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Length-Weight Relationships of Four Fish Species Associated to Shrimp Trawl Fishery as by-Catch in the Persian Gulf, Iran

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Abstract

Length-length relationships (LLRs) and length-weight relationships (LWRs) were determined for four marine fish from Iranian waters of the Strait of Hormuz: *Pseudotriacanthus strigilifer*, *Rhinobatos annandalei*, *Muraenesox cinereus*, *Nematalosa nasus* belonging to four families Triacanthidae, Rhinobatidae, Muraenesocidae, Clupeidae. Specimens were collected monthly between October to December 2018 from artisanal shrimp vessels equipped with non-selective bottom trawl net (with mesh size of 20 and 40 mm, respectively at cod-end and body of trawl net). Trawling operation carried out in a depth range of 2 to 20 m. Total length (TL) (nearest to 0.1 cm) and body weights (nearest 0.1 g) were taken each individual. The result of this research provides first length-weight relationship references for *R. annandalei* and *P. strigilifer* and first LLR for *R. annandalei* and new maximum total length for *M. cinereus*. Estimated parameters of the LLR and LWR models (*a* and *b* value) of the equation $W_B = a(TL)^b$ and $TL = a + b(SL)$ were highly significant ($P < 0.01$) with a reliable coefficient of determination (R^2) ranged from 0.967 to 0.99.

Keywords Length-length · Length-weight · Persian Gulf

Introduction

Morphometric relationships such as length-weight relationship (LWRs) and length-length relationships (LLRs) are useful tool understand the condition of fishes in their habitat such as growth pattern, general health, habitat conditions, life history, and fish fatness (Froese 2006). The studies of LWRs and LLRs are important for efficient fishery management as well, since it is necessary in fish stock assessment models such as population dynamic and growth pattern (Anastasopoulou et al. 2016). In some models, length data can be use as a proxy of age information (Hilborn and Walters 1992). Obtaining weight through length observation is also considered to be useful in a data-limited situation (Spencer 1864–1867; Fulton 1904; Le Cren 1951). Some previous studies of LWR have been done in the studied region, coastline of the Persian Gulf and off the Hormozgan province (Salahi-Gezaz et al. 2015; Raeisi et al. 2017; Pouladi et al. 2018; Salahi et al. 2018; Hajializadeh et al. 2019). The aim of this study was to provide initial estimates of LWRs of five species for which no reliable data on this relationship exist on FishBase.

Materials and Methods

Specimens were collected from shrimp fishing grounds of Hormozgan Province in northern coastline of Strait of Hormuz, which is located between the Persian Gulf and Oman Sea geographically distributed from 57°01′ E 26°29 N to 56°08 E 27°02 N during October to December 2018. Samples were collected by artisanal shrimp vessels equipped with non-selective bottom trawl net (with mesh size of 20 and 40 mm, respectively at cod-end and body of trawl net). Trawling operations were carried out in a depth range of 2 to 20 m. Lengths of all

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Table 1 Length-weight relationships of four marine fish species associate to shrimp trawl fishery as bycatch in the Persian Gulf, Iran

		TL(cm)		W_B(g)		Parameters of WLRs					
Species	n	Min	Max	Min	Max	a Value	b Value	SE(b)	95% CI (a)	95% CI (b)	r^2
Pseudotriacanthus strigilifer	37	12.4	23.5	31	165	0.019	2.858	0.119	0.015–0.025	2.776–2.941	0.967
Rhinobatos annandalei	24	24.3	76.3	50	1900	0.002	3.065	0.075	0.001–0.005	2.907–3.223	0.988
Muraenesox cinereus	33	60	139.5	300	4500	0.001	3.194	0.044	0.0004–0.001	3.104–3.284	0.994
Nematalosa nasus	45	13	20	21	89	0.14	2.931	0.103	0.004–0.061	2.765–3.138	0.98

a; intercept, b; slop, CI; confidence interval of the regression model

specimens were measured to the nearest millimeter. Measured lengths were total length (TL) and standard length (SL), and body weight was measured in grams. Specimens were identified according to the main references (Fischer and Bianchi 1984; Carpenter et al. 1997; Nelson 2006) to belong to the families: Triacanthidae, Rhinobatidae, Muraenesocidae, Clupeidae. Length–weight relationships were computed by using the equation of $W_B = a(TL)^b$ (Ricker 1973, 1975). Log-transformation was used to length and weight data for both male and female in combination (unsexed specimens) to fit least square linear regression model $log\ W_B = log\ a + b\ log\ (TL)$, where W_B is the wet body weight of the fishes, TL is the total length, a is the intercept of the fitted regression curve and b is the slope of LWRs regression. Length-length relationships between TL and SL were analyzed using linear regression $TL = a + b\ (SL)$, where a and b are the regression coefficients. Growth types of each species were determined using t-test at significance level of 5% according (Pauly 1984):

$$t = \frac{SD_L}{SD_W} \times \frac{|b-3|}{\sqrt{1-r^2}} \times \sqrt{n-2}$$

Where SD_L is standard deviation of logarithm transformed of length; SD_W is standard deviation of logarithm transformed of weight; n is the number of specimen used in the calculation. Growth types were isometric if the b-value is statistically equal to 3, otherwise allometric growth (negative allometric growth when $b < 3$ and positive allometric growth when $b > 3$).

Results and Discussion

This research provides length-weight and length-length relationship for first time globally at species level for two species of *R. annandalei* and *P. strigilifer*, first LLR for *R. annandalei* and new maximum total length for *M. cinereus*. Parameters of length-weight and length-length regression, plus descriptive statistics for the measured species are given in Tables 1 and 2.The LWRs reported in the present study are between 2.5 to 3.5 which indicate that our results match the suggested range of (Froese 2006). Plus, In comparison with Bayesian estimator, the observed b coefficient for *P. strigilifer* was smaller than Bayesian prediction ($b = 3.01$), but it was closer ($b = 3.11$) for *R. annandalei* (Froese et al. 2014). The b values of LWR for *M. cinereus* reported by Wang et al. (2016) and Perkins et al. (2019) ($b = 2.8$ and 3.421) from East China Sea was not very close to our result. Hussain et al. (2010) observed similar b value for *N. nasus* from northern Arabian Sea (2.946) in compare to the present study. While, Panda et al. (2016) and Xu et al. (1994) suggested not similar b value (3.13 and 3.105) for this species from India and China. The b value of LLR suggested by (Froese and Pauly 2019) based on measurements of photo in Fishbase database for *P. strigilifer* ($b = 0.93$) was not similar to the present study. Also, the present study reports first LLR for *M. cinereus*, *P. strigilifer* and *R. annandalei*. Thus, this study provides useful information for marine ecologists, fishery managers and online database of FishBase.

Table 2 Length-length relationships of four marine fish species associate to shrimp trawl fishery as bycatch in the Persian Gulf, Iran

	Parameters of LLR (TL = a + bSL)				
Species	a Value	b Value	95% CI (a)	95% CI (b)	r^2
Pseudotriacanthus strigilifer	−0.068	1.169	−0.331-0.195	1.153–1.186	0.985
Rhinobatos annandalei	−0.304	1.082	−1.543-0.934	1.037–1.127	0.994
Muraenesox cinereus	−0.052	1.023	−0.712-0.608	1.016–1.031	0.999
Nematalosa nasus	0.173	1.391	−0.612-0.487	1.131–1.521	0.935

a; intercept, b; slop, CI; confidence interval of the linear regression model

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