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Length-weight and length-length relationships of *Cyprinion macrostomum* from the Tigris River drainage

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Abstract. The length-weight and length-length relationships for *Cyprinion macrostomum* are described from 319 adult specimens collected during the year 2013 in the Tigris River drainage, the Persian Gulf basin, west of Iran. The maximum standard length recorded for males and females were 15.5 cm and 16.2 cm, respectively. The length-length relationships between total length (TL), fork length (FL) and standard length (SL) for *C. macrostomum* were found to be highly significant ($r^2 > 0.97$, $p < 0.001$). The average value of "b" of the length-weight relationship was 3.44 which indicated a positive allometric growth trend of this species in the studied region.
Key Words: Cyprinidae, Persian Gulf basin, Gamasiab River, Iran.

Introduction. The cyprinid genus *Cyprinion* is found from the Indus River basin west to the Arabian Peninsula and the Tigris-Euphrates basin but excluding northern drainages such as the Lake Orumiyeh, Caspian Sea and Hari River basins (Coad 2014). The genus *Cyprinion* comprises nine species (including *Cyprinion acinaces*, *C. kais*, *C. macrostomum*, *C. mhalensis*, *C. microphthalmum*, *C. milesi*, *C. semiplotum*, *C. tenuiradius*, and *C. watsoni*), among which five are reported from Iran (*C. kais*, *C. macrostomum*, *C. milesi*, *C. tenuiradius* and *C. watsoni*) and three from Tigris-Euphrates basin (*C. kais*, *C. macrostomum* and *C. tenuiradius*). The first two species are well distributed in inland waters of Iran, Iraq, Turkey, and Syria (Coad 1995, 1996, 2014; Epler et al 2001; Eschmeyer 1998).

C. macrostomum is found in the Orontes, (= Asi), Quwayq and Tigris-Euphrates basins. In Iran, it is found in the Tigris River basin including the Hawr Al Azim, Khersan, Jarrahi, Marun and Gamasiab rivers and the northern Gulf basin in the Shapur, Dalaki and Helleh rivers, the Zohreh River and possibly Lake Famur. This species and *Garra rufa* are economically important because these are identified as the "doctor fish". Also it is to be important in riverine and culture fisheries in northern Iraq (Coad 2014). So, because of the wide distribution and the economic importance, this species is chosen in the present study.

Indeed, the knowledge on quantitative aspects such as length-weight relationship, length-length relationship, condition factor, growth and recruitment are important tools for the adequate management of any fish species (King 2007; Ndome et al 2012). The length-weight (LWR) and length-length (LLR) relationships have been applied for basic uses for assessment of fish stocks and populations (Ricker 1968). The length-weight relationships also helps to figure out the condition, reproduction history, life history and the general health of fishing species (Nikolsky 1963; Wootton 1990, 1992; Pauly 1993)

and is also useful in local and interregional morphological and life historical comparisons in species and populations. The length-weight relationship of fish is an important fishery management tool. It is important estimating the average weight at a given length group (Beyer 1987) and it is also useful for converting length observations into weight estimates to provide some measure of biomass (Froese 1998). It is necessary to use standard measures for all populations to render the results more reliable when making comparisons between populations. Therefore, the length-length relations of species under various environmental conditions should be known. The length-length relationship is also of great importance for comparative growth studies (Moutopoulos & Stergiou 2002). In fisheries studies, fish length can often be measured more rapidly and easily than mass. The knowledge of the length-weight relationship makes it easier to determine the mass where only the length is known. In the field, the tail flukes are often cut, which makes it difficult to measure the total length accurately. Knowing the standard length will enable us figure out the total length. The well-being state of the fish can be inferred with a condition factor (Le Cren 1951), which is used for comparing the condition, fatness or well-being of fish (Tesch 1968), assuming that heavier fish of a given length are in better condition. Keeping in view that the basic requirements for the sustainable management of the fisheries is the assessment of the fish populations, the present study was initiated. The aim of the present study is to determine the length-weight and length-length relationships of males and females of *Cyprinion macrostomum*, the species caught in Gamasiab River in 2013.

Material and Method. Fishes were collected monthly from January 2013 to December 2013 by electrofishing from a related stream to Gamasiab River (34°22'249"N, 047°54'729"E) in Kermanshah region in western Iran (Figure 1).

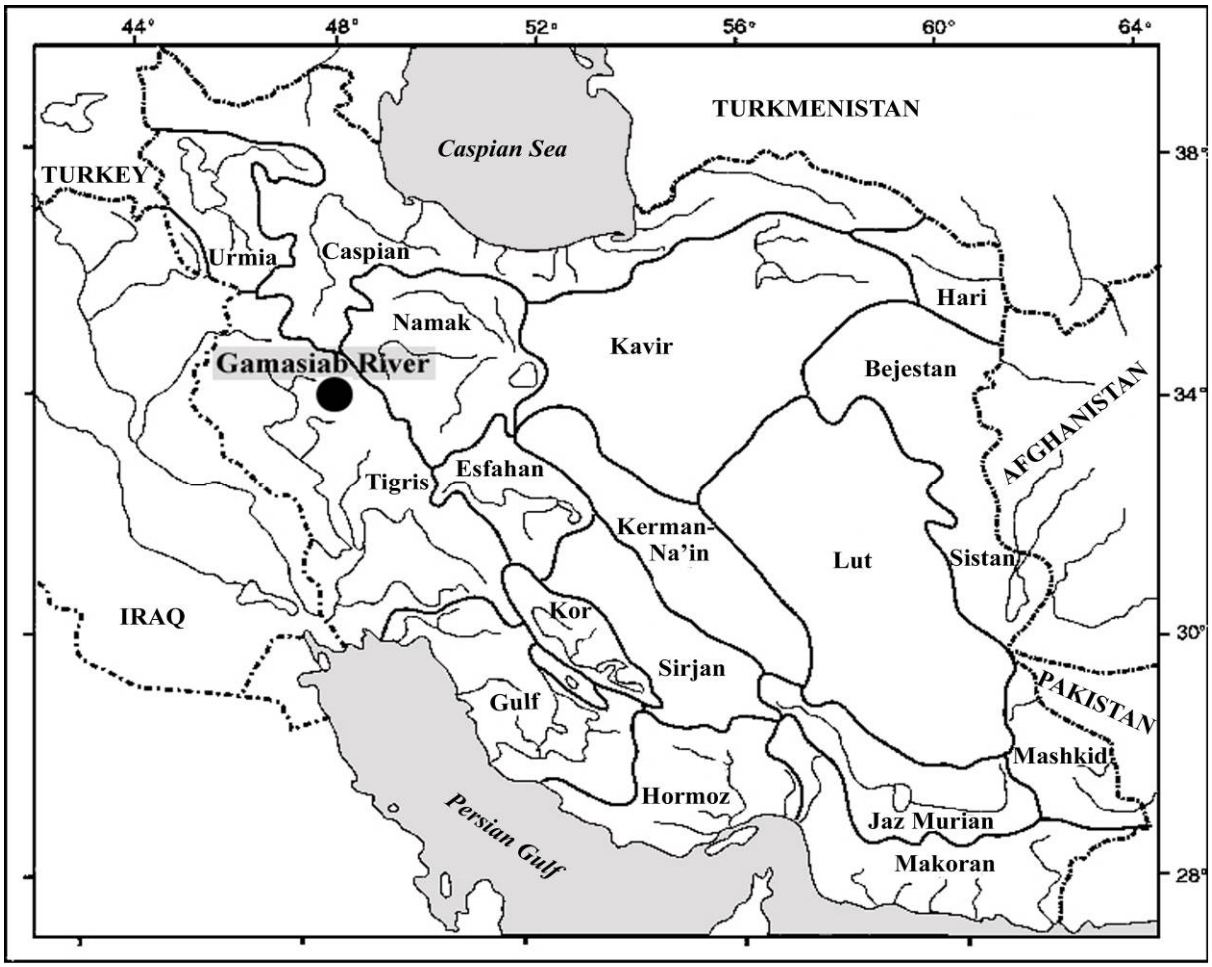

Figure 1. The map of Iranian basins, showing the Tigris River drainage and Gamasiab River.

The specimens were collected from the same sampling site. The sampling site is a shallow and narrow (up to 5 m wide) stream with diverse structures (pools, riffles, gravelbed, sandy shore, etc.). The total length (TL), standard length (SL) and fork length (FL) of fish were measured (±0.1 cm), weighted (± 1 g) with an electronic balance, and the sex was assigned by examining the gonads.

The length-weight relationships for weight were calculated using the equation, $W = aL^b$ (Ricker 1979), where 'a' is a coefficient related to body form and 'b' is an exponent indicating isometric growth when equal to 3. The statistical significance level of r^2 was estimated by linear regressions on the transformed equation, LogBW = log a + b * logSL. The length-weight relationship between males and females were calculated separately. Moreover, TL vs FL; FL vs SL; and SL vs TL relationships were calculated by linear regressions. All statistical analyses were evaluated at $p < 0.05$ significance level.

Results. A total of 319 specimens of *C. macrostomum* were examined. The maximum SL and weight of *C. macrostomum* recorded in this study were 16.2 cm and 95.7 g, respectively. The minimum and maximum standard length and weight are shown in Table 1. It was determined that 38.9% of the samples were females (n = 124) and 61.1% males (n = 195).

Length-weight relationship. Length-weight relationships for males, females and the total sample population were determined and shown in Table 1. Analysis of covariance revealed significant differences between sexes for the slopes (b) of the regression lines ($p < 0.05$).

Table 1

Descriptive statistics and estimated parameters of length-weight relationships for both sexes of *C. macrostomum* in Gamasiab River

Sex	*N*	*Standard length (cm)*		*Total weight (g)*		*Relationship parameters*		
		Range	*Mean±SD*	*Range*	*Mean±SD*	*a*	b	r^2
Male	195	9.4-15.5	12.9±1.8	23.9-81.4	55.1±17.9	0.363	3.416	0.865
Female	124	11.1-16.2	13.7±1.9	38.5-95.7	70.6±23.3	0.379	3.318	0.912
Total	319	9.4-16.2	13.1±1.8	23.9-95.7	58.8±19.9	0.355	3.442	0.869

N = number of individuals; a = intercept; b = slope, r^2 = coefficient of determination.

Length-length relationship. Length-length relationships and the coefficient of determination r^2 are given in Table 2. In this study the length-length relationships in *C. macrostomum* were found to be highly correlated (in all cases: $r^2 > 0.97$, $p < 0.001$).

Table 2

Length-length relationships between total length (TL), fork length (FL) and standard length (SL) of *C. macrostomum* in Gamsaiab River

Sex	*N*	*Equation*	*a*	*b*	r^2
Male	195	TL = a + b FL	0.1469	0.9932	0.9718
		FL = a + b SL	0.1532	0.9873	0.9875
		SL = a + b TL	-0.1533	0.9898	0.9816
Female	124	TL = a + b FL	0.2269	0.9763	0.9904
		FL = a + b SL	-0.2188	1.0606	0.9984
		SL = a + b TL	0.0499	0.9534	0.9858
All	319	TL = a + b FL	0.1734	0.9876	0.9762
		FL = a + b SL	0.1103	0.9955	0.9879
		SL = a + b TL	-0.1438	0.9888	0.9800

N = number of individuals; a = intercept; b = slope, r^2 = coefficient of determination.

Discussion. In Iran several researchers have made estimations on length-weight and length-length relationships in different cyprinid species e.g., *Alburnus atropatenae*, *A. caeruleus*, *A. chalcoides*, *A. filippii*, *A. hohenackeri*, *A. mossulensis*, *A. zagrosensis* and

Hemiculter leucisculus (Mousavi-Sabet et al 2013a, 2013b, 2014), and loach species e.g., *Cobitis faridpaki* and *C. keyvani* in different localities (Mousavi-Sabet et al 2011, 2012a, 2012b; Mousavi-Sabet 2012). Le Cren (1951) has stated that the length-weight relationships in fishes are probably related to the seasonal variation since fat and water content of fish may vary according to temperature. The change in 'b' value shows allometric growth of the body due to the influence of numerous factors such as seasonal fluctuations, changes in physiological condition during spawning periods, gonad development, sex, physicochemical conditions of the environment and nutrition conditions of the environment (Sinha 1973). The reported exponent values for 'b' for different fishes ranged between 2.5 to 4.0 (Hile 1936; Martin 1949) and 2 to 4 (Bagenal & Tesch 1978; Koutrakis & Tsikliras 2003). Sekharan (1998) have also observed an inter specific for 'b' that remains constant at '3.0' for an ideal fish. In the present fish sample, the calculated values for 'b' for length and weight were higher than 3, i.e., 3.416 and 3.318 in males and females respectively, which were of expected range and indicated that the growth is almost positive allometric in *C. macrostomum*. Le Cren (1951) states that the length weight relationship in fishes is probably related to the seasonal variations as fishes do not retain the same shape or body contour throughout the year. So there should be slight change in slope values in different seasonal studies. The values of coefficient of determination 'r^2' calculated for all relationships viz., TL-Wt, and TL-SL, FL-TL and SL-FL in *C. macrostomum* (Tables 1 and 2) were 0.869 and 0.9800, 0.9762 and 0.9879, respectively which are highly significant ($p < 0.001$).

Wootton (1992) however opined that $b < 3$ indicates that the fish gets relatively thinner as they grow larger while $b > 3$, it is plumper as it grows larger. Regression coefficients obtained from length-weight relationships (L-W) which are indicative of isometric or allometric growths differ not only between species but sometimes also between stocks of same species. The development of fish involves several stages, each of which has its own length-weight relationships. There may also be differences in the relationships due to sex, maturity, season and environmental conditions (e.g. pollution).

Conclusions. As conclusion in the present study an important contribution is the provision of base-line data on the length-weight and length-length relationships of the *C. macrostomum*, which are important tools for the adequate management of the fish stocks and populations. The provided data on the LWR and LLR would be beneficial for fishery biologist's managers to impose suitable regulations for sustainable fishery management and conservation programs in the region.

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