

# Age and growth of *Carasobarbus luteus* (Heckel, 1843) in Karkheh River, Southwestern Iran

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## Abstract

Age and growth of the Hemri, *Carasobarbus luteus* in Karkheh River, Southwestern Iran were estimated for 210 individuals (89 males, 107 females and 14 immature) captured between July 2010 and July 2011. Male to female ratio was 0.83 to 1. The age of females ranged from 0+ to 6+ years and of males from 0+ to 5+ years. Total length and total weight ranged from 75 to 290 mm and 5.6 to 341 g, respectively. The length–weight relationship was  $W = 0.0152 L^{2.9293}$  for males and  $W = 0.0185 L^{2.857}$  for females. Growth of Hemri was expressed by von Bertalanffy's equation as  $L_t = 31.78 (1 - e^{-0.16(t+0.35)})$  for males and  $L_t = 28.34 (1 - e^{-0.23(t+0.44)})$  for females.

**Key words:** age, *Carasobarbus luteus*, growth, Karkheh River, Iran.

## Introduction

The cyprinid fish *Carasobarbus luteus* (Heckel, 1843), which is called Himri or Hemri in Iran, is widely distributed in the rivers Tigris and Euphrates and adjacent drainage basins. In Iran, it is found in the Tigris River Basin, the Persian Gulf Basin, the Lake Maharlu Basin and the Hormozgan Basin. This fish is highly appreciated as it is in high request as food (Borkenhagen et al. 2011; Coad 2011).

Fish growth can be expressed by numerous parameters. Fish in good condition may be expected to grow in length; consequently, body size and condition are good growth indicators (Ložys 2004). Information on the biological characteristics of a population of each species is important for the preservation of the species.

A few studies have been performed on the biology of *C. luteus* in Iraq (Al-Jaferye et al. 1976; Bhatti, Al-Daham 1978; Al-Daham, Bhatti 1979; Barak, Mohammad 1982; Jerzy, Ali 1982; Ahmed 1982; Ahmed et al. 1984; Naama, Muhsen 1986; Epler et al. 1996; Szypula et al. 2001; Epler et al. 2001), in Syria (Al Hazzaa 2005), in Turkey (Gokcek, Akyurt 2008) and in Iran (Hashemi 2010; Eydizadeh et al. 2013; Eydizadeh et al. 2014; Hashemi et al. 2014). Differences are known to occur in age and growth structures between populations of the same species living in different areas. There is presently information available on biological characteristics of *C. luteus* in Karkheh River. Considering the financial importance of this species and distribution in Iran, studies on biological characteristics of the species for fisheries management and protection of environment seems to be important. Therefore, the present study was aimed to obtain the first information on population structure (age, sex ratio,

length-weight relationship and growth) of *C. luteus* in the Karkheh River.

## Materials and methods

A total of 210 *C. luteus* individuals were captured from July 2010 to July 2011 in Karkheh River. The sampling was carried out using gill-nets with various mesh size (10 × 10, 20 × 20 and 30 × 30 mm). The stations were located at a latitude of 31°33'7"N and longitude 48°26'30"E and 31°29'39"N and 48°26'2"E for station 1 and 2, respectively.

Samples of *C. luteus* were transported to laboratory in an ice-box. Total length (TL) and total weight (TW) were measured with an accuracy of 1.0 mm and 0.1 g, respectively. An average of 14 scales from each fish were mounted between two glass microscope slides for age estimation. Scale age was determined by viewing all scales on a slide and assigning age based on the scale with the largest number of annuli (Robinson et al. 2010).

The commonly used length-weight relationship  $W = aL^b$  was applied (Ricker 1975), where  $W$  is the weight (g),  $L$  is the total length (cm), and  $a$  and  $b$  are constants. A significant difference of  $b$  from 3 was tested by using the equation given by Pauly (1984):

$$t = \frac{sd \ln L}{sd \ln W} \times \frac{|b - 3|}{\sqrt{1 - r}} \times \sqrt{n - 2}$$

where  $n$  is the number of specimens,  $b$  is the slope of the regression line,  $sd \ln L$  and  $sd \ln W$  are standard deviations of length and weight, respectively, and  $r$  is the regression coefficient.

Growth was estimated using the von Bertalanffy growth curve model (Pauly 1984; Sparre, Venema 1998):

$$L_t = L_{\infty} [1 - e^{-K(t-t_0)}],$$

where  $L_t$  = total length (cm),  $L_{\infty}$  = asymptotic length (cm),  $k$  = Brody growth coefficient,  $t$  = age (years), and  $t_0$  = age at zero length. The von Bertalanffy growth parameters were estimated for males and females separately as well as for both sexes combined. In addition, the growth performance index was calculated from  $(\Phi') = \log k + 2\log L_{\infty}$  equation (Pauly, Munro 1984), to compare growth of different populations.

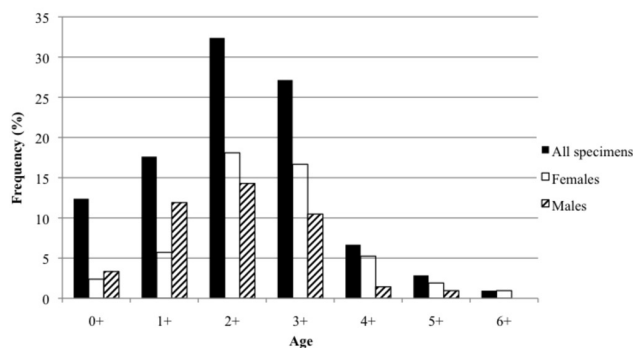
**Results**

A total of 210 Hemri individuals (89 males, 107 females and 14 immature) were sampled with gill nets. Male to female ratio was 0.83 : 1; the difference between sexes was not statistically significant ( $\chi^2$ -test;  $P > 0.05$ ).

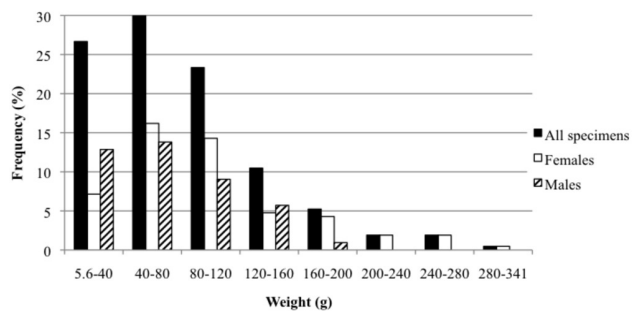
Age distribution of males and females are shown in Fig. 1. The ages ranged from 0 to 6 years (females: 0 to 6 years, males: 0 to 5 years). The 2+ and 3+ year classes were dominant; accounting for over 50% of the total. The number of older fish was rather low.

The weight of samples ranged from 5.6 g to 341 g (Fig. 2), but the majority of male and female individuals had weight 40 to 80 g. The length distribution ranged from 75 to 290 mm (Fig. 3) and the majority of the samples were in the 155 to 195 mm length group. The weight and length frequency distributions were different for males and females.

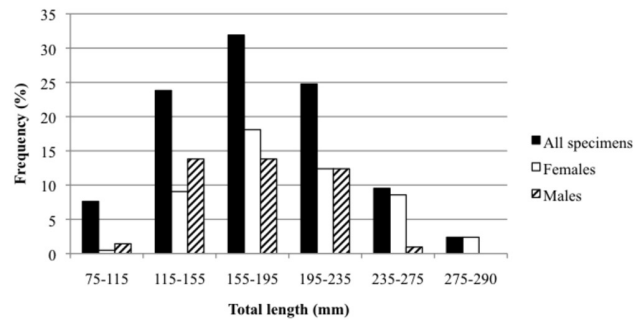
The length–weight relationship was calculated using



**Fig. 1.** Age-frequency distribution for males, females and total population of *Carasobarbus luteus* in Karkheh River from July 2010 to July 2011.

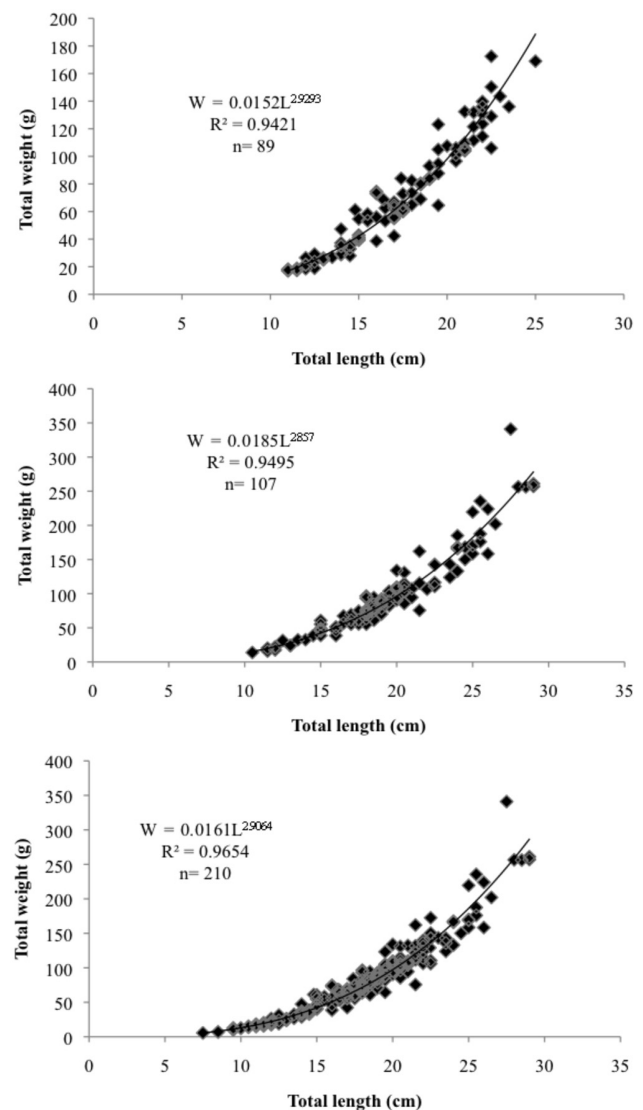


**Fig. 2.** Weight distribution of *Carasobarbus luteus* in Karkheh River from July 2010 to July 2011.



**Fig. 3.** Length distribution of *Carasobarbus luteus* in Karkheh River from July 2010 to July 2011.

the data from all 210 specimens. The relationship was  $W = 0.0152 L^{2.9293}$  for males,  $W = 0.0185 L^{2.857}$  for females and  $W = 0.0161 L^{2.9064}$  for all specimens. Length–weight curves for males, females and all specimens are plotted in Fig. 4.



**Fig. 4.** Length–weight relationship for *Carasobarbus luteus* males (A), females (B) and all specimens (C) in Karkheh River from July 2010 to July 2011.

The calculated von Bertalanffy growth parameters and equations are presented for males, females and all specimens (Table 1), with males reaching a greater asymptotic length ( $L_{\infty}$ ). Von Bertalanffy curves for males, females and all specimens are plotted in Fig. 5. The growth ratio ( $k$ ) for males indicated slower growth than that for females. The  $\Phi'$  values of males, females and all specimens were calculated as 2.2, 2.26 and 2.33, respectively.

## Discussion

The sex ratio of Hemri in Karkheh River was 0.83:1, which was similar to the 1:1 ratio expected for most fish species (Bagenal 1978). This is also in good agreement with values reported for this species by Al-Hazza (2005) for Euphrates River as well as by Gokcek and Akyurt (2008) for Orontes River. However Eydizadeh et al. (2014) reported the male to female ratio of this species in Hoor Al-azim wetland to be 0.51:1, which was significantly different from the ratio of 1:1. As showed by Nikolsky (1963), the sex ratio may differ from one population to another and year to year within the same population; the factors affecting the sex ratio are mostly unknown.

The captured *C. luteus* specimens from Karkheh River has age between 0+ and 6+. The average age range of this species was reported to be 1 to 9 years by Gokcek and Akyurt (2008) for Orontes River, and 2 to 7 years by Al-Hazza (2005) for Euphrates River. This may be explained by the selectivity of the sampling nets used and high fishing pressure on this species in the Karkheh River.

In the present study, the exponent ( $b$ ) in the length-weight relationship was 2.9293 for males and 2.857 for females. The Pauly t-test showed that the growth pattern of *C. luteus* was isometric in males and negative allometric in females and all fishes. Hashemi et al. (2014) reported that the growth pattern of *C. luteus* from Shadegan wetland of Iran was negative allometric in males, females and all fishes. Eydizadeh et al. (2013) found the pattern growth of *C. luteus* in Hoor Al-azim wetland of Iran to be isometric. The exponent ( $b$ ) values of the *C. luteus* population are given in Table 2, with a comparison to ( $b$ ) values estimated in the present study. The exponent ( $b$ ) in this table ranged from 2.50 to 3.18 and our results are within this range. The  $b$  value in from some other studies in *C. luteus* was 3.06 in Shadegan wetland of Iran (Hashemi 2010), 3.18 in Hoor Al-azim wetland of Iran (Eydizadeh et al. 2013), 2.988 in Orontes River of Turkey (Gokcek and Akyurt 2008) and

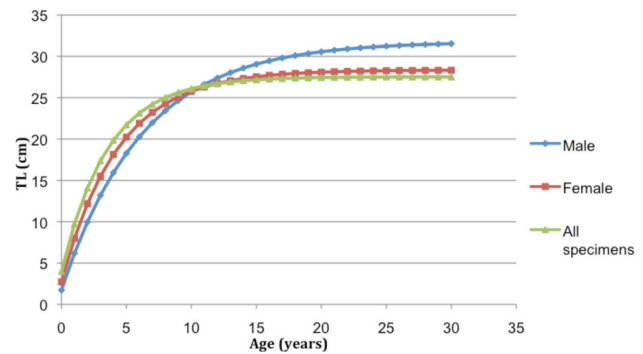


Fig. 5. von Bertalanffy growth curve for *Carasobarbus luteus* of males, females and all specimens in Karkheh River from July 2010 to July 2011.

2.6 in Shadegan wetland of Iran (Hashemi et al. 2014). Differences in  $b$  values can be due to one or more reasons: (i) differences in the number of specimens observed; (ii) range/season effect; (iii) habitat; (iv) degree of stomach fullness; (v) gonad maturity; (vi) sex; (vii) health and overall fish situation; (viii) preservation methods; and (ix) differences in the observed length ranges of the specimens caught (Wootton 1998).

The  $L_{\infty}$  value in males was higher than that of females (Table 1). This may be due to variation in growth differences between females and males. Growth coefficient values ( $K = 0.16$  per year for males and  $0.23$  per year for females) indicated relatively low growth to maximal size.

The data on the von Bertalanffy growth parameters for this species indicate differences (Table 2), that can be attributed to temporal and geographical variations. The values of  $L_{\infty}$  and  $K$  from other studies for this species were 25.9 cm and  $0.24 \text{ year}^{-1}$  for all fishes in Asi River of Turkey (Ozdilek et al. 2004),  $L_{\infty} = 54.71 \text{ cm}$ ,  $K = 0.11 \text{ year}^{-1}$  for males and  $L_{\infty} = 56.93 \text{ cm}$ ,  $K = 0.105 \text{ year}^{-1}$  for females in Euphrates River of Syria (Al-Hazza 2005),  $L_{\infty} = 39.32 \text{ cm}$ ,  $K = 0.282 \text{ year}^{-1}$  for all fishes in Orontes River of Turkey (Gokcek and Akyurt 2008),  $L_{\infty} = 30.2 \text{ cm}$ ,  $K = 0.24 \text{ year}^{-1}$  for all fishes in Shadegan wetland of Iran (Hashemi 2010), and  $L_{\infty} = 37.5 \text{ cm}$ ,  $K = 0.67 \text{ year}^{-1}$  for all fishes in Hoor Al-azim wetland of Iran (Eydizadeh et al. 2013). Fish populations of the same species from different geographical areas may have highly variable growth rates (Wotton 1990). Differences noted in growth may be attributed to variation in habitat, temperature, and perhaps, differences in feeding habits (Yildirim et al. 2001). These differences may also be due to over-exploitation of natural stocks by over-fishing and

Table 1. Von Bertalanffy growth parameters and equations for males, females and all specimens of *Carasobarbus luteus* in Karkheh River from July 2010 to July 2011

Sex	$L_{\infty}$ (cm)	$k$ ( $\text{year}^{-1}$ )	$t_0$ (years)	$\Phi'$	von Bertalanffy growth equations
Males	31.78	0.16	-0.35	2.2	$L_t = 31.78 (1 - e^{-0.16(t+0.35)})$
Females	28.34	0.23	-0.44	2.26	$L_t = 28.34 (1 - e^{-0.23(t+0.44)})$
All specimens	27.52	0.28	-0.56	2.33	$L_t = 27.52 (1 - e^{-0.28(t+0.56)})$

**Table 2.** Comparison of study results on *Carasobarbus luteus* age ranges and parameters of length-weight relationship (a and b), growth ( $L_{\infty}$ , k and  $t_0$ ) and growth performance ( $\Phi'$ )

Age	a	b	$L_{\infty}$ (cm)	k (year <sup>-1</sup> )	$t_0$ (year)	$\Phi'$	Sex	Reference
-	0.0127	3.09	-	-	-	-	M+F	Sevik, Hartavi 1997
-	0.0002	2.88	-	-	-	-	M+F	Sagat, Erdem 1997
1-5	0.0145	3.08	25.9	0.24	-0.6	-	M+F	Ozdilek et al. 2004
2-7	0.0130	3.05	54.71	0.11	-0.163	-	M	Al Hazzaa 2005
	0.0190	2.98	56.93	0.105	-0.377	-	F	
-	0.01265	2.97	-	-	-	-	M+F	Basusta, Cicek 2006
-	0.0098	3.159	-	-	-	-	M+F	Esmaili, Ebrahimi 2006
1-7	0.0125	3.003	40.32	0.247	-1.58	-	M	Gokeck, Akyurt 2008
1-9	0.0129	2.986	38.77	0.300	-1.69	-	F	
1-9	0.0129	2.988	39.32	0.282	-1.64	-	M+F	
-	0.0770	2.837	-	-	-	-	M+F	Özcan 2008
-	0.0116	3.06	30.2	0.24	-0.37	2.3	All	Hashemi 2010
-	0.0018	3.18	37.5	0.67	-0.16	2.76	All	Eydizadeh et al. 2013
-	0.00003	2.83	-	-	-	-	M	Hashemi et al. 2014
	0.0002	2.50	-	-	-	-	F	
	0.0001	2.60	-	-	-	-	All	
0-5	0.0152	2.9293	31.78	0.16	-0.35	2.2	M	Present study
0-6	0.0185	2.857	28.34	0.23	-0.44	2.26	F	
0-6	0.0161	2.9064	27.52	0.16	-0.56	2.33	All	

deteriorated environmental conditions.

In the present study, age at zero length ( $t_0$ ) was estimated as -0.56 for all fishes. The value of  $t_0$  for all fishes of *C. luteus* was -0.6 in Asi River of Turkey (Ozdilek et al. 2004),  $t_0$  = -1.64 in Orontes River of Turkey (Gokcek, Akyurt 2008),  $t_0$  = -0.37 in Shadegan wetland of Iran (Hashemi 2010), and  $t_0$  = -0.16 in Hoor Al-azim wetland of Iran (Eydizadeh et al. 2013). Negative  $t_0$  values indicate that juveniles grow more quickly than the predicted growth curve for adults, while positive  $t_0$  values show that juveniles grew more slowly (Biswas 1993).

In our study, the calculated  $\Phi'$  value of all specimens of *C. luteus* was 2.33. The  $\Phi'$  values of this species from other studies were 2.3 in Shadegan wetland in the Iran country (Hashemi 2010) and 2.76 in Hoor Al-azim wetland of Iran (Eydizadeh et al. 2013).

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