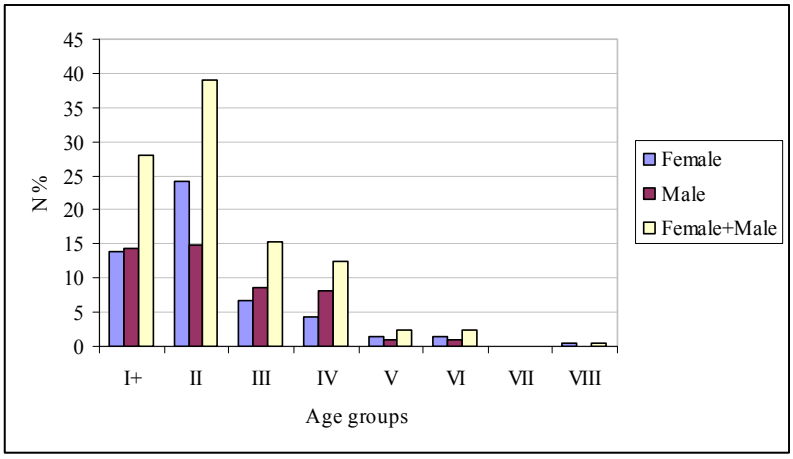

Figure 2. The graphics of the age and sex ratio of tench inhabiting Beyşehir Lake.

(Table 2.). Weight composition of *Tinca tinca* is given in Table 3 and Figure 3.

Age-Length and Age-Weight Relationships

Von Bartelanffy growth parameters (age-length and age-weight relationships) and equations of *T. tinca* according to sex were given in Table 4 and 5.

Length-Weight Relationship

The equations for logarithmic length-weight relationship were shown in Table 6. Correlation coefficient was found as 0.94 and 0.95 for females and males, respectively (Table 6).

Discussion

In Beyşehir Lake, the composition of age groups for *T. tinca* population indicates a distribution between I^+ to VIII. Of the specimens examined, it was determined that age group II was the largest, and the groups I^+, III, IV, V, VI and VIII were following this group (Table 1). The domination of age group II for both females and males may be due to our fishing method. The age distribution of the tench population was found I to VI in Kesikköprü Dam Lake, I to V in Bayındır Dam Lake (Altındağ *et al*., 1998; 2002), The age composition of the tench population was found I to VII in Mogan Lake by Ergönül and Altındağ (2005) and Kayaboğazı Dam Lake has the age distribution I to VII (Alas and Solak, 2004). It was reported that maximum life span for fish is limited by temperature, fishering and other ecological conditions (Gonzales *et al*., 2000). In addition, these findings implied that female specimen has longer life span than male specimen.

Sigle (1958) and Linfield (1982) have stated that if a habitat has aged individuals there is a light fishing in this area, in contrast if the population is younger in any habitat, there is a heavy fishing namely, the latter is under catching pressure (Çetinkaya, 1989). This idea fits the age distribution of the tench population in Beyşehir Lake. *Tinca tinca* is a quite resistant species in different ecological conditions (Balık *et al*., 2004). On the other hand, some researchers reported that *T.*

Table 2. The average fork length (cm) and weight (g) of age groups of tench from Beyşehir Lake*

	Female			Male			Female+Male			t-test (p<0.05)
	1		2	3		4				1-3
Age	N	L±SD (Min-Max)	W±SD (Min-Max)	N	L±SD (Min-Max)	W±SD (Min-Max)	N	L±SD (Min-Max)	W±SD (Min-Max)	
I +	29	19.5±0.165 (15-21.5)	123.3±34.91 (56-154.3)	30	18.5± 0.26 (14.9-21.3)	103.2±32.78 (48.5-178.4)	59	19.0 ± 1.90 (14.9-21.5)	113.3±95.04 (48.5-178.4)	0.0315 (P<0.05)
II	51	22.6±1.056 (18.5-25.5)	181.0±35.05 (88.9-180.8)	31	21.9±0.12 (20.3-23.2)	163.4±20.85 (126.6-200.9)	82	22.3 ± 1.35 (18.5-25.5)	172.2±31.51 (88.9-259.3)	0.00113 (P<0.05)
III	14	24.8±0.40 (20.6-27)	236.1±49.49 (156.5-297)	18	23.9±0.14 (23.1-25.1)	213.2±16.87 (260.4-234.1)	32	24.3±1.34 (20.6-27.0)	224.6±36.77 (123.6-297.1)	0.106 (p>0.05)
IV	9	27.7±0.10 (25.4-29.5)	326.4±41.92 (263.6-367.8)	17	25.1±0.17 (23.5-27)	253.1±39.60 (206.7-331.6)	26	26.0±1.67 (28.5-29.5)	281.5±51.73 (206.7-367.8)	0.0003 (P<0.05)
V	3	29.8±0.24 (29.5-30)	454.3±61.20 (368-495)	2	27.8±0.07 (27-28.5)	348.9±24.25 (331.7-366)	5	27.8±0.07 (27-28.5)	412.1±79.32 (331.7-500.1)	0.206 (p>0.05)
VI	3	31.1±0.13 (30-31.8)	516.8±28.78 (502-550)	2	30.0±0.05 (27-33)	456.9±176.99 (332-592)	5	28.8±1.27 (27-33)	492.8±96.55 (500.2-582)	0.770 (p>0.05)
VIII	1	38.5	967.10	-	-	-	1	-	967.10	-

*VII age group was absent in this table.
N: Number of samples

Table 3. Fork length (cm) and weight (g) distribution of *Tinca tinca* L., 1758 inhabiting Beyşehir Lake

		Female		Male		Female + Male	
		N	%	N	%	N	%
Length	10-15	-	-	2	0.95	2	0.95
	15-20	13	6.19	21	10	34	16.19
	20-25	71	33.81	65	30.95	136	64.76
	25-30	20	9.52	11	5.24	31	14.76
	30-35	5	2.38	1	0.48	6	2.66
	35-40	1	0.48	-	-	1	0.48
Weight	0-150	32	15.24	36	17.14	68	32.38
	150-300	65	30.95	56	26.67	121	57.62
	300-450	7	3.33	7	3.33	14	6.66
	450-600	5	2.38	1	0.48	6	2.86
	600-750	*	-	*	-	*	-
	750-900	*	-	*	-	*	-
	900-1050	1	0.48	-	-	1	0.48

*There wasn't found
N: Number of samples

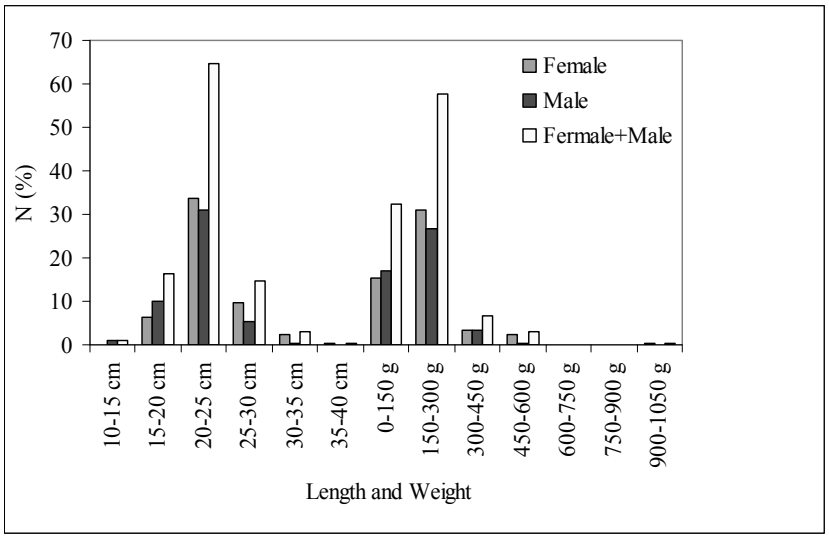

Figure 3. The graphics of the fork length and weight distribution of *T. tinca* inhabiting Beyşehir Lake.

Table 4. Von Bertalanffy growth parameters and equations of *T. tinca* from Beyşehir Lake

Sex	Growth Parameters			Growth Equations
	L_∞	k	t_0	$L_t=L_\infty[1- e^{1-k(t-t_0)}]$
Female	41.36	0.152	-3.1396	$L_t=41.36[1- e^{1-0.152(t+3.1396)}]$
Male	44.23	0.1176	-3.6745	$L_t=44.23[1- e^{1-0.1176(t+3.6745)}]$

Table 5. Von Bertalanffy growth parameters and equations of *T. tinca* from Beyşehir Lake

Sex	Growth Parameters				Growth Equations
	W_∞	K	t_0	b	$W_t= W_\infty (1- e^{-k(t-t0)})^b$
Female	1202.16	0.152	-3.1396	3.0993	$W_t= 1202.16 (1- e^{-0.52(t+3.1396})^{3.0993}$
Male	1458.303	0.1176	-3.6745	3.0718	$W_t=1458.30 (1- e^{-0.1176 (t+3.6745)})^{3.0718}$

Table 6. The length-weight relationship equations and correlation coefficient of *Tinca tinca* collected from Beyşehir Lake

Sex	log c	c	b	r	Equations
Females	-1.930307	0.011741	3.0993	0.94	LogW= -1.930307+3.0993∗logL
Males	-1.89147	0.012839	3.0718	0.95	LogW= -1.89147+3.0718∗logL

tinca can have such a long life span, if there is no sufficient and heavy fisheries activity in a lake (Sinis *et al*., 1999). We think that they can have long life span in this lake for these reasons. The sex ratio was found to be 1.10 females: 1 male in the studied samples, as in Kesikköprü Dam Lake (Altındağ *et al*., 1998).

The fork length of *T. tinca* specimens of the study was ranged from 14.9 to 33.0 cm in length. It was reported that the maximum length of the tench may be 65-70 cm. In an investigation by Yiğit (1995) at Mogan Lake, the length of *T. tinca* was found changing from 21-35 cm. In another study by Alas and Solak (2004) at Kayaboğazı Dam Lake, the length of *T. tinca* was found changing from 9.1 to 27.7 cm. It was found that the length distribution of the tench is between 15.4 cm - 41.4 cm in the Kesikköprü Dam Lake (Altındağ *et al*., 1998).

The weights of *T. tinca* specimens in this investigation, ranged from 48.5 to 967.10 grams. In the other study by Altındağ *et al*. (Altındağ *et al*., 1998) in Kesikköprü Dam Lake, the weight of *T. tinca* was found to vary from 83 to 1350 grams. It was reported that *T. tinca* is able to have a maximum weight up to 3000 grams (Kuru, 1996). The differences in length and weight distribution in these studies may be due to the different mesh sizes of nets used.

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 (Bagenal, 1978).

The length-weight relationship in fish may change with age, season, nutrition, sexual maturity and species (Ricker, 1975; San Juan, 1994). The length-weight relationship of tench inhabiting in Beyşehir Lake was LogW = -1.930307+3.0993∗logL (r = 0.94) for females and was LogW = -1.89147+3.0718∗logL(r = 0.95) for males. This relationship was found as LogW = -3.9315+3.2470∗logL for females, LogW = -2.2294+3.0358∗logL for males in Kesikköprü Lake by Altındağ *et al*. (1998), and as LogW= -1.9142+3.0819∗logL(r = 0.966) for females and LogW = -2.1074+3.2151∗logL (r = 0.961) for males in Bayındır Lake, by Altındağ *et al*. (2002). These differences may be due to differences in genetics and ecological factors.

Le Cren (1951), Brown (1957) and Ricker (1975) reported that the b value for length-weight relationship in the fish population, indicating the type of growth nature in fish, has been shown to be ranging from 2 to 4. On the other hand, the b value in fish may vary according to age and sexual maturity (Ricker, 1975). The b value found for *Tinca tinca* specimens in Beyşehir Lake was 3.0993 for females and 3.0718 for males. These findings in Beyşehir Lake showed that *T. tinca* grows with a slightly positive allometric character.

According to Lucowicz (1979), there are differences between the growths of males and females of *T. tinca* individuals reaching sexual maturity. Altındağ *et al*. (1998) have determined that females have higher growth rates than males. This finding fits with the results of our study. According to the results of this study, we can report that females have better growth than males (These differences are more significant ($p<0.05$) in the age group IV).

Consequently, as no studies have been done on population structure of *T. tinca* living in Beyşehir

Lake, no comparison has been made. Thus, the present investigation provides basic information about the population structure of *T. tinca* in Beyşehir Lake.

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