

Length-Weight Relationships of Five Fish Species from the Sakarya River, Turkey

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Authors' contributions

This work was carried out in collaboration between all authors. Author AEK conceived and designed the study. Authors AEK and DG managed the literature searches, wrote the protocol, performed the statistical analysis, wrote the first draft of the manuscript, and managed the analyses of the study, manuscript editing and review. Author EA performed the experiment. All authors read and approved the final manuscript.

Original Research Article

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ABSTRACT

Aims: The study aimed to investigate the length-weight relationships for five fish species (*Capoeta baliki*, *Capoeta sieboldii*, *Squalius cephalus*, *Silurus glanis* and *Esox lucius*).

Place and Duration of Study: Samples were caught by trammel nets from the Sakarya River, in the northwestern region of Turkey, between October 2010 and February 2012.

Methodology: Fish samples were obtained by trammel nets (inner mesh sizes 32, 36, 40, 44, and 48 mm nominal bar length). Scientific names for each species were checked with the Catalog of Fishes [34]. Total length (TL) was measured to the nearest centimeter (cm) and body weight (W) was recorded in nearest gram (g). All length-weight relationships for five species were calculated using the equation $W=a L^b$ [35]. The coefficients obtained were analyzed with ANOVA. The Student's *t*-test was used for comparison of the slopes [36]. Furthermore, the physical and chemical characteristics of the studied area were monitored.

Results: A total of 1197 fish samples were collected in this survey. Five fish species belonging to three families, Cyprinidae (90.64%), Siluridae (5.35%), and Esocidae (4.01%), were examined. Estimates for parameter *b* of the length-weight relationship ranged between 2.444 and 3.222. There was no significant difference in *b*-value for *S.*

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cephalus ($P>0.05$). In contrast, the b -values of the other species were significantly different from each other ($P<0.05$). The growth type of *S. cephalus* and *S. glanis* was determined as positive allometry ($b>3$), whereas *C. baliki*, *C. sieboldii* and *E. lucius* showed negative allometry ($b<3$).

Conclusion: In this study, a large number of *C. baliki* specimens were examined for the first time. In addition, it was determined that the parameters of length-weight relationships for all studied species were substantially different from each other.

Keywords: Sakarya river; freshwater fish species; trammel nets; Turkey.

1. INTRODUCTION

The length-weight relationships (LWR) parameters are important and useful tools in fish biology, fisheries assessment, stock conditions and other components of fish population dynamics [1,2,3,4,5,6]. The LWRs are also used to convert growth-in-length equations for prediction of weight-at-age and use in stock assessment models, modeling aquatic ecosystems, comparing life history and morphological aspects of populations or a certain species inhabiting different regions [7,8,9,10,11,12].

In this study, the LWRs were estimated for five freshwater species, *Capoeta baliki* Turan, Kottelat, Ekmekçi & Imamoglu, 2006, *Capoeta sieboldii* (Steindachner, 1864), *Squalius cephalus* Linnaeus, 1758, *Silurus glanis* Linnaeus, 1758, and *Esox lucius* Linnaeus, 1758, caught by trammel nets from the Sakarya River, Turkey. There are many papers on the LWR of these species [e.g. 13,14,15,16,17,18,19,20,21,22,23,24,25,26]. However, these studies were carried out in many lakes, reservoirs and the rivers, all of which were out of our study area. Apart from the present study, there is only one reported study on LWR parameters for *C. baliki* [27]. Therefore, our study aims to contribute to the knowledge of LWR data and gives up-to-date information for some Turkish freshwater fish species.

2. MATERIALS AND METHODS

Fish samples were obtained from a survey seasonally conducted for selectivity by trammel nets (inner panel: 32, 36, 40, 44, and 48mm, outer panel: 300mm; nominal bar length) in the Sakarya River from October 2010 to February 2012 (Fig. 1).

The design and specifications of the net used in the experiment were similar to the trammel nets commercially used in the study area, where depths range between 5 and 25m. Moreover, the obtained minimum and maximum values of dissolved oxygen, salinity, pH, and temperature were recorded. This study is also a part of the project regarding the selectivity of the trammel nets.

Fish catches at each sampling were registered in numbers of individuals per species. Fish species were taxonomically identified in the laboratory according to Geldiay and Balık [29], Kuru [30], Kottelat and Freyh of [31], Wheeler [32], and Turan et al. [33], and the scientific names of each species were checked with the Catalog of Fishes [34]. Total length (TL) was measured to the nearest centimeter (cm) and body weight (W) was recorded in nearest gram (g). TL of each fish was taken from the tip of the snout to the extended tip of the caudal fin using a measuring board.

Length-weight relationships were calculated using the equation $W=a L^b$ [35], where 'W' is the body weight of the fish, 'L' is the total length, 'a' is the intercept of the regression curve and 'b' is the regression coefficient. The significance of the obtained coefficients was assessed by analysis of variance (ANOVA) and the Student's *t*-test was used for comparison of the slopes [36].



Fig. 1. Study area: The Sakarya River [28]

3. RESULTS AND DISCUSSION

A total of 1197 fish samples from the Sakarya River were collected in this survey. Five fish species belonging to three families, Cyprinidae (90.64%), Siluridae (5.35%), and Esocidae (4.01%), were examined. Sample size (N), minimum and maximum lengths, the parameters of length-weight relationships (*a* and *b*), standard error (SE), and the coefficient of determination (R^2) are presented in Table 1. Additionally, the relationship between total length (TL) and total weight (W) were described as $W=0.0408 L^{2.6339}$ for *C. baliki*, an endemic and less-studied species in Turkey (Fig. 2). All relationships were highly significant ($P<0.001$). It was found that there was no significant difference between our *b*-value and the other results for *S. cephalus* ($P>0.05$). On the other hand, the *b*-values for the other species were significantly different each other ($P<0.05$).

Table 1. Parameters of the LWR for five fish species from the Sakarya River (Turkey)

Family	Species	N	TL(cm)		W(g)		Parameters of the LWR			
			(Min)	(Max)	(Min)	(Max)	a	b	SE(b)	R ²
Cyprinidae	<i>Capoeta baliki</i>	1024	18.00	51.70	72.30	1819.50	0.0408	2.6339	0.040	0.808
	<i>Capoeta sieboldii</i>	24	22.40	33.40	274.80	717.60	0.1356	2.4440	0.149	0.925
	<i>Squalius cephalus</i>	32	21.10	29.30	147.20	398.10	0.0079	3.1875	0.202	0.893
Siluridae	<i>Silurus glanis</i>	64	22.50	86.70	66.10	5987.60	0.0032	3.2216	0.049	0.986
Esocidae	<i>Esox lucius</i>	48	40.20	76.30	689.40	3421.50	0.0659	2.4814	0.089	0.944

* N, sample size; TL, total length; W, body weight; Min, minimum; Max, maximum; a and b, intercept and slope of length-weight relationship; SE (b), standard error of the slope b; and R², coefficient of determination

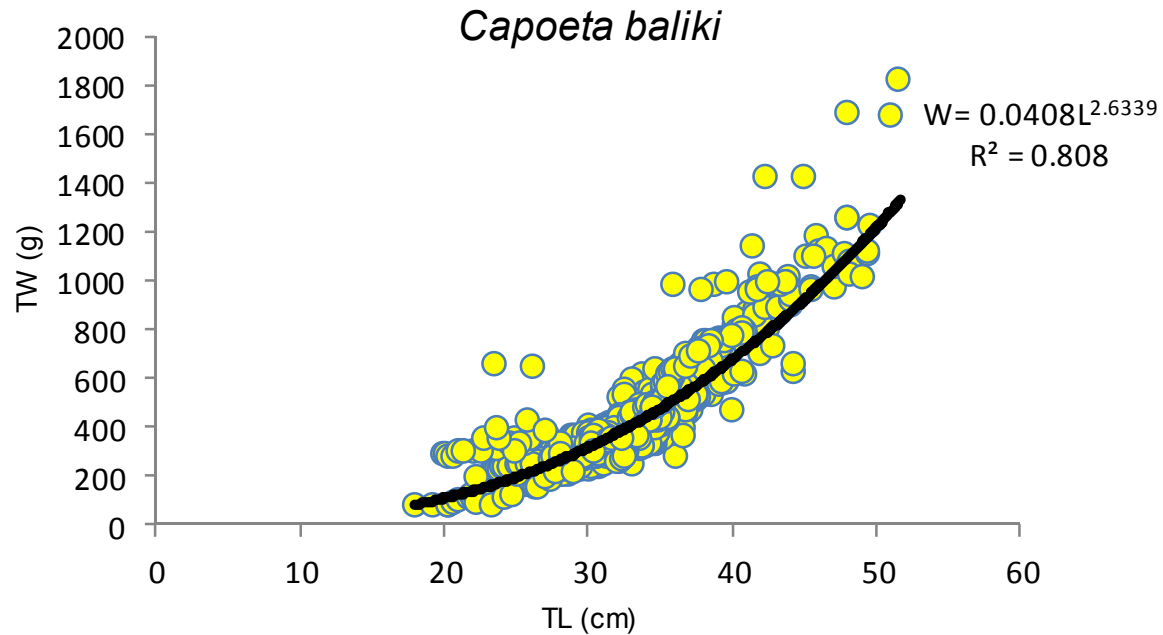


Fig. 2. Length-weight relationship of the *Capoeta baliki*

Furthermore, the physical and chemical characteristics of the studied area were monitored. The obtained minimum and maximum values of dissolved oxygen, salinity, pH, and temperature were recorded as 5.1–11.6mg/L, 0.34–0.54 ppt, 7.5–8.6, and 9.3–25.2°C, respectively.

In the present study, the growth type of *S. cephalus* and *S. glanis* was determined as positive allometry ($b > 3$), whereas *C. baliki*, *C. sieboldii*, and *E. lucius* showed negative allometry ($b < 3$). In many studies carried out in Turkey (Table 2), the different growth types for these species were reported. Of these studies, there was only one study [27] about *C. baliki* carried out in Turkish freshwaters. Unlike our finding, they reported that the growth type of *C. baliki* was positively allometric. Except for *S. cephalus*, our LWR parameters were relatively different from those found in other studies (Table 2).

As widely known, LWR parameters are influenced by many factors such as the season and effects of different areas, changes in water temperature and salinity, pollution status or anthropogenic activities, gonad maturity, food availability, stomach fullness and differences in the number of specimens examined, and the observed length ranges of the species caught [1,37,38,39,40]. Likewise, our LWRs were naturally different from the other observed parameters caused by the various factors mentioned above.

Table 2. The length-weight equations for five species in Turkish freshwaters

Species	Present study		Other studies		Ref.
	N	W-L equation	N	W-L equation	
<i>Capoeta baliki</i>	1024	$W=0.0408 L^{2.6339}$	55	$W=0.009L^{3.17}$	[27]
<i>Capoeta sieboldii</i>	24	$W=0.1356 L^{2.444}$	404	$W=0.012L^{3.039}$	[14]
			170	$W=0.0100L^{3.078}$	[17]
<i>Squalius cephalus</i>	32	$W=0.0079 L^{3.188}$	126	$W=0.009L^{3.032}$	[27]
			27	$W=0.006 L^{3.19}$	[13]
			101	$W=0.0138FL^{3.0276}$	[23]
			466	$W=0.0106L^{3.0884}$	[26]
<i>Silurus glanis</i>	64	$W=0.0032 L^{3.222}$	242	$W=0.00005L^{2.8278}$	[25]
			7	$W=0.0199L^{2.568}$	[16]
			21	$W=0.0320L^{2.57}$	[13]
			257	$W=0.0104L^{2.9133}$	[24]
<i>Esox lucius</i>	48	$W=0.0659 L^{2.481}$	6	$W=0.0096L^{2.90}$	[15]
			13	$W=0.003L^{3.210}$	[15]
			311	$W=0.0226L^{2.7195}$	[21]
			313	$W=0.0004L^{3.208}$	[22]
			100	$W=0.0357L^{2.69}$	[20]
			284	$W=0.0076L^{3.18}$	[19]
166	$W=0.0022L^{3.39}$	[18]			
			13	$W=0.0030L^{3.21}$	[15]

*N, sample size; L, total length; FL, fork length

4. CONCLUSION

In this study, the length-weight relationships for five fish species (*C. baliki*, *C. sieboldii*, *S. cephalus*, *S. glanis*, and *E. lucius*) from the Sakarya River (Turkey) were determined. The LWR values indicated positive allometric growth for *S. cephalus* and *S. glanis*. Therefore, while compared with the other studied species, the two species were in good

condition. Moreover, a large number of *C. baliki*, which is an endemic species, were assessed for the first time.

The references given in this paper are mostly from other regional observations. Modern conservation and ecosystem-based management strategies for freshwater species require updating and area specific information. Almost no recent information is available for our study area. In this respect, we have considered that our results will contribute positively to the management of freshwater fisheries and to related studies to be carried out in the future.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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