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Original Article

Length-weight, Condition factor and gonadosomatic index of blackspot snapper *Lutjanus fulviflamma* (Forsskal, 1775) (Perciformes: Lutjanidae) in the northern Persian Gulf

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Abstract: The present study aimed to evaluate the length-weight and length-length relationships as well as the condition factor and gonadosomatic index of the Blackspot snapper, *Lutjanus fulviflamma* in the northern Persian Gulf, Hormozgan Province, Iran. The specimens were collected monthly from April 2016 to March 2017. The size (TL, total length; FL, fork length; SL, standard length) were measured and weighted (BW, total body wet weight). A total of 446 individuals were analyzed. The TL-BW relationship indicated isometric growth pattern in both sexes. In females, the means for condition factor was higher than males. In both sexes, the lowest value of both condition factor and gonadosomatic index were detected in autumn with ascending trend in the next seasons reaching the peak in spring. The oscillation in condition factor, as well as gonadosomatic throughout the sampling period, was most prominent in females which may be related to the reproductive cycle. The information reinforces data to define fishing closed seasons in this important fish that is used in many places in the world.

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Introduction

The Blackspot snapper, *Lutjanus fulviflamma* (Lutjanidae), is a widespread species throughout the Indo-Pacific regions. This fish occurs from the Red Sea and the Persian Gulf to South Africa to the east to Australia, and the Ryukyu Islands in the west Pacific as far as Samoa (Carpenter and Niem, 2001). This species mainly inhabits coral reefs or rocky substrata at depth of 3-35 m. Their juveniles sometimes found in brackish water or mangrove estuaries or in the lower reaches of fresh-water streams. The diet of this species mainly consists of fishes, shrimps, crabs, and other crustaceans. At New Caledonia and East Africa spawning occurs mainly from August to March (spring and summer) (Carpenter and Niem, 2001).

Lutjanus fulviflamma commonly utilized in subsistence fisheries in Iran with an uninterrupted fishery through the entire year, seen frequently fresh in local markets. Catching is mainly performed with handlines, traps, and gill nets. Despite its importance in different regions, there are few published studies on its biology and life history. Some studies on this species have done including investigations about age, growth, and reproduction performed around Okinawa Island, Japan (Shimose and Tachihara, 2005), Yaeyama Island, Japan (Shimose and Nanami, 2015), Kenyan inshore waters (Kaunda-Arara and Ntiba, 1997), and Mafia Island, Tanzania (Kamukuru and Mgaya, 2004) and some aspects of its life cycle in the Persian Gulf (Grandcourt et al., 2006).

The length-weight relationship (LWR) assumes an important prerequisite in studies of biology, physiology, and ecology, especially in species with commercial value (Froese, 2006). This relationship allows converting one variable to another, estimating the expected weight for a certain size, or detecting ontogenetic morphological changes related to maturation of fishes (Lima-Junior et al., 2002; Zamani-Faradonbeh et al., 2015a, b). Such knowledge can be useful for further studies on the life history of

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the species and in the development of its fishery, resource management, and culture (Radkhah and Eagderi, 2015).

The most frequently regression model used to evaluate this relationship is the power function $Y=aX^b$ (Huxley, 1950) which is also known as allometric growth equation. The exponent *b* is considered equal to 3 as a benchmark for a fish with isometric growth. Those with values above or below 3 are considered as positive or negative allometric growth, respectively (Hartnoll, 1982). Condition factor is commonly used as a quantitative indicator of the general status or 'well-being' of the individual (Lloret et al., 2013). It is based on the principle that individuals of a given length, exhibiting higher weight, are in a better condition. The condition factor is deeply affected by a series of factors, including individual, exogenous parameters like environmental factors and those endogenous such as feeding condition and growth rate, the degree of parasitism, reproductive cycle, etc. Therefore, this quantitative value may vary according to seasons, geographical location and populations (Lima-Junior et al., 2002).

The age, growth and reproduction traits of some Lutjanids, including *L. synagris* (Luckhurst et al., 2000), *L. analis* (Burton, 2002; Teixeira et al., 2010), *L. argentimaculatus* (Russell and McDougall, 2008a), *L. griseus* (Fischer et al., 2005), *L. bohar* (Marriott et al., 2007), *L. carponotatus* (Kritzer, 2004), *L. vitta* (Ramachandran et al., 2013), *L. guttatus* (Amezcua et al., 2006), *L. campechanus* (Patterson III et al., 2001; White and Palmer, 2004; Wilson and Nieland, 2001), *L. sebae* (Newman et al., 2010), *L. fulvus* (Shimose and Nanami, 2014), *L. erythropterus* (Fry and Milton, 2009), *L. malabaricus* (Fry and Milton, 2009) and *L. fulviflamma* (Grandcourt et al., 2006; Kaunda-Arara and Ntiba, 1997; Shimose and Nanami, 2015; Shimose and Tachihara, 2005) have been previously studied. In almost all above-mentioned studies, the relationship between age and otolith weight or length have been provided. Although LWR was only considered in a few studies, however, it is not compared seasonally in detail. The evaluation of this relationship in recent studies is restricted to compare between sexes.

Hence, the purpose of the present study was to describe the length-weight (LWR) and length-length relationships (LLR) and to clarify some of the life history parameters i.e. condition factor and gonadosomatic index of the Blackspot snapper *L. fulviflamma* inhabiting the northern Persian Gulf. This study will provide useful information during interpretation of these relationships among growth-related traits, management plans and to monitor populations of this species. In addition, the results will help the understanding the reproductive cycle of this fishery resource, and aid to complete information about the biology of snappers in the Persian Gulf through comparison of the results with previously published studies.

Materials and Methods

Study area and specimens sampling: Specimens of *L. fulviflamma* were sampled monthly from April 2016 to March 2017. A total of 446 individuals captured by hook and line from the Persian Gulf (Qeshm Island) (26°53'58"N, 56°10'03"E; 26°44'10"N, 56°00'27"E), in Hormozgan Province, Iran. The specimens were identified according to Allen (1985) and sexed macroscopically by visual observation of the gonads. Each specimen was weighed (BW, total body weight) to the nearest 0.1 g using a digital balance. The length parameters, including total length (TL), fork length (FL) and standard length (SL) were measured with a biometric ruler to the nearest 1.0 mm.

Databases and calculations: To estimate the relationship between BW and TL, the empirical points were submitted to regression analysis using the allometric growth power function ($Y=aX^b$), according to Ricker (1973), where 'Y' is the total expected body weight (g), '*X*' is the total length (mm), '*a*' is the *Y*-intercept, and '*b*' is the slope. These parameters are easily estimated by linear regression analysis based on logarithmic transformation (*Ln*) of variables with a fit equation ($LnY=Lna+bLnx$) that was evaluated by the coefficient of determination (R^2).

Fulton's condition factor (K) was estimated for

Table 1. Monthly descriptive statistics and estimated parameters of length-weight relationships for both sexes of *Lutjanus fulviflamma* in the Persian Gulf (Qeshm Island) from April 2016 to March 2017.

			Total length (cm)		Total body weight (g)		Regression parameters				
season	sex	n	min	max	min	max	a	95% Cl of a	b	95% Cl of b	*r*
January	**F**	22	14.00	25.80	45.9	270.1	0.0145	0.0139 - 0.0151	3.0741	3.0655 - 3.0828	0.995
	M	13	12.70	26.00	31.1	252.1	0.0142	0.0135 - 0.0149	3.0769	3.0678 - 3.0859	0.993
February	**F**	20	18.50	26.50	95.3	272.8	0.0142	0.0136 - 0.0147	3.0680	3.0604 - 3.0756	0.958
	M	11	20.90	25.50	123.6	238.2	0.0128	0.0119 - 0.0138	3.0571	3.0432 - 3.0710	0.844
March	**F**	15	14.50	25.70	46.3	243.5	0.0140	0.0132 - 0.0147	3.0656	3.0551 - 3.0760	0.970
	M	20	17.00	24.90	58.0	222.7	0.0131	0.0127 - 0.0136	3.0623	3.0558 - 3.0688	0.972
April	**F**	23	17.50	28.70	95.5	342.1	0.0149	0.0143 - 0.0155	3.0766	3.0688 - 3.0844	0.957
	M	29	18.40	25.10	107.2	238.0	0.0145	0.0141 - 0.0148	3.0803	3.0753 - 3.0853	0.964
May	**F**	22	15.00	26.90	57.0	348.6	0.0157	0.0148 - 0.0166	3.0880	3.0765 - 3.0995	0.969
	M	10	15.00	24.00	58.1	219.5	0.0155	0.0148 - 0.0163	3.0962	3.0862 - 3.1063	0.994
June	**F**	32	13.20	26.70	35.7	324.8	0.0145	0.0140 - 0.0150	3.0752	3.0684 - 3.0820	0.981
	M	14	14.90	23.00	46.6	163.2	0.0137	0.0130 - 0.0144	3.0727	3.0629 - 3.0824	0.985
July	**F**	31	14.00	27.30	37.3	309.4	0.0138	0.0133 - 0.0143	3.0659	3.0590 - 3.0728	0.987
	M	14	13.70	22.00	33.7	122.1	0.0128	0.0121 - 0.0134	3.0587	3.0489 - 3.0685	0.981
August	**F**	17	14.10	22.60	43.8	146.7	0.0133	0.0125 - 0.0142	3.0593	3.0463 - 3.0722	0.942
	M	16	14.50	18.90	47.6	89.9	0.0131	0.0124 - 0.0137	3.0636	3.0534 - 3.0737	0.933
September	**F**	24	13.90	23.30	42.5	167.1	0.0137	0.0131 - 0.0142	3.0644	3.0558 - 3.0730	0.968
	M	14	13.70	19.30	41.8	93.6	0.0135	0.0127 - 0.0144	3.0705	3.0576 - 3.0833	0.908
October	**F**	19	15.00	21.00	48.0	123.5	0.0130	0.0125 - 0.0134	3.0539	3.0467 - 3.0611	0.968
	M	17	14.30	23.10	40.3	159.7	0.0122	0.0117 - 0.0126	3.0494	3.0425 - 3.0564	0.985
November	**F**	18	12.40	23.70	29.9	183.5	0.0130	0.0125 - 0.0135	3.0541	3.0460 - 3.0621	0.993
	M	16	14.60	24.40	44.1	196.4	0.0129	0.0123 - 0.0135	3.0605	3.0506 - 3.0705	0.980
December	**F**	19	13.50	24.50	37.5	209.3	0.0136	0.0131 - 0.0141	3.0629	3.0554 - 3.0704	0.990
	M	11	14.80	25.50	47.1	262.7	0.0133	0.0128 - 0.0138	3.0661	3.0595 - 3.0727	0.997
All	**F**	**262**	**12.40**	**28.70**	**29.9**	**348.6**	**0.0141**	**0.0139 - 0.0143**	**3.0682**	**3.0656 - 3.0708**	**0.983**
	M	**185**	**12.70**	**26.00**	**31.1**	**262.7**	**0.0135**	**0.0133 - 0.0137**	**3.0656**	**3.0650 - 3.0706**	**0.983**
	B	**447**	**12.40**	**28.70**	**29.9**	**348.6**	**0.0138**	**0.0137 - 0.0140**	**3.0680**	**3.0661 - 3.0699**	**0.983**

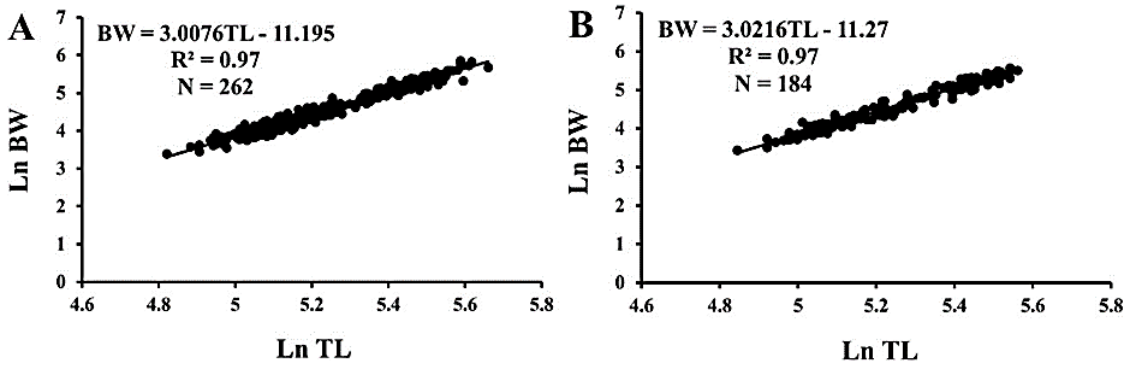

Figure 1. The relationship between total length (mm) and body weight (g) for both sexes of *Lutjanus fulviflamma* in the Persian Gulf (Qeshm Island) from April 2016 to March 2017.

each sex using the formula of $K=(100BW)/TL^b$, where: K is condition factor, BW is mean total body weight (g), TL is mean total length (mm), and 'b' is the weight growth coefficient from the length-weight relationship.

Gonadal development was assessed in terms of gonadosomatic index through the formula of GSI=(100GW)/BW (Busacker et al., 1990) where: GSI is gonadosomatic index, GW is mean total gonad weight (g), and BW is mean total body weight (g).

Statistical analysis: All data were checked for normality by Shapiro-Wilk test. The growth pattern was defined by the coefficient 'b', which had its equality to 3 tested by the Student's t-test. Student's t-test was used for analyzing the differences between the sexes. The Mann-Whitney-U test was applied to compare the variables between sexes since data were heteroscedastic. All data in percentage were first transformed and arcsin of data was used in the analytical comparison (Zar, 2010). All analysis was carried out by SPSS (version 15.0) packet program. Type I error was accepted as 0.05. Average values are given as mean ±SEM.

Results

From a total of 446 sampled specimens, 262 (58.74%) were females and 184 (41.26%) males and the sex ratio significantly biased in favor of females

Table 2. Length–length relationships between total length (TL), fork length (FL) and standard length (SL) of *Lutjanus fulviflamma* in the Persian Gulf (Qeshm Island) from April 2016 to March 2017.

Sex	Equation	n	*a*	*b*	r^2
Female	TL = *a* + *b*SL	262	10.016	1.142	0.988
	SL = *a* + *b*FL		-6.201	0.907	0.988
	FL = *a* + *b*TL		-0.215	0.952	0.996
Male	TL = *a* + *b*SL	184	8.383	1.154	0.991
	SL = *a* + *b*FL		-6.305	0.908	0.991
	FL = *a* + *b*TL		1.196	0.942	0.994
Both	TL = *a* + *b*SL	446	9.440	1.147	0.989
	SL = *a* + *b*FL		-6.230	0.907	0.989
	FL = *a* + *b*TL		0.294	0.948	0.995

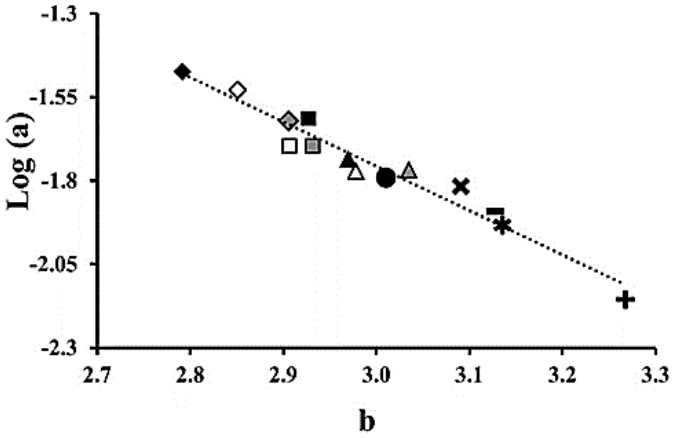

Figure 2. Test plot of log (a) against b for some LWRs of fishes belong to Lutjanidae. ●=present study parameters of *Lutjanus fulviflamma*; ◆= parameters of *Lutjanus argentimaculatus*; ◇= parameters of *Lutjanus quinquelineatus*; □= parameters of *Lutjanus russellii*; ◈= parameters of *Lutjanus fulviflamma*; ■= parameters of *Lutjanus fulvus*; ▣= parameters of *Lutjanus lutjanus*; ▲= parameters of *Lutjanus monostigma*; △= parameters of *Lutjanus vitta*; ◭= parameters of *Lutjanus bohar*; ✖= parameters of *Lutjanus gibbus*; - = parameters of *Lutjanus sebae*; ✱= parameters of *Lutjanus kasmira*; ✚= parameters of *Lutjanus adentii*. Dotted line = regression line, r^2 = 0.95.

(χ^2=13.641, *P*<0.001). Length-weight relationships indicated isometric growth pattern in both females (BW=0.00001TL$^{3.01}$, r^2=0.97) and males (BW= 0.00001TL$^{3.02}$, r^2=0.97) (Fig. 1). The results revealed no significant differences between sexes for *b* value (females: *b*=3.01, t_{262} = 0.23, *P*>0.05; males: *b*=3.02, t_{184}=0.52, *P*>0.05). Monthly LWR is presented in Table 1 showing range of *b* 3.0539-3.088 in females (CV%=0.32), and 3.05-3.10 in males (CV%=0.41). In both sexes, the minimum allometric coefficient (*b*) was recorded in October and maximum one in May. LWR was highly significant correlated (*P*<0.001), with all coefficient values being more than 0.989 (Table 2). The comparison between the parameters *a* and *b* in the *L. fulviflamma* with other *Lutjanus* species is also shown in Figure 2.

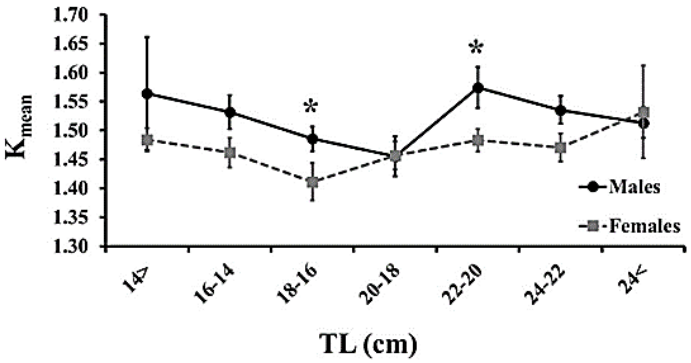

Figure 3. Mean Fulton's condition factor (K_{mean}) per length (total length) class for both the sexes of *Lutjanus fulviflamma* in the Persian Gulf (Qeshm Island) from April 2016 to March 2017. Asterisk (*) indicated significant difference (*P*<0.05) between females and males K_{mean} values.

The mean Fulton's condition factor in relation to TL size class (K_{mean}) is depicted in Figure 3. The K_{mean} displayed a descending trend in females up to 16-18 cm TL and increased onwards. In males, the value of the K_{mean} is decreased until 18-20 cm TL and after that, the trend showed an increasing manner. The K_{mean} in females was significantly lower than that of the males in two size classes; 16-18 cm TL with the value of 1.41±0.03 in the females and 1.49±0.02 in the males (t_{70}=-1.995, *P*=0.049) and 20-22 cm TL with the value of 1.48±0.02 and 1.57±0.03 in the females and the males, respectively (t_{62}=-2.308, *P*=0.024).

The Fulton's condition factor (K) ranged 0.0103 to 0.0184 in females and 0.0104 to 0.0179 in males. The average K in the females (0.0141) was significantly higher than that of males (0.0135) (t_{444}=4.293, *P*=0.000). There was a significant difference in K between months in both sexes (females: $F_{11,261}$=7.154, *P*=0.000; males: $F_{11,183}$=9.350, *P*=0.000). In the females, the lowest mean K was found in October and

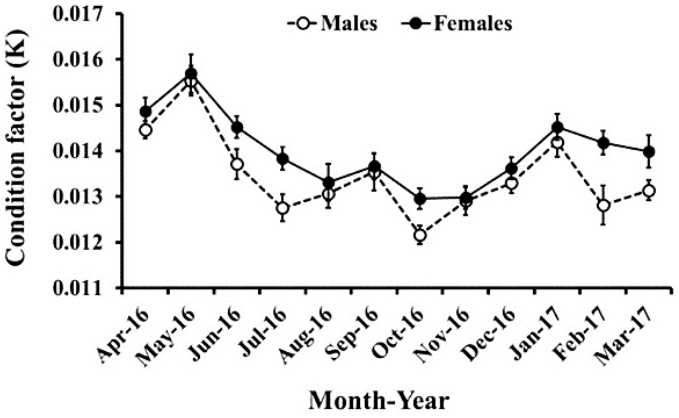

Figure 4. Fulton's condition factor (K) for both the sexes of *Lutjanus fulviflamma* in the Persian Gulf (Qeshm Island) from April 2016 to March 2017. Bars indicate standard error of mean values.

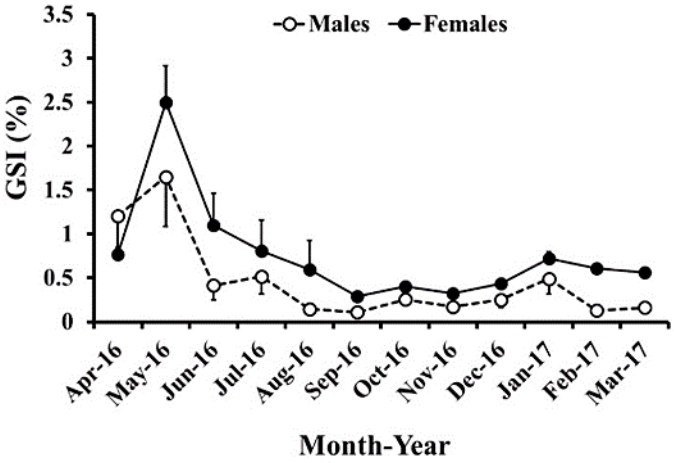

Figure 5. Monthly mean gonadosomatic index (GSI) for females and males of *Lutjanus fulviflamma* in the Persian Gulf (Qeshm Island) from April 2016 to March 2017. Bars indicate standard error of mean values.

November (0.0130) and highest in May (0.0157); in the males, the lowest in October (0.0122) and highest in May (0.0155) (Fig. 4).

The monthly variations of the gonadosomatic index of females and males are shown in Figure 5. The mean value of GSI was significantly higher in the females compared to that of the males (t_{114}=3.134, P<0.05). In the females, the GSI fluctuated during the sampling months with the minimum level of 0.289 in September. The value onwards increased gradually with an abrupt increase in May reaching the maximum levels of 2.498. In males, the value of GSI revealed some minor variations throughout the sampling time with the maximum level of GSI (1.6498) in May (Fig. 5).

Discussion

The results revealed no significant difference between female and male regarding total length and body weight. Both sexes have the same growth pattern i.e. isometric one as 3.008, 3.02 and 3.01 for females, males and combined, respectively. The measured *b*-values were within the expected value for most of fishes (Froese, 2006) and in accordance with other studied populations of *L. fulviflamma* (Grandcourt et al., 2006; Shimose and Nanami, 2015; Shimose and Tachihara, 2005) as well as other members of the family Lutjanidae (Grandcourt et al., 2011; Kritzer, 2002; Newman, 2002; Newman and Dunk, 2002; Ramachandran et al., 2013). Plotting the log (*a*) against regression coefficient '*b*' provides a comparison of the estimates found in this study on *L. fulviflamma* with the other *Lutjanus* species. Considering the coefficient of determination (R^2=0.95) extracted from the assumed plot clearly revealed a highly significant correlation which approved the assumption of the same *b*-value in the species of the family Lutjanidae.

The results from comparing the growth parameter estimation between sexes in this study is also consistent with the findings on *L. synagris* (Luckhurst et al., 2000), *L. argentiventris* (Piñón et al., 2009), *L. erythropterus* (McPherson, 1992), *L. bohar* (Marriott et al., 2007), *L. campechanus* (Patterson III et al., 2001), *L. analis* (Burton, 2002), *L. guttatus* (Amezcua et al., 2006) and *L. alexandrei* (Fernandes et al., 2012). Although some studies demonstrated similar *b*-value but show a significantly different sex-related body size between sexes (Grandcourt et al., 2011; Newman et al., 2000; Shimose and Nanami, 2015). In some species e.g. *L. griseus* (Fischer et al., 2005), *L. gibbus* (Nanami et al., 2010), *L. carponotatus* (Kritzer, 2004; Newman et al., 2000) *L. adetii* (Newman et al., 1996), *L. quinquelineatus* (Newman et al., 1996), *L. malabaricus* (McPherson, 1992; Newman, 2002), *L. sebae* (McPherson, 1992; Newman and Dunk, 2002) and *L. vitta* (Davis, 1992; Newman et al., 2000) male grows larger than female

while in *L. fulvus* (Shimose and Nanami, 2014), *L. argentimaculatus* (Russell and McDougall, 2008b), *L. fulviflamma* (Grandcourt et al., 2006; Kamukuru et al., 2005; Shimose and Nanami, 2015; Shimose and Tachihara, 2005) and *L. ehrenbergii* (Grandcourt et al., 2011) the growth pattern is biased towards the females.

Different sex-related body size is a common phenomenon reported among Lutjanids. Those from different geographical regions demonstrated various growth patterns. It is assumed that in species found in Atlantic, Caribbean, and Hawaiian regions, females usually show larger size while those from the Indo-Pacific possesses a general growth pattern with a larger size in favor to males (Grimes, 1987; Nanami et al., 2010). Although this presumption looks like true, is not credited for all studies (Fischer et al., 2005; Russell and McDougall, 2008b; Shimose and Nanami, 2014) and the same growth pattern was also shown in both regions (Amezcua et al., 2006; Fernandes et al., 2012; Fry and Milton, 2009; Piñón et al., 2009). In the majority of these studies, the correlation between the fish age with length or body weight is analyzed and higher growth rate in females or males has been concluded. Almost in all of these studies, the growth pattern is not distinctive between sexes during the first years of life but differences will prominent with age increment. In the present study, the same growth pattern between males and females is probably due to restricted analysis to length-weight relationship without considering the fish age classes. Further studies on the age-length or age-weight of this species in this region will provide complementary data to have a better picture of this fish.

Based on the results, the Fulton's condition factor of *L. fulviflamma* fluctuates throughout the year. Although the females demonstrated higher value than males, but almost the same. This species in the present studied area showed the lowest condition factor in October with gradual increasing trend peaked in May.

The maximum value of gonadosomatic index measured in May in both sexes and decreased to reach the lowest level in September and October. Then, the value fluctuated with ascending trend toward April and May. These findings are in agreement with the results of other studies on this species (Grandcourt et al., 2006; Shimose and Nanami, 2015). Grandcourt et al. (2006) demonstrated an augmentation of the gonadosomatic index value for both males and females of *L. fulviflamma* from January to May and a descending pattern from May to September. Shimose and Tachihara (2005) also showed the higher value in this species from April to July, with a peak in May and June for both sexes and low values from October to March with no exception of both sexes. Also, the finding of the present study in agreement with the results of Shimose and Nanami (2015) showing the mean gonadosomatic values for both sexes increase in April, reaching a peak in May and then decreased from June to August and remained in low levels from September to March. In the present study, the spawning periods was from April to August with a peaked in May and June based on the gonadosomatic index and the Fulton's condition factor. The higher value of the Fulton's condition factor could be credited to the deposition of lipids and fats as an energetic source for the coming spawning periods. The highest value in the Fulton's condition factor during the spawning periodicity are shown in other species (Mir et al., 2012; Rahman, 2017; Ramachandran et al., 2013).

In conclusion, both sexes of blackspot snapper have isometric growth pattern in the northern Persian Gulf with no difference in mean Fulton's condition factor between various length classes in both sexes but different monthly with the same pattern in males and females. This value was significantly high in April to August with a peak in May. As the gonadosomatic index was revealed the same oscillation as that of the Fulton's condition factor, it can be suggested that April to June can be considered as reproductive months in this species in the northern Persian Gulf.

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چکیده فارسی

بررسی رابطه طول-وزن، ضریب چاقی و ضریب رشد گناد در ماهی سرخو زرد خال سیاه *Lutjanus fulviflamma* (Forsskal, 1775) در بخش شمالی خلیج فارس

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چکیده:

هدف از انجام این مطالعه بررسی رابطه طول-وزن و طول-طول و همچنین ضریب چاقی و ضریب رشد گناد در ماهی سرخو زرد خال سیاه (*Lutjanus fulviflamma*) می‌باشد. این خصوصیات برای هر دو جنس نر و ماده بر اساس نمونه برداری ماهانه از فروردین تا اسفند ۹۵ در بخش شمالی خلیج فارس در استان هرمزگان مورد تجزیه و تحلیل قرار گرفت. برای هر نمونه شاخص‌های طولی شامل طول کل، طول چنگالی و طول استاندارد و همچنین وزن کل اندازه گیری شد. در این تحقیق در مجموع ۴۴۶ عدد ماهی مورد ارزیابی قرار گرفت. بررسی رابطه بین طول و وزن نشان داد که رشد این ماهی در هر دو جنس نر و ماده ایزومتریک می‌باشد. ضریب چاقی در ماده‌ها بیش از نرها بود. کمترین میزان ضریب چاقی و نیز کمترین ضریب رشد گناد در هر دو جنس نر و ماده در فصل پاییز مشاهده گردید که در فصل زمستان روند صعودی به خود گرفته و در بهار به اوج خود رسید. در طی مدت زمان مطالعه، ماده‌ها در مقایسه با نرها به مراتب میزان نوسان بیشتری را در ضریب چاقی و ضریب رشد گناد نشان دادند که ممکن است به چرخه‌ی تولید مثل سالیانه در آنها بستگی داشته باشد. این اطلاعات می‌تواند در زمینه تعیین زمان‌های ممنوعیت صید در مورد این گونه مهم مورد استفاده قرار گیرد.

کلمات کلیدی: رشد ناهمگون، ضریب رشد گناد، سرخوماهیان، فصل تولید مثل.