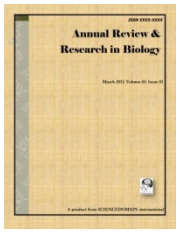

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Length-Weight and Length-Girth Relationships, Relative Weight and Relative Condition Factor of Four Commercial Fish Species of Northern Persian Gulf

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Research Article

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ABSTRACT

Length-weight and length-girth relationships (*LWR* and *LGR*), relative weight (W_r) and relative condition factor (K_{rel}) of four commercial fish species (*Lethrinus nebulosus*, *Carangoides talamparoides*, *Lutjanus argentimaculatus* and *Argyrops spinifer*) from northern Persian Gulf (Bushehr coastal waters) were calculated. Samples were collected on monthly basis during December 2006 to June 2008 using pot nets. The *LWR* had a significant correlation for all species and the exponent *b* ranged from 2.6657 (*L. nebulosus*) to 2.8353 (*L. argentimaculatus*). All length-girth relationships also were highly significant and the exponent *b* ranged from 0.2776 (*L. nebulosus*) to 0.3591(*A. spinifer*). Relative weight ranged from 0.50±0.59 (*C. talamparoides*) to 1.02±1.35 (*L. argentimaculatus*). Relative condition factor also ranged from 1.01±0.17 (*A. spinifer*) to 1.05±0.5 (*L. nebulosus*). In conclusion, this study provides basic information for fishery biologists and managers in the Persian Gulf.

Keywords: Length-weight relationship; length-girth relationship; relative weight; relative condition factor; Persian Gulf.

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1. INTRODUCTION

Knowledge of length-weight relationships is useful for the prediction of weight from length values, condition of fish, stock assessment, and estimation of biomass (Petrakis and Stergiou, 1995; Vaslet et al., 2007). These factors are applicable in population dynamics and aquatics ecology science (Pauly, 1993; Santos et al., 2002) also data of length-weight are useful for fishery biologists for monitoring the state of health of a population (Cone, 1989; Ecoutin et al., 2005).

Data of length-girth relationships can be important tools in the management of gillnet fisheries (Jasper and Evenson, 2006). Fish body length and girth are related to biological parameters such as condition and swimming capability. The length and girth parameters determine whether a gape-limited predator can ingest a special fish, thus explaining predator–prey relationships and the ecological position of fishes within the food webs in which they are implanted (Hambright, 1991; Pauly, 2000; Stergiou and Karpouzi, 2003).

Relative weight (W_r) and relative condition factor (K_{rel}) are Common factors for indication of the condition of fish. Data of relative weight is better than relative condition factor, because (i) calculating of W_r is easier than K_{rel} (ii) W_r values can be compared between fish of different lengths and various populations and (iii) W_r does not change with different measurement units (Wege and Anderson, 1978; Blackwell et al., 2000).

The Persian Gulf is in a subtropical zone lying between the latitudes of 24° and 30° N and longitudes of 49° to 61° 25' E (Valinassab et al., 2006). Although fishing industry in this region has been important since ancient times, but fisheries studies and information about fish biological characteristics From the Persian Gulf is little (Taghavi Motlagh et al., 2010; Raeisi et al., 2011). Thus, the aim of the present study was to report the Length-weight and Length-girth relationships and condition factors of *Carangoides talamparoides* (Bleeker, 1852), *Lutjanus argentimaculatus* (Forsskål, 1775), *Argyrops spinifer* (Forsskål, 1775) and *Lethrinus nebulosus* (Forsskål, 1775) from Iranian waters of the Persian Gulf.

2. MATERIALS AND METHODS

2.1 Collection of Samples

The study area extends from 50° 6' to 52° 58' E and 27° 14' to 30° 16' N (Bushehr coastal waters) in the Persian Gulf (Fig. 1). Samples were collected on monthly basis during December 2006 to June 2008 of fishing research surveys. The specimens were caught by pot nets (with mesh size 35 - 40 mm) and all the fishs' length (total length), weight and girth (in front of the first dorsal fin) were measured. Fishing took place at depths ranging from 10 to 25m.

Fig. 1. Map of the Persian Gulf showing the location of study area

2.2 Data Analysis

The relation between the weight and the length of samples was computed by equation:

$$W = a\,L^{b} \quad (1)$$

Where *W* is the total weight in grams, *L* the total length in centimetres, *a* the intercept and *b* the exponent. The parameters *a* and *b* were obtained by the least-squares method based on logarithms: *Log (W) = log (a) + b log (L)*. The 95% confidence limits of exponent *b* and standard error r^2 (the coefficient of determination) also were calculated.

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

$$t_s = \frac{b-3}{s_b} \quad (2)$$

Where t_s is the t-test value, *b* is the slope and s_b is the standard error of the slope (*b*).

Comparison between obtained values of t-test and the respective tabled critical values give 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 relationship between length and girth was estimated using equation:

$$\hat{G}=a+b\times L \quad (3)$$

Where $\hat{G}$ is the observed girth, L is the observed length and *a* and *b* are the intercept and regression coefficient (slope) respectively (Santos et al., 2006).

For each specimen, relative weight (W_r) and relative condition factor (K_{rel}) was calculated using following equations:

$$W_r = \frac{W}{W_s} \quad (4)$$

Where W_r is the relative weight, W is the weight of a specimen and W_s is a standard weight representing the 75th percentile of observed weights at that length (Wege and Anderson, 1978; Froese, 2006).

$$K_{rel} = \frac{W}{aL^b} \quad (5)$$

Where W is the body weight (g), L is total length (cm) and *a* and *b* are the parameters of the length-weight relationships (Le Cren, 1951).

3. RESULTS AND DISCUSSION

A total of 1566 specimens of four fish species were collected. Results of the *LWR* regressions are shown in Table 1 and Table 2. The exponent *b* ranged from 2.6657 (*Lethrinus nebulosus*) to 2.8353 (*Lutjanus argentimaculatus*). Overall mean of the exponent *b* was 2.7385 ± 0.08. The coefficients of determination (r^2) of the *LWR* regressions ranged between 0.85 and 0.93 and were all statistically significant (P<0.0001).

According to Carlander the exponent *b* should normally fall between 2.5 and 3.5 (Froese, 2006). In this study the exponent *b* for all the species was within this range (Fig. 2) and therefore the parameters can be used as the referred length range.

All length-girth relationships presented (Table 3) were highly significant (P<0.001). The exponent *b* ranged from 0.2776 for *Lethrinus nebulosus* to 0.3591for *Argyrops spinifer*. The coefficients of determination (r^2) of the *LGR* regressions ranged between 0.80 and 0.98.

Table 1. Length-weight relationships for four fish species from the northern Persian Gulf (Bushehr coastal waters)

Families/species	L	N	Length (cm)		Length-weight characteristics					
			Min.	Max.	*a*	*b*	95%CL (*b*)	r^2	S.E (r^2)	*r*
Lethrinidae										
Lethrinus nebulosus	TL	154	17.00	46.00	0.0543	2.6834	0.049	0.85	0.283	0.92
Carangidae										
Carangoides talamparoides	TL	603	13.00	50.00	0.0532	2.6657	0.02	0.91	0.020	0.95
Lutjanidae										
Lutjanus argentimaculatus	TL	291	13.00	58.00	0.0295	2.8353	0.047	0.93	0.256	0.96
Sparidae										
Argyrops spinifer	TL	518	13.00	42.00	0.0537	2.739	0.02	0.92	0.166	0.96

L: length type and N: sample number

Table 2. Type of growth for four commercial fish species of northern Persian Gulf (Bushehr coastal waters)

Species	t value	Growth type
Lethrinus nebulosus	12.664*	Negative allometric
Carangoides talamparoides	33.43*	Negative allometric
Lutjanus argentimaculatus	6.862*	Negative allometric
Argyrops spinifer	26.1*	Negative allometric

(: P<0.001)*

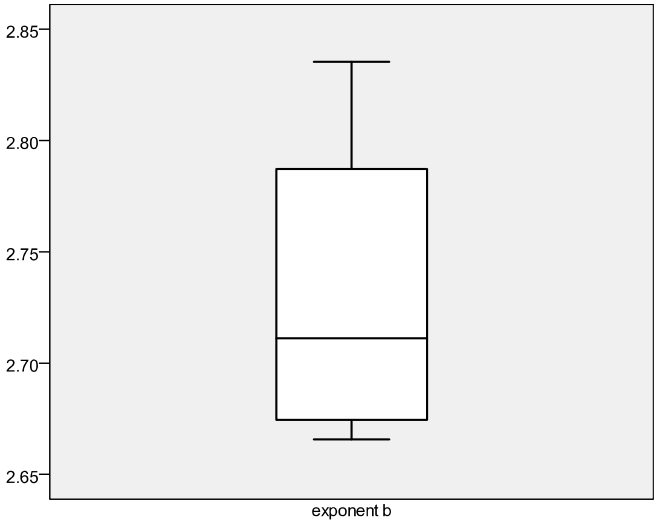

Fig. 2. Box plots of exponent *b* values of the length-weight relationships for four fish species caught in Bushehr coastal waters (N Persian Gulf). The box includes 50% of the data values. The central liner shows the median, and the vertical line represents the range of values.

Table 4 and Fig. 3 indicate the results of relative weight (W_r) and relative condition factor (K_{rel}). W_r ranged from 0.50±0.59 (*Carangoides talamparoides*) to 1.02±1.35 (*Lutjanus argentimaculatus*). Also K_{rel} ranged from 1.01±0.17 (*Argyrops spinifer*) to 1.05±0.5 (*Lethrinus nebulosus*).

Table 3. The relationship between total length (TL in cm) and girth (Ĝ in cm) for four fish species from the northern Persian Gulf (Bushehr coastal waters).

Species	N	Equation	Length-Girth characteristics					
			a	***b***	**95%CL (*b*)**	r^2	**S.E (r^2)**	***r***
Lethrinus nebulosus	154	$\hat{G} = a + b\times$ TL	1.7042	0.2776	0.00002	0.80	0.021	0.89
Carangoides talamparoides	603	$\hat{G} = a + b\times$ TL	2.6708	0.2896	0.0001	0.90	0.06	0.95
Lutjanus argentimaculatus	291	$\hat{G} = a + b\times$ TL	0.7771	0.3165	0.00004	0.98	0.056	0.99
Argyrops spinifer	518	$\hat{G} = a + b\times$ TL	1.8316	0.3591	0.00008	0.91	0.058	0.95

Table 4. Relative weight (W_r) of four commercial fish species of northern Persian Gulf (Bushehr coastal waters) during December 2006 to June 2008.

Species	W_s (*g*)	Relative weight(W_r)			
		Min.	**Max.**	**Mean**	**95% CL (W_r)**
Lethrinus nebulosus	1000	0.12	1.78	0.66	0.006
Carangoides talamparoides	450	0.07	4.55	0.50	0.002
Lutjanus argentimaculatus	440	0.11	8.52	1.02	0.009
Argyrops spinifer	350	0.14	4.06	0.79	0.002

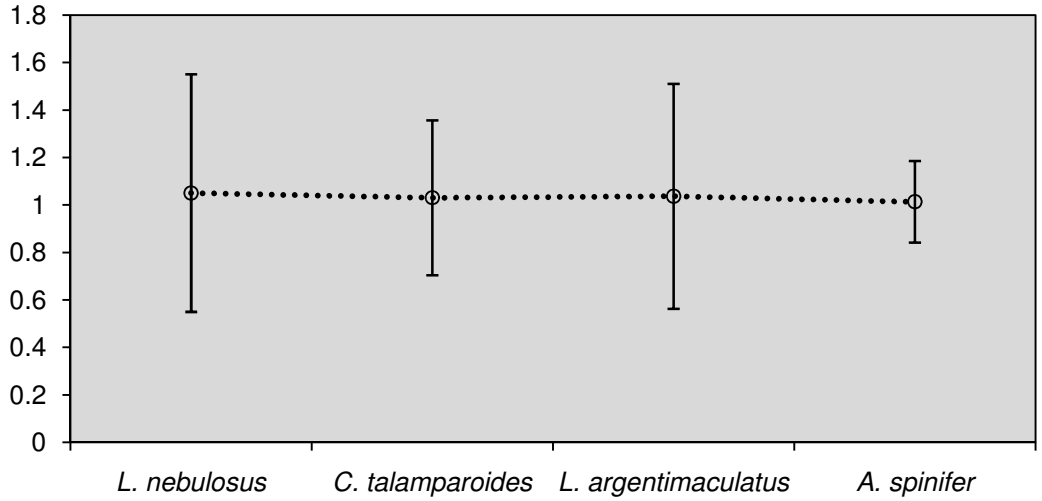

Fig. 3. Relative condition factor (K_{rel}) (±STD) of four commercial fish species of northern Persian Gulf (Bushehr coastal waters), during December 2006 to June 2008.

Since collection of samples were done during two years, the parameters *a* and *b* would be treated as mean annual value, and this paper would be useful for fishery managers in the Persian Gulf. Table 5 shows the parameters of the length-weight relationships of selected species obtained from other parts of the world. Even though the difference of exponent *b* depends primarily on the body shape and fatness of the species, various factors such as food, temperature, salinity, time of year, sex and stage of maturity may cause the differences in parameters of the length-weight relationships among seasons and years (Pauly; 1984, Sparre, 1992, Cherif et al., 2008).

Fish body girth can be calculated via three producers: (i) across the vertical eye diameter (G_1), (ii) behind the gill-cover (G_2) and (iii) in front of the first dorsal fin (G_3). In our study, there was a linear relation between the increasing body girth (G_3) and total length (TL), which is in agreement with reports of Santos and Monteiro (1995); Santos et al. (1998) and Stergiou and Karpouzi (2003). Data of length-girth, along with other biological parameters (such as fish behaviour) and technical aspects (such as fishing techniques, gear construction and dimensions) determine the size selectivity of gill nets. Also, the different girth types determine the probability of different ways of capture by a fishing gear, assessed by G_1 when fish are tangled, by G_2 when fish are gilled and by G_3 when fish are wedged (Reis and Pawson, 1999; Stergiou and Karpouzi, 2003). Finally, results of length-girth relationships of the selected species in this investigation are particularly useful for gill net Fisheries management in the Persian Gulf.

Table 5. *a* and *b* parameters of length-weight relationships of selected species obtained from other parts of the world

Species	Locality	Length type	Length (cm)	Sex	*a*	*b*
Lethrinus nebulosus	Kuwait (Mathews and Samuel, 1991)			unsexed	0.0173	3.010
	New Caledonia; lagoon (Letourneur et al., 1998)	FL	8.0-69.5	unsexed	0.0204	2.975
	Gulf of Aden and Red Sea (Al Sakaff and Esseen, 1999)	TL	23-73.5	female	0.0950	2.619
	Gulf of Aden and Red Sea (Al Sakaff and Esseen, 1999)	TL	22.5-70.5	male	0.0670	2.708
Carangoides talamparoides	Australia; Northern Territory (Willing and Pender, 1989)	FL	6.0-21.5	unsexed	0.0114	3.319
Lutjanus argentimaculatus	South Africa (Torres, 1991)	TL		unsexed	0.0071	3.180
	New Caledonia; lagoon (Pakoa, 1998)	FL	5.5-67.5	unsexed	0.0336	2.792
Argyrops spinifer	Oman; NW Arabian Sea (Druzhinin, 1976)	FL		mixed	0.0798	2.657
	Yemen; Gulf of Aden (Edwards et al., 1985)			unsexed	0.1110	2.540
	Persian Gulf (Raeisi et al., 2011)		10.2-42.5	unsexed	0.0504	2.733

4. CONCLUSION

The Persian Gulf has a large area of shallow water, known to be a preferred habitat for demersal fish species. Some of these species are protected, listed or endangered. Unfortunately, the catch data of fishes indicate 21% decreases in landing from 110,000 tonnes in 2002 to 87,240 tonnes in 2003. Thus, to access a sustainable management is essential collecting of biological data and biomass estimates.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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