Studies on length-weight, length-length relationships and condition factor of *Capoeta aculeata* in Gamasiab river, Kermanshah province, Iran

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Abstract. This study includes the length-weight, length-length relationships and condition factor of *Capoeta aculeata* in Gamasiab river from Kermanshah province. 50 samples (18 male and 32 female) of *C. aculeata* were collected from Gamasiab river. All fish were measured for total length, fork length, standard length (0.01 mm precision), and weighed with an electronic scale (0.01 g precision). The length-weight relationship (LWR) was highly significant ($P<0.05$), with r^2 value 0.99. Also, the results showed that the b value is 2.92 for *C. aculeata*. LWR indicated negative allometric growth ($b<3$) for *C. aculeata* in Gamasiab river. All length-length relationships (LLRs) were highly significant ($P<0.01$), with all coefficient of determination values being >0.98. Also, in the present study, the condition factor of *C. aculeata* for males and females were 0.83 and 0.87 respectively. The results obtained from this study provide basic information for sustainable fishery management in Iran.
Key Words: Cyprinidae, length-weight relationship, environment, sustainable fishery, fishery management.

Introduction. Length-weight relationship (LWR) is important for comparison of growth studies (Moutopoulos & Stergiou 2002). LWR provide useful data for population dynamics studies and stock assessment (Shadi et al 2011; Safran 1992). The length-weight relationship of fish can be used to determine its condition factor (CF) that refers to the degree of well-being and the suitability to the environment (Farzana & Saira 2008; Fafuiye & Oluajo 2005). The condition factor (K) is calculated from the relationship between the weight of a fish and its length (Radkhah & Eagderi 2015). This factor can be use for comparing the observed weight of an individual with the mean weight for that length (Froese 2006; Raeisi et al 2011). In fisheries biology, LWR and CF are needed for the conversion of fish populations. Therefore, one of the most commonly used analyses of fisheries biology are LWR and CF (Mendes et al 2004; Ndome et al 2012).

    Capoeta aculeata belongs to the family Cyprinidae, the largest fresh water fish family that contains a number of large genera (Poria et al 2013). This species is found in the Namak lake, Dasht-e Kavir, Kerman-Na'in, Esfahan, Kor river basins and Tigris river (Coad 2016). It feeds plant, filamentous algae and diatoms (Abdoli 2000). *C. aculeata* is widely distributed in Iran, yet its biology and habitat requirements are unknown (Coad 2016). Consequently, the LWR and CF of this species in Iran should be studied. Therefore, in this study, we presented LWR and CF (K) of *C. aculeata* in Gamasiab river. The results obtained from this study are useful to biologists and fishery scientists.

Material and Method. 50 Samples of *C. aculeata* (18 male and 32 female) were collected from Gamasiab river in Kermanshah province by electrofishing (Figure 1). All fish were measured for total length (TL), fork length (FL) and standard length (SL) (0.01 mm precision), and weighed with an electronic scale (0.01 g precision). The relation of

weight-to-length was calculated applying the exponential regression equation $W = aL^b$, where L is total length (cm), W the total weight (g), a and b, the parameters to be estimated (LeCren 1951; Froese 2006). The CF (K) was calculated using the equation $K = 100W/L^3$ for male and female populations (Froese 2006; Farzana & Saira 2008), where W = total weight (g); L = total length (cm) and K = condition factor (g/cm^3).
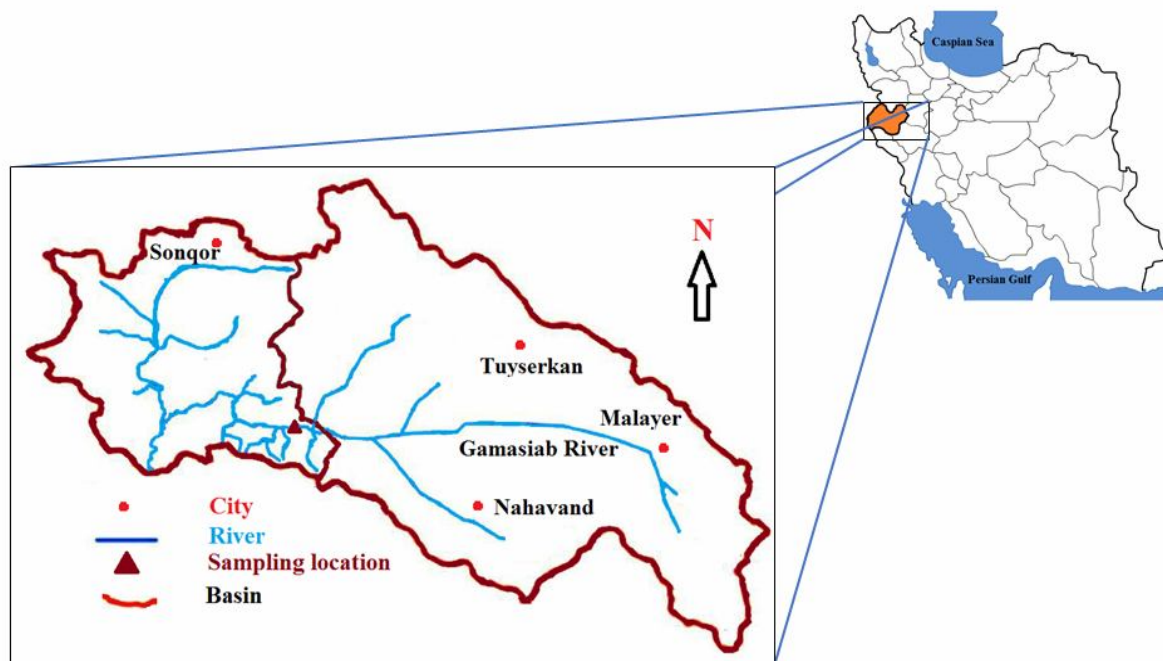

Figure 1. Collecting location for *Capoeta aculeata* in the Gamasiab river, Kermanshah province, Iran.

Results and Discussion. A total of 50 specimens ranging from 50 to 176 mm total length and 1.40 to 50.56 g total weight were collected. The LWR was highly significant ($P<0.05$), with r^2 value 0.99. Also, the results showed that the b value is 3.92 for *C. aculeata* (Table 1). LLR and the coefficient of determination (r^2) are given in Table 2. All LLRs were highly significant ($P<0.01$), with all coefficient of determination values being >0.98. Also, the condition factor of fish was 0.85.

Table 1

Length-weight relationship and condition factor of *Capoeta aculeata* in Gamasiab river

Gender	N	Length characteristics (mm)			Parameters of relationship			Condition factor
		Min	Max	Mean±SD	a	b	R^2	
Male	18	70	176	98.78±0.86	0.0654	2.98	0.99	0.83
Female	32	50	163	80.53±0.97	0.0504	2.91	0.99	0.87
Total	50	50	176	87.60±0.83	0.0625	2.92	0.99	0.85

The length-weight data of a species in different habitats is useful to compare life history and morphological aspects of populations living in different habitats (Cherif et al 2008). The relationship between length and weight can be used to assess the well-being of individuals and to determine possible differences between separate unit stocks of the same species (King 2007). The differences in weight for all the sampled batches may be due to the individual CF as it relates to the well-being and degree of fatness (Pauly 1983).

Table 2

Length-length relationships between total length (TL), fork length (FL) and standard length (SL) of *Capoeta aculeata* in Gamasiab river

Gender	N	Equation	Regression parameters		
			a	b	R^2
Male	18	TL = a + bFL	1.361	1.077	0.99
		FL = a + bSL	3.076	1.058	0.99
		SL = a + bTL	4.661	1.140	0.99
Female	32	TL = a + bFL	1.298	1.188	0.99
		FL = a + bSL	3.058	1.236	0.98
		SL = a + bTL	4.819	1.101	0.99
Total	50	TL = a + bFL	1.302	1.116	0.99
		FL = a + bSL	3.049	1.146	0.98
		SL = a + bTL	4.554	1.134	0.99

In LWR, the growth coefficient 'b' of the fish should be close to 3.0. It may range between 2.4 and 4.0 as reported by Dahare (2011). Differences in b value can be attributed to the combination of one or more factors such as: number of specimens, gonadal maturity, sex, health, habitat, seasonal effect etc. (Wootton 1991). Values of the exponent 'b' provide information on fish growth. When b=3, the increase in weight is isometric. When the value of b is other than 3, weight increase is allometric (positive if b>3, negative if b<3 (Froese 2006). In this study, the type of growth was negative allometric (b<3). Sedaghat et al (2013) quantified the LWR of *Capoeta capoeta intermedia* in Dalaki river, Bushehr, South of Iran. In this study, total length and weight ranged from 75.67 to 215 mm and 3.31 g to 90 g, respectively. Also, LWR showed positive allometric values for males, as: W=0.07×L$^{3.79}$ (r^2=0.93) and negative allometric values for females, as: W=0.05 L$^{2.87}$ (r^2=0.96). In addition to, Mousavi-Sabet et al (2013) calculated the LWR and LLR in populations of *Hemiculter leucisculus* from the Southwestern Caspian Sea Basin. In their study, LWR showed b values for males, females and male-females of 2.549, 2.680 and 2.465 respectively, which indicated a negative allometric growth trend of this species. Also, the LLR among the total length (TL), fork length (FL) and standard length (SL) for *H. leucisculus* were found to be highly significant (r^2>0.96, p<0.001).

In the present study, the CF of *C. aculeata* for males and females were 0.83 and 0.87 respectively. Javaheri Baboli et al (2012) reported CF for the samples of *Capoeta trutta* in Shour river downstream. The CF estimated for the samples was 0.94. Also, Mousavi-Sabet et al (2013) found a CF (K) for males and females of *H. leucisculus*, of 0.92 and 0.84 respectively. These results were almost same to our study. K value of the rest of species were >1 showing their perfect condition whereas, its value <1 reflects that the well being of the fish is not in a good condition (Manorama & Ramanujam 2014). In the present study, values of K which are found to be <1 indicates that the well being of *C. aculeata* is not good in Gamasiab river. Condition factor significantly varied between sexes of fishes. It also may vary among fish of different species in different location. The CF in fishes is affected by a number of parameters including sex, diet, health, habitat, season and etc. (Tesch 1971; Froese 2006). Therefore, the differences in the results of this study could be attributed to the age, sex, sample size, habitat and environmental conditions. In conclusion, this study has provided basic information on the LWR and K of *C. aculeata* that would be beneficial for fishery scientists in Iran.

Conclusions. The present study provided the first basic information on LWRs, LLRs and 'K' for *C. aculeata* in Gamasiab river. Therefore data from this research will be useful as important tools for ecological studies, management and conservation of the fish stocks.

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