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Seasonal Variations in the Length-weight Relationship and Condition Factor of Rudd (*Scardinius erythrophthalmus* L.) in Sapanca Lake

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Abstract: In this study, length-weight relationships, condition (K) factors of 409 rudd individual were determined between the period of December 2000-December 2001 in Sapanca Lake. According to sexes and seasons individuals which were examined about the length-weight relationships, mean weights and values of the condition (K) in the same length group were found no significance difference ($p>0.05$). The length-weight relationship of rudd were detected $W= 0.004\ L^{3.3731}$. The mean of value of condition (K) of rudd was determined 1.243.

Key words: Length-weight relationship, condition factor, Lake Sapanca, *Scardinius erythrophthalmus*

INTRODUCTION

The economical fish species are becoming less in Sapanca Lake where the commercial and sportive fishing is made[1-3]. Rahe and Worthmann[2] indicated in their research that in the commercial fishing, in nets fishermen mostly caught 13 fish species and from these they constituted the 8% of 4 economical species [6.3% pike (*Esox lucius* L.), 1.4% rainbow trout (*Oncorhynchus mykiss* Walbaum, 1972), 0.44% wels (*Siluris glanis* L.), 0.22% carp (*Cyprinus carpio* L.)], and the fish species which had economically less value constituted the majority (92%) of the rest. On the other hand 15 species were determined in the research that was done between 2000-2001 in the lake by Karabatak and Okgerman[3]. From these 15 fish species (total 1723 individuals) constituted of 12% of 5 economical species (7.4% pike (*Esox lucius* L.), 2.9% of tench (*Tinca tinca* L.), 1.1% of carp (*Cyprinus carpio* L.), 0.5% of wels (*Siluris glanis* L.), 0.23% of rainbow trout (*Oncorhynchus mykiss* Walbaum, 1972) and the rest of 88% was the non-economical fish species. These researchers indicated that fish species which were caught in the net constituted of 25% of rudd (*Scardinius erythrophthalmus* L.) and 22% of roach (*Rutilus rutilus* L.) and fishermen mostly caught these species.

Although very limited information is available about the biology of these economical species (pike and carp) that still present in the lake, no research has been done yet on the biology of rudd which is caught most intensively for the commercial fishing and the most abundant one in the lake.

As it is well known, the length-weight relationships and the condition factors of a fish species are one of the most significant biological parameters that supply information to us about the growth level.

Therefore in 2000-2001 study was conducted about the feeding of *Rutilus rutilus* L., *Scardinius erythrophthalmus* L. In the examined samples, seasonally Fulton condition factor and length-weight relationships of this species were designated by making use of datas that belong to the determined length and body weight. By evaluating the present datas, the growth level of this species was tried to be exposed in the lake conditions .

MATERIALS AND METHODS

The rudd in Sapanca Lake were obtained from December 2000-December 2001 at monthly intervals. All fish specimens were caught using gill nets of various (10, 22, 26, 30, 34, 38, 42, 48, 50 mm) mesh sizes. In study was used two nets of (2 and 4 m deep; 50 m long) each size. Fish were processed 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.

In total, 414 rudd were examined. The length-weight relationships regression coefficients of both sexes were determined by the formula $W= aL^{b}$[11]. The general growth curves of length for males and females are plotted. Values of the Fulton condition coefficient (K) were calculated ($K= WL^{-3} * 100$). Significance of differences in fish growth was tested with the Student's t test.

In the research 5 samples of the 414 total individuals were caught during winter (December, January, February). Because of the samples that belong to winter were rare, these were not evaluated. Mean length, weight and condition factors were evaluated according to 5 cm length intervals of total 409 rudd individuals.

Study area: Lake Sapanca (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 and 52 m. The lake water is used as a source of drinking water and as a recreational area. Numann[1] who carried out the first limnological study in Lake Sapanca pointed out that the lake had an oligotrophical character. The studies carried out by many authors[4-10] 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* spp., *Najas* sp. and *Nuphar* 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-NO_2 and Chlorophyll-a are 7.73, 82.18 mg L^{-1} and 10.044 mg m^{-3}, respectively. In this lake, the total of 25 fish species (*Abramis brama* L., 1758, *Alburnus alburnus* L., 1758, *Aspius aspius* L. 1758, *Atherina mochon* Boulenger, 1907, *Blicca bjoerkna* L., 1758, *Carassius carassius* L., 1758, *Caspialosa maetotica* Grimm, 1901, *Chalcalburnus chalcoides* Güldenstaedt, 1772, *Cobitis taenia* L., 1758, *Cyprinus carpio* L., 1758, *Gobius gymnotrachilus* Kessler, 1857, *Gobius lacteus* Nordmann, 1840, *Gobius melanostomus* Pallas, 1811, *Leuciscus borysthenicus* Kessler, 1859, *Leuciscus cephalus* L., 1758, *Nemachilus angorae* Steindachner, 1897, *Rhodeus sericeus* Bloch, 1732, *Syngnathus abaster* Risso, 1826, *Varicorhinus* sp., *Vimba vimba* L., 1758, *Scardinius erythrophthalmus* L., 1758, *Rutilus rutilus* L., 1758, *Siluris glanis* L., 1758, *Esox lucius* L. 1758, *Oncorhynchus mykiss* Walbaum, 1792) were determined by Numann[1]. In addition to these species, *Tinca tinca* L. 1758, an exotic species for this lake, was found by Rahe and Worthmann[2]. The rudd have intensively been caught by the fishermen in this lake. The region where the rudd are mostly caught is the west part of the lake. This region is shallow and there are plenty of macrophytes in it.

RESULTS

Length composition: The length of 409 *Scardinius erythrophthalmus* were determined as 13.4-29.2 cm that were caught between 2000 of December to 2001 of December in the lake. From these, the total length of 221 female individuals were distributed between 13.4-29.2 cm although the total length of 188 male individuals were distributed between 13.7-34 cm. The most abundant samples were between 19.0-20.9 cm (24.15%) length groups (Fig. 1). Two male individuals (31.5, 34 cm) were found bigger than 30 cm among the samples (409 individuals).

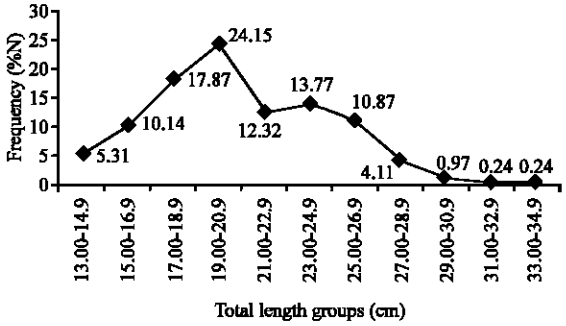

Fig. 1: Total length of distribution of *Scardinius erythrophthalmus*

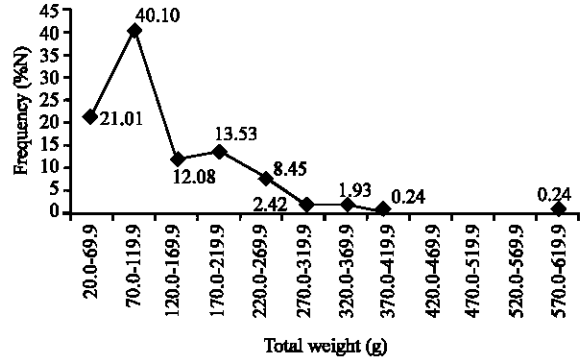

Fig. 2: Total weight of distribution of *Scardinius erythrophthalmus*

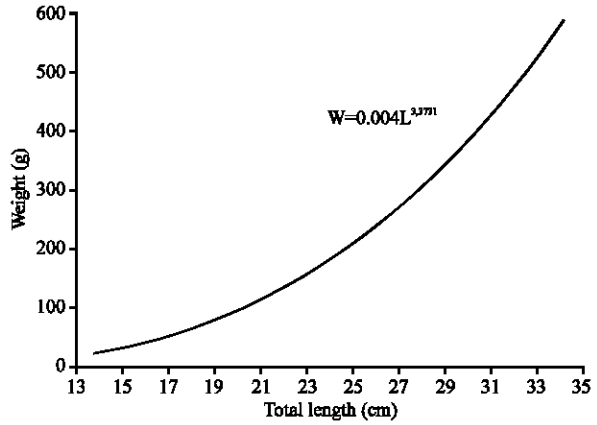

Fig. 3: Curve of Length-weight relationships of *Scardinius erythrophthalmus*

Weight composition: The weights of the examined samples were found. 40% of 409 individuals were between 70.0-119.9 g. Among the samples 2 male individuals, whose weights were more than 369 g, were found (Fig. 2).

Length-weight relationships: In Table 1, length-weight relationships, growing parameters ($W=aL^b$) and

Table 1: Seasonal variations in the length-weight relationships ($W= aL^b$) and correlation coefficients (r) and in the calculated weights for same length groups of rudd specimens collected from Sapanca Lake between December 2000-December 2001

					Calculated weights (W.g)				
Seasons	Sex	n	$W=aL^b$	r	15 cm	20 cm	25 cm	30 cm	35 cm
Spring	Female	92	$W= 0.0043\ L^{3.342}$	0.993	36.99	96.82	204.12	375.49	628.34
	Male	59	$W= 0.0038\ L^{3.395}$	0.986	37.00	98.31	209.65	389.40	656.90
	F+M	151	$W=0.0042\ L^{3.358}$	0.991	37.04	97.36	205.96	380.01	637.38
Summer	Female	49	$W=0.0133\ L^{2.979}$	0.976	42.45	100.04	194.49	334.81	529.78
	Male	38	$W=0.0497\ L^{2.548}$	0.938	49.30	102.65	181.25	288.46	427.16
	F+M	87	$W=0.0210\ L^{2.829}$	0.963	44.60	100.69	189.32	317.10	490.34
Autumn	Female	80	$W= 0.0043\ L^{3.352}$	0.987	37.78	99.15	209.45	385.92	646.69
	Male	91	$W= 0.0033\ L^{3.442}$	0.990	36.33	97.83	210.91	395.09	671.42
	F+M	171	$W= 0.0038\ L^{3.391}$	0.988	37.16	98.62	210.18	390.12	657.80

Table 2: According to length groups of 5 cm, seasonally, mean length (TL), mean weight (W), mean condition (K) values of rudd and standard deviation and significance test of differences between means (student's t-test, p=0.05). *p<0.05

		Spring				Summer			
Total length groups		n	TL	W	K	n	TL	W	K
13.1-18.0 cm	Female	45	15.7±1.3	44.2±13.1	1.116±0.07	9	17.3±0.6	64.6±9.3	1.234±0.13
	Male	21	16.0±1.3	48.3±15.7	1.145±0.12	1	-	-	-
18.1-23.0 cm	Female	41	19.5±1.1	90.8±19.03	1.199±0.08	31	20.6±1.2	111.6±20.8	1.267±0.10
	Male	36	19.5±0.8	89.5±13.2	1.205±0.06	30	20.7±1.4	113.5±23.8	1.274±0.11
23.1-28.0 cm	Female	4	26.2±1.9	241.7±43.2	1.335±0.04	8	24.7±1.2	187.4±32.9	1.227±0.07
	Male	2	24.3±1.6	200.2±53.5	1.384±0.09	6	24.6±1.3	183.2±29.0	1.228±0.05
28.1-33.0 cm	Female	2	29.1±0.1	350.9±26.0	1.423±0.08	2	28.6±0.7	241.9±91.5	1.021±0.31
	Male	-	-	-	-	-	-	-	-
33.1-38.0 cm	Female	-	-	-	-	-	-	-	-
	Male	-	-	-	-	-	-	-	-
Seasonal	Female	92	18.1±3.3	80.2±61.3	1.169±0.10	50	20.9±2.8	120.4±50.6	1.245±0.12
			(13.4-29.2)	(25.5-369.2)	(0.936-1.482)		(16.1-29.1)	(50.4-306.6)	(0.798-1.500)
Average	Male	59	18.3±2.2	78.5±34	1.190±0.10	37	21.2±2.1	123.6±36.4	1.268±0.10
			(13.7-25.4)	(23.6-238)	(0.917-1.452)		(17.4-26.2)	(69.7-220.8)	(1.016-1.472)
Values	Female	151	18.2±2.9	79.5±52.2	1.177±0.10	87	21.1±2.5	121.8±44.9	1.255±0.11
	+		(13.4-9.2)	(23.6-369.2)	(0.917-1.482)		(16.1-29.1)	(50.4-306.6)	(0.798-1.500)
	Male								

		Autumn				Annual			
Total length groups		n	TL	W	K	n	TL	W	K
13.1-18.0 cm	Female	12	17.04±0.7	59.49.5	1.197±0.16	66	16.1±1.3	49.7±14.5	1.147±0.11
	Male	7	17.3±0.9	61.6±10.6	1.187±0.08	29	16.3±1.3	52.2±15.6	1.161±0.11
18.1-23.0 cm	Female	25	19.9±1.3	97.2±21.1	1.220±0.15	97	19.9±1.2	98.9±21.7	1.225±0.11
	Male	29	20.6±1.5	107.9±29.9	1.211±0.11	95	20.1±1.3	102.1±24.7	1.225±0.10
23.1-28.0 cm	Female	38	25.4±1.2	222.3±36.1	1.350±0.06	50	25.3±1.2	218.2±38.3	1.329±0.08
	Male	52	24.9±1.1	212.2±31.1	1.365±0.07	60	24.8±1.1	210.0±33.1	1.353±0.08
28.1-33.0 cm	Female	5	28.6±0.2	349.4±13.1	1.499±0.04	9	28.6±0.3	325.8±59	1.376±0.23
	Male	2	30.3±1.7	390.6±61.9	1.398±0.01	2	30.3±1.6	390.6±61.9	1.398±0.01
33.1-38.0 cm	Female	-	-	-	-				
	Male	1	-	-	-	1			
Seasonal	Female	80	22.6±3.7	166.6±87.4	1.296±0.14	222	20.3±3.9*	120.2±79.2	1.229±0.13*
			(15.9-28.8)	(48.8-360.3)	(0.952-1.684)		(13.4-29.2)	(25.5-369.2)	(0.798-1.684)
Average	Male	91	23.1±3.2	175.6±84.8	1.305±0.12	187	21.2±3.4*	134.7±77.2	1.259±0.12*
			(15.7-34)	(47.7-603.4)	(1.047-1.535)		(13.7-34)	(23.6-603.4)	(0.917-1.535)
Values	Female	171	22.9±3.4	171.4±85.9	1.300±0.13	409	20.7±3.7	126.9±78.5	1.243±0.13
	+		(15.7-34)	(47.7-603.4)	(0.952-1.684)		(13.4-34)	(23.6-603.4)	(0.798-1.684)
	Male								

mathematical equations that were calculated seasonally for the individual samples which were female, male and female-male and the calculated weights for the length groups according to the equations were demonstrated. As it was seen here, the correlation (r) between length-weight relationships generally occurred high in the each gender and in all seasons. That also showed that there was a strong connection between length-weight relationships. Although there were some differences between the mean weights that were calculated for females and males which were in the same length groups, from the statistical point of view, it was discovered that the weight differences

were non significant between the genders in all seasons and they displayed a similar growing. In Fig. 3, the curve of length-weight relationships that were determined for male and female mixture of total 409 individuals were demonstrated.

The highest mean length (22.9 cm) and weight (171.4 g) values of the samples were in autumn whereas the lowest mean length (18.2 cm) and weight (79.5 g) values were in spring (Table 2). When we compared Table 1 and 2 it was discovered that although there were some differences in the weights which were found out by scales and the calculation of the same length groups, these differences statistically were non significant.

Condition factor: The condition factor values which were calculated according to the length groups in the seasonal samples of kızılkanat were given in Table 2. As it was seen here, the condition factors of each genders showed variations as to the seasons and the length groups. The difference between the mixture of female, male, female-male individuals in the same season and in the same length group was found statistically non significant (Table 2). It was seen that the more the length of the fish got bigger the more the condition factor increased. In the kızılkanat individual the highest mean condition factor was in autumn (1.300.13) whereas the lowest condition factor was in spring (1.160.10).

DISCUSSION

The measured total length changed between 13.4-34 cm and the weight changed between 23.6-603.4 g in 409 rudd individuals (*Scardinius erythrophthalmus* L.) that were caught in Sapanca lake. In present research it was determined that the highest total length was between 19-20.9 cm (24%) and the highest weight values were between 70-119.9 g (40%). In the research of Balık *et al.*[12] in Kuş Lake, they indicated that the highest length distribution of rudd was 5.5 cm (15.98%), and the highest weight distribution was 22.5 and 32.5 g of the individuals (7.69). However Papageorgıou and Neophytou[13] stated that the length distribution of rudd, which was present in Kastorias lake in Greece, was in the highest level (≅52%) in the length group of 13-15cm. The length frequency percentage of the samples in the research in Sapanca lake being different from the samples that were caught in Kus lake and Kastoria Lake might arise from the mesh size of the nets that were used in the researches.

The total length was used for the length-weight relationships of the samples of rudd and regression curve coefficient was calculated as b=3.34. It was determined that b value was bigger than 3 and showed resemblance with the common sample in the calculations of length-weight relationships related to gender (for males b=3.347, for females b=3.341). Prokes and Rebickova[14] used the total length for the length-weight relationships of 0+ age group and they found the coefficient of curve as b=3.27 in their research in Musov reservoir of Italy. In the research of Balık *et al.*[12] used the fork length in the length measurement of fish and they determined the regression curve coefficient as b=3.27 in Kus lake. Erdem *et al.*[15] determined the curve coefficient as b= 4.27 by using the fork length in the length-weight relationships of rudd samples in Hamam Lake. When all the researches were compared with one another; the reason of curve coefficient being in the highest degree in Hamam lake provoked us the convenient habitats for the feeding of the fish species and the dominancy in the competition with the other fish species for the feeding.

The mean condition factor of rudd samples were determined as; for female individual it was 1.220 (0.70-1.68), for male individual it was 1.259 (0.91-1.53), for female-male individuals it was 1.243 (0.79-1.68). It was determined that the condition factor increased as the length got bigger in both all samples and in males and females (Table 2). Balık *et al.*[12] found the condition factor between 1.552-2.669 in females, 1.097-2.732 in males of kızılkanat individual in Kus lake. However Erdem *et al.*[15] determined the annual mean condition factor as 1.602 (1.482-1.705) of rudd samples in Hamam lake. Prokes and Rebickova[14] found out the condition factor value between 0.6 and 1.6 for the 0+ age group in Musov reservoir. Fork length was used in the calculation of the condition factor of rudd in Kus lake and Hamam lake whereas total length was used in our research and also in the research that was taken place in Musov reservoir. The condition factor values of the samples that were got in Sapanca Lake, Musov reservoir and Kus lake designated similarities. It was considered that the condition factor of rudd in Hamam lake was lower than the condition factor values in the other lakes. The reason was considered as the environmental conditions and differences between the individuals. When the condition factor values were examined between males and females, these values were determined that there was statistically major difference ($p<0.05$) and the difference was high in favour of males (Table 2). In the seasonal calculations, these values were established that the lowest condition values were in spring. The condition factor being in the lowest degree in this season arised from the spawning period of rudd. On

the other hand the highest condition factor values of the samples were in autumn. In this season rudd individuals were determined that the digestive canals of their were at the highest values of theirs mean wet weights[16].

As a conclusion, in this research the value of b being 3.34 and the condition factor value being 1.243 provoked us that the more the fish got bigger the more environmental condition of this fish grew better. In the commercial fishing , according to the information from the fishermen, rudd took place of pike, carp and wels which were decreasing recently in the lake. In order to benefit from this fish species, researches on the biological feature of this species should be continued.

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