Research Article

Reproductive biology of *Grammoplites suppositus* (Troschel, 1840) (Teleostei: Platycephalidae) in coastal waters of the Persian Gulf

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**Abstract:** This study was conducted to determine reproductive biology of Spotfin flathead *Grammoplites suppositus* for a period 16 months from November 2016 to April 2018 in coastal waters of the Persian Gulf. Sampling was carried out by shrimp bottom trawl net as bycatch and a total of 635 fish were examined during the study period. The recorded results showed that the sex ratio between male:female was not significantly being 1:1 throughout the study period with 55.28% of fish was female. Analysis of morphological maturity stages of ovary was showed that *G. suppositus* can spawn in throughout the year with a peak from November to March. Also, the GSI was uptrend in November to February and then declined from March in the region. The minimum size of the female *G. suppositus* that reaches the sexual maturity was observed in the size classes 160–179 mm of total length. The L\(_{50}\)% was estimated at 199.4 mm of total length for this flathead fish.

**Keywords:** Spotfin flathead, Sex ratio, Spawning season, LM50%, Persian Gulf.


**Introduction**

The family Platycephalidae includes 85 species belonging to 18 genera that found in benthic habitat, often burying in the mud or sand bottoms, occurring from about 10–300m in marine (some brackish water) environments (Fischer & Bianchi 1984; Nelson et al. 2016; Fricke et al. 2019). In the Persian Gulf, 8 species of this family have been reported (Carpenter et al. 1997; Eagderi et al. 2019), with only the *Platycephalus indicus* (Linnaeus, 1758) having a good food fish in the Iranian waters, while others are as discards in the shrimp bottom trawl net in the area.

The spotfin flathead, *Grammoplites suppositus* (Troschel, 1840) is a one of the common flathead fish exploited (as bycatch) in the shrimp bottom trawl net in the Iranian coast. The previous study in the Iranian waters showed that this species accounts for 0.33% of the total biomass of aquatic animals in the Persian Gulf and Oman Sea (Valinassab et al. 2006). It is ecologically important because of this species essentially is benthic predator and feeding on benthic crabs, penaeid prawns and fishes (Abdurahiman et al. 2007).

The present study has been undertaken to investigate some aspects of reproductive biology of *G. suppositus* in the northern Persian Gulf as the first experience time to be used for further resource management on this species.

**Materials and Methods**

**Study area, sampling and measurements:** Sampling was carried out using shrimp bottom trawling nets with a 20mm cod end mesh size. The study area was restricted in an area extending from 26°55' N, 56°52' E to 26°59' N, 56°05' E, and the biological data were collected monthly within 16 months from November...
2016 to April 2018 in coastal waters of Hormozgan Province in the northern Persian Gulf, Iran (Fig. 1). At least 30 specimens were taken per month, each fish was measured and recorded for its sex, total length and its body weight, and reproductive aspects.

The maturity stages of ovaries were grouped into five main classes following the procedure adopted by Biswas (1993). The Gonado-Somatic Index (GSI) were calculated as following formula:

\[
\text{GSI} (\%) = \frac{\text{Drained ovary weight}}{\text{Total live weight}} \times 100
\]

**Data Analysis:** Using size frequency distribution of total length, for male and female fish was depicted in each month. To establish the length-weight relationship, the commonly used relationship \( W = a L^b \) was applied (Pauly 1983), Where: \( W \) is the weight (g.), \( L \) is the total length (cm), \( a \) is the intercept (condition factor) and \( b \) is the slope (growth coefficient).

A linear equation (\( \ln W = \ln a + b \ln TL \)) was fitted for log-transformed data. The Parameters \( a \) and \( b \) were estimated using power regression and the coefficient of determination (\( R^2 \)) to show the total length-weight relationship. The parameter \( b \) is a shape parameter for the body form of the fish species. In theory, one might expect that the exponent \( b \) would have a value of roughly \( b = 3 \) because the volume of a 3-dimensional object is roughly proportional to the cube of length for a regularly shaped solid.

Computing \( b \) value estimated with 3 was tested by using the \( t \)-test (Pauly 1983):

\[
t = \frac{s.d (L) \times |b-3|}{s.d (W) \times \sqrt{1-t^2}} \times \sqrt{n-2}
\]

Where: \( s.d. (L) \) is the standard deviation of the ln TL values, and \( s.d. (W) \) the standard deviation of the ln \( W \) values, \( n \) being the number of fish used in the computation. The value \( b \) is different from 3 if \( t \) is greater than the table value for \( t \) in \( n - 2 \) df. (Pauly 1983).

The sex ratio analysis was carried out by monthly data sets of the total number of male and female fish. Chi-square (\( X^2 \)) statistical was performed to test the difference between ratios in both sexes. Spawning season of this species was forecast from the percentage of ovary stage 4 and monthly GSI index trend. The \( L_{50\%} \) was estimated by using following formula (King 2007) and least square method (Solver Tools in Microsoft Excel ver. 2013):

\[
P = L/\left[ 1+\exp \left( - r_m (L- L_{50\%}) \right) \right]
\]

Where: \( r_m \) is the slope of curve, \( L_m \) is the mean total length (cm) at sexual maturity, \( L \) is mean total length (cm) and \( P \) is probability of presence mature fish.

**Results**

**Descriptive statistics and total length-weight relationship:** The results showed that the total length
(TL) of 284 males and 351 females, ranged from 12.2 to 27.2cm and 13.5 to 32.3cm, respectively (Fig. 2). The mean (±SE) TL was 17.67±1.56 for males and 20.14±1.62cm for females. Also, the marketable size of males and females *G. suppositus* were dominated throughout the study area with its peak during January to March. Whereas, the juvenile fishes was dominant from April to July.

### Table 1. Total length -weight relationships of *Grammoplites suppositus* in the Persian Gulf.

<table>
<thead>
<tr>
<th>Sex</th>
<th>Total length-weight Equation</th>
<th>$R^2$</th>
<th>N</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>$W = 0.000009 \times TL^{3.35}$</td>
<td>0.83</td>
<td>284</td>
<td>$P&lt;0.05$</td>
</tr>
<tr>
<td>Female</td>
<td>$W = 0.00002 \times TL^{3.21}$</td>
<td>0.86</td>
<td>351</td>
<td>$P&lt;0.05$</td>
</tr>
<tr>
<td>Total</td>
<td>$W = 0.00002 \times TL^{3.18}$</td>
<td>0.86</td>
<td>635</td>
<td>$P&lt;0.05$</td>
</tr>
</tbody>
</table>

**Fig.2.** The changes in total length (Mean±SE) for *Grammoplites suppositus* in the study area.

**Fig.3.** Sex ratio between male and female of *Grammoplites suppositus* from the Oman Sea, Iran.

**Fig.4.** All maturity stages of female *Grammoplites suppositus* sampled from the Oman Sea, Iran.

The total length-weight relationship (Table 1) of *G. suppositus* had a high $R^2$ value and the exponent ($b=3.18$) was significantly different from 3 ($P<0.05$), indicating that growth in this species is positively allometric.

**Sex-ratio:** The overall sex ratio between male and female individuals of *G. suppositus* throughout the year was significantly different from 1:1 ($P<0.05$),
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with 55.28% of the fish were female. An inspection of the monthly sex ratio revealed that there was also a female bias in sex ratio in most months of the year (Fig. 3).

Gonad Development and Size at Sexual Maturity (LM50%): All five stages of the ovarian development of G. suppositus were observed throughout the year (Fig. 4). The abundance of mature fish (stages 3 to 5) had relatively high percentage and young fish (stages 1 and 2) showed the same trend, indicating this species have continuous spawning in throughout the year. Monthly GSI estimations for both sex had fluctuation in different months, showing upswing trend from November to February with the maximum GSI value of 7.29±1.01 observed in February 2017 in females (Fig. 5).

Calculating monthly percentage of the ovary development in G. suppositus, reveals that mature females were actively in the breeding condition throughout the year. In addition, concerning the percentages of fish in the maturity stage 4 and GSI value, this species had a spawning peak from November to March in the region. The minimum size of the female G. suppositus that reaches the sexual maturity was observed in the size classes 160-179mm of total length. Figure 6 shows a logistic curve fitted the estimation of length at which 50% of female fishes were in stage 4 (adult ones) with the estimated TL50%=19.94cm of total length.
Discussion

The study on spotfin flathead, *G. suppositus* stocks is ecologically important in the area because of this species almost feeds on high-value benthic invertebrates such as crabs and penaeid prawns, thus its population size may affect benthic community in the area.

In the present study, the total length for males and females *G. suppositus* ranged from 12.2 to 27.2 cm and 13.5 to 32.3 cm, respectively. Also, based on the monthly size frequency data of *G. suppositus*, the females were always larger in size than males. The total length of this species has been reported at a range of 15-30.7 cm in the Khuzestan coastal waters, Iran (Hashemi et al. 2013). In another study, Abdurahiman et al. (2007) measured a size range of 14.1-29 cm for this species landed at the southeast Arabian Sea. The previous studies on another species of this family in the Persian Gulf, Iran including *P. indicus* (Linnaeus, 1758)) and *P. fuscus* Cuvier, 1829, showed that the males and females have a different size range and females were always larger than males (Gray & Barnes 2008; Hashemi et al. 2014; Mohammadikia et al. 2014; Mousavi-Sabet et al. 2015). Also, the recorded results revealed that the juvenile *G. suppositus* individuals were dominant from April to July. Whereas, the adult population were found throughout the year demonstrating high peak during January to March. The abundant adult fishes were found from mentioned period, which might be due to the presence of mature fishes being gathered for spawning behavior.

The estimated $b$-values as $b=3.35$, 3.21 and 3.18 for males, females and total fishes, respectively derived from length-weight relationship of *G. suppositus* in which was significantly different from 3, implying this species have positive allometric growth. Hashemi et al. (2014) reported the negative allometric growth (with $b=2.95$) for this species in the north of the Persian Gulf. While, a different growth pattern has been reported for other species (*P. indicus*) of this family in the Persian Gulf (Hashemi et al. 2014; Mousavi-Sabet et al. 2015).

Ricker (1975) believed the length-weight relationships can be found the condition of fish and determine whether growth is isometric or allometric. Also, Negative allometric growth implies the fish becomes more slender as it increase in weight while positive allometric growth implies the fish becomes relatively stouter or deeper-bodied as it increases in length (Riedel et al. 2007). Variation in estimated $b$-value from cube law reported by other authors may be due to difference in the number and ranged of size classes of samples used for $t$-test and the environmental conditions of the study area. There are sometimes remarkable differences between different populations of the same species, or between the same populations in different years, presumably associated with their nutritional condition (Ricker 1975).

In this study, the overall sex ratio M:F = 0.81:1 was significantly different from the expected 1:1; and female bias in sex ratio in most months of the year. Studies on a bartail flathead, *P. indicus* in the Persian Gulf indicated that males population was dominate (Hashemi et al. 2014; Mousavi-Sabet et al. 2015), whereas, the results on dusky flathead *P. fuscus* in estuaries of Australia, was confirmed with our research results (Gray & Barnes 2008).

The recorded results showed that the females *G. suppositus* have a spawning peak from November to March in the region. Also, the Lm50% was estimated at 19.94 cm of total length. Mohammadikia et al. (2014) reported that high GSI in both sexes of *P. indicus* was observed from December to March in coastal waters of the Persian Gulf. Gray & Barnes (2008) noted that the female dusky flathead, *P. fuscus* were reproductively active primarily for 5 months between November and March in the New South Wales, Australia. They also reported that the size at 50% maturity in female *P. fuscus* was occurred at 56.75 cm in total length. While, the spawning peak for *P. speculator* Klunzinger, 1872 in the south coast of Western Australia has been reported from summer and early autumn (Hyndes et al. 1992). Bani et al. (2009) found that the *P. bassensis* Cuvier, 1829 actively spawned from October to March in the
Given GSI trend and ovary maturity stages, the results of the present study indicated that the *G. suppositus* have two peak of spawning season in the area, so that the exploitation of this resource should be properly managed.

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**References**


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مقاله پژوهشی

*Grammoplites suppositus* (Troschel, 1840) در آب‌های ساحلی خلیج فارس

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چکیده: این مطالعه با هدف بررسی زیست‌شناسی تولید مثل ماهی زمین کن خال باله *Grammoplites suppositus* در آب‌های ساحلی خلیج فارس انجام شد. نمونه‌های ماهی به عنوان صید ضمنی می‌گو و در مجموع 635 ماهی جمع‌آوری و مورد بررسی قرار گرفتند. نتایج نشان داد که نسبت فراوانی نر: ماده به طور معنی‌داری 1:1 نبود و در کل دوره مورد مطالعه ماده‌ها با 28/55 درصد غالب بودند. گستره درصد رسیدگی تخم‌مانده ماهی زمین کن خال باله نشان داد که این گونه در تمامی طول سال می‌تواند تخم‌ریزی داشته باشد و اوج آن در ماه‌های آبان تا اسفند بود. همچنین شاخص GSI در ماه‌های آبان تا بهمن به طور معنی‌داری کاهش نشان داد. براساس نتایج حاصل از اندام‌های ماهی‌ها که به اندازه بلوغ جنسی رسیدند در کلاس 179-160 میلی‌متر طول کل که 50% ماهی‌های زمین کن خال باله به بلسمی می‌رسند در طول کل 19/4 میلی‌متر برآورد شد.

کلمات کلیدی: زمین کن خال باله، نسبت جنسی، فصل تخم‌ریزی، LM50%، خلیج فارس.