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Length-Weight Relationship and Condition Factor of Three Endemic and Threatened Freshwater Fishes from Orontes River

Gülnaz Özcan and Ayhan Altun

Faculty of Marine Sciences and Technology, İskenderun Technical University, TR-31200 Iskenderun, Hatay, Turkey

Abstract.- This study was conducted to determine length–weight relationships and condition factors of three threatened species, *Alburnus orontis* (31), *Capoeta barroisi* (95) and *Chondrostoma kinzelbachi* (53), inhabiting Orontes River within Turkish boundaries. Individuals were obtained by electrofishing. Length-weight relationships were found to be $W=0.001TL^{2.555}$ ($R^2=0.838$), $W=0.0078TL^{2.942}$ ($R^2=0.974$) and $W=0.005TL^{2.769}$ ($R^2=0.831$) for all individuals of *A. orontis*, *C. barroisi* and *C. kinzelbachi*, respectively. A negative allometric growth ($b<3$) was observed for *A. orontis* whereas it was isometric ($b=3$) for *C. barroisi* and *C. kinzelbachi*. Calculation of average Fulton's condition factors resulted as 0.404 for *A. orontis*, 0.722 for *C. barroisi* and 0.629 for *C. kinzelbachi*. Average relative condition factors of these species were found to be 1.021, 1.041 and 1.055, respectively. This study is the first reference on length-weight parameters of *A. orontis* and *C. kinzelbachi*.

Key Words: *Alburnus orontis*, *Capoeta barroisi*, *Chondrostoma kinzelbachi*, length-weight relationship, condition factor.

INTRODUCTION

There have been 167 freshwater resources designated as key biodiversity areas (KBAs) in the Mediterranean Basin. These KBAs cover an area of 302.557 km^2 in in total. Out of them 40 KBAs meet the criteria to be categorized as Alliance for Zero Extinction (AZE). Turkey and Levant sub-region includes southern and western Turkey, a large part of Syria, Lebanon, the northern part of Iraq, Jordan, Palestinian Occupied Territories and Israel (Darwall *et al*., 2014). The region is characterized by a number of freshwater ecoregions including: Thrace, western Anatolia, southern Anatolia, central Anatolia, upper Tigris and Euphrates, Orontes, coastal Levant and Jordan River (Abell *et al*., 2008). There are 47 freshwater KBAs in the sub-region Turkey and Levant. One of these KBAs is lower Asi drainage which includes Tahta Köprü reservoir and the streams running into this reservoir, Gölbaşı lake, Büyük Karaçay stream and Küçük Karaçay stream. This ecosystem shelters 10 triggers species (Darwall *et al*., 2014).

Özcan (2013) claims that 50 fish species have been recorded from Orontes River and Hatay region by Krupp and Schneider (1991), Fricke *et al*. (2007) and Yalçın-Özdilek (2007). Smith and Darwall (2006) emphasized that the river basin is the second richest basin in terms the diversity of endemic freshwater fish species (8-10 fish species) in the Mediterranean coast after Po River Basin (11-17 species, Italy).

Orontes spotted bleak *Alburnus orontis* Suavage, 1882 and Levantine Nase *Chondrostoma kinzelbachi* Krupp, 1985 are endemic to Asi (Orontes) river basin and distributed along the river. However Orontes Scraper *Capoeta barroisi* Lortet, 1894 is also an endemic species, the species inhabits wider area including Orontes watershed, Eastern Mediterranean watersheds, upper Euphrates and Tigris watershed (Fricke *et al*., 2007). It has been claimed that *A. orontis* and *C. barroisi* are trigger species for the KBA Lake Homs (Qatinah) in Turkey and Levant sub-region. The number of trigger species for the KBA lower Asi drainage, where the sampling was carried out, is six including *A. orontis*, *C. kinzelbachi* and *C. barroisi* (Darwall *et al*., 2014). Conservation status of each of these species is rather conflicting and the establishment of a proper conversation status necessitates detailed studies. Fricke *et al*. (2007) claims that *A. orontis*

* Corresponding author: gulnaz.ozcan@yahoo.com
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and *C. kinzelbachi* are critically endangered (CR) species in Turkey. However, *A. orontis* and *C. kinzelbachi* are, respectively, categorized as vulnerable (VU) and endangered (EN) in the IUCN Red List of Threatened Species (Freyhof, 2014a,c). *C. barroisi* is reported as an endangered (EN) species (Fricke *et al*., 2007; Freyhof, 2014b).

Length-weight correlations are important parameters for fisheries science. Estimation of length–weight relationships (LWR) are useful for comparing life history and morphological aspects of populations inhabiting different regions and are necessary for stock assessment and management (Pauly, 1983; Petrakis and Stergiou, 1995; Gonçalves *et al*., 1997, Stergiou and Moutopoulos, 2001; Koutrakis and Tsikliras, 2003).

In fisheries biology length–weight relationships are needed for the conversion of growth-in-length equations to growth-in-weight for use in stock assessment models and to estimate stock biomass from limited sample sizes (Koutrakis and Tsikliras, 2003; Özcan, 2008; Başusta *et al*., 2013, 2014). Condition factors are also important parameters for the evaluation of fish stocks and Fulton's condition factor is widely used in fisheries and fish biology studies. Relative condition factor has been one of the most popular indexes for assessing condition of freshwater fishes in the USA since last two decades (Rypel and Richter, 2008; Rahman *et al*., 2012).

The study documented in this manuscript has been carried out in order to determine the LWR and condition factors of *A. orontis*, *C. barroisi* and *C. kinzelbachi* from the Turkish part of Orontes river basin.

MATERIALS AND METHODS

Fish were collected from Orontes River in Turkey between December 2012 and April 2013 via electrofishing using the SAMUS 725 MP portable electro fishing gear (Fig. 1). Specimens were transported on ice in a cooler box to the laboratory at Mustafa Kemal University. Total length and weight measurements were obtained with a precision at 1 mm and 0.01 g, respectively. Sexes were identified by macroscopic and microscopic examination of the gonads.

The LWRs were determined for males, females and all specimens according to the equation $W = a\ L^b$ given by Le Cren (1951) where W is the total weight (g), L is the total length (cm), and a and b are parameters of the equation. Sparre and Venema (1992) modified the equation as $W(i) = q*L(i)^b$ where i indicates the number of specimen and q is used instead of a in previous equation. In this study the formula given by Le Cren (1951) is used. The parameters a and b of the LWR were estimated by the least squares regressions method and, then, subjected to logarithmic transformation log(w)=log(a)+b*log(L). Standard error was calculated for the slope (b). The hypothesis of isometric growth was tested through Student's t-test, with values of $p < 0.05$ considered significant. The degree of correlation between the variables was computed to determine coefficient, R^2.

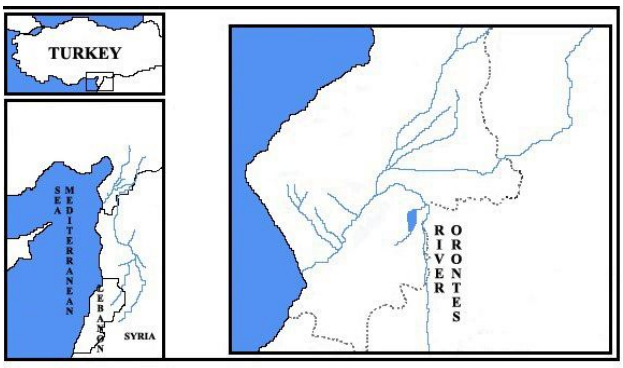

Fig. 1. Map of the study area.

Fulton's condition factor (K) was calculated using the equation $K=(W/L^3)*100$. The equation used for relative condition factor was $K_n=W/a*L^b$, where a and b are the exponential form of the intercept and slope, respectively, of the logarithmic length-weight equation.

RESULTS

A total of 179 individuals (31 *A. orontis*, 95 *C. barroisi*, and 53 *C. kinzelbachi*) were used for the investigation (Table 1). Average total length and weight values were 8.42±0.16 cm and 0.24±0.01 g for *A. orontis*, 8.4±0.47 cm and 9.57±2.17 g for *C. barroisi* and 22.4±0.47 cm, 77.5±8.17 g for *C. kinzelbachi*, respectively.

Table I.- Length-weight relationships of *A. orontis*, *C. barroisi*, and *C. kinzelbachi* captured in Orontes River, Turkey. Sample size (N), coefficient of determination (R^2), total length (TL), weight (W) and equation parameters for a and b.

Species	Sex	n	TL (min-max)	W (min-max)	a	b	R^2
A. orontis	F	14	7.1-9.8	0.15-0.34	0.0010	2.558^{I}	0.869
A. orontis	M	17	5.7-9.1	0.07-0.33	0.0010	2.546^{I}	0.872
A. orontis	All	31	5.7-9.8	0.07-0.34	0.0010	2.555^{A-}	0.838
C. barroisi	F	19	6.7-24.6	1.5-130.42	0.0032	3.342^{A+}	0.985
C. barroisi	M	26	6.6-21.7	1.5-98.55	0.0074	2.936^{I}	0.963
C. barroisi	All	95	4.0-24.6	0.5-130.4	0.0078	2.942^{I}	0.974
C. kinzelbachi	F	20	16.2-31.1	18.9-236.5	0.0068	2.951^{I}	0.759
C. kinzelbachi	M	33	11.2-26.4	8.5-121.9	0.0142	2.703^{I}	0.855
C. kinzelbachi	All	53	11.2-31.1	8.5-236.5	0.0117	2.769^{I}	0.831

Table II.- Condition factors of *A. orontis*, *C. barroisi*, and *C. kinzelbachi* from Orontes River, Turkey. K, Fulton's condition factor and K_n, Relative condition factor.

Species	Sex	TL	W	K (min-max)	K mean	K_n (min-max)	K_n mean
A. orontis	F	8.61±0.23	0.26±0.02	0.282-0.501	0.402±0.02	0.712-1.304	1.039±0.04
A. orontis	M	8.28±0.23	0.23±0.01	0.258-0.718	0.405±0.03	0.670-1.339	1.002±0.05
A. orontis	All	8.42±0.16	0.24±0.01	0.258-0.718	0.404±0.02	0.676-1.378	1.021±0.03
C. barroisi	F	11.6±1.22	21.27±1.22	0.386-0.897	0.739±0.04	0.611-1.305	1.022±0.05
C. barroisi	M	11.6±0.99	16.88±5.00	0.379-1.012	0.666±0.04	0.591-1.586	1.046±0.07
C. barroisi	J	5.6±0.11	1.32±0.09	0.417-1.080	0.746±0.03	0.573-1.688	1.036±0.04
C. barroisi	All	8.4±0.47	9.57±2.17	0.379-1.080	0.722±0.02	0.553-1.513	1.041±0.03
C. kinzelbachi	F	23.3±0.74	98.92±18.5	0.335-1.350	0.672±0.06	0.559-2.239	1.125±0.10
C. kinzelbachi	M	21.7±0.60	64.08±5.09	0.348-0.965	0.599±0.04	0.625-1.712	1.046±0.06
C. kinzelbachi	All	22.4±0.47	77.5±8.17	0.335-1.350	0.629±0.03	0.559-2.239	1.055±0.05

The LWRs of *A. orontis* calculated as $W=0.0010TL^{2.558}$ ($R^2=0.869$) for females, $W=0.0010TL^{2.546}$ ($R^2=0.872$) for males and $W=0.0010TL^{2.555}$ ($R^2=0.838$) for all specimens (Fig.2). Investigation of *C. barroisi* specimens showed that the LWRs were $W=0.0032TL^{3.342}$ ($R^2=0.985$) for females, $W=0.0074TL^{2.936}$ ($R^2=0.963$) for males and $W=0.0078TL^{2.942}$ ($R^2=0.974$) for all specimens (Fig.2). Finally, the evaluation of the LWRs for the species *C. kinzelbachi* resulted as $W=0.0068TL^{2.951}$ ($R^2=0.759$) for females, $W=0.0142TL^{2.703}$ ($R^2=0.855$) for males, $W=0.0117TL^{2.769}$ ($R^2=0.831$) for all specimens (Fig. 2, Table I).

When the growth was evaluated in terms of length, it was found that the growth for all specimens of *A. orontis* was negative allometric (A^- ($b<3$, $p<0.05$)). The growth of males and females of this species was found to be isometric (I ($b=3$, $p>0.05$)). Although the growth for the females of *C. barroisi* was positive allometric (A^+ ($b>3$, $p<0.05$)), it was isometric (I ($b=3$, $p>0.05$)) for both the males and all the specimens. The growth for the males, females and all the specimens of *C. kinzelbachi* was isometric (I ($b=3$, $p>0.05$)) (Table I).

Calculation of condition factors are summarized in Table II. Fulton's condition factor (K) values for all the specimens of *A. orontis* ranged between 0.258 and 0.718 with an average of 0.404±0.02. Although the values were almost the same with a mean of 0.405±0.03 for the males of the species, K was smaller for the females (mean: 0.402±0.02). In consideration of *C. barroisi*, K value was the lowest with an average of 0.666±0.04 for the males of the species. Minimum K value was observed in both the males and all the specimens whereas maximum K value was lowest (0.897) for the females while it was around 1.050 for the other groups. The females and all the specimens of *C. kinzelbachi* had the minimum K value (0.335) and

the maximum K value at 1.350. However, the males reached to the lowest maximum value at 0.965. Average K for the female, the male and all the specimens were 0.672±0.06, 0.599±0.04 and 0.629±0.03, respectively (Table II).

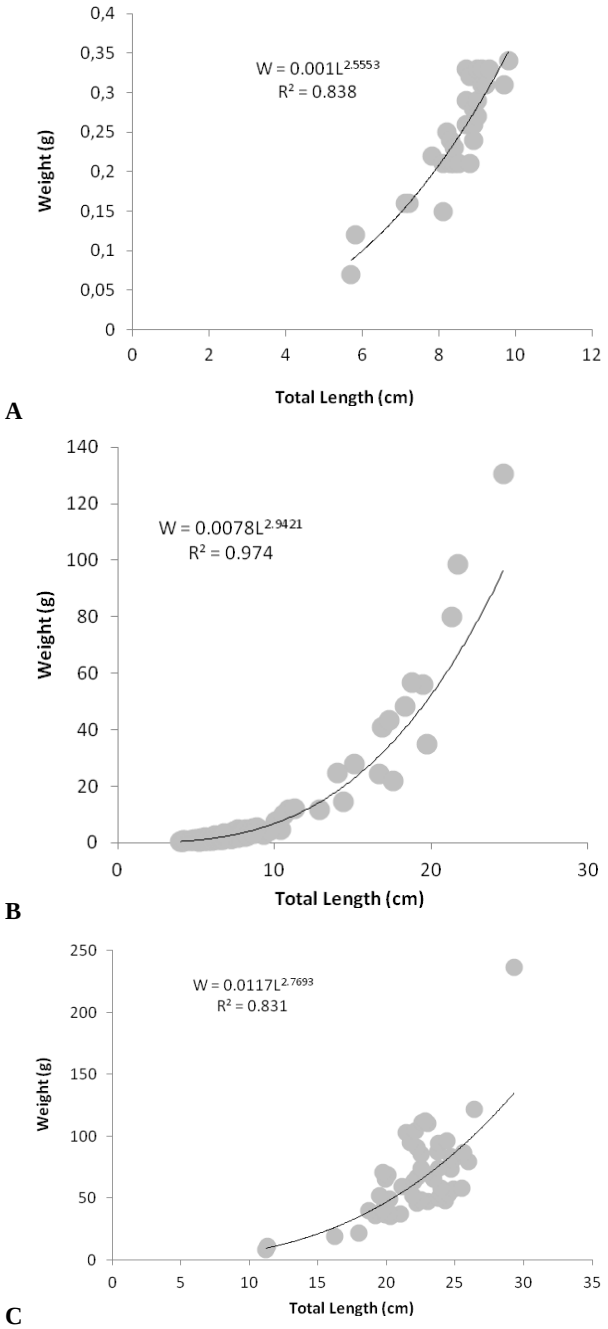

Fig. 2. Length-weight relationship of *A. orontis* (A) *C. barrosis* (B) and *C. kinzelbachi* (C) for all specimens.

Average relative condition factor (K_n) for *A. orontis* was the highest (1.039±0.04) for the females and the lowest (1.002±0.05) for the males of the species. On the contrary, the males of *C. barroisi* revealed the highest average K_n (1.046±0.07) whereas it was the lowest (1.022±0.05) for the females. Mean relative condition factors were 1.125±0.10 for females, 1.046±0.06 for males, 1.055±0.05 for all specimens in *C. kinzelbachi* (Table II).

DISCUSSION

LWR s and condition factors for two species; *A. orontis* and *C. kinzelbachi* has never been reported elsewhere before. This study reveals the first LWR and condition factors data on these species.

LWRs and condition factors of *C. barroisi* has been reported for different populations (Table III). Koca (2006) reported TL as 19.4-33.2 cm and 19.1-32.1 cm and weight (W) as 65-161 g and 64-154 g for males and females, respectively, of *C. barroisi* collected from Menzelet Dam Lake. Investigations on the population of the same species inhabiting Asi (Orontes) river showed that average TLs were 19.32±0.05 cm for females, 16.11±0.04 cm for males and 5.3±0.01 cm for the juvenile individuals of the species. The weight was averaged as 75.98±0.41 g, 44.84±0.28 g, 1.25±0.01 g for the same groups of individuals, respectively. (Demirci and Yalçın-Özdilek, 2007). Erguden and Goksu (2009) reported that the maximum and minimum values of TLs of the individuals collected from Seyhan Dam Lake ranged between 19.0-48.0 cm with an average of 26.9 cm. Birecikligil and Çiçek (2011) found out that TL and weight of *C. barroisi* specimens obtained from the tributaries of Euprates and Orontes river in Gaziantep had a mean value of 8.21±3.12 cm and 6.93±6.56 g, respectively. The range extended from 3.6 to 16.3 cm for length and from 0.25 to 23.75 g for weight. It has been indicated that the individuals' TLs captured in Persian Gulf varied between 5.59 and 21.3 cm (Esmaeili *et al*., 2014).

Growth in fish stocks is isometric when b value is 3.0. However, the growth depends on species, sex, age, seasons and feeding (LeCren, 1951;

Table III.- Length-weight parameters and condition factors of *C. barroisi*. A, all specimens, F, female, M, male, J, juvenile, R, reservoir, dam lake.

Locality	Sex	N	TL	W	a	b	R^2	K	Author
Menzelet R.	A	-	-	-	-	-	-	0.91	Sağat *et al*. (1991)
Mehmetli R.	A	215	-	-	0.016	2.837	-	1.100-1.331 (1.189)	Başusta (1993)
Aslantaş R.	A	217	-	-	0.023	2.862	-	1.391-1.557 (1.477)	Başusta (1993)
Menzelet R.	F	33	19.4-33.2	65-161				-	Koca (2006)
Menzelet R.	M	27	19.1-32.1	64-154				-	Koca (2006)
Menzelet R.	A	60	19.1-33.2	64-161				0.935-1.769	Koca (2006)
Asi River	F	81	19.32	75.98					Demirci and Yalçın-Özdilek (2007)
Asi River	M	114	16.11	44.84					Demirci and Yalçın-Özdilek, (2007)
Asi River	J	30	5.3	1.25					Demirci and Yalçın-Özdilek (2007)
Asi River	A	225			0.008	3.074	0.955	-	Demirci and Yalçın-Özdilek (2007)
Seyhan R.	A	37	26.9	-	0.002	3.58	0.974	-	Erguden and Goksu (2009)
Gaziantep	A	39	8.21	6.93	0.009	3.02	0.996	-	Birecikligil and Çiçek (2011)
Persian Gulf	A	355	5.59-21.3	2.64-99.6	0.019	2.80	0.974	-	Esmaeili *et al*. (2014)
Orontes River	F	19	6.7-24.6	1.5-130.4	0.0032	3.342	0.985	0.386-0.897 (0.739)	Present work
Orontes River	M	26	6.6-21.7	1.5-98.6	0.0074	2.936	0.963	0.379-1.012 (0.666)	Present work
Orontes River	J	50	4.0-6.8	0.50-3.32				0.417-1.080 (0.746)	Present work
Orontes River	A	95	4.0-24.6	0.5-130.4	0.0078	2.942	0.974	0.379-1.080 (0.722)	Present work

Bagenal and Tesch, 1978) and may be lower or higher than 3 indicating negative and positive allometric growth, respectively. Calculated b values in reference to all specimens were 2.555 for *A. orontis*, 2.942 for *C. barroisi* and 2.769 for *C. kinzelbachi* (Table I). Various authors have reported results of b value for *C. barroisi*. Başusta (1993) reported negative allometric growth representing two locations where the value for the populations were 2.83702 for Mehmetli dam lake and 2.86155 for Aslantaş dam lake. Similarly, Esmaeili *et al*., (2014) has reported be value as 2.80. On the contrary, some reports of positive allometric growth of the species has also been reported by various authors. Demirci and Yalçın-Özdilek (2007) reported mean value of b as 3.074 as the result of a study on the species collected from Asi (Orontes) river. The population in Seyhan reservoir had a value of 3.58 (Erguden and Goksu, 2009). Birecikligil and Çiçek (2011) has given the b as 3.015 for a population in Gaziantep. However, positive and negative allometric growth for *C. barroisi* has been reported for different populations, our findings reveal an isometric growth which accords with the result obtained by Birecikligil and Çiçek (2011).

Condition factor of a population may vary depending on the age and sex composition of the population, environmental elements and season (Erkoyuncu, 1995). The investigation of condition factors of *A. orontis*, *C. barroisi* and *C. kinzelbachi* revealed that mean Fulton's condition factors (K), as far as all specimens was concerned, were 0.404±0.02, 0.722±0.02 and 0.629±0.03, respectively. Similarly, mean relative condition factors (K_n) were found to be 1.021±0.03, 1.041±0.03 and 1.055±0.05, respectively. Mean K_n for *C. barroisi* has been reported as 0.91 for

population inhabiting Menzelet reservoir (Sağat *et al*., 1991) however Koca (2006) claimed that the value changed in the range of 0.935-1.769. Başusta (1993) has given the variation as 1.100-1.331 (mean 1.189) for Mehmetli reservoir and 1.391-1.557 (mean 1.477) for Aslantaş reservoir. Although K calculated for *C. barroisi* is lower than that of the references, feeding activities, sexes, environmental factors and seasonal differences might be effective for this occurrence.

These three species have critical conservation status due to pollution caused by human activities, irrigation, fishing and habitat destruction. Findings of this research are very important for stock estimation and evaluation studies and conservation of these species in future.

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