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Biological Aspects of *Rutilus rutilus* (Roach) in Sapanca Lake (Turkey)

[1]Hacer Okgerman, [1]Muammer Oral and [2]Sibel Yigit
[1]Faculty of Fisheries, University of Istanbul, Ordu C. No: 200 34470, Laleli, Istanbul, Turkey
[2]Department of Biology, Hydrobiology Section, University of Ankara, Besevler, Ankara, Turkey

Abstract: The age and the growth parameters of the roach (*Rutilus rutilus* L., 1758) caught in Sapanca Lake were investigated monthly between October 2000 and September 2001. The age values of the 398 roach caught were between 1 and 9 and the majority of the fish consisted of individuals of the 5 and 6 age group. The difference between the average lengths with respect to sex was significant in 1, 2, 5 and 8 age groups ($p<0.05$). The von-Bertalanffy equation was determined with $L_t = 31.87\ (1\text{-}e^{0.195(t+0.034)})$; $W_t = 380.91\ (1\text{-}e^{0.195(t+0.034)})^3$ for males and $L_t = 47.19(1\text{-}e^{0.109\ (t+0.056)}$; $W_t = 1256.93\ (1\text{-}e^{0.109(t+0.056)})^3$ for females. The relationships between length and weight were found highly significant ($r = 0.99$). The differences of mean length, weight and condition factors between females and males in the same length groups were compared. The length-weight correlation was found to be $W = 0.014\ L^{2.933}$ for male and $W = 0.013\ L^{2.972}$ for female. The mean values of condition factors (K) of females and males were determined as 1.241±0.02 and 1.221±0.03, respectively.

Key words: Roach, *Rutilus rutilus* L., 1758, length-weight relationship, the von bertalanfy growth equation, Sapanca Lake

INTRODUCTION

Penczak *et al*. (1990) described that growth in fishes tends to be a plastic, density dependent phenomenon and variability has been related to competitive interactions, both intra-and interspecific. Thus, a feature of populations of a species is the variability that occurs between different in freshwaters. Krause *et al*. (1998) stated that 2 of the main factors controlling growth in fish are food availability and temperature. According to Zerunian *et al*. (1986), the red-eye roach, *Rutilus rutilus*, L is peculiar to still and slow-moving water with abundant vegetation, environments in which they are often the dominant species. Keckeis and Schiemer (1990) determined that according to feeding habits, adult roach is a generalist and prefers the littoral zone and the bottom layer.

Red-eye roach, *Rutilus rutilus* L. widely distributed in European fresh waters is a species mostly caught in Lake Sapanca together with rudd, *Scardinius erythrophthalmus* L. and white bream, *Blicca bjoerkna* L., 1758. Regarded as a valuable species both for angling and commercial food in European freshwater fisheries but tends to be a nuisance in areas where it has become established (Froese and Pauly, 2008). Horppila *et al*. (2000) and Hellawell (1972) and Zerunian *et al*. (1986) have examined that roach stomach content, reproduction and food, respectively. Specziar *et al*. (1997) studied feeding strategy and growth. Libosvarski and Saeed (1983), Linfield (1979), Zalachowski and Krzykawska (1995), Cowx (1988), Goldspink (1978) and Muler and Meng (1986) have made studies on growth rate of roach. The aim of the present study, is the determination of the growth rate of roach in Sapanca Lake. Additionally, the comparison of the information contained here in with the information obtained with regard to this species will contribute to the information about the growth parameters of roach in Sapanca Lake.

MATERIALS AND METHODS

Study area: Lake Sapanca (Fig. 1) (40° 41′N-40° 44′N and 30° 09′E-30° 20′E) is located in north-west and is the lake of tectonic origin. Surface area (A) 46.8 km^2, mean and maximum depths are 29 m and 52 m. The lake water is used as a source of drinking water by the city and district of Adapazari and as a recreational area. The study carried out by Aykulu *et al*. (2006), show that Lake Sapanca tends to convert from the oligotrophical character to the mesotrophical one. Most shoals of the lake are surrounded by *Phragmites* sp. There are some submerged macrophytes such as *Chara* sp., *Myrophyllum* sp., *Ceratophyllum* sp., *Potamogeton* sp., *Najas* sp. in the lake. It was determined that the minimum and maximum temperature of surface water were 8 and 29°C, respectively. The annual average amounts of PO_4, NO_3-

Corresponding Author: Hacer Okgerman, Faculty of Fisheries, University of Istanbul, Ordu C. No: 200 34470 Laleli, Istanbul, Turkey

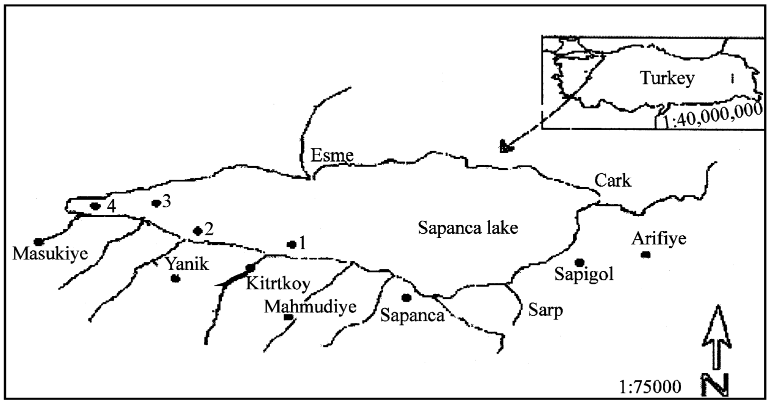

Fig. 1: Sapanca Lake location of sampling stations

NO_2 and Chlorophyll-a are 7.73, 82.18 and 10.044 mg m^{-3}, respectively. The roach have intensively been caught by the fishermen in this lake. The region where the roach are mostly caught is the west part of the lake. This region is shallow and there are plenty of macrophytes in it.

Sampling methods: The roach in Sapanca Lake were obtained from December 2000-2001 at monthly intervals. All fish specimens were caught using gill nets of various mesh sizes (10, 22, 26, 30, 34, 38, 42, 48, 50 mm knot to knot). In total, 398 roach were examined. Fish were procesed soon after capture. In the laboratory, the fish lengths were measured (total length) to the nearest 1 mm, weighed to the nearest 0.01 g and sex were registered. Age of roach was ascertained from microscopic examination of scales. The scales from the left side of the body between the lateral line and dorsal fin were gathered and analyzed between 2 slides for binocular microscopy (Lagler, 1966). Lengths have been corrected where necessary to fork length using the following relationship derived for roach standart length = 0.93 fork length, tail length = 1.12 fork length (Man, 1973).

Growth was investigated by fitting the von Bertalanffy growth function to pooled size-at-age and weight-at-age data for both sexes using standart non-linear optimization methods. The von Bertalanffy growth function were calculated according to:

$$Lt = L\infty\ (1\text{-}e^{k(t\text{-}to)})$$

for TL and weight (Von-Bertalanfy, 1938):

$$W_t = W_\infty\ (1\text{-}e^{k(t\text{-}to)})^b$$

where:

- L_t = Length at age t
- $L\infty$ = The asymptotic length
- k = The growth coefficient
- t_o = The hypothetical age at which length is equal to 0
- W_t = The weight of the fish in g at age t
- W_∞ = The asymptotoic weight of the fish in g
- b = The constant in the length-weight relationship (Ricker, 1975; Sparre and Venema, 1992)

The length-weight relationship ($W = aTL^b$) was calculated separately for the 2 sexes using the least squares method with length expressed in cm and weight in grams (Ricker, 1975).

Condition coefficients (CF) were calculated for each sex using the equation $CF = W/L^3 \times 100$ (Ricker, 1975). The comparison of the length, weight and condition factor between sexes was done for age classes using t-test. Statistical analyses were carried out with SPPS for Windows V 11.0.

RESULTS AND DISCUSSION

Length distribution: The range of male and female roachs' lengths were between 6.7-32 cm. Total lengths of 262 female were between 6.7-32 cm, total lengths of 136 male fish were between 6.8-28 cm. Roach were classified intervals 4 cm length groups. Length range of male and female roachs' were mostly between 17-20.9 cm (Fig. 2).

Growth in length and weight: Growth during the life span was investigated by calculating the mean length and weight of males and females through year. The apparent depression of the means 5+ and 6+ years in almost certainly an effect of the very strong (5+, 6+) year class. The significant grade of between the mean lengths and weights in accordance with the sex was determined according to t-test ($p = 0.05$) (Table 1). The growth in length of male and female roach with age is shown in Fig. 3, growth in weight with age is shown in Fig. 4.

The Von-Bertalanfy growth equation was obtained by using the mean lengths of each age groups of males and females ultimate lengths and ultimate weights of males and females were determined (Table 2).

Maximum length of the females was more high than maximum length of males. These differences between sexes (L_∞) was significance ($p<0.05$).

Length-weight relationship and condition: The values a and b are calculated as the Y-intercept and regression coefficient, respectively, in $\log_{10}$-$\log_{10}$ regression by the method of least squares. The weight data were obtained from the following length-weight regressions computed for males and females through year separately:

$$\text{Male: } W= 0.0148\ L^{2.9336};\ r = 0.989/$$
$$\text{Female: } W = 0.0133\ L^{2.9723};\ r = 0.995$$

When analyzed montly variations of the condition factor, it is seen that this value reached the highest point in April (1.246±0.011) and in August (1.323±0.025). The variations occured in the other months were given in Fig. 5.

Total of 398 specimens were investigated for the age determination and the ages of roach were determined as age groups of 1+ – 9+. The minimum lengths for female and male were 6.83 cm (age 1+) and 7.25 cm (age 1+) and the maximum lengths for female and male 30.97 cm (age 9+)

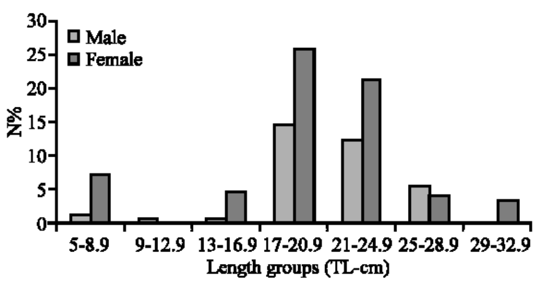

Fig. 2: Length distribution of males and females of roach according to 4 cm intervals of total length in Sapanca Lake

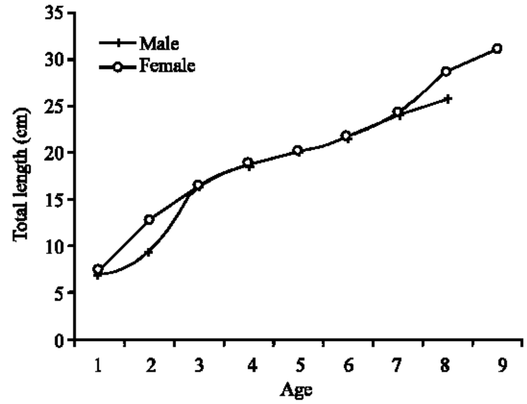

Fig. 3: Mean length of each age class of roach

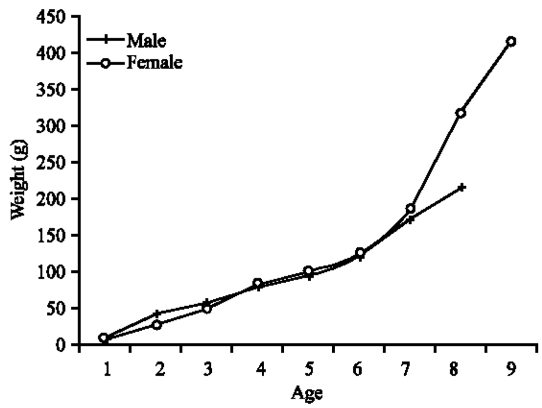

Fig. 4: Mean weight of each age class of roach

Table 1: According to sex, mean lengths, weights, condition factors values of each age group ±SE, (minimum-maximum values), p = 0.05 (t-test) between males and females of roach

	N		L±SE (min-max)			W±SE (min-max)			CF±SE (min-max)		
Age	Male	Female	Male	Female	p-value	Male	Female	p-value	Male	Female	p-value
1+	3	25	6.83±0.033 (6.8-6.9)	7.25±0.066 (6.7-7.9)	<0.05	4.93±0.564 (4-6.3)	5.19±0.138 (3.9-6.3)	>0.05	1.4377±0.069 (1.2721-1.5547)	1.3599±0.024 (1.0750-1.7043)	>0.05
2+	3	12	9.20±1.239 (7.4-11)	12.79±0.811 (8.2-14.9)	<0.05	39.20±0.400 (6.3-40)	25.38±3.389 (5.9-40.9)	<0.05	1.0904±0.107 (0.9837-1.5547)	1.1127±0.036 (0.9038-1.3240)	>0.05
3+	2	11	16.30±0.400 (15.9-17)	16.26±0.191 (15.3-17.4)	>0.05	54.95±4.150 (50.8-59)	47.56±3.267 (36.0-66.2)	>0.05	1.1474±0.026 (1.1219-1.1730)	1.0918±0.044 (0.9416-1.4472)	>0.05
4+	10	13	18.56±0.120 (17.9-19)	18.67±0.098 (18.0-19.0)	>0.05	75.32±2.944 (63.6-89)	81.14±1.924 (69.9-92.1)	>0.05	1.1760±0.030 (1.0292-1.3626)	1.2460±0.024 (1.1393-1.3992)	<0.05
5+	44	86	19.93±0.081 (18.9-21)	20.10±0.051 (19.0-20.9)	<0.05	93.42±1.897 (78.1-146)	99.01±0.962 (69.1-122.9)	<0.05	1.1785±0.020 (1.0238-1.8250)	1.2173±0.009 (0.9917-1.4565)	<0.05
6+	26	74	21.63±0.161 (20.2-23)	21.66±0.066 (20.7-23.0)	>0.05	119.78±3.312 (94.6-158)	122.96±1.497 (102.1-160.0)	>0.05	1.1779±0.015 (0.9831-1.3381)	1.2083±0.012 (0.9090-1.6702)	>0.05
7+	18	16	24.00±0.107 (22.9-25)	24.13±0.299 (22.5-26.5)	>0.05	171.39±4.085 (134.4-204)	183.59±9.355 (108.4-258.0)	>0.05	1.2381±0.023 (1.0423-1.4092)	1.3004±0.044 (0.7022-1.4679)	>0.05
8+	30	19	25.79±0.195 (24.6-28)	28.58±0.205 (27.1-29.9)	<0.05	214.09±6.434 (175.2-311)	315.34±9.249 (237.4-379.7)	<0.05	1.2604±0.018 (1.0819-1.4642)	1.3444±0.019 (1.1797-1.4960)	<0.05
9+	-	6	-	30.97±0.426 (30.0-32.5)			412.53±22.960 (349.9-497.1)			1.3838±0.042 (1.2454-1.5170)	

Table 2: The Von-bertalanfy growth equation of male and female roach (TL: cm; W: g) in Sapanca Lake

	Growth parameters				
Sex	L∞	k	t_0	W∞	Growth formula
Male	31.87	0.195	-0.034	380.91	$L_t = 31.87\ (1\text{-}e^{0.195(t+0.034)})$; $W_t = 380.91\ (1\text{-}e^{0.195(t+0.034)})$
Female	47.19	0.109	-0.056	1256.93	$L_t = 47.19(1\text{-}e^{0.109\ (t+0.056)})$; $W_t = 1256.93(1\text{-}e^{0.109(t+0.056)})$

Table 3: Growth rate of roach at different localities

Site	Sex	Mean length at 1 age (cm)	L∞ (cm)	Max. mean length (cm)	Max. age recorded (years)
Lugg River (Hellawell, 1972) Length:TL	Male	-	24.00	22.40	13+
	Female	-	31.00	26.60	13+
Dabie Lake (Zalachowski and Krzykawska, 1995) Length: TL	Male	-	32.55	21.90	12+
	Female	-	48.00	26.80	12+
Slapton Ley (Wyatt, 1988) Length: TL	Female + Male	-	42.50	30.00	5+
Muso'v Reservoir (Libosvarski and Saeed, 1983) Length: SL*	Male	4.80	57.92	20.85	6
	Female	4.68	73.34	24.58	7
Sarnen Lake (Muller and Meng, 1986) Length: TL	Male	6.70	36.87	25.90	9
	Female	6.90	40.19	31.70	12
Sapanca Lake (present study) Length: TL	Male	6.83	31.87	25.79	8
	Female	7.25	47.19	30.97	9

*Lengths have been corrected where necessary to fork length using the following relationship derived for roach by Man (1973): Standart length = 0.93, fork length, tail length = 1.12 fork length

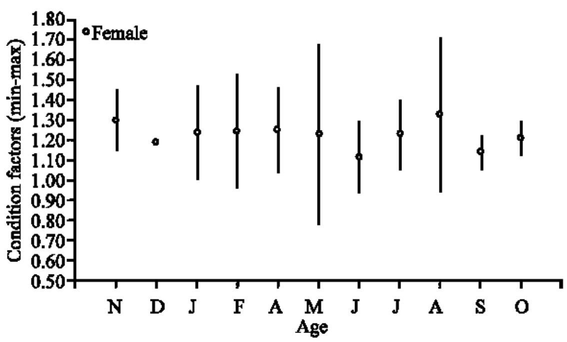

Fig. 5: Monthly changes in condition factors of females of roach in Lake Sapanca

and 25.79 (age 8+), respectively. These results are different from those of the other researchers (Table 3). It is believed that this differences result from the selectivity of the nets used in sampling, variations in sampling amounts and that the changes in population dynamics of the roach were part of a general ecological change occurring within the lake as a whole.

Except for River Lugg and Musov Reservoir, the maximum theoretical length (L∞) estimated for male and female in the other localities was around 30 and 40 cm, respectively and these results were also similar to our results. L∞ value of this study is higher than that of the study carried out in River Lugg, but it is lower than that of the study in Musow Reservoir. Beverton and Hold (1957) suggested that L∞ is affected by environmental factors such as food supply or population density. As the population density of the roach at River Lugg was very high, the low value of L∞ and mean length of the maximum age are not surprising. The maximum length (L∞) calculated for after the age of 13+ was 24 cm for male and was 31 cm for female, but in Slapton Ley, this value for after the age of 5+ was 42.5 cm (Wyatt, 1988). In this study, value of L∞ for male and female are 31.87 and 47.19 cm, respectively. Thus, it is possible that the L∞ and the mean length of the maximum age values varies in the extreme conditions such as high density, pollution and food deficiency (Nikolsky, 1962).

The length-weight relationship is affected by species, age, sexual maturity, season, feeding and sex (Ricker, 1975). In this study, the length-weight relationships for male and female were determined as $W = 0.015\ L^{2.9336}$ (r = 0.989) and $W = 0.013\ L^{2.9723}$ (r = 0.995), respectively. In the River Lugg, this value was calculated for female and male as $W = 0.013\ L^{3.07}$, $W = 0.009\ L^{3.25}$, respectively. In Reservoir Musov, it was calculated for female and male as $W = 0.013\ L^{3.378}$ (r = 0.998) and $W = 0.003\ L^{3.208}$ (r = 0.997), respectively. In Lake Dabie, b value was determined for male and female as 3.025 and 3.071, respectively. The variations of b value observed in different regions result from environmental factors (Le Cren, 1951; Nikolsky, 1963; Cushing, 1968).

In this study, the mean value of Condition Factors (CF) of females and males were determined as 1.241±0.02 and 1.221±0.03, respectively. It is observed that the condition factor estimated for the age and sex of the specimens increases together with the age (Table 1). Fish move more rapidly at early ages, so the food consumption in this period becomes more. The movement of fish begins to decrease at later ages; therefore, there are plenty of fat and carbohydrate at later ages, though there are excess amount of protein at early ages (Nikolsky, 1980). The roach was determined that the condition factor values increased together with the age. It was obvious that the condition factor value was in the highest level in April and then this value began to decrease until June (Fig. 5). Also, the roach was in the reproduction period among these months.

CONCLUSION

In this study, we carried out, the age group of the roach that were caught the most in the lake was 5+. The length parameters with related age of the roach population in Sapanca lake, is higher than the other localities (except Slapton Ley). This situation may derived from the roach population in this lake, is well adapted to the lake ecosystem. However, the male and the female of the roach which caught from Sapanca lake, not only b value, but also condition factor value are lower than the other localities. This situation can result from the heavy fisheries during spawning period. To utilize the stocks profitably, it is necessary to develop the studies on fish biology and the legislative regulations concerning with fisheries put into effect. This is the first study carried out in Sapanca Lake on the growth parameters of the roach and we hope it will be reference for the studies in the future.

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