-RESEARCH ARTICLE-

Length-weight relationship and condition factor of Ankara barb *Capoeta angorae* (Hankó, 1925) in Asi River (Hatay, Turkey)

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Abstract

The length-weight relationship (LWR) for commecially important Ankara barb, *Capoeta angorae* was studied. A total of 208 specimens, collected from Asi River during the period from March 2015 to February 2016 were examined. The relationship between length and weight of the samples were evaluated as $W = 0.020 x L^{2.784}$ ($R^2 = 0.983$). Negative allometric growth for all individuals was found. Fulton's condition (CF) factor values showed significant variations ($P < 0.001$) for both females (1.102) and males (1.068). To the best knowledge of this study presented the first reference on LWR and Condition Factor (CF) this species from Asi River.

Introduction

Ankara barb *Capoeta angorae* (Hankó, 1925) is a benthopelagic cyprinid fish species and belongs to the family Cyprinidae, that occur in the Anatolian freshwater systems. This species is locally found mainly in rivers, reservoirs, and streams of Anatolia, Turkey (Geldiay & Balık, 2007; Fricke

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et al., 2007; Erguden, 2016). *C. angorae* is a large species, reaching over 42 cm total length and 832 g body weight (Alp et al., 2005; Froese & Pauly, 2017).

Length–weight relationship (LWR) of fishes are an important aspect of fishery biology and have a number of applications in fish stock assessment. LWR for fish was originally used to obtain information on the condition of fish and to determine whether somatic growth was isometric and/or allometric (Le Cren, 1951; Ricker, 1975).

In fisheries biology, LWR data are useful to determine the weight of an individual fish of known length or total weight from length-frequency distribution (Froese, 1998; Koutrakis & Tsikliras, 2003). It is also helpful in local and interregional, morphological and life historical comparisons in species and populations (Kara & Bayhan, 2008; Erguden et al., 2011; Erguden, 2016). Besides LWR of threatened and commercially important fishes are highly significant for management and conservation of populations in natural waterbodies.

Condition factors are also important parameters for the evaluation of fish stocks and Fulton's condition factor (CF) is widely used in fisheries and fish biology studies.

Capoeta angorae (Hankó, 1925) is the commercially valued and Anatolian endemic fish in the Asi River Basin and distributed along the river. In recent studies, *C. angore* have been reported in the inland waters of Turkey (Başıaçık, 2013; Emre et al., 2014; Ayyıldız et al., 2015; Erguden, 2016).

To date there are a number of length-weight reports available on freshwater fishes collected from Asi (Orontes) River (Demirci & Yalçın-Özdilek, 2007; Demirci & Özdilek, 2010; Ozcan & Altun, 2015).

The present study was a first attempt to estimate the LWR and Condition factor of *C. angorae* fish species from Asi River with further possible application in line with the strategies of conservation, restoration and management of this species.

Materials and Methods

Fish samples were collected from the Asi River using gill net and trammel net of various mesh sizes from March 2015 to February 2016 (Figure 1).

Specimens were transported on ice in a cooler box to the laboratory. All sampled individuals were weighted (TW) by an electric balance to the nearest 0.01 g and the total length was measured by slide calipers to the nearest 0.1 cm. Sex was identified by macroscopic and microscopic examination of the gonads.

LWR was calculated using the expression: $W = a \times L^b$, where W is the total wet weight (g), L is the total length (cm), a is the intercept of the regression and b is the regression coefficient. The parameters a and b were estimated by linear regression on the transformed equation: $\log(W) = \log(a) + b \log(L)$. Additionally, the Student's t-test (Zar, 1999) was used to test for difference of the parameter "b" from the theoretical value of 3.

Fulton's Condition Factor (CF) (Cone, 1989) was calculated using the equation $K = (W/L^3) \times 100$, where a and b are the exponential form of the intercept and slope, respectively, of the logarithmic length-weight equation.
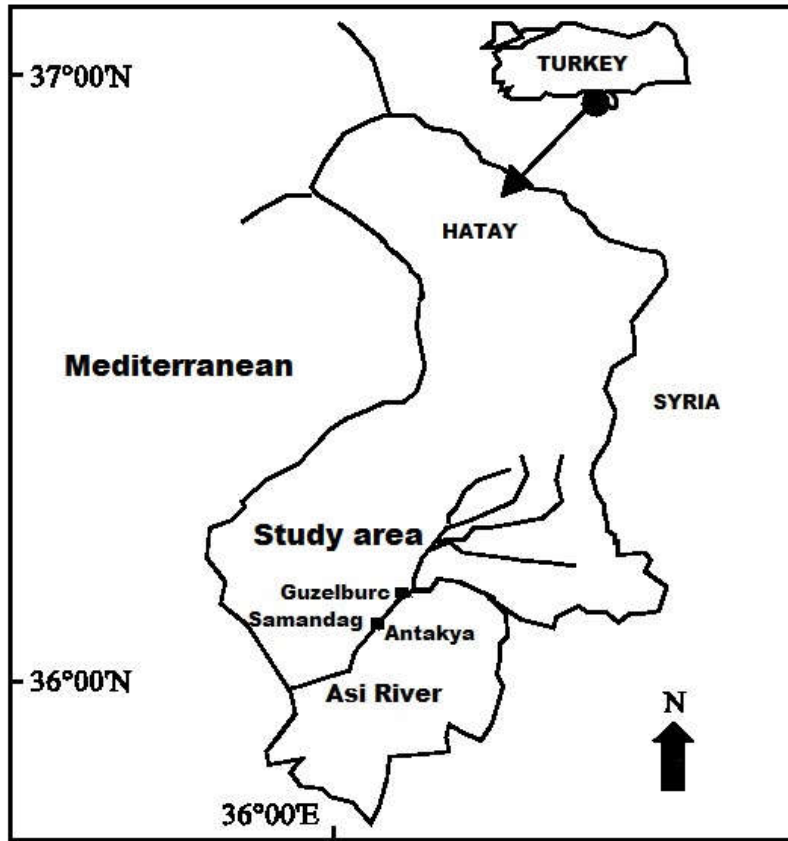
**Figure 1.** The map of the sampling area, Asi River, Turkey

Results

A total of 208 individuals (122 female, 86 male) were used for the investigation (Table 1). Average total length and weight values of all individuals of *C. angorae* were 20.46±0.40 cm and 111.29±6.45 g respectively. Total length values of female, male and overall specimens ranged from 8.5-37.0 cm, 8.9-36.2 cm and 8.5-37.0 cm respectively. Within the population of this species, most of the individuals in our samples ranged from 16.0 to 22.0 cm, the minimum and maximum total lengths of the specimens being 8.5 and 37.0 cm, respectively (Figure 2). The ratio of males to females (M: F) was estimated as 1.41:1.00 and this was not statistically significant ($P > 0.05$). The details of the length and weight of the sampled individuals, parameters of LWR (a, b and r^2), and 95% confidence intervals of b are given in Table 1.

Table 1. Descriptive statistics and estimated parameters of length-weight relationships for *C. angorae* from Asi River, Turkey

Sex	n	Length Range (TL, cm)	Mean±SD	Weight Range (W, g)	Mean±SD	a	b	95% CI of b	SE(b)	r^2
F	86	8.50-37.00	20.68±6.65	6.10-426.00	120.25±104.23	0.0218	2.767	2.695-2.838	0.036	0.986
M	122	8.9-36.20	20.32±5.29	6.50-403.00	104.98±84.16	0.0190	2.804	2.735-2.874	0.035	0.981
F+M	208	8.50-37.00	20.46±5.88	6.10-426.00	111.29±93.05	0.0204	2.785	2.735-2.834	0.025	0.983

F: female; M: male; n: sample size; TL, total length; W, total weight; a, intercept; CI: Confidence limit; b, slope; SE, standard error; r^2, coefficient of determination
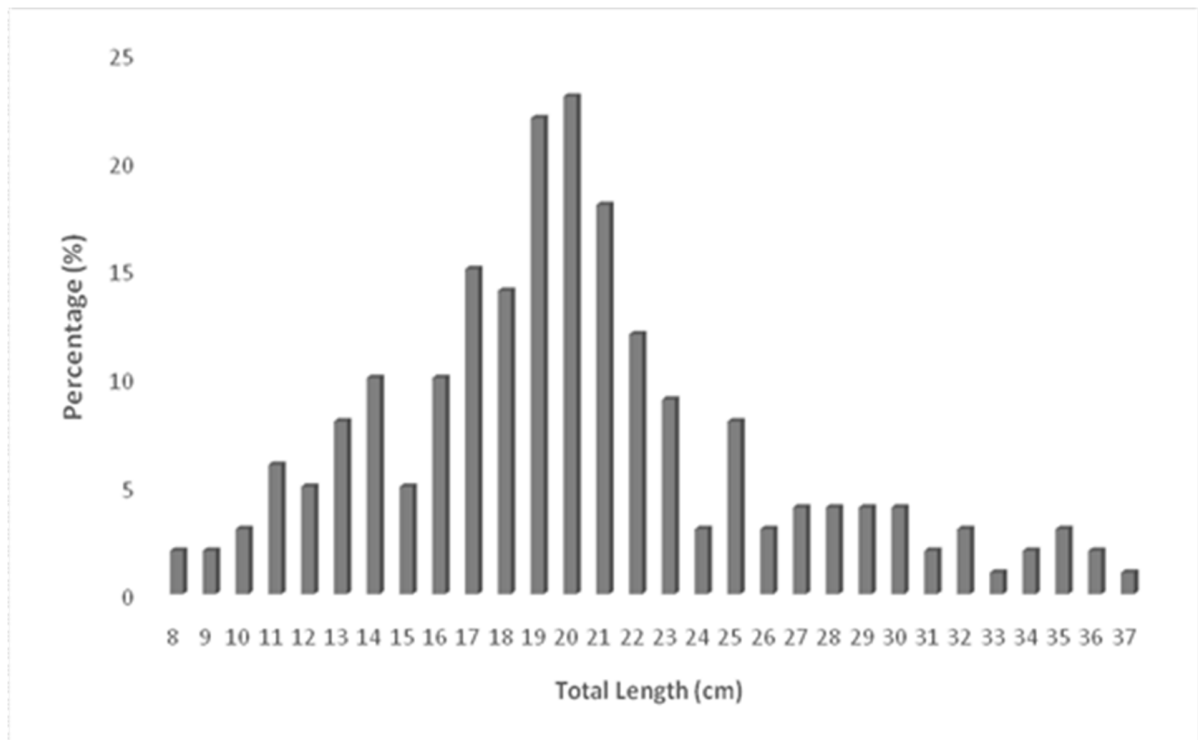
Figure 2. Length–frequency distribution of all individuals of *Capoeta angorae*

The LWR of *C. angorae* calculated as W=0.0021TL$^{2.766}$ (R^2=0.986) for females, W=0.0019TL$^{2.804}$ (R^2=0.981) for males and W=0.0020TL$^{2.784}$ (R^2=0.983) for all individuals (Figure 3, Figure 4 and Figure 5). In the present study, *b* (based on TL) was 2.766 for females and 2.804 for males. Our data suggested that *C. angorae* showed negative allometric growth for all sexes. The parameter "b" of length–weight relationships was significantly different from 3 (P < 0.05).

Fulton's condition factor (CF) was 1.102±0.15 for females, 1.068±0.12 for males and 1.083±0.13 for all individuals. Condition factor values also showed significant variations (P<0.001) for female and male individuals of *C. angorae*.
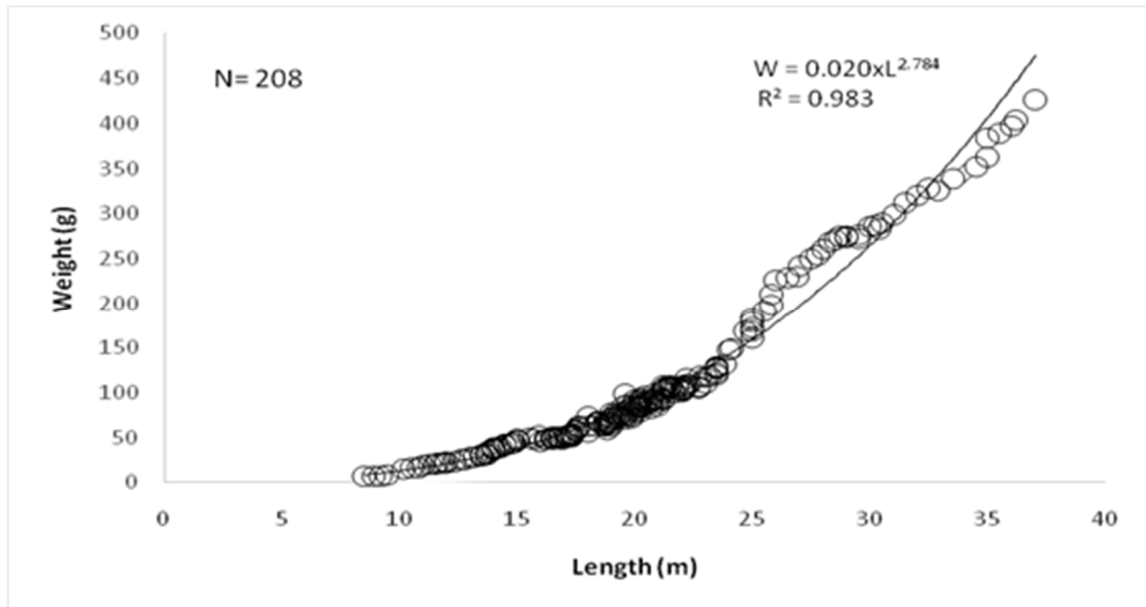

Figure 3. Length weight relationship for all individuals of *C. angorae* in Asi River.
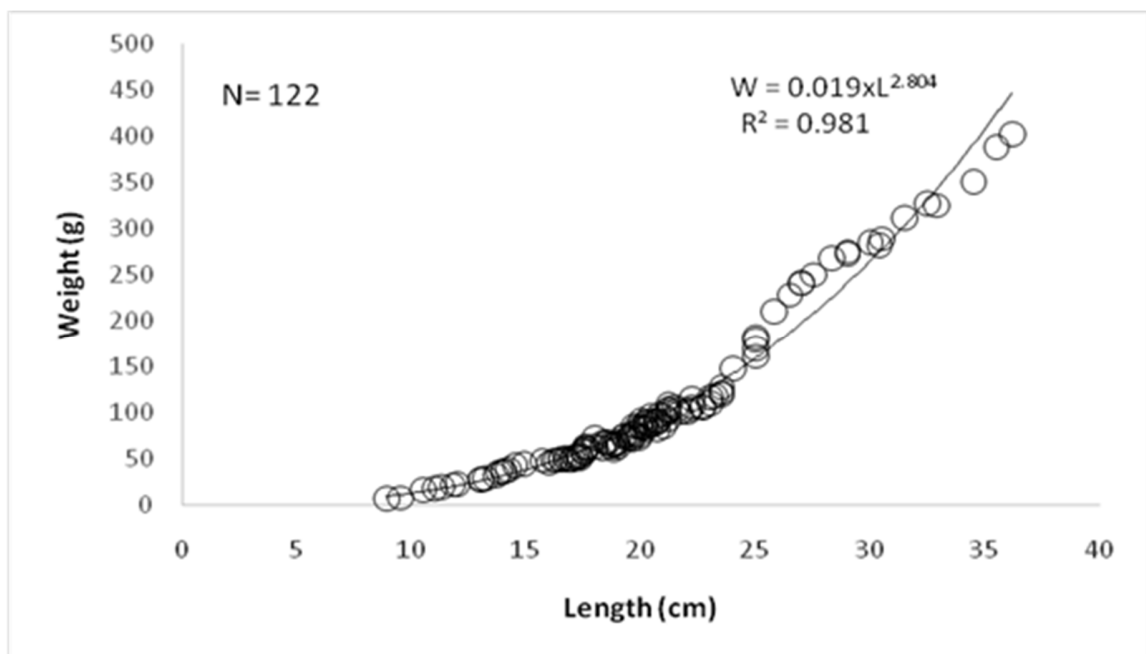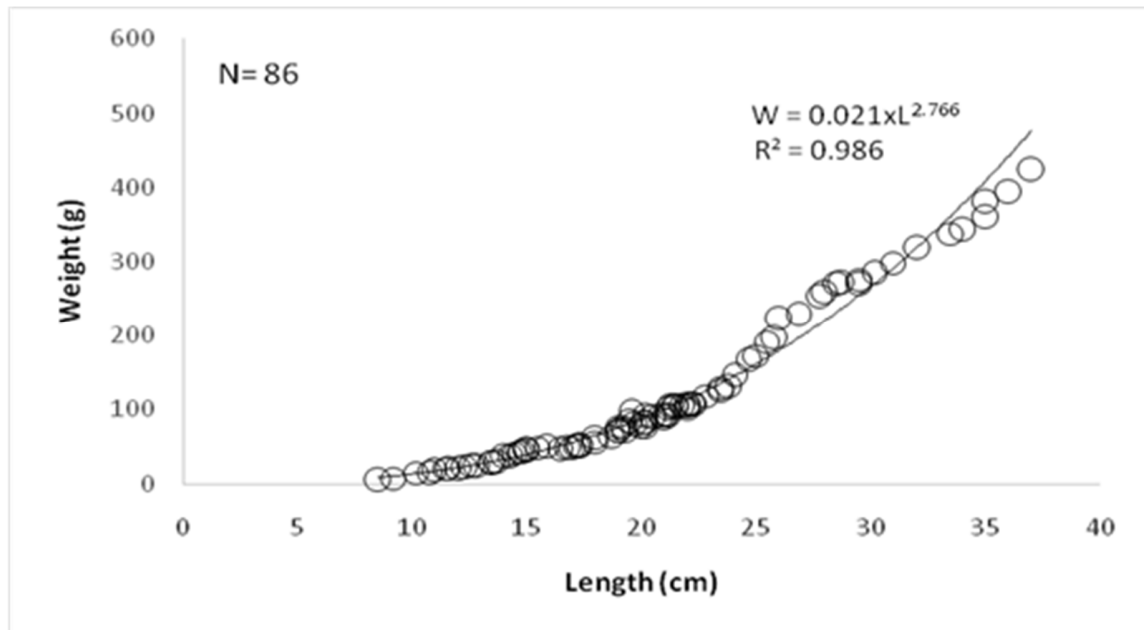

Figure 4. Length weight relationship for male individuals of *C. angorae* in Asi River.

Figure 5. Length weight relationship for female individuals of *C. angorae* in Asi River.

Discussion

Values of the parameter b in the length-weight relationship characteristics an isometric growth when equal to 3 (Ricker, 1975). In the present study, the values found for *C. angorae* showed negative allometry in the growth of both sexes. The results received were compared with previous LWRs studies in Anatolian watersheds (Alp et al., 2005; Emre et al., 2014; Ayyıldız et al., 2015; Erguden, 2016), Table 2. The values of b for the Asi River were close to the data marked from Alp et al. (2005), Emre et al. (2014) and Ayyıldız et al. (2015) for the reservoir and river system of Turkey. However, Erguden (2016) reported *b* values closer to isometric growth in Seyhan Reservoir (Adana, Turkey). The differences are possibly originated from the differences in habitat, temperature, food availability and size (Weatherley & Gill, 1987).

The length-weight relationship in fishes is affected by a number of factors including season, habitat, gonad maturity, sex, diet and stomach fullness, health and preservation techniques (Tesch, 1971), all of which were not accounted for in the present study.

In Asi River, condition factor values also showed significant variations ($P<0.001$) for female and male individuals of *C. angorae*. The condition factor of fish population presents changes with gonad development, age, seasonal changes in growth and net mesh size (Le Cren, 1951; Ricker, 1975).

Table 2. The LWR results of previous studies for *C. angorae* from different locations.

Locality	Sex	n	Length Type	Length (cm)					References
				min	max	a	b	r²	
Ceyhan River, Turkey	F	259	TL	7.7	42.0	0.03480	2.681	0.968	Alp et al. 2005
Ceyhan River, Turkey	M	312	TL	8.0	33.0	0.02420	2.807	0.956	Alp et al. 2005
Menzelet Reservoir and Fırnız Stream, Turkey	F	68	TL	-	-	0.0128	2.870	0.975	Emre et al. 2014
Menzelet Reservoir and Fırnız Stream, Turkey	M	104	TL	-	-	0.0103	2.946	0.969	Emre et al. 2014
Menzelet Reservoir and Fırnız Stream, Turkey	F+M	172	TL	7.5	27.0	0.0097	2.962	0.978	Emre et al. 2014
Goksu River and Menzelet Reservoir, Turkey	F+M	178	TL	7.5	37.8	0.00980	2.963	0.978	Ayyildiz et al. 2015
Seyhan Reservoir, Turkey	F+M	55	TL	7.0	43.0	0.01210	3.033	0.995	Erguden 2016

To date, LWR and condition factors for *C. angorae* has never been reported from Asi River. This study reveals the first LWR and condition factors data on this species.

   In conclusion, the data recieved provides basic information on LWR and condition factor for *C. angorae* that would be useful for fishery biologist and managers in Turkey and contributed to the knowledge on sustainable fishery in Asi River and other areas.

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