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RESEARCH ARTICLE

Length-weight relationships and condition factors of three fish species in the Karamenderes Stream (Çanakkale, Türkiye)

Şükran Yalçın Özdilek[1], Nurbanu Partal[2,3]

[1]Çanakkale Onsekiz Mart University, Faculty of Arts and Sciences, Department of Biology, Çanakkale, Türkiye

[2]Çanakkale Onsekiz Mart University, Faculty of Political Sciences, International Relations Office, Çanakkale, Türkiye

[3]Çanakkale Onsekiz Mart University, Faculty of Arts and Sciences, Department of Biology, Aquatic Ecology Laboratory, Çanakkale, Türkiye

ORCID: S.Y.Ö. 0000-0001-8264-7606; N.P. 0000-0001-7203-8129

Abstract

Objective: The aim of this study is to determine the length-weight relationships and condition factors of two native freshwater fish species and the invasive *Carassius gibelio* in the Karamenderes Stream (Çanakkale, Türkiye).

Materials and Methods: Fish specimens were caught monthly from August 2007 to July 2008 using cast nets in Karamenderes Stream's Pınarbaşı location. The length-weight relationship was calculated according to $W = aL^b$ and the Fulton's condition factor was calculated according to $K = 100*W/L^3$ equations.

Results: The b (slope) values of the length-weight relationships are 3.026, 3.201, and 3.255, respectively, for *Barbus oligolepis*, *Squalius cii*, and *C. gibelio*. The growth was isometric in *B. oligolepis* and positive allometric in *C. gibelio* and *S. cii*. The Fulton's condition factor varied between 0.51 and 2.08 in *C. gibelio*, 0.76 and 1.25 in *B. oligolepis*, and 0.59 and 1.44 in *S. cii* specimens.

Conclusion: This study is the first report that presents the length-weight relationship of two native *species, B*. *oligolepis* and *S. cii*, in the presence of invasive *C. gibelio*. The length and weight distribution pattern through the year indicated that there was seasonality in the utilization of this section of the stream by juvenile and adult stages of three species. The lowest condition factor and b value in *B. oligolepis* led us to the conclusion that the competitive exclusion risk of this species. The effect of invasive *C. gibelio* on the natives should be further researched focusing on species interactions. From the fact that there are limited data on the length-weight relationship and biology of *B. oligolepis* and *S. cii*, there is a need for further research.

Keywords: Growth, Condition, Invasive species, Native species, Çanakkale

Introduction

In general, length-weight relationships in fisheries biology aid to determine the regional or habitat-specific biological characteristics of the species (Gonçalves et al., 1997). Additionally, the length-weight relationships are useful for determining the stock assessment, sexual maturation of fishes (Ogle, 2018; Wottoon, 1990) and are a time-saving tool in the fieldwork (Martin-Smith, 1996). It has been assumed that the length-weight relationships of fish species sharing the same habitat will shed light on interspecific relationships in the community (Robinson et al., 2010). *Barbus oligolepis* (Battalgil, 1941) and *Squalius cii* (Richardson, 1857) are two native freshwater fish species that share the same habitat with invasive *Carassius gibelio* (Bloch, 1782) in Karamenderes Stream. The length-weight relationship and condition factor values of these native species with an invasive species may give interesting data because of possible food or habitat competitions that may have to arise due to the interaction of species with

each other. When studying length-weight relationships, it is important to keep in mind that they are influenced by a variety of biotic and abiotic factors (Froese, 2006). In addition to physical or chemical constitutes, there is limited study on the length-weight relationships of native *B. oligolepis* and *S. cii* species in the presence of invasive competitors. Therefore, the aim of this study is to determine the length-weight relationships, length, weight, and condition factor distributions of two native freshwater fish species and invasive *C. gibelio* in the Karamenderes Stream's Pınarbaşı location.

Material and Methods

Field studies were carried out with monthly surveys between August 2007 and July 2008. Sampling was carried out along nearly to 2 km section at Pınarbaşı location (39°53′28″ N, 26°17′32″E and 39°54′07″N, 26°16′28″E) of Karamenderes Stream in Çanakkale (Türkiye) with cast nets (12-25 mm mesh size) (Fig. 1). Karamenderes Stream originates from Kaz and Ağı mountain, flows through Troy, and reaches Çanakkale Strait. The stream is 109 km long, nearly 3–15 m wide, and it includes two irrigation reservoirs (Bayramiç and Pınarbaşı Reservoirs). The depth of the study area is nearly 25-80 cm, habitat is run, riffle, and pool characteristic and the bottom type includes gravel, sand, and clay. After sampling, the specimens were kept in clove oil treatment under ethical guidelines then they were carried to the laboratory (Prince & Powell, 2000). In the laboratory, the total length (*TL*) of the fish specimens was measured with a ruler nearest to 0.1 mm. Body weights (*W*) were weighed with a digital balance nearest to 0.1 g. The descriptive statistics were given as mean, standard

deviation, minimum and maximum values for *TL, W,* and *K*. The equation of $W = aL^b$; *W*: body weight (g), *a*: regression intercept, *b*: growth coefficient, *L*: total length (cm) equation was used to determine the length-weight relationships of the specimens (Bagenal, 1978; Froese, 2006). In this equation, the growth type was determined based on the *b* value. If this value is greater than 3, it is defined as positive allometric growth, if it is less than 3, it is defined as negative allometric growth, and if it is equal to 3 it is defined as isometric growth (Bagenal, 1978). The linear regression model was used to estimate 95% confidence limits (Cl) of *a* and *b*, and the coefficient of determination (r^2) according to Ogle (2018) in R Software (R Core Team, 2021). The visualization of the figure was produced with the *ggplot2* package (Wickham, 2016) in R Software (R Core Team, 2021). The maps were produced in ArcGIS. Fulton Condition Factor ($K = 100*W/L^3$) equation was used to determine the body condition of specimens (Le Cren, 1951).

Results

A total of 271 specimens were examined of three species whereas 77 specimens were *B. oligolepis*, 117 specimens were *C. gibelio* and 77 specimens were *S. cii*. Even attempts, fish could not be caught in some months (Fig. 2). The species total length, weight and condition factors descriptive are given in Table 1.

The specimens of *B. oligolepis* were found to be smaller between August and October (2007) than in other months in terms of overall length and weight (Fig. 2). The largest specimens in the population were sampled in March, April, and July 2008. In terms of the condition factor, it was

Figure 1. The map of the sampling area (Karamenderes Stream, Çanakkale, Türkiye).
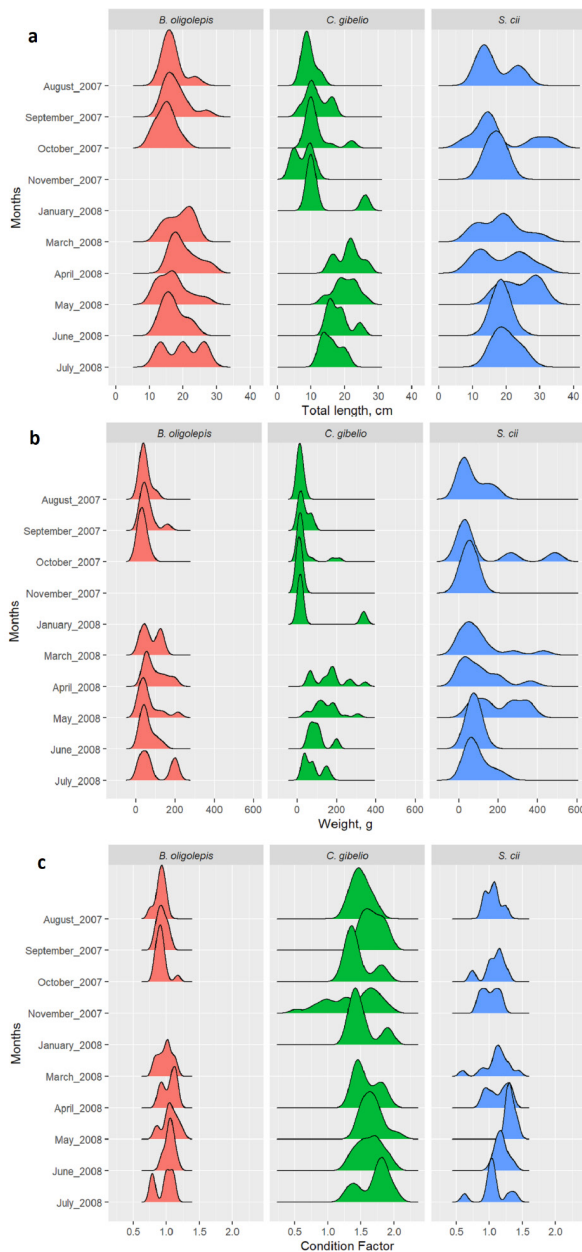
Figure 2. a:Total length (cm), b:weight (g), and c:condition factor values of three species.

determined that the condition was low in August-October 2007. Based on total length and weight by month, the *C. gibelio* population was smaller in August-October 2007

than in other months (Fig. 2). The largest specimens in the population were sampled in April-June 2008. The condition factor was found to be higher in *C. gibelio* specimens than in other species specimens. In November 2007 and June 2008, the specimens in the *S. cii* population were smaller than in other months in terms of total length and weight by month (Fig. 2). The largest specimens in the population were sampled in October 2007 and April-May 2008. In terms of condition factors for *S. cii* specimens, it was determined that the highest condition factor was in May and June 2008 (Fig. 2).

The growth characteristics and descriptive statistics of the three species were given in Table 1. The growth equation of the examined *B. oligolepis* specimens was $W=0.0091L^{3.0256}$, the growth equation of *C. gibelio* specimens was $W=0.0079L^{3.2552}$ and the growth equation of *S. cii* specimens was $W=0.0062L^{3.2006}$. According to the growth equations of the examined specimens, the growth was isometric in *B. oligolepis* and positive allometric in *C. gibelio* and *S. cii*. (Table 1). The highest growth coefficient (*b* value) out of the three species was found in *C. gibelio* specimens (Table 1).

Discussion

In this study, the length-weight relationships and condition factors of three freshwater fish species have been examined. The *b* values for all three species were within the predicted range (2.5–3.5) (Froese, 2006). The feeding behaviours, reproductive characteristics, seasonality, and habitat characteristics can be given among the elements that affect the length-weight relationship and the condition factor (Froese, 2006; Wootton, 1990). The predicted range of *b* values should be evaluated by various elements of species' life-history traits. As it is known, the gonads of freshwater fish mature during the spawning season, which causes an increase in body weight (Nikolsky, 1963; Wootton, 1990). The high condition values in three species in

Table 1. Length-weight relationships parameters and descriptive statistics for three species (*TL*: Total length; *W*: Body weight; *K*: Condition factor; n: Number of specimens; SD: Standard deviation; *a*: Intercept of linear regression; *b*: Slope of linear regression; CI: Confidential interval; r²: Coefficient of determination (R<0.05)).

Species	n	*TL* (cm) mean±SD	min	max	*W* (g) mean±SD	min	max	*K* mean±SD	min	max	*a*	95% CI of *a*		*b*	95% CI of *b*		r²
B. oligolepis	77	17.3±3.9	11.1	28.1	59.4±45.6	12.1	213.4	0.99±0.11	0.76	1.25	0.0091	0.007	0.013	3.026	2.907	3.144	0.9733
C. gibelio	117	14.7±6.4	4.0	32.5	77.9±84.4	0.6	344.1	1.55±0.26	0.51	2.08	0.0079	0.007	0.009	3.255	3.194	3.317	0.9898
S. cii	77	18.8±5.4	7.8	33.8	97.8±96.5	3.5	487.6	1.12±0.17	0.59	1.44	0.0062	0.004	0.009	3.201	3.084	3.318	0.9754

the spawning season (spring and beginning of summer) might be explained by maturity.

In the literature there are many well documented studies on the length-weight relationship and condition features of invasive *C. gibelio* (Ağdamar & Gaygusuz, 2021; Birecikligil et al., 2016; Bostancı et al., 2007; Erguden, 2016; Güçlü & Küçük, 2021; Ilhan & Sari, 2015; Kırankaya & Ekmekçi, 2013; Saç & Okgerman, 2016; Şaşı, 2015; Yazıcıoğlu et al., 2013). Based on these studies it can be said that there were spatial variations in length-weight relationships and the condition factor values depending on local conditions and community structure. In Kocabaş Stream (Biga Peninsula), the *b* values of *B. oligolepis* specimens are higher (3.17 and 3.31) than that in Karamenderes population (Ertürk Gürkan & Yalçın Özdilek, 2020). On the other hand, when this study is compared to the study in Kocabaş Stream, *b* values for *S. cii* specimens were similar with the downstream population (3.21) but lower than the upstream population (3.41, see Ertürk Gürkan & Yalçın Özdilek, 2020). The *b* values of *B. oligolepis* and *S. cii* reported by İlhan et al (2012) are similar to the present results.

This study is the first report that presents the length-weight relationship of two native species, *B. oligolepis* and *S. cii*, in the presence of invasive *C. gibelio*. The fact that *C. gibelio* had a high *b* value and the high condition factor is compatible with the previous studies that have been reported invasive characteristics of this species. For instance, the characteristics of the invasive species include high plasticity (Yalçın Özdilek & Jones, 2014), rapid spreading through the gynogenesis and reproductivity characteristics (Paschos et al., 2004), altering the native species niches (Yalçın Özdilek et al., 2019), and filling the vacant niches (Karlson et al., 2015).

As a conclusion of this study, the section of Karamenderes Stream was used for both juvenile and adult stages by three species. The length and weight distribution pattern through the year indicated that there was seasonality in the utilization of this section by juvenile and adult stages of three species. The lowest condition factor and *b* value in *B. oligolepis* led us to the conclusion that the competitive exclusion risk of this species. The effect of invasive *C. gibelio* on the natives should be further researched focusing on species interactions. From the fact that there are limited data on the length-weight relationship and biology of *B. oligolepis* and *S. cii*, there is a need for further research.

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