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Growth and Reproductive Properties of Flathead Trout (*Salmo platycephalus* Bhenke, 1968) Population from Zamantı Stream, Seyhan River, Turkey

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Abstract

In this study the growth and reproductive features of the flathead trout (*Salmo platycephalus*) found in the IUCN red list of threatened species in Zamantı Stream of Seyhan River were investigated. The population was composed of 50.44 % female, 40.71% male and 8.85% immature individuals. The fork lengths (cm) and total weights (g) of the individuals varied between 11.3 to 40.1 cm and 19.7 to 988.7 g, respectively. Ten age groups (1 to 10) were identified in the population and majority of the sample was between 26.0 to 38.0 cm (69.91%) and 36.28% was between 410 and 660 g in weight. The length-weight relationship for all sample was $W = 0.016*FL^{2.938}$ with $R^2 = 0.989$. The growth parameters was estimated as; L_∞=60.78 cm, K=0.091 and to= -1.72. The condition factors varied from 1.04 to 1.93 and the differences in condition between female and male was not significant (P>0.05). According to GSI and agg dimaters, spawning period was determined between October and December. Mean fecundity was 2,398 egg/fish, egg diameters was between 4.387 and 5.408 mm (mean diametrers was 4.782 mm) on mature individuals in reproductive periods.

Keywords: *S. platycephalus*, growth, reproductive, Zamantı Stream, Seyhan River.

Seyhan Nehri, Zamantı Çayı'ndaki (*Salmo platycephalus* Bhenke, 1968) Populasyonunun Büyüme ve Üreme Özellikleri

Özet

Bu çalışmada endemik bir tür olan ve IUCN listesinde kırmızı listede bulunan Seyhan Nehri, Zamantı Çayı'ndaki *Salmo platycephalus* populasyonunun büyüme ve üreme özellikleri incelenmiştir. Populasyonun %50,44'ü dişi, %40.71'i erkek ve %8,85'i ise immatür bireylerden oluşmuştur. İncelenen bireylerin çatal boyları 11,3–40,1 cm, total ağırlıkları ise 19,7-988,7 g arasında değişim göstermiştir. Populasyonda 10 yaş grubu (1 ve 10 yaşları arasında) tespit edilmiş ve örneklerin çoğunluğu 26,0-38,0 cm boy grubu (%69,91) ve 410-660 g arasındaki bireylerden (%36,28) oluşmuştur. Bütün örneklerde boy-ağırlık ilişkisi, $W = 0{,}016*FL^{2{,}938}$, $R^2 = 0{,}989$ olarak bulunmuştur. Büyüme parametreleri; $L_\infty = 60{,}78$ cm, $K = 0{,}091$ 1/ yıl, $t_0 = -1{,}72$ yıl olarak hesaplanmıştır. Kondüsyon faktörü 1,04-1,93 arasında değişmiş ve aynı yaş grubunda erkek ve dişiler arasında istatistiki açıdan önemsiz bulunmuştur(P>0,05). Gonadosomatik indeks (GSI) ve yumurta çaplarına göre üreme dönemi Ekim ve Aralık ayları arasında olmuştur. Populasyona ait ortalama fekondite 2.398 yumurta/balık olup üreme dönemindeki olgun bireylerde yumurta çapları 4,387-5,408 mm arasında değişmiş ve ortalama 4,782 mm'dir.

Anahtar Kelimeler: *S. platycephalus*, büyüme, üreme, Zamantı Çayı, Seyhan Nehri.

Introduction

Flathead trout (*S. playtcephalus*) was also known as Anatolian trout and firstly reported by Behnke (1968) from the Soğuksu and Karagöz tributaries of Zamantı Stream in Seyhan River. Bhenke (1968) investigated the 3 specimen of *S. platycephalus* in terms of morphologic features and compared them to the various types of the Salmonids. He realized that this salmonid was remarkably different in respect to some features, which were spotting and some signs on the body and fins, from other Salmonids. Also gill lamels and number of pyloric caeca of this species contributed to be considered as a new species. Stearley and Smith (1993) analyzed the morphologic characteristics of this species by using Cladistric approach. The *S. platycephalus* was supported by Stearley and Smith (1993) and he proofed that *S. platycephalus* was very close to *S. obtusirostris*. *Salmo trutta* populations, however, in Turkey are oriented from the Adriatic and Dunabien phlogeographic genealogical tree have been

known by mitochondrial DNA analysis (Bernatchez, 2001). Molecular studies based on the mitochondrial DNA analysis maintaned that this species is accepted as *Salmo trutta* (Sušnik *et al*., 2004; Bardakcı *et al*., 2006). The differences in morphologic features of *S. platycephalus* specimen were explained with some special environmental factors which might have forced to adaptation (Sušnik *et al*., 2004). Although the natural trout living in Zamantı Stream have been accepted as *S. trutta*, the common usage named of this species is *S. platycephalus*.

The *S. platycephalus* population, living in Zamantı Stream, has been exposed to over fishing pressure and competition, due to non-native species which entered into system such as *O. mykiss*. In the same area *Esox lucius* specimen were also observed, which are inevitably act as a predator organism on the *S. platycephalus*. In Seyhan basin, the distribution of flathead trout is limited with some of the streams which are Soğuksu, Sarız water, Karagöz and Uzunyayla of Zamantı Stream (Bhenke, 1968; Sušnik *et al*., 2004; Alp and Kara, 2004). Among the location where the flathead trout individuals were observed, most of them were identified in the Uzunyayla location in the Zamantı Stream. The first information about the *S. platycephalus* living in Zamantı Stream is based on the studies of Bhenke (1968). Later, the living habitats and distribution (Schöffmann, 1992), weight and condition factor (Alp and Kara, 2004), genetic properties and filogenetic situation (Sušnik *et al*., 2004; Bardakçı *et al*., 2006) of this species were published.

This species have taken in the IUCN Red List of Threatened species (IUCN, 2003; Tarkan *et al*., 2008). In this study, therefore, for the management propose as well, age, growth and reperoduction properties of *Salmo platycephalus* living in Zamantı Stream were investigated.

Materials and Methods

The present study was carried out in Zamantı Stream, an upper tributary of the River Seyhan located at the latitude of 38°38′ N, longitude of 36°17′ E and at the altitude of 1768 m. In the study area, the stream is characterized by a high velocity (1 m^{-1}), abundant in oxygen (12.5 mg L^{-1}) and low temperature (5°C in winter, 19°C in summer) stream width is about 1 m and depth is about 45 cm. The stream and its surrounds are highly vegetated.

A total of 113 individuals were collected during June 2005 to April 2006 from Zamantı Stream using electroshock equipment (a portable Honda generator with 1000 W and, 120 V on AC output). After sampling, the fish were placed on ice and transferred to the laboratory. Fork lengths (nearest mm), weight (nearest 0.01 g) and sex of all specimens were recorded. Sex was determined by examining the gonads under the stereo microscope. In order to get more accuracy in age reading, both scale and otoliths of each individual were used (Chugunova, 1959).

Length-weigth relationships were calculated with $W = a*FL^b$, where W is the fish weight (g) and FL is the fork length (cm). The growth of the *S. platycephalus* population was characterized with the von Bertalanffy growth equation (VBGE) as;

$$L(t) = L_\infty \left[1 - \exp^{(-k(t-t_0))}\right]$$

where L_∞ is the average asymptotic length, k the growth coefficient which determines how fast the approaches L_∞, and t_0 the hypothetical age for $L_{(t)}$ =0 cm. Condition factors of flathead trout were estimated by the equation of $C= (W/FL^3)*100$ by using body weights (g) and fork lengths (cm).

In order to calculate fecundities, the ovaries were weighed; three subsamples were taken from the front, mid - and rear-section of each ovary and they were weighed. The total number of eggs in each subsample ovary was determined. This value was proportional to the total ovary weight; the number of eggs (F1) for the subsample was estimated using the equation, F1= (Gonad weight x number of eggs in the subsample)/subsample weight (Yeldan and Avşar, 2000). Later, by taking the mean number of three subsample fecundities (F1, F2 and F3), the individual fecundity for each female fish was calculated $\left[F = (F_1 + F_2 + F_3)/3\right]$ (Alp *et al*., 2003). Fork length, fecundity and body weight, and fecundity relationships were determined from the equations:

$$\text{In } F = a + b \text{ x In FL; } F = q \text{ x } FL^b$$
$$\text{In } F = a + b \text{ x In } W_B; F = q \text{ x } W_B{}^b$$

where F is the number of eggs (fecundity), FL and W_B are the fork length (mm) and body weight (g), respectively. ‘a’ and ‘b’ are constant parameters in linear regression analysis and $q = e^a$. Fecundity was estimated according to Bagenal and Braun (1978). The diameters of 10 ova (30 ova in each female fish) were measured by digital micrometer. The egg shapes were round and slightly hard when diameters were being measured. The mean fecundities and mean egg diameters for individuals were recorded by age, length and weight. The differences in length, weight and condition factor between males and females among age groups were tested with the Tukey HSD or “t” test (Özdamar, 1999).

Results

Age Groups and Length and Weight Relationship

A total of 113 *S. playtcephalus* individuals were obtained between June 2005 and April 2006 monthly. The examined specimens, 57 were females, 46 males and 10 immature. The ratio of males to females was estimated as 1.00:1.23 and this was not significant from the ratio of 1.00:1.00 (P>0.05).

Mean fork lengths of *S. platycephalus* individuals in the age groups varied from 12.93 cm (age 1) to 40.06 cm (age 10). Mean fork lengths of the combined samples were also 28.48 cm (Table 1). Majority of *S. platycephalus* individuals (69.91%) was between 26.0 and 38.0 cm in length (Figure 1a). The total weights varied from 19.7 to 988.70 g and mean weight of the combined sample was 367.60 g (Table 1). The ten age groups were recorded from 1 to10 (Figure 1b). Individuals of 5-7 age groups are dominant and they were composed of 59.29% of the population.

Table 1. The fork lengths (cm) and total weights (g) in the age groups of *S. platcephalus* from Zamantı Stream of the River Seyhan

Age	Sex	N	FL (cm)	Min-Max	SD	W (g)	Min-Max	SD
1	Juvenil	7	12.93	11.34-14.63	1.480	30.68	19.70-42.40	10.480
	Female	1	13.68			37.70		
	Male	1	15.15					
	Combined sex	9	13.26	11.34-15.15	1.486	33.67	19.70-50.6	11.320
2	Juvenil	3	18.03	16.11-19.00	1.66	98.03	58.00-132.00	37.37
	Female	1	18.03			79.20		
	Male	1	18.72			98.20		
	Combined sex	5	18.17	16.11-19.00	1.21	94.30	58.00-132.00	27.74
3	Female	6	21.63	20.94-22.48	0.61	139.70	121.3-159.2	14.06
	Male	8	20.91	19.49-22.42	0.96	134.86	110.7-171.3	19.96
	Combined sex	14	21.21	19.49-22.48	0.88	136.96	110.7-171.3	17.22
4	Female	2	25.55	24.84-26.25	0.99	232.75	202.6-262.9	42.63
	Male	2	25.11	23.41-26.79	2.38	213.30	196.9-229.7	23.19
	Combined sex	4	25.33	23.42-26.79	1.51	223.02	196.9-262.9	30.18
5	Female	10	28.29	26.80-29.29	0.78	312.72	268.3-436.5	50.45
	Male	7	27.97	27.28-28.44	0.45	293.30	229.7-337.6	34.33
	Combined sex	17	28.16	26.81-29.29	0.66	304.72	229.7-436.5	44.39
6	Female	12	30.85	29.34-32.47	0.89	402.41	349.4-475.2	41.36
	Male	10	30.88	30.05-31.69	0.61	406.78	341.0-472.8	45.38
	Combined sex	22	30.86	29.34-32.47	0.76	404.40	341.0-475.2	42.23
7	Female	18	33.37	31.79-34.67	0.77	506.63	411.1-572.9	40.86
	Male	10	33.13	32.23-34.03	0.64	488.90	407.0-540.9	48.32
	Combined sex	28	33.28	31.79-34.67	0.72	500.30	407.0-572.9	43.64
8	Female	3	36.03	34.94-36.68	0.94	604.56	547.6-661.7	57.05
	Male	5	35.94	35.17-36.86	0.73	644.96	582.0-681.2	41.77
	Combined sex	8	35.79	34.94-36.86	0.75	629.81	547.6-681.2	48.62
9	Female	2	38.30	37.13-39.48	1.65	742.2	667.1-817.3	106.20
	Male	1	37.04			695.8		
	Combined sex	3	37.88	37.04-39.48	1.38	726.7	667.1-817.3	79.73
10	Female	2	40.0	39.93-40.06	0.09	956.25	923.8-988.7	45.89
	Male	1	39.20			739.2		
	Combined sex	3	39.73	39.20-40.06	0.46	883.9	739.2-988.7	129.44
Total	Juvenil	10	14.46	11.34-19.00	2.85	50.89	19.7-132.0	37.97
	Female	57	30.37	13.68-40.06	5.31	415.90	37.7-988.7	190.60
	Male	46	29.20	15.15-39.20	5.76	376.60	50.6-739.2	184.91
	Combined sex	113	28.48	11.34-40.06	6.90	367.60	19.7-988.7	205.42

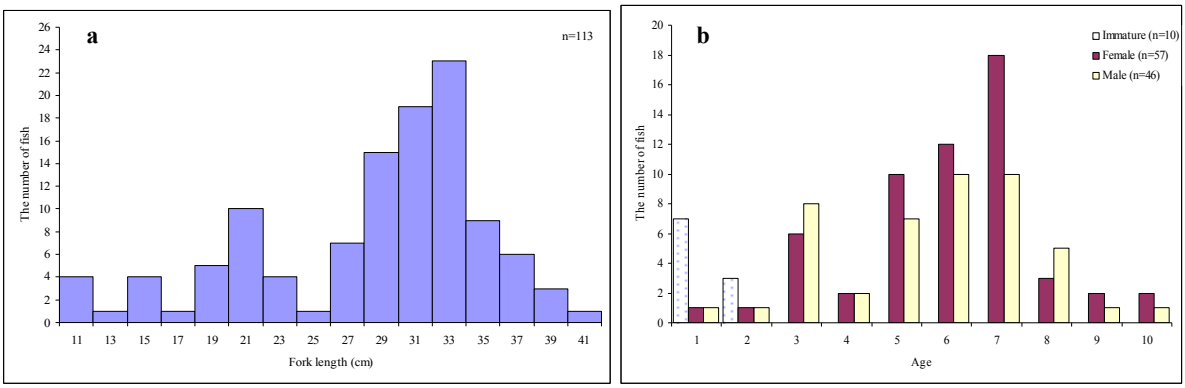

Figure 1. Length and age frequency distributions of *S. platcephalus* in Zamantı Stream of the River Seyhan. a) Length frequency distribution, b) Age frequency distribution.

Length-weight relationship for whole sample was $W = 0.016*FL^{2.953}$ with r = 0.993 (Figure 2).

Growth Characteristics and Condition Factor

The fork lengths and total weights in the age groups of juvenile, male and female *S. platycephalus* are given Table 1. The differences in length between juvenile, males and females in the same age groups were not statistically significant (P>0.05). The parameters of the von Bertalanffy growth model were estimated as L_∞= 60.78 cm, K = 0.091 1/year and, t_0=-1.72 year (Figure 3).

The condition factors were investigated for age groups, monthly (Table 2). The condition factors in the age groups varied from 1.04 to 1.93 and the differences in conditions between females and males in the same age groups were not significant (P>0.05).

Seasonal Fluctuations in the Gonadosomatic Index (GSI)

The reproductive period of flathead trout in the Zamantı Stream was determined by GSI and monthly development of the egg diameters. The GSI in 57 female flathead trout ranged from 0.078 to 14.872. Gonadosomatic index (GSI) has been showed variation between 0.053-13.517 in male individuals (n: 46).

Gonadosomatic index (GSI) was minimum (GSI=0.129) on June and it was maximum (GSI=7.240) on November in female specimens. Similarly, GSI was minimum (GSI=0.128) on June and maximum (GSI=7.942) on November in male individuals (Figure 4). The spawnin season of the population was October and December (Figure 4). In the reproduction period, October and December, water temperature were measured as 7-10°C, dissolved oxygen 8.98-9.20 mg/L and pH 8.05-8.12 (Table 3).

Fecundity and Egg Size

Based on 35 females individuals in the age between IV and IX, fecundity varied form 470 to 6,175 eggs/fish (Table 4). The mean fecundity ±SD of the population was estimated as 2,398±1,253 eggs/fish. Mean fecundities were 1,563 eggs/fish in

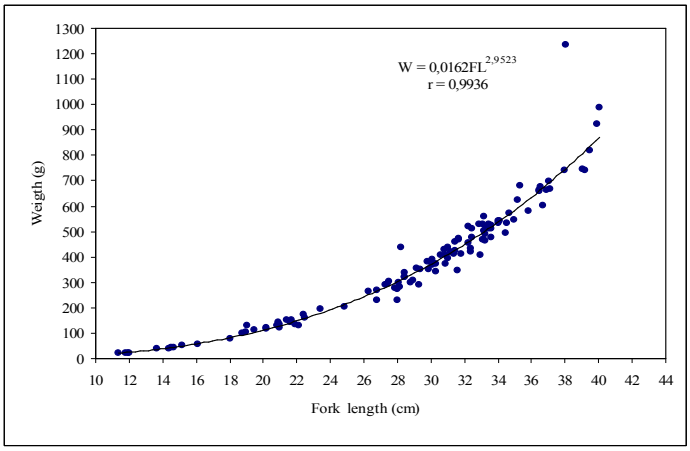

Figure 2. *S. platcephalus* fork length (cm) and weight relationship.

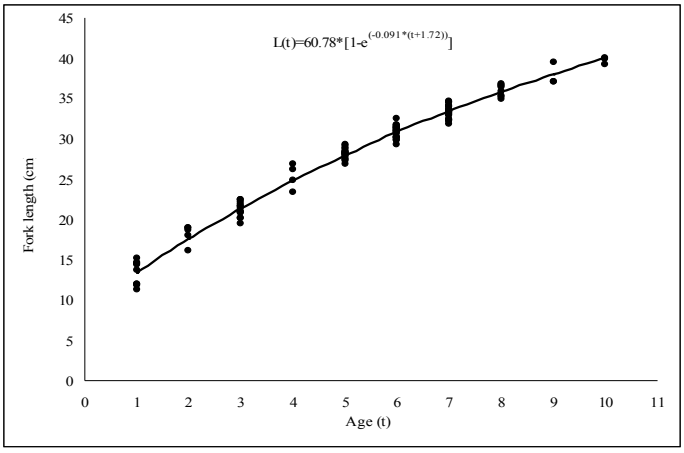

Figure 3. von Bertalanffy age-length realationships.

Table 2. The condition factors of the age groups

The condition factors (C) for different age groups						The condition factors (C) for different months					
Age	Sex	N	C	Min-Max	SD	Date	Sex	N	C	Min-Max	SD
1	Juvenile	7	1.37	1.34-1.42	0.025	June	Juvenile	2	1.45	1.38-1.51	0.092
	Female	1	1.46				Female	4	1.42	1.35-1.48	0.063
	Male	1	1.45				Male	8	1.46	1.26-1.54	0.088
	Combined sex	9	1.39	1.34-1.46	0.045		Combined sex	14	1.44	1.26-1.54	0.077
2	Juvenile	3	1.60	1.38-1.92	0.280	August	Juvenile				
	Female	1	1.35				Female	6	1.37	1.19-1.47	0.103
	Male	1	1.49				Male	6	1.37	1.19-1.58	0.155
	Combined sex	5	1.53	1.35-1.92	0.228		Combined sex	12	1.37	1.19-1.58	0.125
3	Female	6	1.37	1.19-1.48	0.109	Septe.	Juvenile	1	1.92		
	Male	8	1.46	1.26-1.58	0.099		Female	7	1.32	1.20-1.40	0.062
	Combined sex	14	1.43	1.19-1.58	0.109		Male	6	1.43	1.38-1.47	0.040
							Combined sex	14	1.41	1.20-1.92	0.163
4	Female	2	1.38	1.32-1.45	0.092	Octob.	Female	8	1.28	1.14-1.38	0.072
	Male	2	1.36	1.19-1.53	0.239		Male	13	1.39	1.25-1.53	0.083
	Combined sex	4	1.37	1.19-1.53	0.149		Combined sex	21	1.35	1.14-1.53	0.096
5	Female	10	1.38	1.14-1.93	0.219	Nove.	Female	5	1.38	1.28-1.48	0.073
	Male	7	1.33	1.04-1.47	0.148		Male	6	1.35	1.04-1.54	0.147
	Combined sex	17	1.36	1.04-1.93	0.189		Combined sex	11	1.36	1.04-1.54	0.115
6	Female	12	1.36	1.25-1.48	0.059	Dece.	Female	5	1.38	1.25-1.54	0.138
	Male	10	1.37	1.09-1.48	0.128		Male	2	1.31	1.26-1.36	0.073
	Combined sex	22	1.37	1.09-1.48	0.094		Combined sex	7	1.36	1.25-1.54	0.117
7	Female	18	1.36	1.20-1.55	0.098		Juvenile	6	1.37	1.34-1.42	0.027
	Male	10	1.34	1.14-1.50	0.099		Female	13	1.36	1.25-1.55	0.085
	Combined sex	28	1.35	1.14-1.55	0.097		Male	3	1.20	1.14-1.23	0.052
							Combined sex	22	1.34	1.14-1.55	0.089
8	Female	3	1.29	1.22-1.36	0.070	March	Juvenile	1	1.35		
	Male	5	1.39	1.26-1.54	0.107		Female	8	1.46	1.22-1.93	0.216
	Combined sex	8	1.35	1.22-1.54	0.103		Male	1	1.22		
							Combined sex	10	1.42	1.22-1.93	0.206
9	Female	2	1.31	1.30-1.32	0.018	April	Female	1	1.32		
	Male	1	1.36				Male	1	1.43		
	Combined sex	3	1.33	1.30-1.36	0.033		Combined sex	2	1.37	1.32-1.43	0.078
10	Female	2	1.49	1.45-1.53	0.061						
	Male	1	1.22								
	Combined sex	3	1.40	1.22-1.53	0.160						
Total	Juvenile	10	1.44	1.34-1.92	0.176						
	Female	57	1.37	1.14-1.93	0.118						
	Male	46	1.38	1.04-1.58	0.122						
	Combined sex	113	1.38	1.04-1.93	0.126						

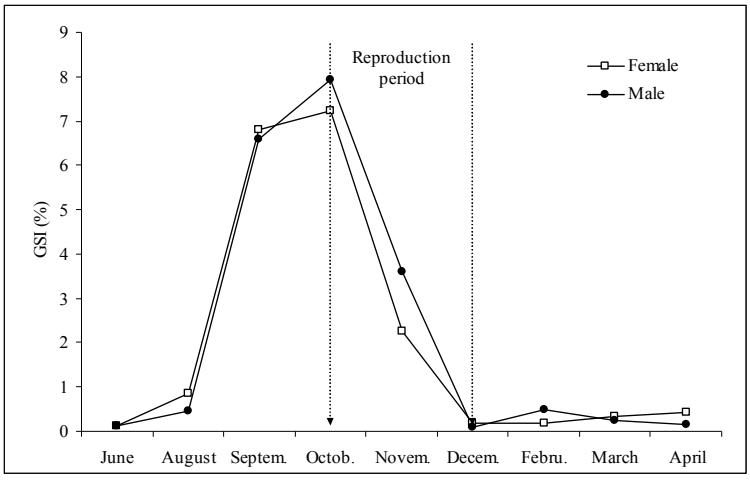

Figure 4. Seasonal fluctations in the mean gonadosomatic index (GSI) in female and male brown trout in the Zamantı Stream, a tributary of the Seyhan River, from June 2005 to April 2006.

Table 3. Some structural and physico-chemical features determined during investigation in Zamantı Stream

Month	Water temperature (°C)	EC (µs)	O_2 (mg/L)	%O_2 (mg/L)	pH
June	16.2	349	9.75	118.1	8.09
August	19.2	343	8.59	112.7	8.33
September	17.1	334	7.45	88.7	8.07
October	11.0	332	5.57	55.3	8.04
November	10.0	331	9.20	102.1	8.12
December	7.1	346	8.98	87.7	8.05
February	9.7	333	6.53	70.9	7.92
March	10.6	320	14.26	157.2	8.03
April	11.3	322	15.48	158.7	8.19

Table 4. Fecundities and egg diameters in age groups of flathead trout caught September, October, November and December in the Zamantı Stream of the Seyhan River. [MFL: Mean fork length (mm); MW: mean body weight (g); F: number of eggs (fecundity); Range: number of eggs; SD: standard deviation; Diameter: mean egg diameter (mm); Range: (mm) in egg diameter]

			Fecundities						Egg size		
Age	MFL (mm)	MW (g)	F	Range	SD	F/W	F/FL	NF	Diameter (mm)	Range (mm)	SD
IV	280.0	273.4	470	-	-	1.71	1.67				
V	294.3	335.2	1,563	1,348-1,767	844.3	4.64	5.33	2	1.81	1.18-2.44	0.88
VI	322.1	450.4	2,058	1,465-2,681	878.0	4.59	6.38	3	1.07	0.60-1.82	0.65
VII	348.6	617.9	2,702	2,272-3,136	1,233.6	4.29	7.66	5	2.55	0.67-4.55	1.76
VIII	366.9	836.1	6,175	-	-	7.38	16.82	1	4.38	-	-
IX	370.7	888.7	3,965	-	-	4.46	10.69				
X	400.6	988.7	4,824	-	-	4.87	12.04	1	5.40		

V. age group, 2058 eggs/fish in VI. age group and 2,702 eggs/fish in VII. age group. Maximum fecundity was estimated as 6,175 eggs/fish in VIII. age.

Linear relationship was determined between fecundity and fork length and body weight (Figure 5). These positive correlations may be expressed by the following regression equations:

$$F = 0.5166.W^{1.3266} \quad (r = 0.685)$$
$$F = 0.0004.FL^{4.4128} \quad r = 0.629)$$

Eggs diameters for 1050 ova of 35 specimens were given in Table 5. Monthly development in egg diameters as consistence to fluctuation in monthly gonadosomatic indexes has been showed that reproduction actions have started in October and finished in December (Table 5). In the reproduction period, maximum egg diameter was 5.408 mm and mean egg diameter was 4.782 mm.

Discussion

Biological studies about *S. platycephalus* are limited, despite a lot of study about *S. t. macrostigma* populations present in Turkey.

The sex ratio determined in this study was consistent with the sex ratios reproted for other Salmo populations. The sex ratio of *S. t. macrostigma* was reported as 19 for males and 35 females in the Teke Stream (Yüksel and Kocaman, 1998), 27 for males and 11 for females in the Çatak Stream (Çetinkaya, 1999) and 79 males and 118 females in Fırnız Stream (Alp *et al*., 2003). The sex ratio of *S. t. labrax* in the Black Sea Region was reported as 509 males and 668 females for stream ecotype and 123 males and 251 females for sea ecotype (Tabak *et al*., 2001). *Salmo trutta fario* individuals were 170 males and 132 females in Yadong Stream, Tibet (Hao and Chen, 2009). The sex ratio of *S. platycephalus* individuals in Zamantı Stream showed similarity with *S. t. macrostigma* populations and quite variety from Çatak Stream populations. The sex ratio of the fish populations changes in the spawing season, life stage of the fish, spawing ground and migration (Nikolsky, 1963).

Age distribution of *S. platycephalus* population in Zamantı Stream was reported between 2 and 10 age groups (Alp and Kara, 2004). In the present study, age distribution were between 0 and 10 age groups and majority of them belongs to 3-7 age groups (75.22%). Age composition for *S. trutta macrostigma* populations were reported as 1-8 ages in Çatak Stream (Çetinkaya, 1996); 0-5 ages in streams of Kaz mountain (Geldiay, 1968); 1-5 ages in Teke Stream (Yüksel and Kocaman, 1998); 0-4 ages in Madrek Stream (Aras *et al*., 1986); 0-8 ages in Alara Stream (Gülle *et al*., 2007); 0-5 ages in Alakır Stream (Gülle *et al*., 2007), 1-4 ages in Köprüçay (Küçük *et al*., 1995) and 1-9 ages in Fırnız Stream (Alp *et al*., 2003).

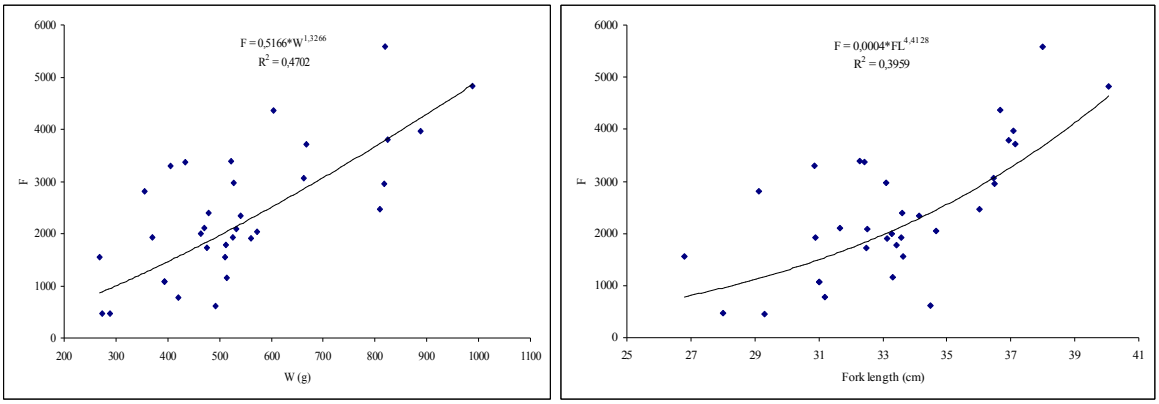

Figure 5. Relationships between fecundity and body weight and fork length in 35 flathead trout.

Table 5. Mean egg diameter development according to months in flathead trout individuals captured in Zamantı Stream. [MFL: Mean fork length (mm); MW: mean body weight (g); SD: standard deviation]

information about fish				Information about egg diameter				
Date	Fish (N)	MW(g)	MFL (mm)	Egg (N)	Mean egg size (mm)	Min.	Max.	SD
18.08.2005	1	268.3	268.05	30	3.151	-	-	-
22.09.2005	2	371.5	302.76	60	2.529	1.822	3.237	1.000
21.10.2005	3	357.56	303.08	90	2.737	2.186	3.585	0.745
19.11.2005	3	721.63	366.12	90	4.782	4.387	5.408	0.548
23.12.2005	4	453.57	315.68	120	0.697	0.603	0.807	0.084
11.02.2006	12	590.34	350.30	360	0.735	0.653	0.845	0.069
18.03.2006	7	655.12	357.03	210	0.884	0.750	0,964	0.078
16.04.2006	3	813.23	392.42	90	1.144	0.953	1.471	0.284

The ages of stream ecotype of *S. trutta labrax* individuals were 0-4 and 0-8 in marine ecotypes (Tabak *et al*., 2001). The 10 age individuals have been determined in the *S. platycephalus* populations which in Zamantı Stream and it has bigger than age groups stated for *S. t. macrostigma* populations.

The age and length of *S. platycephalus* populations in Zamantı Stream was higher than *S. t. macrostigma* in Çatak Stream (Çetinkaya, 1996) and Teke Stream (Yüksel and Kocaman, 1998). Fork lengths of *S. platycephalus* populations in Zamantı Stream were similar to stream ecotype of *S. t. labrax* (Tabak *et al*., 2001) population in Black Sea area, *S. t. macrostigma* populations in Fırnız Stream (Alp *et al*., 2005) and Gürün Gökpınar Stream (Karataş, 1990). The length and weight variations among populations in different regions of the same species may be due to environmental features such as water temperature, feeding and nourishment abound (Nikolsky, 1963).

In this study, growth parameter of *S. platycephalus* population were: L_∞= 60.78 cm, K=0.091 1/year and, t_0= -1.72 year. Asymptotic length at the Fırnız Stream *S. t. macrostigma* population was reported as L_∞=72.75 cm for female and L_∞= 51.01 cm for male individuals (Alp *et al*., 2005).

The exponent "b" in the length-weight relationships of *S. trutta* varied from 2.3 to 4.0 and it was generally reported as about 3 and growth was isometric (Aras *et al*., 1997). In the present study, the exponent "b" was found to be 2.871 for females and 2.853 for males and these "b" values were agreement with the above exponents "b".

Mean condition factors of *S. platycephalus* population in Zamantı Stream varied between 1.04-1.93. Condition factors in *S. t. macrostigma* populations were reported as 1.174 in Çatak Stream (Çetinkaya, 1996), 1.052 in Teke Stream (Yüksel and Kocaman, 1998), 1.87 in Madrek Stream (Aras *et al*., 1986), 1.173 in Karasu Stream (Nakipoğlu, 1992), 1.372-1.584 in Fırnız Stream (Alp and Kara, 2004), 1.132 in Barhal Basin *S. t. labrax* population (Yıldırım, 1991) and 0.890 in stream form of *S. t. labrax* population in Black Sea Region and also, 0.960 in marine form (Tabak *et al*., 2001). The mean condition factors of flathead trout population living in Zamantı Stream are higher than that of the other Salmo populations, except brown trout populations in Fırnız Stream (Table 2). Condition factor may be variate according to fish size, reproduction period, disease and parazite of fish (Bagenal and Tesch, 1978; Welcomme, 2001).

Spawning season of *S. trutta* populations were reported in November-February at the Fırnız Stream (Alp *et al*., 2003), in December-January in Köprüçay (Küçük *et al*., 1995), in November in Gökpınar

(Karataş, 1990) in Turkey. Spawning season were also reported for *S. t. labrax* in November for stream ecotypes and in November-December for the marine ecotypes (Tabak *et al*., 2001). Spawning period were in October-December for *S. trutta fario* population in Yadong Stream, Tibet (Hao and Chen, 2009). Bhenke (1968) was stated that the egg diameters of three *S. platycephalus* specimens caught in July from the Zamantı Stream was about 2 mm and reproduction would be occur in autumn. In the present study, reproduction started in October and finished at the middle of December (Figure 4, Table 4).

The fecundity of brown trouts in Turkish waters were reported as 2,938 egg/kg in Gürün Gökpınar Stream (Karataş, 1990), 3,230 egg/kg in Hodaçu Stream (Yanar *et al*., 1987), 3,053 egg/kg in Köprüçay (Küçük *et al*., 1995), 2,340 egg/fish in Çatak Stream (Çetinkaya, 1999) and also, mean fecundity has been counted 554 egg/fish in Fırnız Stream. Fecundity of *S. t. labrax* populations in Black Sea were 2,428 egg/kg of stream ecotype and 2543 egg/kg at the marine ecotype (Tabak *et al*., 2001). Fecundities of *S. platycephalus* in the present study are consistent with the *S. trutta* populations.

Egg diameters of *S. trutta* were reported as 4.0-4.5 mm at the reproduction period in Çoruh Stream (Tortonese, 1954), 3.93 mm in Gökpınar Stream (Karataş, 1990), 3.0-5.1 mm in Köprüçay (Küçük *et al*., 1995) and mean egg diameter 4.176 mm in Fırnız Stream (Alp *et al*., 2003). Egg diameters of stream ecotype of *S. t. labrax* populations in Black Sea were 4.48 (3.6-5.7) mm for stream ecotype and 5.48 (4.6-7.2) mm for marine ecotype in September-December in reproduction period (Tabak *et al*., 2001). The mean egg diameters of *S. platycephalus* in the present study varied between 2.529-4.782 mm in September, October and November (Table 5). Egg sizes in this study are consistent with *S. trutta* populations in Turkey and smaller than marine ecotypes of *S. t. labrax* populations in Black Sea Region.

S. platycephalus population in Zamantı Stream are endangered and it is under threatend beceuse of fishing pressure, pollution and competition of non-native fish (Tarkan *et al*., 2008). A predator fish, *Esox lucius*, was introduced in this habitat and this has predator effect on the *S. platycephalus* population. Trout farms in the region have also polluted effect on this stream habitat of *S. platycephalus*. Consequently, the upper tributaries of Zamantı Stream should be accepted as a protection area by the concerned institution and this endangered endemic fish species should be protected.

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