Growth properties of Tench (*Tinca tinca* L., 1758) living in Hirfanlı Reservoir (Kırşehir, Turkey)

Semra Şanlı Benzer ; Ali Gül* and Mehmet Yılmaz

Department of Biology Education, Gazi Education Faculty, Gazi University, Teknikokullar 06500, Ankara, Turkey

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Tinca tinca is originally from the Near East and West-Siberia and nowadays is spread all over the world (Lukowicz & Proske, 1979). Previous reports showed that they abundantly present in the rivers flowing to the Black Sea and various lakes as well as in rivers in Central Anatolia (Kuru, 1999). It has no economical importance due to its slow growth rate and tasteless meat.

There are many publications on the growth (e.g, Cerny, 1968; Lukowicz & Proske, 1979; Alaş, 1998; Altındağ *et al*., 1998; Altındağ *et al*., 2002; Balık *et al*., 2004; Ergönül & Altındağ, 2005; Erol *et al.*, 2006; Balık *et al*., 2009), the biology (e.g., Göktaş, 1987; Q'Maoileidigh & Bracken, 1989; Vetlugina, 1992; Neophiotu, 1993; Yılmaz, 1997) and the bio-ecology and feeding (e.g., Bircan, 1988; Balık *et al*., 1997; Şanlı, 1998) of *T. tinca*.

This study was carried out to investigate the growth properties, such as weight, length and condition factor, in *T. tinca* inhabit in Hirfanlı Reservoir built in 1959 on Kızılırmak River with the altitude of 856m and volume of 7.63 x$10^9$$m^3$ (DSİ, 1968)(Fig. 1).

The study was carried out from August 1996 to July 1997 on 241 *T. tinca* species. The age was determined using the scales (Lagler, 1966). They were grouped according to their ages and their weight-length, age-length and age-weight relationships (Chuqunova, 1963). The growth in length and weight were shown in absolute and relative growth parameters. The growth equations of the fish ($W = c \times L^n$) were derived from $\log W = \log c + n \times \log L$ (Le Cren, 1951). Here, W represents the weight "c" and "n" are the coefficients of the logarithmic equation.

Fish age was between 1 and 6 years. 48.13% of specimens were males and the rest were females. The dominated age groups in males were 2 and 3 years old while the females were much more abundant in age groups 4, 5 and 6.

The lengths of specimens ranged between 147 and 380mm (Table 1). There were no significant variation between the weight and lengths of specimens in most age groups. However, the difference of fork lengths between males and females in age group 4 was found to be statistically significant (using t-test).

* Corresponding author's email: aligul@gazi.edu.tr

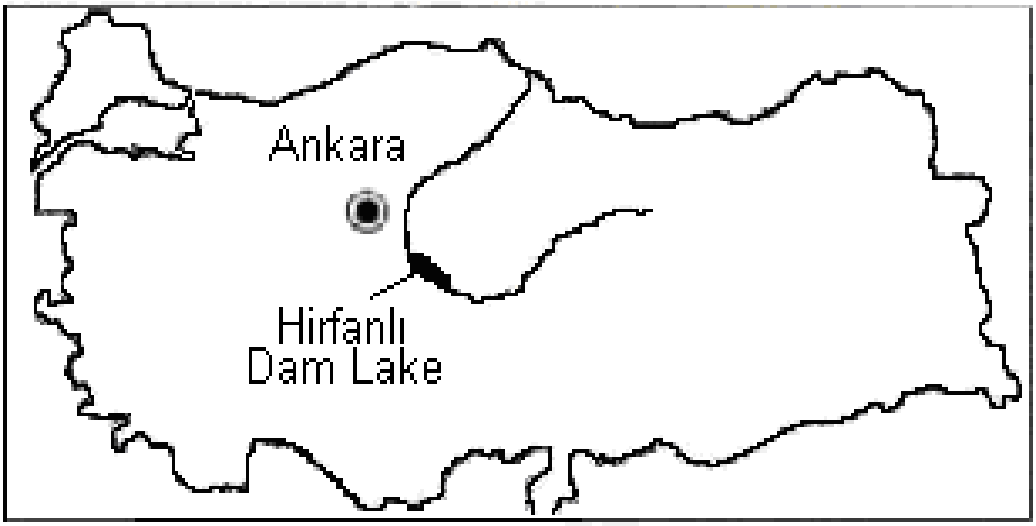

Figure 1: Hirfanlı Reservoir

The weight of *specimens* varied between 58 and 857g (Table 2). The difference in the average weights of the males and females in the population of *T. tinca* in the lake was statistically insignificant irrespective of their age. There was a direct relationship between increase in age and weight among specimens both in males and females.The growth equations relating the growth in weight and the growth in length were derived from the statistical data and they are given as logW= -4.651 + 2.967 logL for females, logW = -4.359 + 2.837 logL for males and logW = -4.567 + 2.928 logL for female +males.

The condition factor ranged between 0.675-2.204 (with average 1.413) in females and 0.576-2.273 (with average 1.168) in males. The difference between the conditioning factor of females and males was found to be statistically insignificant by t-test. The condition factor showed a decrease at the end of the breeding period as a result of discharge of the gonads and started to increase after that.

The population of *T. tinca* in Hirfanlı males and female according to age groups Reservoir showed a distribution of 1 to 6 age groups. The highest percentage among this distribution belonged to 3 years old group with 28.22 %. There was an increase in numbers up to the age group 3 and a decrease afterwards. This has been attributed to hunting stress on older individuals (Göktaş, 1987; Yılmaz, 1997).

The average fork length of specimens inhabiting Hirfanlı Reservoir was found between 179.56 and 342.00mm. This change was 226.42 and 318.14mm in females and 220.98 and 342.00mm in males (Table 1). Atasagun & Karabatak (1995) reported that the fork length of *T. tinca* was between 21 and 35cm in Mogan Lake. The average fork length of *T. tinca* population living in Hirfanlı Reservoirr is smaller than those in Mogan Lake (Göktaş, 1987) and higher than those in Porsuk (Yılmaz, 1997), Kayaboğazı Reservoir (Alaş, 1998) and Çivril Lake (Balık *et al.,* 2004).

The maximum length of *T. tinca* was reported as 70cm (Geldiay & Balık, 1988). Both the males and females reach to sexual maturity at the same age (at 3 years). The difference in length among different genders according to age was statistically significant at age group 3 and insignificant at other age groups.

Table 1: Length distribution according to age and sex in the present study

Age	Female			Male			Female + Male		
	N	L(mm)±SD (Min-Max)	SE	N	L(mm)±SD (Min-Max)	SE	N	L(mm)±SE (Min-Max)	SE
1	-	-	-	-	-	-	27	179.56 ±23.96 (147-210)	4.61
2	12	226.42±14.66 (200-242)	4.24	54	220.98±15.42 (191-251)	2.10	66	221.92±15.32 (191-251)	1.89
3	28	254.79±23.26 (226-347)	4.40	40	247.70±22.47 (218-363)	3.56	68	250.62 ±22.90 (218-363)	2.78
4	30	276.20±18.08 (250-351)	3.30	11	265.82±827 (255-275)	2.49	41	273.42 ±16.61 (250-351)	2.60
5	21	300.14±22.23 (262-320)	4.85	7	306.14±1293 (282-323)	4.88	28	301.6420/26 (262-323)	3.83
6	7	318.14±4.63 (313-325)	1.75	4	342.00±40.78 (301-380)	20.39	11	326.82±25.63 (301-380)	7.71

L: Length; SD: Standard Deviation; SE: Standard Error

Table 2: Weight distribution according to age and sex in the present study

Age	Female			Male			Male + Female		
	N	W(g)±SD (Min-Max)	SE	N	W(g)±SD (Min-Max)	SE	N	W(g)±SD (Min-Max)	SE
1	-	-	-	-	-	-	27	103.22±35.46 (58-175)	6.82
2	12	192.17±29.18 (135-217)	8.43	54	189.48±36.35 (110-247)	4.95	66	189.96±34.96 (110-247)	4.31
3	28	299.68±49.30 (234-378)	9.32	40	289.65± 42.83 (215-391)	6.78	68	293.78±45.52 (215-391)	5.52
4	30	398.90±40.47 (350-556)	7.39	11	378.64±33.79 (350-470)	10.18	41	393.46±39.41 (350-556)	6.16
5	21	524.05±98.17 (383-679)	2.43	7	519.68±88.30 (400-550)	33.32	28	506.57±51.89 (283-679)	9.81
6	7	662.57±39.13 (570-694)	14.77	4	706.75±169.67 (550-857)	84.84	11	678.64±100.56 (550-857)	30.20

W: Weight; SD: Standard Deviation; SE: Standard Error

T. tinca individuals are reported to reach a weight of 300g in three years time (Geldiay & Balık, 1988). The weight of *Tinca tinca* individuals was between 103.22 and 706.75g Hirfanlı Reservoir. The difference between the average weights of males and females according to age groups was found to be statistically insignificant. Ekmekçi (1989), in her study found that females were heavier than males in 2, 4 and 5 age groups of *T. tinca* population of Sarıyar Reservoir.

It was found that the weight increase of *Tinca tinca* population living in Mogan Lake (Göktaş, 1987) and Kayaboğazı Reservoir (Alaş, 1998) was higher than those living in Hirfanlı Reservoir. However, the average weights of *T. tinca* population in Porsuk Reservior at the age of 1, 2 and 3 were similar to those in Hirfanlı Reservoir (Yılmaz, 1997). The investigation of length-weight relationship of *T. tinca* population in Hirfanlı Reservoir revealed that the increase in length was higher at early ages. At older ages the increase in weight becomes much more dominant.

The logarithmic regression equations between weight (W) and length (L) of *T. tinca* population in Hirfanlı Reservoir were similar to those found in Porsuk, Kayaboğazı, Kesikköprü, Bayındır Reservoirs, Çivril and Beyşehir Lake (Yılmaz, 1997; Alaş, 1998; Altındağ *et al*., 1998; Altındağ *et al*., 2002; Balık *et al*., 2004; Balık *et al*., 2009). However these equations differ with those obtained for Mogan Lake (Göktaş, 1987).

The (n) value in $W = c.L^n$ equation, used for the determination of weight-length relationship in fish populations, varies between 2.5 and 4.0 (Brown, 1957). This value is reported to change according to age, gender and sexual maturity (Le Cren, 1951). The values obtained for *T. tinca* individuals in Hirfanlı Reservoir indicated that the growth level in the population was normal. It was reported that the condition factor in fish populations changes according to age, sex, season, time and place of capture (Le Cren, 1951; Ricker, 1980) which gives information about the feeding level, population density, the effect of seasons upon the growth of the fish (Weatherley, 1972). The condition factors of female, male and female+male *T. tinca* population in Hirfanlı Reservoir were found to be 1.413, 1.168 and 1.091, respectively which are lower than those in Kesikköprü (Altındağ *et al*., 1998), Kayaboğazı (Alaş, 1998), Bayındır (Altındağ *et al*., 2002) Reservoirs and Beyşehir Lake (Erol *et al*., 2006). It was reported that length increases at early ages and weight at later stages (Nikolskii, 1980). The condition factor reaches to its maximum value in June. Also the spawning process in breeding season is thought to affect the condition factor of the fish.

According to the data obtained in this study, we can conveniently claim that growth level of *Tinca tinca* population in Hirfanlı Reservoir is satisfactory and there is a hunting pressure on fish at older ages.

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