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Length-Weight and Length-Length Relationships of *Capoeta sieboldii* from Hirfanlı Dam Lake, Turkey

Savaş Yılmaz^{a,c}, Okan Yazıcıoğlu^a, Mahmut Yılmaz^b and Nazmi Polat^a

ABSTRACT

This study describes the length-weight (LWR) and length-length relationships of *Capoeta sieboldii* from Hirfanlı Dam Lake, Turkey. Condition factor (K) was also calculated per fork length class of females and males. A total of 170 individuals was collected from monthly sampling between March 2004 and August 2005. LWRs of females and males were not statistically different with and within season. LWRs indicated isometric growth in both sexes. The slopes of LWRs were 3.171 for females and 2.980 for males. All correlations among fork length, total length, and standard length were highly significant ($P < 0.001$, $r^2 > 0.92$). The values of K ranged from 1.21 to 1.43 for females and from 1.12 to 1.36 for males.

INTRODUCTION

The length-weight relationship (LWR) is an important tool for fish biology and fisheries management. LWRs are useful in determining weight when only length measurements are available, allow for comparisons of species growth between different localities (Koutrakis and Tsikliras 2003, Oscoz et al. 2005), and express whether growth of fish is isometric or allometric (Le Cren 1951, Ricker 1975). The LWR in fish can be affected by several factors including habitat, area, season, degree of stomach fullness, gonad maturity, sex, health, preservation techniques, and differences in the observed length ranges of the specimen caught (Tesch 1971, Wootton 1998). Length-length relationships (LLRs) are also important for comparative growth studies (Froese and Pauly 1998, Moutopoulos and Stergiou 2002).

Capoeta sieboldii (Steindachner, 1864) is a species of the family Cyprinidae and has a wide distribution from Sakarya river basin to Caucasia. This species is commonly known as "siraz" in Turkey, and it is extensively present in rivers and streams running to the Black Sea. *Capoeta sieboldii* can grow up to 40 cm and is consumed as food by local people (Geldiay and Balık 2007).

In Turkey, length-weight relationships of *C. sieboldii* were investigated in the Delice branch of the Kızılırmak River (Gül et al. 2005) and the upper Çoruh River (Yıldırım et al. 2008). Because there have been no previous studies on LWRs and LLRs of *C. sieboldii* inhabiting Hirfanlı Dam Lake, we undertook this investigation.

METHODS AND MATERIALS

The Hirfanlı Dam is located in the borders of Kırşehir city (38°50'-39°50' N, 33°30'-34°50' E) in the central Anatolia region. It was constructed on the Kızılırmak River and became operational in 1959. Reservoir volume is 598,000 hm³, and reservoir area is 263 km². Although the lake has been classified as oligotrophic (Gürses 2000), there are many fish species present, including *Cyprinus carpio*, *Sander lucioperca*, *Silurus glanis*, *Squalius cephalus*, *Alburnus orontis*, *Capoeta sieboldii*, *Chondrostoma regium*, *Barbus escherichii*, *Tinca tinca*, *Atherina boyeri*, and *Aphanius danfordii*.

Fish were collected from different areas of the lake on a monthly basis from

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March 2004 to August 2005. The specimens were caught using nets with meshes of 18x18, 32x32 and 45x45 mm, seines and fyke nets. All fish were measured to the nearest 0.1 cm for total length (TL), fork length (FL), and standard length (SL) and weighed to the nearest 1 g. Sex was determined from gonad examination. The chi-squared test was used to show whether the sex ratios deviated significantly from 1:1 (Zar 1999).

All length-weight relationships were computed using the equation $W=aL^b$, where W is the total weight of the fish (g), L is the fork length (cm), a is the intercept, and b is the slope (Bagenal and Tesch 1978). The parameters a and b were estimated by linear regression of the transformed equation: $\log W = \log a + b \log FL$. The determination coefficient (r^2) was used as an indicator of the quality of the linear regression. The slopes of LWRs of females and males were compared for significant difference in same season and among seasons by analysis of covariance (ANCOVA). The student's t-test was applied to confirm whether the slopes (b) were significantly different from 3, indicating the growth type: isometric ($b=3$), positive allometric ($b>3$) or negative allometric ($b<3$) (Zar 1999). All length-length relationships were established using linear regression analysis. Relationships between TL vs FL, FL vs SL, and SL vs TL were estimated separately according to females, males and overall samples. The Fulton's condition factor (K) was calculated using the equation $K=W/L^3 \times 100$ (Le Cren 1951, Ricker 1975), where W is the total weight of the fish (g) and L is the fork length (cm). K values of fish were determined separately according to fork length class of female and male individuals. Difference between K values of females and males was tested using the student's t-test (Zar 1999).

RESULTS AND DISCUSSION

From the total of 170 individuals was captured, 79 (46.47%) were females and 91 (53.53%) were males. The overall sex ratio of females to males was 1:1.15, which did not deviate from 1:1 ($\chi^2=0.847$, $P>0.05$). The sex ratios for this species from different habitats in Turkey were estimated as 1:1.21 in the Sakarya River (Ekmekçi 1996), 1:0.85

Table 1. Seasonal descriptive statistics and estimated parameters of LWR for *Capoeta sieboldii* from Hirfanlı Dam Lake, Turkey.

Season	Sex	N	Fork length (cm)		Weight (g)		Parameters of LWR			
			Min	Max	Min	Max	a	b	95% CI of b	r^2
Spring	F	23	24.5	35.4	188	714	0.0037	3.361	2.899-3.822	0.92
	M	46	22.2	34.9	112	624	0.0071	3.177	2.872-3.383	0.91
	Both	69	22.2	35.4	112	714	0.0058	3.235	3.995-3.476	0.92
Summer	F	24	22.8	33.8	130	476	0.0083	3.127	2.732-3.321	0.92
	M	6	25.8	35.6	230	494	0.0573	2.552	1.830-3.275	0.95
	Both	30	22.8	35.6	130	494	0.0154	2.944	2.610-3.277	0.92
Autumn	F	20	20.7	33.5	142	486	0.0143	2.970	2.674-3.267	0.96
	M	28	21.8	33.3	122	434	0.0153	2.954	2.712-3.197	0.96
	Both	48	20.7	33.5	122	486	0.0152	2.955	2.777-3.133	0.96
Winter	F	12	26.8	37.3	256	742	0.0041	3.350	2.773-3.927	0.94
	M	11	26.3	31.5	234	422	0.0106	3.062	2.247-3.876	0.89
	Both	23	26.3	37.3	234	742	0.0043	3.335	2.950-3.721	0.94
Total	F	79	20.7	37.3	124	742	0.0073	3.171	2.990-3.352	0.94
	M	91	21.8	35.6	112	624	0.0139	2.980	2.812-3.147	0.93
	Both	170	20.7	37.3	112	742	0.0100	3.078	2.959-3.197	0.94

in the Delice branch of Kızılırmak River (Gül et al. 2005), and 1:2.06 in the upper Çoruh River (Yıldırım et al. 2008). Our results are in accordance with the previous ones.

The LWRs were highly significant ($P < 0.001$, $r^2 > 0.88$; Table 1). The values of parameter b in this study were within the expected range of 2.5-3.5, but they can vary between 2 and 4 (Bagenal and Tesch 1978). The parameter b values of seasonal LWRs for females and males ranged from 2.970 (autumn) to 3.361 (spring) and from 2.552 (summer) to 3.177 (spring), respectively. Totally, coefficient b of LWR was computed as 3.171 for females, 2.980 for males, and 3.078 for combined sexes. No significant difference was observed in slopes of LWRs of females and males with and within season (ANCOVA, $P > 0.05$). The variations in estimated b values from 3 were not statistically significant ($P > 0.05$) according to sexes and seasons, and this result indicated an isometric growth for *C. sieboldii* throughout the year (Table 1). Gül et al. (2005) reported that b values of LWRs were 2.619 in females, 2.587 in males, and 2.710 for the entire population of *C. sieboldii* inhabiting the Delice branch of Kızılırmak River. These parameters were determined as 3.001 for females, 2.933 for males, and 3.039 for overall individuals in the upper Çoruh River by Yıldırım et al. (2008). Our results were in agreement with findings of Yıldırım et al. (2008), while they were higher than scores of Gül et al. (2005). This may be attributed to differences in the ecological properties of the study areas. Moreover, LWRs in fish are affected by a number of factors including food availability, feeding rate, gonad development, and spawning period as well as season, sex, and habitat (Bagenal and Tesch 1978). The values for coefficient of determination (r^2) for all the LLR parameters of females, males, and entire specimens were > 0.92 and were highly significant ($P < 0.001$; Table 2).

Table 2. Length-length relationships between total length, fork length and standard length of *Capoeta sieboldii* in the Hirfanlı Dam Lake, Turkey.

Sex	N	Equation	a	b	r^2
Female	79	TL = a + bFL	0.112	1.090	0.99
		FL = a + bSL	0.350	1.080	0.98
		SL = a + bTL	0.249	0.824	0.98
Male	91	TL = a + bFL	-0.080	1.100	0.96
		FL = a + bSL	0.840	1.060	0.97
		SL = a + bTL	1.060	0.798	0.93
Both	170	TL = a + bFL	-0.031	1.100	0.98
		FL = a + bSL	0.769	1.070	0.96
		SL = a + bTL	0.851	0.805	0.94

The values of K varied from 1.21 to 1.43 for females and from 1.12 to 1.36 for males (Fig. 1). The higher K values of females and males were obtained in the 37.5 cm ($K=1.43$) and 23.5 cm ($K=1.36$) classes, respectively. The mean K values in females and males were 1.31 ± 0.13 and 1.31 ± 0.11 , respectively. There was no significant difference in mean K between sexes ($P > 0.05$). K values of specimens > 23.5 cm fork length displayed an upward trend in females but a downward trend in males. This difference between sexes may be attributed to both biotic and abiotic factors such as feeding regime and state of gonadal development. The similar result was reported by Hossain et al. (2006) for the Asian striped catfish (*Mystus vittatus*) in the Mathabhanga River, southwestern Bangladesh. They observed that the average condition of samples > 7.0 cm standard length increased with length groups in females and decreased in males.

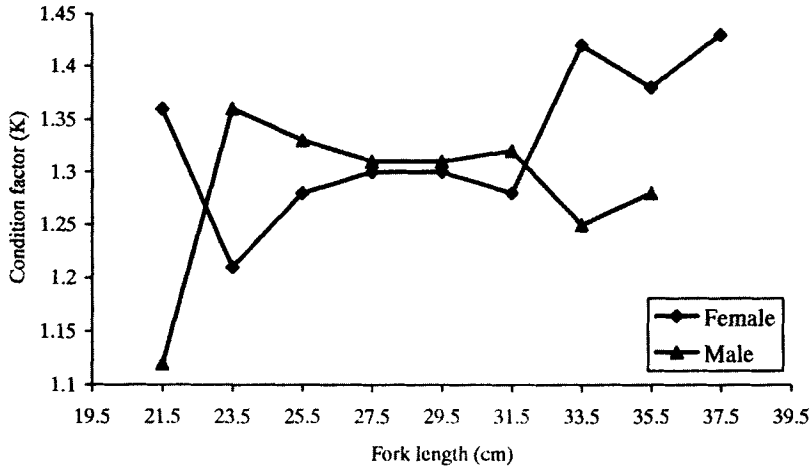


Figure 1. Mean condition factor (K) values per fork length class for female and male individuals of *Capoeta sieboldii* inhabiting Hirfanlı Dam Lake.

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