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Some Growth Characters of Tench (*Tinca tinca* L., 1758) in Lake Yeniçağa, Bolu, Turkey

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Abstract

This study provided basic information on the population structure and some growth characteristics of tench (*Tinca tinca* L., 1758) in Lake Yeniçağa. A total 291 tench were sampled between March 2009 and July 2010. The age of sampled tench ranged from I to IX. The ratios of male and female in this population were 60.5% and 39.5%, respectively. Fork-length and weight ranged from 10.9 cm to 41.5 cm and from 24.0 g to 1127.2 g, respectively. For all individuals, von Bertalanffy growth parameters were determined as $L\infty = 44.19$ cm, $W\infty = 1304.46$ g, $k = 0.236$, $t_0 = -0342$, and $b = 2.999$. Relation between length and weight was calculated as $W = 0.015\ FL^{2.999}$. Mean condition factor was calculated as 1.55 ± 0.01.

Keywords: Lake Yeniçağa, Tench, *Tinca Tinca*, Growth, Bolu, Turkey

INTRODUCTION

Tench *(Tinca tinca* L., 1758) is a member of the Cyprinidae family and native to continent of Europe and Asia [1]. Tench was introduced to continent of Africa, Sought America and Australia as well as in island including Cyprus, Japan, Indonesia and New Zealand [1, 2]. Tench also native to all of the Black Sea coast and Trakya Region which is part of the Marmara Region in Turkey. Afterwards, it has been introduced to some of the lakes of Central Anatolia Region in Turkey [3]. Tench is an important fish for sport fishing in Europe. Aquaculture of tench has been made in some European countries and China [4, 5].

Although biological characteristics of tench have been studied limited in the world [4, 6-10], many studies have been conducted on population structure and growth characteristics of tench in recent years in Turkey [11, 19]. Lake Yeniçağa in which commercial and sport fishing activities carried out, is one of the natural lakes having economic value in Turkey [20]. Commercial fishing activities are provided by Yeniçağa Fisheries Cooperative and fished carp (*C. carpio*), chub (*S. cephalus*), tench, curucian carp (*C. carassius*) and Anatolian khramulya (*C. tinca*) [21]. Tench is one of the most exploited species in Lake Yeniçağa [22]. The aim of this study was to determine age, sex, length, and weight distributions, condition factors, and relationship between weight and length of tench (*Tinca tinca*) in Lake Yeniçağa. These parameters in fisheries are necessary component of describing population dynamics, stock assessment methods and fisheries management in the lake.

MATERIALS AND METHODS

The Lake Yeniçaga is located in in west Black Sea region of Turkey (40º 46' 45" N, 32º 01' 33" E), within the borders of the city Bolu and in the north of the town Yeniçağa. Lake Yeniçağa is a shallow eutrophic freshwater lake with maximum depth of 5.2 m [23], 989 m above sea level, and covers surface area of about 260 ha (Figure 1.)

Tench were sampled between March 2009 and July 2010 as monthly from representative location in the Lake Yeniçağa (Figure 1). Five different gillnets 18, 22, 30, 40, and 50 mm mesh size, each with 100 m long and 2.5 m depth were used to sampling of the fish. The fork length was measured as cm and the weight was measured using digital scale with 0.1 g sensitivity. The age of tench was determined by using the scales [24]. Values of relative growth rate (R) in length (RL) and weight (RW) were calculated using equations $RL = (L_t - L_{t-1}) / L_{t-1}$ and $RW = (W_t - W_{t-1}) / W_{t-1}$, respectively [25]. Length-weight relationship was calculated according to $W = aL^b$ equation described by Le Cren [26]. Age-length and age-weight relationships were evaluated using von Bertalanffy growth equations, which were adapted to fishery by Beverton and Holt [27]. Growth equations $L_t = L_\infty (1 - e^{-k(t-to)})$ and $W_t = W_\infty (1 - e^{-k(t-to)})^b$ were used to estimate the age-length and age-weight relationships, respectively. Isometric growth equation $CF = (W / L^3) \times 100$ of Lagler [24] was used to calculate the condition factor (CF).

All statistical analysis was performed using the statistical program SPSS 15.0. Statistical significance was tested at the 0.05 probability level. Chi-square (χ^2) was used for comparison of sex rations at age groups. Independent samples t-test was used for comparison mean of length, weight, and CF of female and male fish at age groups.

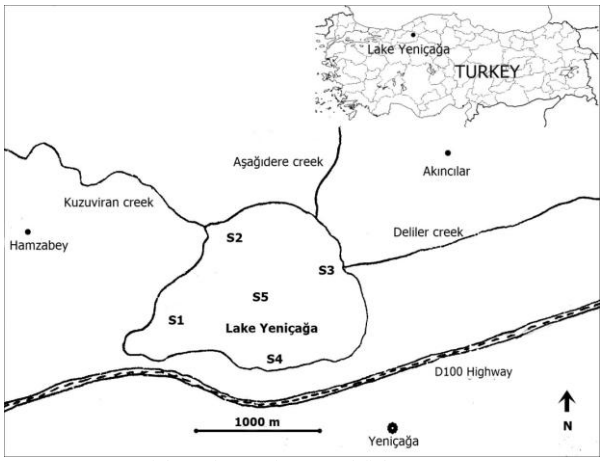

Figure 1. Map of the Lake Yeniçağa and fish sampling locations

RESULTS

The age of sampled tench ranged from I to IX (Figure 2). The ratios of male and female in this population were 60.5% and 39.5%, respectively. Sex ratio of female to male was 1.53: 1.00. The age groups VI, IV, and II were dominant for female, male, and all individuals in the population, respectively. There was no male in age groups VIII and IX. The difference between sex rations were statistically significant in age groups VI, VII, and total ($p < 0.05$). Fork-length of female and male ranged from 10.9 cm to 41.5 cm and 11.7 cm to 37.9 cm, respectively. The 34 cm length group was at the highest percentage (21.6%) in the population (Figure 3). Weight of female and male ranged from 24.0 g to 1127.2 g and 27.3 g to 800.1 g, respectively. The 150 g weight group was at the highest percentage (17.5%) in the population (Figure 4).

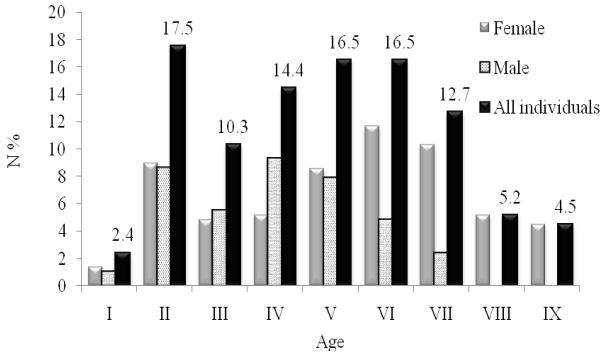

Figure 2. Age and sex distribution (N %)

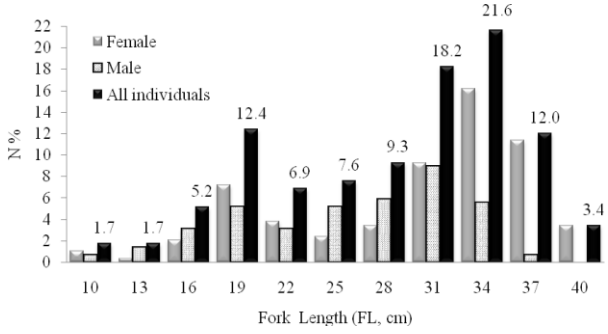

Figure 3. Length distribution (N %)

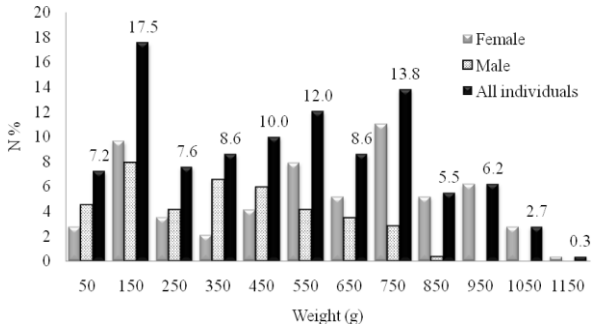

Figure 4. Weight distribution (N %)

The mean fork lengths and weight with the standard errors, and relative growth by sex and age groups of tench are given in Table 1 and Table 2, respectively. Relative length growth curve of female and male are shown in Figure 5. The difference between mean lengths of female and male were statically significant in age group V ($p < 0.05$). The length and weight growth rates for both female and male peaked in the age group II. While length and weight growth rates of male were decreased with increasing age, growth rates of female were increased in age groups IV and VIII for length, and in age group IV for weight according to previous age groups. The difference between mean weights of female and male were statically significant in age groups V and VII ($p < 0.05$).

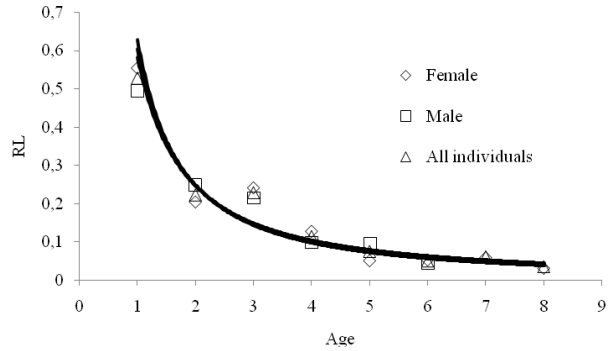

Figure 5. The relative length growth curve of female and male

The calculated von Bertalanffy growth parameters and equations by sex are given Table 3. Due to the lack of age groups VIII and IX of male in population, these age groups weren't included in the calculation. The relation between length and weight was calculated as $W = 0.015\ FL^{2.996}$ ($r = 0.961$) for female, $W = 0.016\ FL^{2.981}$ ($r = 0.964$) for male, and $W = 0.015\ FL^{2.999}$ for all individuals. Relation between length and weight for all individuals are shown in Figure 6.

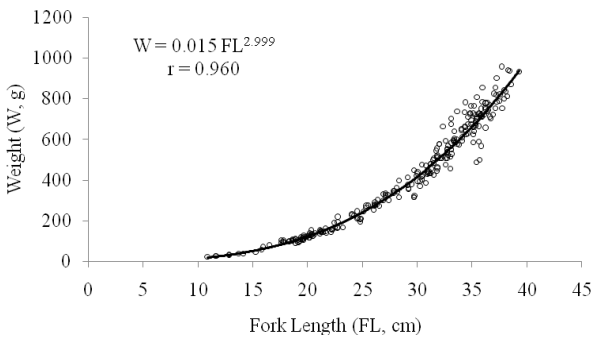

Figure 6. Length-weight relationship for all individuals

The mean condition factor (CF) was calculated as 1.57 ± 0.01 for female, 1.52 ± 0.01 for male and 1.55 ± 0.01 for all individuals (Table 4). The condition factors of females in age group IV, VII, and total were higher than those of males and the difference between them were statistically significant ($p < 0.05$).

Table 1. The mean fork lengths (FL, cm) with standard errors, and relative growth (RL) rates by sex and age groups

	Female			Male				All individuals		
Age	N	FL ± SE (min - max)	RL	N	FL ± SE (min - max)	RL	t-test	N	FL ± SE (min - max)	RL
I	4	12.65 ± 0.97 (10.90 - 15.30)	-	3	12.73 ± 0.58 (11.70 - 13.70)	-	-0.067 $p > 0.05$	7	12.69 ± 0.56 (10.90 - 15.30)	-
II	26	19.68 ± 0.26 (16.50 - 22.80)	0.555	25	19.04 ± 0.38 (14.10 - 22.40)	0.496	1.384 $p > 0.05$	51	19.37 ± 0.23 (14.10 - 22.80)	0.528
III	14	23.69 ± 0.43 (20.40 - 26.20)	0.204	16	23.78 ± 0.51 (21.10 - 26.90)	0.249	-0.130 $p > 0.05$	30	23.74 ± 0.33 (20.40 - 26.90)	0.222
IV	15	29.40 ± 0.57 (25.40 - 33.10)	0.241	27	28.87 ± 0.36 (25.10 - 31.90)	0.214	0.818 $p > 0.05$	42	29.06 ± 0.31 (25.10 - 33.10)	0.228
V	25	33.14 ± 0.35 (30.10 - 37.20)	0.127	23	31.70 ± 0.37 (27.30 - 35.80)	0.098	2.817 $p < 0.05$	48	32.45 ± 0.27 (27.30 - 37.20)	0.113
VI	34	34.79 ± 0.28 (31.90 - 38.60)	0.050	14	34.67 ± 0.26 (32.70 - 35.90)	0.095	0.260 $p > 0.05$	48	34.76 ± 0.21 (31.90 - 38.60)	0.074
VII	30	36.60 ± 0.22 (34.30 - 39.30)	0.052	7	36.21 ± 0.58 (33.40 - 37.90)	0.043	0.722 $p > 0.05$	37	36. 52 ± 0.21 (33.40 - 39.30)	0.049
VIII	15	38.73 ± 0.32 (36.90 - 40.40)	0.058	-	-	-	-	15	38.73 ± 0.32 (36.90 - 40.40)	0.060
IX	13	40.00 ± 0.30 (38.10 - 41.50)	0.033	-	-	-	-	13	40.00 ± 0.30 (38.10 - 41.50)	0.034

Table 2. The mean weights (W, g) with standard errors and relative growth (RW) rates by sex and age groups

	Female			Male				All individuals		
Age	N	W ± SE (min - max)	RW	N	W ± SE (min - max)	RW	t-test	N	W ± SE (min - max)	RW
I	4	32.90 ± 5.09 (24.00 - 46.70)	-	3	32.27 ± 3.18 (27.30 - 38.20)	-	-0.096 $p > 0.05$	7	32.63 ± 2.98 (24.00 - 46.70)	-
II	26	121.22 ± 5.22 (81.90 - 216.40)	2.684	25	109.18 ± 6.26 (37.70 - 192.00)	2.384	1.481 $p > 0.05$	51	115.32 ± 4.11 (37.70 - 216.40)	2.534
III	14	199.73 ± 12.07 (130.10 - 286.20)	0.648	16	209.15 ± 15.88 (136.50 - 330.10)	0.916	-0.462 $p > 0.05$	30	204.75 ± 10.04 (130.10 - 330.10)	0.776
IV	15	400.24 ± 21.83 (265.50 - 550.80)	1.004	27	358.55 ± 12.33 (245.60 - 476.00)	0.714	1.801 $p > 0.05$	42	373.44 ± 11.39 (245.60 - 550.80)	0.824
V	25	554.11 ± 19.57 (394.20 - 820.30)	0.384	23	493.37 ± 18.08 (327.20 - 717.30)	0.376	2.268 $p < 0.05$	48	525.00 ± 13.96 (327.20 - 820.30)	0.406
VI	34	668.20 ± 15.27 (508.30 - 871.10)	0.206	14	650.89 ±13.80 (555.30 - 712.80)	0.319	0.679 $p > 0.05$	48	663.15 ± 11.52 (508.30 - 871.10)	0.263
VII	30	798.95 ± 13.44 (701.40 - 954.80)	0.196	7	718.70 ± 20.18 (641.20 - 800.10)	0.104	2.709 $p < 0.05$	37	783.76 ± 12.58 (641.20 - 954.80)	0.182
VIII	15	907.77 ± 19.07 (759.10 - 1028.70)	0.136	-	-	-	-	15	907.77 ± 19.07 (759.10 - 1028.70)	0.158
IX	13	1011.63 ± 16.93 (907.50 - 1127.20)	0.114	-	-	-	-	13	1011.63 ± 16.93 (907.50 - 1127.20)	0.114

Table 3. The calculated von Bertalanffy growth parameters by sex

Sex	L∞	W_∞	k	t_0	b
Female	43.27	1210.96	0.255	-0.253	2.996
Male	44.20	1242.55	0.228	-0.380	2.981
All individuals	44.19	1304.45	0.236	-0.342	2.999

Table 4. The mean condition factors (CF) with standard errors by sex and age groups

	Female		Male			All individuals	
Age	N	CF ± SE (min - max)	N	CF ± SE (min - max)	t-test	N	CF ± SE (min - max)
I	4	1.62 ± 0.12 (1.30 - 1.85)	3	1.56 ± 0.07 (1.49 - 1.70)	0.418 $p > 0.05$	7	1.60 ± 0.07 (1.30 - 1.85)
II	26	1.58 ± 0.03 (1.35 - 1.83)	25	1.54 ± 0.03 (1.30 - 1.91)	0.880 $p > 0.05$	51	1.56 ± 0.02 (1.30 - 1.91)
III	14	1.48 ± 0.04 (1.27 - 1.67)	16	1.51 ± 0.03 (1.39 - 1.70)	0.652 $p > 0.05$	30	1.50 ± 0.02 (1.27 - 1.70)
IV	15	1.56 ± 0.02 (1.42 - 1.68)	27	1.48 ± 0.03 (1.21 - 1.75)	2.178 $p < 0.05$	42	1.51 ± 0.02 (1.21 - 1.75)
V	25	1.52 ± 0.03 (1.10 - 1.72)	23	1.54 ± 0.03 (1.27 - 1.76)	-0.566 $p > 0.05$	48	1.53 ± 0.02 (1.10 - 1.76)
VI	34	1.59 ± 0.03 (1.23 - 1.95)	14	1.56 ± 0.02 (1.44 - 1.66)	0.804 $p > 0.05$	48	1.58 ± 0.02 (1.23 - 1.95)
VII	30	1.63 ± 0.02 (1.44 - 1.83)	7	1.52 ± 0.04 (1.39 - 1.72)	2.455 $p < 0.05$	37	1.61 ± 0.02 (1.39 - 1.83)
VIII	15	1.57 ± 0.04 (1.32 - 1.86)	-	-	-	15	1.57 ± 0.04 (1.32 - 1.86)
IX	13	1.58 ± 0.03 (1.48 - 1.77)	-	-	-	13	1.58 ± 0.03 (1.48 - 1.77)
Total	176	1.57 ± 0.01	115	1.52 ± 0.01	2.813 $p < 0.05$	291	1.55 ± 0.01

DISCUSSION

The age distribution of tench in Lake Yeniçağa was showed wider range than other lake in Turkey (Table 5). It can be said that this changes in age distribution due to the differences in used fishing gear and mesh size, growth rate and productivity of population, ecology of lake, and fishing activity in lake. In addition, Nikolsky [28] indicated that a wide range of age distributions in a population is acceptable as an indication of a sufficient level of food in the water. That the rate of 60.1% of tench in population was age groups between IV and VII showed that large majority of the population consisted of elderly individuals. The commercial fishing activities in Lake Yeniçağa were suspended for a long time due to the Lake Lease expiries and failing of the lake leasing from government. Also, fishing pressure was very low on fish population in the lake due to cooperative management issues during this research. Accordingly, it is expected that the proportion of elderly individuals would be higher in population due to low fishing mortality. The 70.8% of the length of the sampled tench were 26 cm and above which is minimum landing size of tench in Turkey [29]. Similarly, this situation showed that there wasn't fishing pressure on tench population in Lake Yeniçağa.

The mean weights at age groups V and VII of female was higher than male as statistically ($p < 0.05$) because the gonad development in female was more than male especially during spawning period (Table 2). Mean fork lengths (FL, cm) and weights (W, g) at age groups of tench in different lakes are given in Table 5. The differences in mean lengths and weight of tench reported from the others lakes may be due to different climatic and geographical conditions, and factors affecting growth (food, water temperature, age at sexual maturity, water quality, and intraspecific and interspecific competition, etc.) of these lakes. The growth rate in length and weight of tench in Lake Yeniçağa peaked until age III, reached first sexual maturity (Table 1, 2).

The von Bertalanffy growth parameters and condition factors of tench in different lakes are shown in Table 3. In this study, the asymptotic length ($L\infty = 44.19$ cm) and weight ($W\infty = 1304.45$ g) for all individuals were similar to values reported from Lake Beyşehir [15]. The slope values (b = 2.999) for all individuals of the length-weight relationship indicated that tench population in Lake Yeniçağa showed isometric growth [30]. The b values reported from Lake Çivril [14] and Lake Beyşehir [15] were similar to this study. Ricker [31] stated that b values in fish differ according to species, sex, age, seasons, and feeding. It is estimated that condition factor of female in age group III was the lowest value related to reaching sexual maturation in this age group (Table 4). In this study, average condition factor was calculated similar to reported from Bayındır Dam Lake [12] and Lake Beyşehir [15]. It was concluded that with the age, length, and weight distributions of tench in Lake Yeniçağa according to its geographical location showed wider range than the other lakes due to nutrient-richness of the lake and lack of intensive fishing activities in the lake.

Table 5. Mean fork lengths (FL, cm) and weights (W, g) at age groups of tench in different lakes

Location		Age I	II	III	IV	V	VI	VII	VIII	IX	∑ n	Reference
Kesikköprü Dam Lake	cm	16.20	22.83	25.67	28.94	31.57	36.89	-	-	-	105	11
	g	84.50	216.25	334.29	478.25	647.89	928.25					
Bayındır Dam Lake	cm	16.52	21.12	26.14	29.77	33.35	-	-	-	-	100	12
	g	66.58	152.27	285.92	436.57	547.58						
Lake Çivril	cm	14.09	18.60	22.63	26.08	27.40	-	-	-	-	506	14
	g	53.80	127.08	229.27	330.07	355.80						
Lake Beyşehir	cm	12.88	17.88	23.17	27.16	30.37	32.50	34.40	36.55	-	2268	15
	g	34.27	88.60	191.37	313.29	437.65	550.19	665.33	761.75			
Lake Yeniçağa	cm	12.69	19.37	23.74	29.06	32.45	34.76	36.52	38.73	40.00	291	This study
	g	32.63	115.32	204.75	373.44	525.00	663.15	783.76	907.77	1011.63		

Table 6. The von Bertalanffy growth parameters and condition factors of tench in different lakes (L∞, W∞, k, t_0, b, and CF)

Location	L∞	W∞	k	t_0	b	CF	Reference
Kesikköprü Dam Lake	57.76	3820.12	0.1262	-1.6838	3.1743	1.95	11
Bayındır Dam Lake	38.46	-	0.335	-0.6069	3.175	1.57 - 1.53	12
Lake Çivril	33.85	723.18	0.284	-0.895	3.01	-	14
Lake Beyşehir	45.38	1425.22	0.1863	-0.8259	3.015	1.504	15
Seyhan Dam Lake	50.86	-	0.1120	-1.551	2.51	1.80	19
Lake Yeniçağa	44.19	1304.45	0.236	-0.342	2.999	1.55	This study

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