Length-weight relationship and condition factor of seven fish species from Shahrbijar River, Southern Caspian Sea basin, Iran

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Abstract

Length-weight relationship and condition factor were estimated in seven fish species, including *Barbus cyri*, *Capoeta gracilis*, *Alburnoides eichwaldii*, *Pseudorasbora parva*, *Ponticola cyrius*, *Cobitis keyvani* and *Acanthalburnus microlepis* from Shahrbijar River, Guilan Province, Iran. A total of 416 specimens ranging from 18 to 135 mm in total length and from 0.06 to 19.25 g in total weight were collected. Based on the results, growth coefficient values "b" ranged from 2.615 (in *B. cyri*) through 3.001 (in *A. microlepis*). All length-weight relationships were significant ($p<0.05$), with r^2 higher than 0.819. The five species viz. *C. gracilis*, *P. parva*, *C.*keyvani, *P. cyrius,* and *B. cyri* showed allometric ($b<3<b$) while two species viz. *A. microlepis* and *A. eichwaldii* showed isometric (b=3) growth patterns. Condition factor ranged from 0.57 (in *C.keyvani*) through 1.11 (in *P.cyrius*). All linear regressions were highly significant ($p<0.05$). The present study provides the first baseline information on the length - weight relationships of the seven fish species from Shahrbijar River which may be useful for further fisheries management of these species.

Keywords: Shahrbijar River, Freshwater fishes, Morphometrics, Allometry, Caspian Sea basin.

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Introduction

A knowledge of length-weight relationships (LWR) is an important tool for the adequate management of any fish species which have been applied in the assessment of fish stocks and populations (King, 2007). It is also useful in local and interregional morphological comparison of populations (Froese, 2006; Ali *et al*., 2013). Length-weight relationship (LWR) data of fishes are useful for biologists (Martin-Smith, 1996) in fishery assessment and proper management of their population. It has been widely used in fish biology with several purposes: to predict weight from length measurements for yield assessment, to calculate the standing crop biomass, to estimate weight at age, stock assessment, to evaluate index of well-being of fish population, to assess age structure and function of fish populations, growth studies, to assess fish population dynamics and growth, to make morphometric comparisons between species and populations and life history comparisons between regions (Pauly, 1993; Petrakis and Stergiou, 1995; Haimovici and Velasco, 2000; Morato *et al*., 2001; Ozaydin *et al*., 2007). LWR is used to obtain information about the condition of fishes in order to determine whether somatic growth is isometric or allometric (Gurkan and Taskavak, 2007; Ujjania *et al*., 2012). Condition factor (K) is an important biological parameter, which indicates the suitability of a specific water body for growth of fish and an index of species average size (Alam *et al*., 2014). The values of this factor depend on physiological features of fish especially maturity, spawning, life cycle, environmental factors and food availability in a water body (Ujjania *et al*., 2012; Dan-Kishiya, 2013). Thus this parameter is of great importance in fishery assessments, more importantly for proper exploitation and management of fish population (Haimovici and Velasco, 2000).

The present study aimed to find out the present status of length-weight relationship and condition factor of seven fish species viz. *Barbus cyri*, *Capoeta capoeta gracilis*, *Alburnoides eichwaldii*, *Acanthal burnus microlepis*, *Ponticolacyrius*, *Cobitis keyvani* and *Pseudorasbora parva* inhabiting Shahrbijar River, a tributary of Sefidrud River in the Caspian Sea basin (Guilan Province, North of Iran). The results play an important role in management of these species in the protection program of their natural stocks.

Materials and methods

Shahrbijar (39°78'11"N, 58°22'79"E) is a mountainous river at the elevation of 189-501m above the sea level surrounded by a dense forest (Fig. 1). The samplings were conducted during the daytime from13 stations in autumn 2013 by a gill net and backpack electrofishing (Samus Mp750).
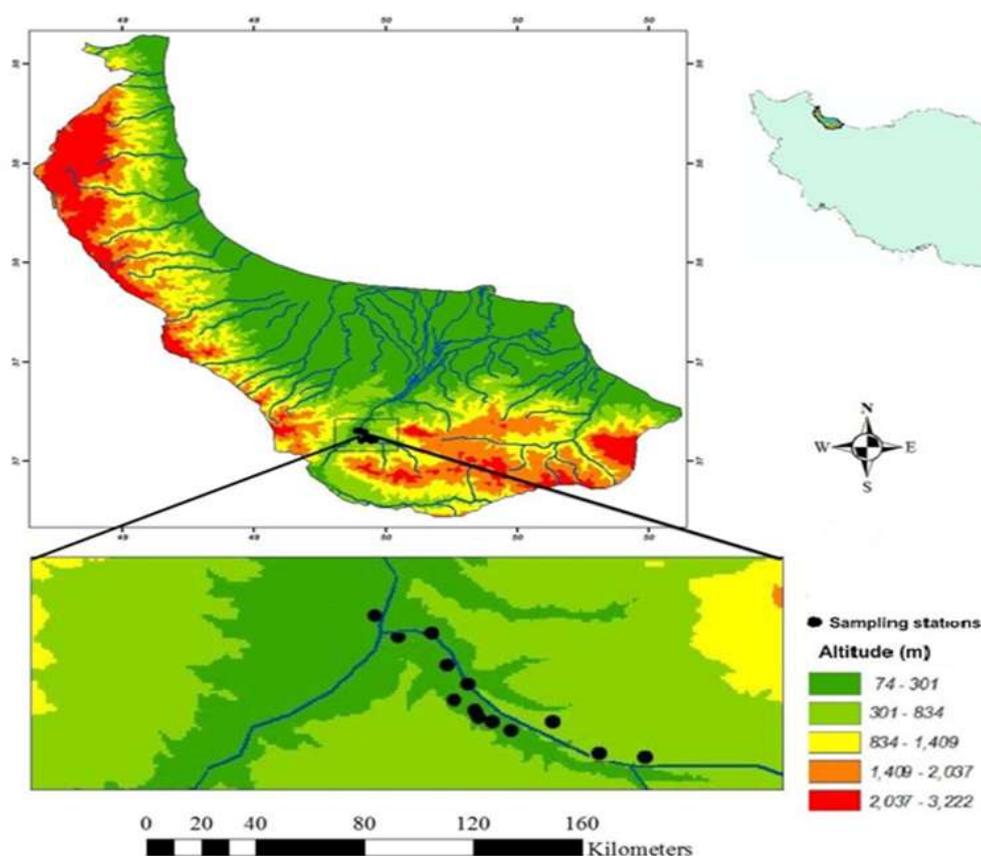
Figure 1: Location of Alborz Province, Shahrbijar River and sampling points.

A total of 416 fish specimens belonging to seven species were collected (Table 1).

Fish specimens were collected monthly at spring tide from April to October (the active period) during 2004 and 2005; The fish were sedated, identified, weighed to the nearest 0.1 g, photographed (by digital camera), and then left in slow -flowing places along the river banks to recover from sedation (according to Abdoli, 2000; Coad, 2015).

A scale was put beside the photographed fishes for extracting morphometric measurements using Image J software (version: 1.47). For each individual, morphometric data, including total length (TL), fork length (FL) and standard length (SL) were measured from its pictures to the nearest 0.01 mm. The body weight (BW) of the specimens was measured using an electronic balance to the nearest 0.01 g after drying by a clean towel.

Table 1: Summary of length-weight relationships for the seven fish species from Shahrbijar River.

Species	n	Total length (mm)			Body weight (g)			Growth coefficient				
		Min	Max	Mean±SD	Min	Max	Mean±SD	a	b	R^2	t_s	tg
Capoeta gracilis	195	24	131	61.19±22.04	0.19	15.07	6.19±3.33	0.00003	2.723	0.982	-2.3	-A
Alburnoides eichwaldii	52	24	116	46.19±18.22	0.13	19.12	3.138±3.41	0.00001	2.985	0.945	0.01	I
Barbus cyri	67	51	135	73.41±23.32	1.19	15.45	4.29±3.48	0.00005	2.615	0.971	-2.31	-A
Acanthalburnus microlepis	17	18	90	50.09±28.67	0.06	6.44	2.203±2.30	0.00001	3.001	0.995	0.02	I
Cobitis keyvani	24	27	79	62.66±11.26	0.15	3.5	1.529±0.80	0.00001	2.862	0.819	-1.3	-A
Pseudorasbora parva	12	21	71	40.71±20.47	0.19	19.19	5.86±1.19	0.00001	2.942	0.988	-0.03	-A
Ponticola cyrius	49	23	119	75.12±24.00	0.19	19.29	5.86±4.36	0.00001	2.938	0.983	-0.07	-A

n: Sample size, Min: minimum, Max: maximum, mm: millimeter, g: gram, α: intercept, b:slope, r^2: correlation coefficient, SE: standard error of the slope, tg: Types of growth, I: isometric growth, -A: negative allometric growth, t: students t-test

The length-weight relationship was determined by the equation W= αLb (Le Cren, 1951; Wang *et al*., 2012; Kahraman *et al*., 2014), where W is total weight (in g), L is total length (in cm), α is intercept i.e. coefficient related to the body, and b is slope. The growth pattern is isometric when the value of b = 3 and allometric when it is significantly different from 3 (Alam *et al*., 2014). The logarithm transformation of the equation was expressed as: Log W= α+b Log L (Wang *et al*., 2012; Kahraman *et al*., 2014) to estimate the parameters α and b. The degree of correlation between the variables was computed by the determination coefficient "r^2". The significance level of r^2 was estimated by ANOVA test. The student's t-test (ts) was used to determine whether the parameter b is significantly different from the expected or theoretical value of 3 (i.e. b = 3, *p*<0.05). The condition factor (K) was estimated according to Le Cren (1951) and Froese (2006) using K =100 W.L^{-3}, where, K is condition factor, W is weight of fish (g) and L is length (total, fork and standard length) of fish (cm). Here, factor 100 is used to bring K close unity. In the present study, we calculated condition factor (K) for all measured length groups, i.e. TL, FL and SL. All the statistical analyses were considered at significant level of 5%. Statistical analyses were performed using the SPSS package (version 16.0) and Microsoft Office Excel software (version 2010).

Results

A total of 416 specimens of the seven fish species of Shahrbijar River belonging to three families were collected from 13 stations. The ranges of the length and weight parameters, estimated LWR parameters, coefficient of the correlation of the seven studied

fish species are presented in Table 1. The specimens ranged from 18 mm for *A. microlpi*s to 135 mm for *B. cyri* in total length and from 0.13 to 19.29 g in total weight for *A. eichwaldii* and *P. cyrius*, respectively. All relationships were highly significant ($p<0.05$) with r^2 values greater than 0.90 in six species and r^2=0.80-0.90 in one species (Table 1).The b values of the length-weight equations among the studied species ranged from 2.615 for *B. cyri* to 3.001 for *A. microlepis*. The b values of other species were obtained; 2.723 for *C. gracilis*, 2.985 for *A. eichwaldii,* 2.938 for *P. cyrius*, 2.942 for *P. parva* and 2.862 for *C. keyvani*. The parameter "b" in all studied species was within the expected range of 2.0-3.0 except for *A. microlepis* with b value of 3.001.The results of student's t-test showed that b

value of *A. microlepis* (b=3.001; t-test: t=0.02; *p<0.05*) and *A. eichwaldii* (b=2.985; t-test: t=0.01; *p<0.05*) was significantly greater than the theoretical value of 2 indicating an isometric growth, whereas the results of student t-test for *C. gracilis*, *P. cyrius*, *P. parva*, *B. cyri* and *C. keyvani* were significantly high (b=2.615- 2.942; t-test: t=0.417-0.686; *p<0.05*) indicating a negative allometric growth. *Barbus cyri*, *A.eichwaldii* and *O. bergianus* showed an isometric growth pattern (b=2.98-3.056; t-test: t=-2.3-0.02; *p>0.05*), with no significant difference from the theoretical value of 3 (Table 2).

Table 2: Correlation of standard body length with body weight of studied fish from Shahrbijar River at different length groups.

Family	species	Condition Factor					
		Total length		Fork length		Standard length	
		K	SD	K	SD	K	SD
Cyprinidae	*Barbus cyri*	0.95	0.13	1.14	0.15	1.50	0.28
	Capoeta gracilis	1.06	0.18	1.55	0.58	2.60	2.25
	Alburnoides eichwaldii	1.01	0.21	1.33	0.29	1.78	0.45
	Pseudorasbora parva	0.79	0.12	0.93	0.15	1.17	0.25
	Acanthalburnus microlepis	0.96	0.14	1.52	0.34	2.02	0.68
Gobiidae	*Ponticola cyrius*	1.11	0.17	-	-	1.91	0.35
Cobitidae	*Cobitis keyvani*	0.57	0.15	-	-	0.81	0.24

K=Condition factor coefficient and SD= standard deviation of condition factor coefficient.

Discussion

The length-weight relationship is a very important tool in fisheries assessment (Haimovidici and Velasco, 2000; Arslan *et al.,* 2004) and also standing

crop biomass can be estimated based on this value (Morey *et al*., 2003). Tahmasebi *et al*. (2014) reported LWRs of *B. cyri* from Sefidrud River (the Caspian basin) with b value of 2.5134,

showing a negative allometric growth. Boron *et al*. (2008) observed that parameter b in standard length-weight equation for the specimens of spined loach, *Cobitis taenia* (Linnaeus, 1758), for males and females are 3.83779 and 3.1683, respectively, indicating allometric growth in both sexes, though more in males than females. The b value of *C. buhsei* in Kordan River was 2.83 close to that of *C. keyvani* in Shahrbijar River (Tabatabaei *et al.,* 2015). Zamani-Faradonbe *et al*. (2015a) showed that the "b" value for *B. cyri*, *C. gracilis*, *A. eichwaldii*, *A. microlepis*, *P. cyrius* and *C. keyvani* in Totkabon River (Southern Caspian Sea basin), Guilan Province were 3.0078, 3.116, 3.056, 2429, 3.214 and 3.71, respectively. In another study, Zamani-Faradonbe *et al*. (2015b) reported that the "b" values for *B. cyri* and *C. gracilis* in Taleghan River (Alborz Province, Iran) were 2.966 and 2.96, respectively; No LWRs data were available from other studied fish species in Iranian inland waters in order to compare with the results of the present study. The results showed that the condition factor values (K, TL-K) range between 0.79 and 1.06, with minimum value for *P. parva* (K=0.79±0.014) and maximum value for *C. gracilis* (K=1.06±0. 055) (Table 2).The maximum value of the condition factor was observed based on the TL group in *C. gracilis* (1.06), based on the FL group in *A. eichwaldii* (1.33) and also on the SL group in *A. eichwaldii* (1.78) (Table 2).

T-test analysis showed that K values calculated based on the three length groups i.e. total, fork and standard lengths, in the studied species are significantly different ($p<0.05$).The condition factor is an index reflecting interaction between biotic and abiotic factors in the physiological conditions of fishes. Therefore, the condition factor may vary among fish species in different locations (Blackwell *et al*., 2000). Condition factor is based on the hypothesis that heavier fishes of a given length are in better condition. This factor is also used as an index of growth and feeding intensity (Seher and Suleyman, 2012). Condition factors of ≥1 indicate a good level of feeding and proper environmental conditions (Ujjania *et al.,* 2012). Based on the results, it was <1 for *C. keyvani* showing no proper environmental conditions of habitat for this species in Shahrbijar River, whereas, K values of the rest of species were >1 showing suitable conditions of this river for them. LWR parameters (α and b) and the "K" value of the fish have been reported to be influenced by many factors such as feeding intensity, availability of food, fish size, age, sex, season, stage of maturation, fullness of the gut, degree of muscular development, the amount of reserved fat and life history (Bagenal and Tesch, 1978; Ujjania *et al.,* 2012; Gupta and Banerjee, 2015). None of the above - mentioned effective factors on LWR and K in the studied fishes have been considered in the present study.

Therefore, for using the results of this study, it should be borne in mind that the samples were taken seasonally and the number of fish examined was limited. Finally, the length-weight relationships and condition factor presented here will provide useful information for fisheries management and fish population dynamic studies. To the best of our knowledge, LWR and K of these fishes were presented in Sharbijar River for the first time. Therefore, the results of the present study can be employed as baseline data for these species and for comparison with further studies.

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