



## Original Article

# Length-weight relationship and condition factor of seven fish species of Totkabon River (southern Caspian Sea basin), Guilan, Iran

Mazaher Zamani Faradonbeh<sup>1</sup>, Soheil Eagderi\*<sup>1</sup>, Fariborz Ghojoghi<sup>2</sup>

<sup>1</sup>Department of Fisheries, Faculty of Natural Resources, University of Tehran, Karaj, Iran.

<sup>2</sup>Department of Fisheries, Faculty of Natural Resources, Islamic Azad University, Azadshahr branch.

**Abstract:** Length-weight relationship and condition factor were investigated in seven fish species, including *Barbus cyri*, *Capoeta gracilis*, *Alburnoides eichwaldi*, *Acanthalbarnus microlepis*, *Ponticola cyrius*, *Cobitis keyvani* and *Oxynemacheilus bergianus* from Totkabon River. A total of 570 specimens ranging from 25.90 to 146.97 mm in total length and 0.1 to 260.3 g in total weight were collected. Based on the results, growth coefficient values “*b*” ranged from 2.429 (*A. microlepis*) to 3.71 (*C. keyvani*). All length-weight relationships were significant ( $P < 0.05$ ), with  $r^2$  greater than 0.856. The four species viz. *A. microlepis*, *C. gracilis*, *P. cyrius* and *C. keyvani* showed allometric ( $b < 3 < b$ ) and three species viz. *B. cyri*, *A. eichwaldi* and *O. bergianus* isometric ( $b = 3$ ) growth patterns. Condition factor ranged from 0.544 (*O. bergianus*) to 0.940 (*P. cyrius*). All linear regressions were highly significant ( $P < 0.05$ ). The result of this study may be useful for biologists and fishery managers.

### Article history:

Received 15 February 2015

Accepted 24 April 2015

Available online 25 June 2015

### Keywords:

River  
Freshwater fishes  
LWRs  
Allometry  
Condition factor

## Introduction

Length-weight relationships (LWRs) data of fishes are useful tools for biologists (Martin-Smith, 1996) in fishery assessment and proper management of fish population. LWR permits assessment of the biomass from length observations and conversion of growth-in-length equations to growth-in-weight (Gurkan and Taskavak, 2007) and also is applied to assess well-being of individuals and to compare life histories of separated populations of the same species in different regions (Martin-Smith, 1996; Ak et al., 2009). In addition, LWRs is used to obtain information about the condition of fishes 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).

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 gracilis*, *Alburnoides eichwaldi*, *Acanthalbarnus microlepis*, *Ponticola cyrius*, *Cobitis keyvani* and *Oxynemacheilus bergianus* inhabiting Totkabon River, a tributary of Sefidrud River in the Caspian Sea basin (Guilan Province, North of Iran). Findings of this work will help better understanding of their biology and play an important role for management of these species in the protection program of their natural stock.

## Materials and methods

Totkabon River (36°53'48"N, 49°30'19"E) is a

\* Corresponding author: Soheil Eagderi  
E-mail address: soheil.eagderi@ut.ac.ir

Table 1. Summary of length-weight relationships for seven fish species from Totkabon River.

Species	n	Total length (mm)			Body weight (gr)			Growth coefficient				
		Min	Max	Mean $\pm$ SE	Min	Max	Mean $\pm$ SE	$\alpha$	$b$	$r^2$	$t_s$	tg
<i>B. cyri</i>	70	50.70	146.97	93.47 $\pm$ 2.59	1.1	26.30	7.95 $\pm$ 0.67	0.0006	3.0078	0.927	0.02	I
<i>C. gracilis</i>	240	25.90	145.90	74.54 $\pm$ 1.27	0.10	16.48	4.45 $\pm$ 0.20	0.000006	3.116	0.902	0.574	+A
<i>A. eichwaldi</i>	62	48.764	101.37	74.24 $\pm$ 1.73	1.00	8.70	4.02 $\pm$ 0.28	0.000006	3.056	0.933	0.142	I
<i>A. microlepis</i>	22	30.92	83.26	50.58 $\pm$ 2.89	0.30	2.88	1.04 $\pm$ 0.17	0.0000005	2.429	0.856	-1.05	-A
<i>P. cyrius</i>	46	49.18	110.32	81.31 $\pm$ 2.08	0.70	10.59	5.54 $\pm$ 0.44	0.00006	3.214	0.861	0.417	+A
<i>C. keyvani</i>	15	40.67	65.97	53.74 $\pm$ 2.04	0.30	1.9	1.08 $\pm$ 0.14	0.0000004	3.71	0.964	0.686	+A
<i>O. bergianus</i>	15	40.67	75.17	63.72 $\pm$ 0.15	0.47	2.24	1.42 $\pm$ 0.15	0.000007	2.98	0.93	0.023	I

n: Sample size, Min: minimum, Max: maximum, mm: millimeter, gr: gram,  $\alpha$ : intercept,  $b$ : slope,  $r^2$ : correlation coefficient, SE: standard error of the slope,  $t_s$ : students t-test, tg: Types of growth, I: isometric growth, +A: positive Allometric growth, -A: negative Allometric growth.

shallow stream with the elevation of 129-208 meters above sea level and surrounded by a dense forest. The samplings were conducted during the daytime in autumn 2013 by a backpack electrofishing (Samus Mp750, 45 cm diameter, aluminum ring anode). A total of 570 fish specimens belonging to seven species were collected (Table 1).

The captured fish specimens were anesthetized in 1% clove oil solution at the field and then weighted by a digital balance and photographed by a digital camera (Canon, 510 IS, 12 MP). Finally, they were returned to the river after identification, and unidentified specimens were fixed in 10% formalin and transferred to the laboratory for identification based on Abdoli (2000) and Coad (2015). A scale was put beside the photographed fishes for extracting morphometric measurements using ImageJ software (version: 1.47). For each individual, morphometric data, including Total Length (TL), Fork Length (FL) and Standard Length (SL) was measured from its pictures to the nearest 0.01 mm. The Body Weight (BW) of the specimens were measured using an electronic balance to the nearest 0.01 g after drying by a clean towel.

The length-weight relationship was determined by the equation of  $W = \alpha L^b$  (Le Cren, 1951; Kahraman et al., 2014; Wang et al., 2012), where  $W$  is total weight (expressed in g),  $L$  is total length (expressed in cm),  $\alpha$  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 significantly different from 3 (Alam et al., 2014).

The logarithm transformation of the equation was expressed as:  $\text{Log } W = \alpha + b \text{Log } L$  (Kahraman et al., 2014; Wang et al., 2012) to estimate the parameters  $\alpha$  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. The student's t-test ( $t_s$ ) 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 (gr) and  $L$  is length (Total, Fork and Standard) 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 significance level of 5%. The Statistical Package SPSS (version 22) and Microsoft Office Excel software (version 2013) were used to analysis data.

## Results and discussion

The ranges of the length and weight parameters, estimated LWR parameters, coefficients of the correlation of seven studied fish species are presented in Table 1. The specimens ranged from 25.90 mm for *C. gracilis* to 146.97 mm for *B. cyri* in total length and 0.1 to 260.3 g in total weight for *C. gracilis* and *B. cyri*, respectively. All relationships were highly significant ( $P < 0.05$ ) with  $r^2$  values

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

Family	Species	Condition Factor					
		Total Length		Fork length		Standard Length	
		K	SD	K	SD	K	SD
Cyprinidae	<i>B. cyri</i>	0.847	0.153	1.08	0.207	1.41	0.259
	<i>C. gracilis</i>	0.911	0.268	1.203	0.340	1.608	0.454
	<i>A. eichwaldi</i>	0.890	0.137	1.217	0.189	1.642	0.252
	<i>A. microlepis</i>	0.73	0.21	1.007	0.26	1.323	0.344
Gobiidae	<i>P. cyrius</i>	0.94	0.207	-	-	1.55	0.339
Cobitidae	<i>C. keyvani</i>	0.632	0.093	-	-	0.944	0.149
Nemachilidae	<i>O. bergianus</i>	0.544	0.070	0.63	0.093	0.83	0.167

*K* = Condition Factor coefficient and *SD* = standard Deviation of Condition Factor coefficient.

greater than 0.90 in five species and  $r^2 = 0.80-0.90$  in two others (Table 1).

The values of *b* of the length-weight equations among studied species ranged 2.429 for *A. microlepis* to 3.71 for *C. keyvani*. The *b* values of other species were obtained 3.116 for *C. gracilis*, 3.056 for *A. eichwaldi*, 2.429 for *A. microlepis*, 3.214 for *P. cyrius* and 2.98 for *O. bergianus*. The parameter “*b*” of all studied species was within the expected range of 2.5-3.5 except for *A. microlepis* and *C. keyvani* with *b* values of 2.429 and 3.71, respectively.

The results of student’s t-test showed that *b* value of *A. microlepis* ( $b = 2.429$ ; t-test:  $t = -1.05$ ;  $P < 0.05$ ) was significantly lower than the theoretical value of 3 indicating a negative allometric growth, whereas the results of student t-test for *C. gracilis*, *P. cyrius* and *C. keyvani* were significantly higher ( $b = 3.116-3.214$ ; t-test:  $t = 0.417-0.686$ ;  $P < 0.05$ ) indicating a positive allometric growth. *Barbus cyri*, *A. eichwaldi* and *O. bergianus* showed an isometric growth pattern ( $b = 2.98-3.056$ ; t-test:  $t = 0.020-0.142$ ;  $P > 0.05$ ), with no significant difference from the theoretical value of 3 (Table 2).

Tahmasebi et al. (2014) reported LWRs of *B. cyri* from Sefidrood River (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 specimens of the 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 (Boron et al., 2008). The *b* value of *O. bergianus* in the Kordan River was 2.83 and close to that of the Totkabon (Tabatabaie et al., 2015). For other studied species, no LWRs data were available from Iranian inland waters to compare with the results of the present study.

The result showed that the condition factor values (*K*, TL-*K*) range between 0.544-0.94, with minimum value for *O. bergianus* ( $K = 0.544 \pm 0.016$ ) and maximum value for *P. cyrius* ( $K = 0.94 \pm 0.0045$ ) (Table 2). The maximum value of the condition factor was observed based on the TL group in *P. cyrius* (0.94), based on the FL group in *A. eichwaldi* (1.203) and based on the SL group in *A. eichwaldi* (1.608) (Table 2). T-test analysis showed that *K* values calculated based on the three length groups i.e. Total and 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  $\geq 1$  indicate a good level of feeding and proper environmental condition (Ujjania et al., 2012). Based on the results, it was  $< 1$

for *O. bergianus* and *C. keyvani* showing no proper environmental conditions of habitat for these species in Totkabon River. Whereas, *K* values of the rest of species were >1 showing perfect condition of this river for them.

LWR parameters ( $\alpha$  and  $b$ ) and the “*K*” value of the fish have been reported to be affected 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 Totkabon River for the first time. Therefore, the results of the present study can serve as baseline data for these species and for comparisons with future studies.

## References

- Abdoli A. (2000). The inland water fishes of Iran, 1st ed. Museum of Nature and Wild Life of Iran, Tehran, 378 pp.
- Ak O., Kutlu S., Aydın I. (2009). Length-weight relationship for 16 fish species from the Eastern Black Sea, Turkey. *Turkish Journal of Fisheries and Aquatic Science*, 9: 125-126.
- Alam M.M., Rahman M.T., Parween S. (2014). Morphometric characters and condition factors of five freshwater fishes from Pagla river of Bangladesh. *International Journal of Aquatic Biology*, 2(1): 14-19.
- Al Hazzaa R. (2005). Some biological aspects of the Himri Barbel, *Barbus luteus*, in the intermediate reaches of the Euphrates River. *Turkish Journal of Zoology*, 29(4): 311-315.
- Bagenal T.B., Tesch F.W. (1978). Age and Growth. In: T.B. Bagenal (ed.). *Methods of assessment of fish production in fresh waters*, Oxford Blackwell Scientific Publication. pp. 101-136.
- Blackwel B.G., Brown M.L., Willis D.W. (2000). Relative weight (Wr) status and current use in fisheries assessment and management. *Reviews in Fisheries Science*, 8: 1-44.
- Boron A., Jelen I., Juchno D., Przybylski M., Borzuchowska E. (2008). Age and growth of the karyologically identified spined loach *Cobitis taenia* (Teleostei, Cobitidae) from a diploid population. *Folia Zoologica*, 57(1/2): 155.
- Coad B.W. 2015. Freshwater fishes of Iran. Available from: <http://www.briancoad.com>. Retrieved 2/9/2015.
- Dan-Kishiya A.S. (2013). Length-weight relationship and condition factor of five fish species from a tropical water supply reservoir in Abuja, Nigeria. *American Journal of Research Communication*, 1(9): 175-187.
- Froese R. (2006). Cube law, condition factor and weight-length relationships: history, meta-analysis and recommendations. *Journal of Applied Ichthyology*, 22(4): 241-253.
- Gupta S., Banerjee S. (2015). Length-weight relationship of *Mystus tengara* (Ham.-Buch., 1822), a freshwater catfish of Indian subcontinent. *International Journal of Aquatic Biology*, 3(2): 114-118.
- Gurkan S., Taskavak E. (2007). Length-weight relationships for syngnathid fishes of the Aegean Sea, Turkey. *Belgian Journal of Zoology*, 137(2): 219.
- Kahraman A.E., Göktürk D., Aydın E. (2014). Length-weight relationships of five fish species from the Sakarya River, Turkey. *Annual Research and Review in Biology*, 4(15): 2476-2483.
- Le Cren E.D. (1951). The length-weight relationship and seasonal cycle in gonad weight and condition in the perch (*Perca fluviatilis*). *Journal of Animal Ecology* 20: 201-219.
- Martin-Smith, K.M. (1996). Length/weight relationships of fishes in a diverse tropical freshwater community, Sabah, Malaysia. *Journal of Fish Biology*, 49(4): 731-734.
- Seher D., Suleyman C.I. (2012). Condition factors of seven cyprinid fish species from Çamlığöze Dam Lake on central Anatolia, Turkey. *African Journal of Agricultural Research*, 7(31): 4460-4464.
- Tabatabaei S.N., Hashemzadeh Segherloo I., Eagderi S., Zamani M. (2015). Length-weight relationships of fish species in Kordan River (Namak Lake basin,

- Iran). *Journal of Applied Ichthyology*, 1-2. doi: 10.1111/jai.12755
- Tahmasebi A., Keivany Y., Farhadian O. (2014). The length-weight relationship in Kura barb, *Barbus lacerta* Heckel, 1843, from Caspian Sea basin. The second Iranian conference of ichthyology, Faculty of natural resources, university of Tehran, 7-8 May 2014-Karaj.
- Ujjania N.C., Kohli M.P.S., Sharma L.L. (2012). Length-weight relationship and condition factors of Indian major carps (*C. catla*, *L. rohita* and *C. mrigala*) in Mahi Bajaj Sagar, India. *Research Journal of Biology*, 2(1): 30-36.
- Wang T., Wang H.S., Sun G.W., Huang D., Shen J.H. (2012). Length-weight and length-length relationships for some Yangtze River fishes in Tian-e-zhou Oxbow, China. *Journal of Applied Ichthyology*, 28(4): 660-662.