

[Research]

## Length-weight and length-length relationships, Relative condition factor and Fulton's condition factor of Five Cyprinid species in Anzali wetland, southwest of the Caspian Sea

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### ABSTRACT

This study was conducted to determine length-weight and length-length relationships, relative condition factor ( $K_{rel}$ ) and Fulton's condition factor ( $K$ ) for five species including *Scardinius erythrophthalmus*, *Carassius auratus gibelio*, *Cyprinus carpio*, *Tinca tinca* and *Hemiculter leucisculus* belonging to Cyprinidae family. Fish sampling was carried out by gill net and fyke net in the western region of Anzali wetland (SW of the Caspian Sea) between Nov. 2010 and May 2011. 368 specimens were measured and weighed. The values of the exponent  $b$  in the length-weight relationships (LWRs) ranged from 2.5358 to 3.3613 and those of the length-length relationship (LLRs) ranged from 0.8717 to 0.9412. Also, relative condition factor ( $K_{rel}$ ) ranged from  $1.00 \pm 0.11$  to  $1.30 \pm 0.21$  and Fulton's condition factor ( $K$ ) ranged from  $0.80 \pm 0.05$  to  $1.60 \pm 0.18$  for all species.

**Keywords:** Fish Cyprinidae, Length-weight relationship, length-length relationship, Caspian Sea, Anzali wetland.

### INTRODUCTION

The results of length-weight relationship can be used for (a) conversion of growth-in-length equations to growth-in-weight, for use in stock assessment models; (b) estimating biomass from length data; (c) calculating total weight of fish caught from length-frequency data; (d) measuring changes in health of fish species (relative to past or future samples at the same place and season); (e) determining the relative condition factor of small fish compared to large fish and (f) for comparing between-region life histories of certain fish species (Wootton, 1992; Pauly, 1993; Petrakis and Stergiou, 1995; Goncalves *et al.*, 1996; Binohlan and Pauly, 1998; Moutopoulos and Stergiou, 2002). Length-length relationship is also very important for comparison of growth studies (Moutopoulos and Stergiou, 2002).

The available information on fish population biology (including length-weight relationship) in Iran is limited to some reports on commercially important

marine and freshwater fishes (Hosseini, 2002; Naddafi *et al.*, 2002; Shokri *et al.*, 2005; Esmaeili, 2006; Esmaeili and Ebrahimi, 2006; Hydarnejad, 2009; Raeisi *et al.*, 2011). There is no previous information about length-weight and length-length relationships of fish species in Anzali wetland (SW Caspian Sea). Subsequently, in this study we presented length-weight relationship (LWR), length-length relationship (LLR), relative condition factor ( $K_{rel}$ ) and Fulton's condition factor ( $K$ ) of *Scardinius erythrophthalmus* Linnaeus, 1758, *Carassius auratus gibelio* (Bloch, 1782), *Cyprinus carpio* (Linnaeus, 1758), *Tinca tinca* (Linnaeus, 1758) and *Hemiculter leucisculus* (Basilewsky, 1855) for the first time in Anzali wetland.

### MATERIALS and METHODS

#### Study area

Anzali wetland is a lagoon connected to the Caspian Sea (Fig. 1). It is important as a spawning ground of anadromous fishes

such as *Rutilus frisii kutum*, *Sander lucioperca* and *Abramis brama* (Holcik and Olah, 1992). The surface area and maximum depth of Anzali wetland (37° 28' N 49° 20' E) is approximately 193 Km<sup>2</sup> and 2.75 m, respectively (JICA, DOE, MOJA., 2004).

#### Data collection

Sampling was done on a monthly basis from Nov 2010 to May 2011 in western part of Anzali Wetland. Two types of fishing gear were used: (i) gill nets with mesh sizes 17 to 42 mm (bar) and (ii) fyke nets with mesh sizes 24 to 32 (bar). The fish were caught using two fishing gear that allowed collection of both adult and juvenile specimens. The samples were fixed with 4% formaldehyde and transferred to the laboratory. For each specimen, total length (TL) and fork length (FL) were measured using measuring board to the nearest 1 mm, and whole body wet weight (g) was taken on a digital balance with 0.1 g accuracy.

#### Data analysis

The length-weight relationships were estimated using the following equation (Froese, 2006):

$$W = aL^b$$

Where  $W$  is the whole body weight (g),  $L$  is the total length (cm),  $a$  is the intercept of the regression and  $b$  is the regression coefficient (slope).

The parameters  $a$  and  $b$  of the length-weight relationships were estimated by the least-squares method based on logarithms:

$$\log(W) = \log(a) + b \log(L)$$

A t-test was used for comparison  $b$  value obtained in the linear regression with isometric value (Sokal and Rohlf, 1987):

$$t_s = \frac{(b - 3)}{S_b}$$

Where  $t_s$  is the t-test value,  $b$  the slope and  $S_b$  the standard error of the slope ( $b$ ). The comparison obtained values of t-test with the respective tabled critical values allowed for the determination of the  $b$  values statistically significant, and their inclusion in the isometric range ( $b=3$ ) or allometric range (negative allometric;  $b<3$  or positive allometric;  $b>3$ ).

The length-length relationships were estimated by conversion among length measurements (TL and FL). Also for each individual, relative condition factor ( $K_{rel}$ ) and Fulton's condition factor ( $K$ ) were calculated by following equations (Le cren, 1951; Froese, 2006):

$$K_{rel} = \frac{W}{aL^b} \quad K = 100 \frac{W}{L^3}$$

Where  $W$  is the whole body wet weight (g),  $L$  is the total length (cm), and  $a$  and  $b$  are the parameters of length-weight relationship.

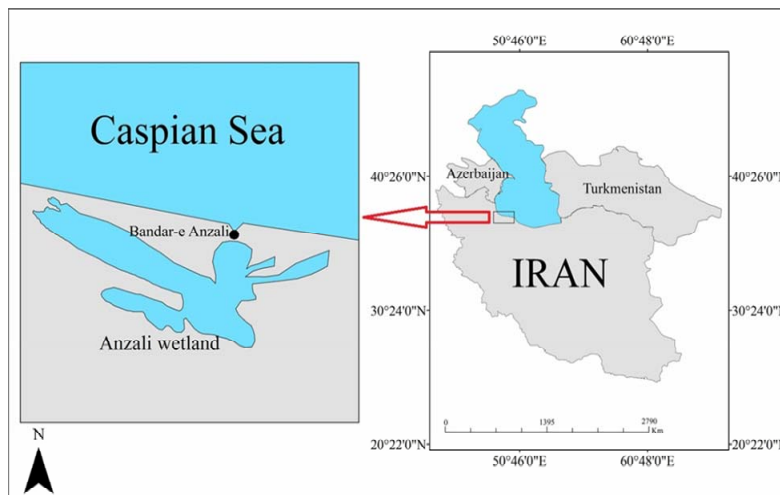


Fig 1. Map of the Caspian Sea showing the location of study area and Anzali wetland position.

## RESULTS

A total of 368 specimens of five fish species were collected from Anzali wetland (SW of the Caspian Sea) during the present study. The sample size ( $n$ ), length range, parameters  $a$  and  $b$  of the length-weight

relationships, the standard error of  $b$  value and the determined coefficient ( $r^2$ ) of selected fishes are given in Table 1. All regressions are highly significant ( $P < 0.01$ ) and the  $r^2$  values range from 0.90 to 0.96.

**Table 1.** Descriptive statistics and length-weight parameters for five Cyprinids in Anzali wetland, SW of the Caspian Sea.

Species	Length	n	Length characteristics (cm)			Parameters of the relationship			
			Min.	Max.	Mean $\pm$ SD	a	b	SE(b)	r <sup>2</sup>
<i>S.erythrophthalmus</i>	TL	141	6.4	17.7	13.19 $\pm$ 1.91	0.0055	3.3613	0.023	0.96
<i>C. auratus gibelio</i>	TL	95	11.3	35.5	23.63 $\pm$ 3.74	0.0224	2.8791	0.013	0.90
<i>C. carpio</i>	TL	35	20.7	59.8	29.97 $\pm$ 8.62	0.0294	2.7621	0.048	0.95
<i>T. tinca</i>	TL	46	15.0	26.5	20.03 $\pm$ 2.45	0.0632	2.5358	0.053	0.90
<i>H. leucisculus</i>	TL	51	14.8	20.0	16.98 $\pm$ 1.19	0.0068	3.0508	0.009	0.91

The growth was positive allometric for *S. erythrophthalmus* and *H. leucisculus* ( $b > 3$ ,  $P < 0.05$ ). *C. auratus gibelio*, *C. carpio* and *T. tinca* showed negative allometric growth ( $b < 3$ ,  $P < 0.05$ ).

All length-length relationships presented (Table 2) were highly significant ( $P < 0.01$ ), with the determination coefficient values being  $> 0.93$ .

**Table 2.** The relationship between total length (TL in cm) and fork length (FL in cm) for five Cyprinids in Anzali wetland, SW of the Caspian Sea.

Species	N	Equation	Regression parameters		SE (b)	r <sup>2</sup>
			a	b		
<i>S.erythrophthalmus</i>	62	FL = a + b $\times$ TL	3.7502	0.8791	0.046	0.99
<i>C. auratus gibelio</i>	91	FL = a + b $\times$ TL	-0.0521	0.91	0.009	0.97
<i>C. carpio</i>	35	FL = a + b $\times$ TL	0.661	0.8717	0.005	0.94
<i>T. tinca</i>	46	FL = a + b $\times$ TL	0.4564	0.9412	0.007	0.98
<i>H. leucisculus</i>	51	FL = a + b $\times$ TL	-0.4094	0.9273	0.004	0.93

Table 3 indicates relative condition factor ( $K_{rel}$ ) and Fulton's condition factor (K) of selected species. Relative condition factor ( $K_{rel}$ ) was ranged from 1.00 (for *S. erythrophthalmus*, *T. tinca* and *H. leucisculus*)

to 1.30 (for *C. carpio*). Also Fulton's condition factor (K) ranged from 0.80 (for *H. leucisculus*) to 1.60 (for *T. tinca*).

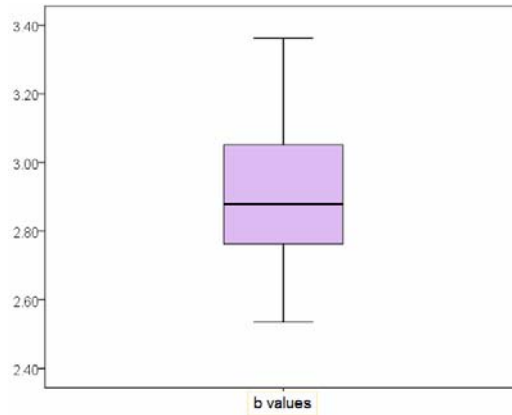
**Table 3.** Relative condition factor ( $K_{rel}$ ) ( $\pm$ SD) and Fulton's condition factor (K) ( $\pm$ SD) for five Cyprinids in Anzali wetland, SW of the Caspian Sea.

	Species				
	<i>S. erythrophthalmus</i>	<i>C. auratus gibelio</i>	<i>C. carpio</i>	<i>T. tinca</i>	<i>H. leucisculus</i>
Relative condition factor ( $K_{rel}$ )	1.00 $\pm$ 0.11	1.01 $\pm$ 0.16	1.30 $\pm$ 0.21	1.00 $\pm$ 0.10	1.00 $\pm$ 0.07
Fulton's condition factor (K)	1.40 $\pm$ 0.17	1.55 $\pm$ 0.24	1.34 $\pm$ 0.24	1.60 $\pm$ 0.18	0.80 $\pm$ 0.05

## Discussion

The exponent  $b$  for length-weight relationships of all caught species was

within the range of 2.5-3.5 (Fig. 2). The parameters can be used in the referred length range (Froese, 2006).



**Fig 2.** Box plots of exponent  $b$  values of the length-weight relationships for five fish species caught in Anzali wetland. The box includes 50% of the data values. The central line shows the median, and the vertical line represents the range of values.

Since, sampling was carried out in different seasons the parameters  $a$  and  $b$  would be treated as mean annual value, and this paper would be useful for fishery biologists and managers in Anzali wetland and the Caspian Sea.

The  $a$  and  $b$  parameters of the length-weight relationships of fishes are affected by a number of factors, including sex, gonad maturity, health, season, habitat,

nutrition, environmental conditions (such as temperature, salinity), area, degree of stomach fullness, differences in the length range of the caught specimen and fishing gear (Tesch, 1971; Froese, 2006). Subsequently, Table 4 shows the parameters of the length-weight relationships of selected species obtained from other parts of the world.

**Table 4.** The  $a$  and  $b$  parameters of the length-weight relationships of selected species from different localities.

Species	Location	length type	length	sex	$a$	$b$
<i>S.erythrophthalmus</i>	Russian Fed; Volga estuary (Belyaeva <i>et al</i> , 1989)	FL	16.0-30.0	unsexed	0.0183	3.121
	Czechoslovakia; Malá Arizomava (Novák, 1982)	SL		unsexed	0.0121	3.188
	Spain; Ter River, Gerona (Miranda <i>et al</i> , 2006)	TL	10.4-23.5	unsexed	0.0030	3.459
<i>C. auratus gibelio</i>	Romania; Uzlina, Danube Delta (Cernisencu and Staras, 1992)	TL		unsexed	0.0830	2.700
	China; China Main (Li, 1998)	SL		unsexed	0.0320	2.980
	Turkey; Lake Iznik, Marmara (Tarkan <i>et al</i> , 2006)		5.2 - 30.2	unsexed	0.0084	3.250
<i>C. carpio</i>	USA; Alabama (Carlander, 1969)	TL	43.1-74.1	unsexed	0.0955	2.620
	Greece; Lake Volvi (Kleanthidis, 2000)	TL	7.8 - 18.1	unsexed	0.0383	2.670
	Iraq; Lake Razzazah (Szypula, 2001)	TL		unsexed	0.0040	3.485
<i>T. tinca</i>	Russian Fed; Volga river (Belyaeva, 1989)		20.0-41.0	unsexed	0.0305	2.964
	Turkey; Terkos Dam, Marmara (Tarkan <i>et al</i> , 2006)	TL	17.0-25.6	unsexed	0.0372	2.740
	Spain; La Nava Reservoir, Navarra (Miranda, 2006)	TL	7.5-43.5	unsexed	0.0130	3.026
<i>H. leucisculus</i>	Russian Fed; Khanka Lake (Gavrenkov, 1976)	FL	15.1-21.5	unsexed	0.0045	3.210
	China Main; Lake Niushan (Ye <i>et al</i> , 2007)	TL	8.9-21.4	unsexed	0.0077	2.984

The results of the present study are not in agreement with reports of Tarkan *et al* (2006), Szypula (2001), Belyaeva (1989) and Miranda (2006).

In studies of population dynamics high condition factor values indicates favorable environmental conditions (such as: habitat and prey availability) and low values indicate less favorable environmental conditions (Blackwell *et al.*, 2000). Relative condition factor ( $K_{rel}$ ) is used by several authors to compare condition of fish species. In the present study, *T. tinca* ( $1.60 \pm 0.18$ ) had best performance, while  $K_{rel}$  value in *H. leucisculus* ( $0.80 \pm 0.05$ ) was lowest across caught species.

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## بررسی رابطه طول- وزن، طول- طول، فاکتور وضعیت نسبی و شاخص وضعیت فولتون پنج گونه ماهی در تالاب انزلی، جنوب غربی دریای خزر

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### چکیده

در این مطالعه رابطه طول- وزن، طول- طول، فاکتور وضعیت نسبی ( $K_{rel}$ ) و شاخص وضعیت فولتون ( $K$ ) برای پنج گونه ماهی از خانواده کپور ماهیان مورد بررسی قرار گرفت. ماهیان از غرب تالاب انزلی (جنوب غربی دریای خزر) از آبان ماه 1389 تا اردیبهشت ماه 1390 توسط تور گوشگیر و تله مخروطی جمع‌آوری شدند. تعداد 368 نمونه اندازه‌گیری و وزن گردیدند. میزان  $b$  (شیب خط) رابطه طول- وزن ماهیان بین 2/5358 تا 3/3613 و میزان  $b$  (شیب خط) رابطه طول- طول ماهیان بین 0/8717 تا 0/9412 بدست آمد. همچنین فاکتور وضعیت نسبی ماهیان بین 1/00±0/11 تا 1/30±0/21 و شاخص وضعیت فولتون بین 0/80±0/05 تا 1/60±0/18 محاسبه گردید.