*Original article*

# Relative Growth, Reproduction and Feeding Habits of The Saddled Bream, Oblada Melanura (Linnaeus, 1758) in Tripoli Coast, Western Libya

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**Abstract**

These studies were carried out to investigate some biological parameters of the saddled bream *O. melanura* in Tripoli coast from May 2015 to April 2016. The total length of all specimens ranged from 127 to 261 mm. Males were mostly dominant in small length while females in large length. Sex ratio was 1:1.45 in favour of females. The percentage of sex reversal was 6% and the mean total length of sex inversion recorded at 190 mm. The slopes (b values) of the length ± weight regressions indicate positive allometric growth for sexes. The condition factor of individual ranged from 0.62 to 1.20, with no difference between males and females. Macroscopic examination of gonads and gonad-somatic index indicated that spawning occurred once a year during summer. Overall size at first maturity ($L_{50}$) was 181.9 mm TL. Stomach content revealed that the saddled bream is a carnivorous species feeding zooplanktonic organisms, mainly on shrimps and fish larvae. The results of this study support available information for other Mediterranean stocks and suggest common biological features among different stocks.

**Keywords:** Oblada melanura; Libya; growth; spawning; feed.

## Introduction

Sparidae is a fish family of the order Perciformes, includes about 115 species of mainly marine coastal fishes of high economic value, exploited and farmed for human consumption. Hence, this family is an essential purchase for anyone working with this important family of fishes (Pavlidis and Mylonas, 2011). Sparidae is represented in the Mediterranean Sea by 11 genera and 25 species that usually inhabit coastal areas and produce pelagic eggs and larvae (Bauchot and Hureau, 1986; Ibrahim, 2013). Libya is known to be richly endowed with different species of Sparid fishes, 14 species were recorded in Libyan coast such as Oblada melanura (Al-Hassan and El-Silini, 1999). The color of back and sides body's O. melanura "saddled bream" is silvery blue somewhat darker on the back and some bluish-black longitudinal bands on the sides; therefore, its local name in Libya is "Kahla" (Fischer, 1973) (Figure 1). *O. melanura* is common throughout the Mediterranean (very rare in Black Sea), eastern Atlantic, Adriatic Sea and Aegean Sea. It inhabited littoral waters above rocky bottoms and Posidonia beds, up to 30 m depth (Bauchot and Hureau, 1986; Jardas, 1996; Karakulak *et al.*, 2006). In 1996, the annual catch of the saddled bream in the eastern Adriatic is around 200 t (Jardas, 1996). Fishes of the families' Sparidae, Triglidae, Serranidae and Mullidae were the most abundant in the catch of bottom trawlers operating in Benghazi Coast, Eastern Libya in 2007, especially Boops boopes, Trigla lucerna, Diplodus annularis, Serranus cabrilla and Pagrus pagrus. However, *O. melanura* was rare and sometimes absent (Buzaid *et al*., 2017). The spawning period of *O. melanura* in Libyan coast is during summer and the dominant length is from 15 to 20cm. It is protogynic hermaphrodite (Qassium *et al.*, 2009). This species feeds on small vertebrates (crustaceans), small fish and algae (Fischer, 1973; Qassium *et al.*, 2009). While found in the stomach of Scorpaena scrofa (Šoljan and Karlovac, 1932), Squalus acanthias (Jardas, 1972), and Epinephelus marginatus, Conger conger, Dentex dentex, Seriola dumerilli, and Phycis phycis (Pallaoro, 1996).

**Figure 1: The saddlead bream, *Oblada melanura.***

The saddled bream is one the most popular sparid fish species in Libyan markets and have a highly appreciated flesh. The published information on its biology and ecology is very scarce especially on Mediterranean Sea. Feeding habits of *O. melanura* were investigated in Tirrenian Sea (Ara, 1937), Mediterranean coast of France (Lenfant and Olive, 1998) and Adriatic Sea (Pallaoro *et al.*, 2003). Thus, reporters studied on length–weight and length–length relationships of this species in Aegean Sea (Greece) (Moutopoulos and Stergiou, 2002) and the northern

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Aegean Sea (Turkey) (Karakulak *et al.*, 2006). Lissia-Frau and Casu (1968) were studied maturation and gonad development in juvenile saddlead bream, whereas Zaki *et al.* (1995) stated the analysis of ova diameter for O. melanura in Egyptian coast. Also, some studies described the growth stages from the Sicilian coastal waters (Cavallaro *et al*., 1984, 1985; Cefali *et al*., 1987). Pallaoro *et al.* (1998) reported the age, growth, sex ratio, and mortality of saddled bream in the eastern Adriatic. Sea breams are commercially important species and have also gained considerable importance for aquaculture (Fischer *et al*., 1987). Recently, *O. melanura* culture became very important, and climate with artificial food of the Adriatic floating fish farm (Ferri *et al*., 2012).

There are many reports about sparid species on Libyan coast (Rizkalla and Emsheri, 1978; El-Ghoshty and Hawaj, 2001; Laith, 2003; Shtewi, 2003; Ibrahim, 2013; Ahmed *et al*., 2014; El-Fergani and El-Mor, 2014; Agbali and El-Mor, 2015; El-Maremie; El-Mor, 2015). But, most studies concentrated on general biology, as food and feeding habits, reproduction, length weight relationships. This is the first study focused on Oblada melanura in Libya (Tripoli coast) about some biological characters of saddled bream collected from Tripoli coast

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**Materials and Methods**

A total of 215 saddled bream *O. melanura* specimens were collected from May 2015 to April 2016 by gill. Samples were caught from artisanal fishers in Tripoli fishing harbor (32° 53' 33" N and 13° 10' 48" E) (Figure 2) at 2 to 10 m deep.


**Figure 2: Tripoli fishing harbor on the Mediterranean.**

**Sex ratio and Length weight relationship**

Total length (TL) was measured to the nearest 0.1 cm and total weight (wet weight), gonad, liver and stomach weight to the nearest 0.01 g. Sex was determined macroscopically according to the shape and appearance of the gonads. For testing the sex ratio, a simple Chi-square test was used. The following relationships were established using linear regression analysis of W vs. TL (log-transformed). The length–weight relationships of O. melanura were also computed separately for four different seasons. The commonly used length ± weight relationship was applied (Ricker, 1975): $W = a L^b$, where W is weight, L is total length, and a and b are constants, and the degree of association between variables was calculated by the determination coefficient ($R^2$).

**Spawning period**

Maturity stages were determined by El-Gamy *et al.* (2004), scale and sexual identification was made macroscopically, then modified to include: immature (I and II), maturing (III and IV), ripe and spawning (V) and spent (VI) (Figure 3), as well, calculated the length at first sexual maturity. Sex was determined macroscopically by shape, appearance and gonad structure. Sex ratio (males/females) was calculated and deviation from a 1:1 null hypothesis statistically tested using chi-squared test (Sokal and Rohlf, 1981). Gonadosomatic index (GSI) was calculated for male and female seasonally with the equation below:
((Gonad Weight(g)/ (Total Body weight-Gonad Weight) (g))*100.

**Figure 3: Ovary of *O. melanura* at stage III.**

Also, hepatosomatic index (HSI) was calculated for male and female seasonally with the equation below:
((Liver Weight(g)/(Total Body weight-Liver Weight)(g))*100

**Length at first maturity**

Length at 50 % maturity ($L_{50}$) was calculated by fitting a logistic ogive to the observed proportion of mature fish per 10 mm length class. The three-parameter logistic is described by the equation:

$$\psi(L) = m_\infty \left(1 + e^{\left(-\frac{L-L_{50}}{\delta_L}\right)}\right)^{-1}$$

Where $\psi(L)$ is the proportion of mature individuals in each length class, L is the midpoint of each size class, $L_{50}$ is the mean total length at sexual maturity (50%, mm) (stage 3+),$\delta_L$ is the width of the curve, $and\ m_\infty$ is asymptotic maturity.

**Stomach contents**

After fish were dissected the gut removed and preserved in a 5% formalin solution to stop digestion. In the laboratory, prey identification was carried out to the lowest possible taxonomy level. A list of general diet composition was made food analysis by points of assessment (Hyslop, 1980; Hynes, 1985). The main food items were identified and determine the Prey-specific index of relative importance (%PSIRI) was calculated using the following equations.

$$\%PSIRI_i = \frac{\%FO_i * (\%PV_i + \%PN_i)}{2}$$ (Brown *et al*., 2012)

**Results**

Total length of *O. melanura* examined ranged from 127 to 261 mm (mean = 208 mm) and the weight from 22 to 225 g (mean = 109.1g). The number of males, females and sex reversal within each total length class of the mature population are shown in Figure 4. All individuals larger than 240 mm were female. Males were observed in length classes 165±175 mm, and females in length classes 175±205 mm, but males were mostly dominant in small length while females in large length. Most samples are females (F=94, M=65). The sex ratio was 1: 1.45 in favor of females. A chi-square revealed no significant departure from the theoretical 1:1 sex ratio ($\chi 2$=5.29, P<0. 021). The first total length of sex reversal showed at 190mm (N=13 ~ 6%).

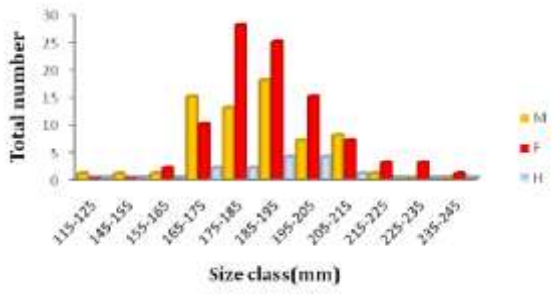


**Figure 4: The length classes of O. melanura from Tripoli coast (M=male, f=female and H=hermaphrodite).**

Length ± weight relationships were calculated for the both sexes and juveniles (Figure 5). The slopes (p values) of the total length ± weight relationship indicate the positive allometric growth (b =3.6469). The correlation coefficient "$r^2$" which measured the association between Length-weight regression parameters was estimated for all months, males, females and the whole sample; $r^2$-values was closed than 0.80 (0.7906

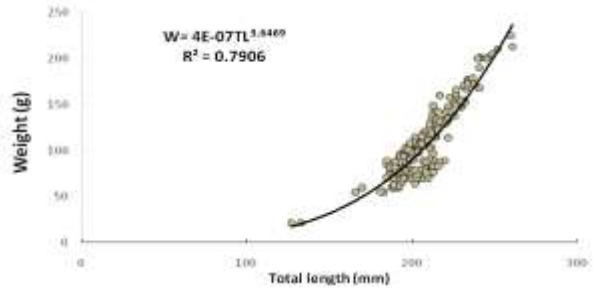


**Figure 5: The relationship between total weight (gm) and total length (cm) for both sexes of *O. melanura* from Tripoli coast**.

The condition factor of individual *O. melanura* ranged from 0.62 to 1.20 (0.89±0.14) (Figure 6). The variations of condition factor due to different season, thus the lower values were observed during cold seasons (autumn and winter) for both sexes. Seasonality noted that no sex effect on condition factor was normalised to the length-weight function for each sex.

Seasonally variations of gonadosomatic index (GSI) values (Figure 7) and macroscopic maturity stages (Figure 8) of both sexes displayed synchronicity. GSI values exhibited a similar trend for both sexes, but males were higher than females during summer. GSI peaked in summer occurring simultaneously for both sexes. Subsequently, a sharp decline in GSI and gonad weight was observed after peak spawning during autumn and decreases suddenly during winter. Males and females with mature gonads (stage III) were recorded all year. Ripe gonads (stage V) were observed in summer. Spent males and females (stage VI) were mainly recorded from last summer to autumn (Figure 8). Overall, *O. melanura* spawn during summer, whereas in colder seasons of the year, the observed parameters suggest no or low sexual activity. In addition, the hepatosomatic index (HSI) was similar with GSI, but males were lower than females except summer, were slightly higher than females (Figure 9).

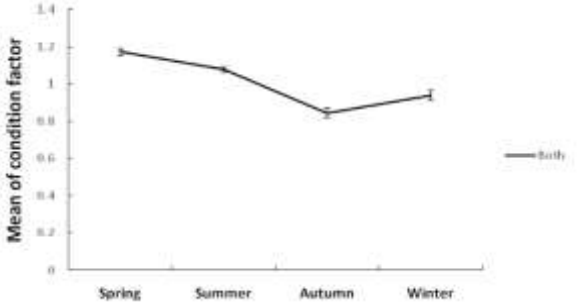


**Figure 6: The average condition factor of *O. melanura* from Tripoli coast for both sexes.**

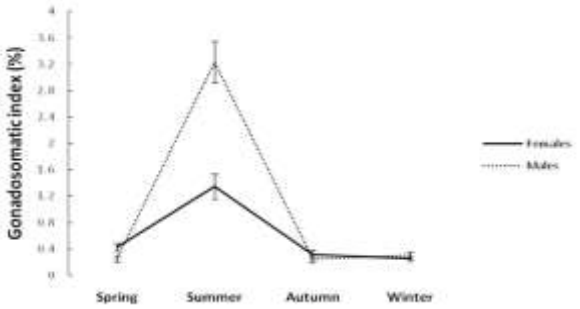


**Figure 7: Variations of gonadosomatic index of *O. melanura* from Tripoli coast.**

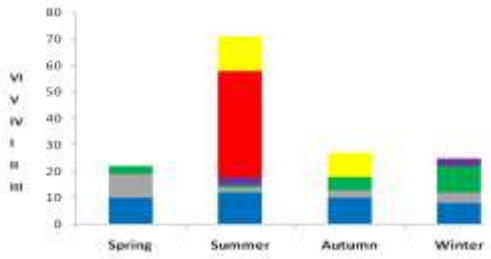


**Figure 8: Variations of gonad maturity stages for both sexes of *O. melanura* collected from Tripoli coast (immature I and II , maturing III and IV , ripe and spawning V and spent VI).**

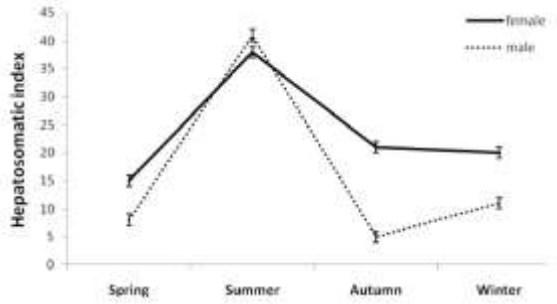


**Figure 9: Variation of hepatosomatic index of *O. melanura* from Tripoli coast.**

The relationship between total length (TL) and the proportion of adult females and males was estimated for 50% sexual maturity ($TL_{50}$) 181.9 mm TL (δ= 35.78; Figure 10). All *O. melanura* either male or female was larger than 170 mm will be in mature case, while the estimated asymptotic maturity ($m_{\infty}$) was 0.80 for all fish.

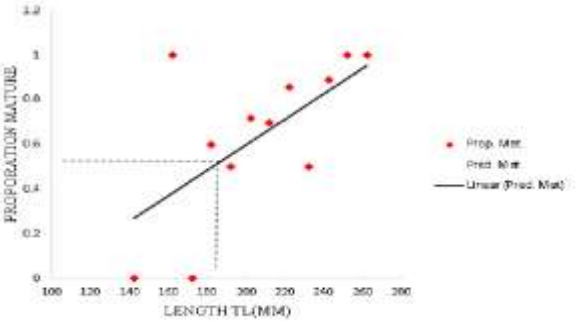


**Figure 10: Length at maturity of *O. melanura* from Tripoli coast (dashed line indicates to TL at-50% maturity).**

The percentage of the annual composition of *O. melanura* diet (Table 1 and Figure 11), revealed that four major different prey groups: shrimp, fish larvae, Polychaete and Nematode. Figure 11 shows the Index of relative importance of different prey groups found in 109 stomachs. Shrimp and fish larvae formed the major food groups for the saddled bream. Shrimp larvae were the most important ingested prey, constituting 50.44 % of the total IRI, whereas fish larvae (34.57 %) coming in the second position of importance, and the third one was Polychaete (21.70%). Other prey groups found in the stomach contents were comparatively low and of less importance. Green algae and Nematoda are the minor food about 12.14% and 2.00% respectively, while digested food (detritus) constituted 28.85% of all food consumed.

**Table 1. The diet composition of *O. melanura* from Tripoli Coast**

| food items | N% | V% | %F.O | IRI |
|---|---|---|---|---|
| shrimp larva | 74.44 | 69.54 | 0.85 | 50.44 |
| fish larvae | 16.05 | 19.38 | 0.42 | 34.57 |
| detritus | 3.79 | 3.06 | 0.05 | 28.85 |
| polychaeta | 4.65 | 6.58 | 0.24 | 21.70 |
| green algae | 1.07 | 1.29 | 0.05 | 12.14 |
| Nematoda | 0.01 | 0.15 | 0.02 | 2.00 |

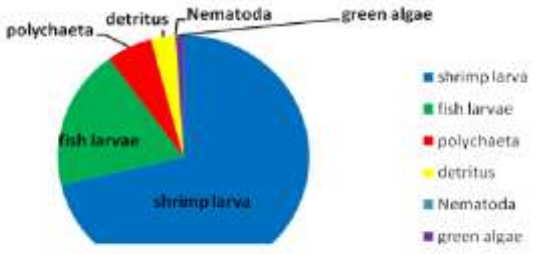


**Figure 11: Index of Relative Importance percentage (IRI%) of different prey groups for *O. melanura* .**

**Discussion**

In the present study, males were mostly dominant in lower length classes and females in higher length classes and smaller than 160mm are all sexually immature. Cavallaro *et al.* (1985) from Sicilian coastal waters and Pallaoro *et al.* (1998) from the eastern Adriatic found almost the same results for the saddled bream, but Pallaoro (1996) found that females of saddled bream from the western Istrian coastal waters-Northern Adriatic were dominant in lower length classes and males in higher. They suggested the sexual dimorphism correlated to growth, when females grow more than males, in agreement with our results. This could be a biological mechanism to control the abundance of the population in particular areas, especially in those which are exposed to intensive fishing (Pallaoro *et al*., 1998). Moreover, the maximum length of saddled bream was 261 mm TL during the present study, while was 340 mm in the south and southwest coast of Portugal (Gonçalves *et al*., 1997), 334 mm in the eastern Adriatic Sea (Pallaora *et al.*, 1998), 289 mm in Greek waters (Stergiou and Moutopoulos, 2001), 300mm in the eastern Mediterranean (Golani *et al.*, 2006), 292 mm in Abu Qir Bay, Egypt (Mahmoud, 2010). Recently, the largest specimen of *O. melanura* was reported with 366 mm in French Catalan coast, western Mediterranean Sea (Crec'hriou *et al.*, 2012) and 357 mm in the southern Aegean Sea, Turkey (Akyol *et al*., 2014).

The percentage of sex ratio male to female in this a study was 1.45:1, with favor of male. Our results on this study compare with Pallaoro *et al.* (1998) from the eastern Adriatic; they found that the sex ratio for *O. melanura* was 1.20:1. Likewise, other species belong to family Sparidae such as *Dipoldus vulgaris* (Dulcic *et al*., 2010 ; Taieb *et al*., 2012), *Boops boops* (Hamwi, 2012), they recorded sex ratio similar with our results; especially *Boops boops* have the same type of hermaphroditism. As well, females were found as dominant since species is synchronous hermaphrodite (Yapici *et al*., 2012). Sadovy and Shapiro (1987) mentioned that the percentage of males to females varied with size of fish and also by season and months, in addition to differences in sex ratio are generally explained by the different growth parameters and migratory behaviors of males and females of a species (Moreno and Morales-Nin, 2003).

The relation between length and weight of fish is very important for estimating growth rates, age structures, and stock conditions; comparing life histories of fish species between regions and assessing the condition of fish as well as other components of fish population dynamics (Bagenal and Tesch, 1978). In the present study, the length-weight relationships of *O.melanura* showed positive allometric growth for both sexes. Cavallaro *et al.* (1984), Cefali *et al.* (1987) from the Eastern Sicilian coast - Messina strait and Karakulak *et al.* (2006) in the northern Aegean sea were indicated positive allometric growth of the saddled bream, whereas Cavallaro *et al.* (1985) in Sicilian coastal waters, Can *et al.* (2002) in Turkish waters and Moutopoulos and Stergiou (2002) in North eastern Atlantic and Mediterranean Sea were noticed negative allometric growth. The differences in b-values can be attributed to the combination of one or more factors: different stages in onto genetic development, age, maturity and sex (Dulčić and Kraljević, 1996), as well as the number of specimen examined. Likewise, geographic location and environmental conditions, such as seasonality (date and time of capture), food availability, changes in water temperature and salinity, disease and parasite loads, differences in the observed length ranges of the specimen caught (Le Cren, 1951; Bagenal and Tesch, 1978; Weatherley and Gill, 1987; Moutopoulos and Stergiou, 2002) can affect the value of b. In fact, the Mediterranean Sea is considered as one of the most oligotrophic regions in the world in terms of both primary productivity and chlorophyll a concentrations (Azovy, 1991).

In fisheries studies; the condition factor is an essential biological parameter needed to understand the suitability of the environment for living of fish (Le Cren, 1951). The condition factor of the saddled bream in the Tripoli coast (0.89) is higher than the eastern Adriatic (Pallaoro *et al.*, 1998) and Sicilian coastal waters (Cefali *et al*., 1987); this difference could be attributed to the variation in temperature and other ecological conditions. Thus, the highest condition factor values were recorded in ending spring and summer, these results coincide with the degree of stomach fullness due to food availability (Anato and Ktari, 1983). This supports observations describe in the French Mediterranean Sea (Bell and Harmelin-Vivien, 1983) and northwestern Mediterranean Sea (Sánchez-Velasco and Norbis, 1997).

Sexual reversal of *O. melanura* occurs at 190 mm, whereas Boughamou *et al.* (2015) observed sex reversal at 243 mm of *Spondyliosoma cantharus*, since both of them are protogynic hermaphrodite. Also, the results indicated that the percentage of sex reversal was 6%, however, *Boops boops* is a gonochoric species as protogynous hermaphroditism was 0.6% (Bottari *et al*., 2014). Studies investigating the size of *O. melanura* at maturity are rather scarce, especially in Mediterranean area. In the present study, the length at first sexual maturity of *O. melanura* was approximately 182 mm TL. This value is compared with other species for Sparidae obtained from different areas where less than our result, such as *Boops boops* in the southern Tyrrhenian sea (Bottari *et al*., 2014) and in Morocco coast (Layachi *et al*., 2015), *Pagellus erythinus* (Ben Smida *et al*., 2014) and *Diplodus vulgaris* (Taieb *et al*., 2012) in Tunisia coast and *Lithognathus mormyrus* in Greece coast (Kallianiotis *et al*., 2004); while *Spondyliosoma cantharus* in the Gulf of Annaba (Algeria) was more than our value (Boughamou *et al*., 2015). These differences are probably due to the fact that size /age of first maturity depends on environmental factors, such as food availability and temperature (Nikolsky, 1963; Hempel, 1965; Blaxter, 1969), and genetic factors (Wootton, 1998), as well as other parameters such as long-term fishing pressure and selectivity (Jørgensen, 1990; Trippel, 1995; Helser and Almeida, 1997; O'Brien, 1999). In addition, length at first sexual maturity directly influences the reproductive potential of a species, partially determining the duration of the spawning period for each individual as well as influencing the quantity of the spawning stock (Cikeš Keč and Zorica, 2012).

In the present study, the seasonally distribution of GSI values indicated that saddled bream spawns in summer. These results were similar to report by Grubišić (1988), Pallaoro (1995) and Jardas (1996) in the Adriatic Sea and Bauchot and Hureau (1986) in Mediterranean Sea. During autumn and winter, GSI values decreased due to the discharge of sexual products (ova and sperms) during the spawning season. GSI values of the females throughout the year is greater than that of the males of *O.melanura*, like that recorded by Assem (1992), as well some species belong to sparidae (El-Maghraby *et al*., 1982; Litany and De Silva, 2003 ; El-Agamy *et al*., 2004). Moreover, the changes in HSI value of *O.melanura*, showing the same trend as those of the GSI and it is associated with the sexual cycle; probably due to storage the energetic reserves in liver during the gonadal maturation period (Ben Smida *et al*., 2014). Hence, HSI value was increased during the spawning season and decreased afterwards, that might be used for the energetic requirements of the spawning, but did not have a direct influence on vitellogenesis (Gordo, 1995; Bottari *et al*., 2014). Generally, the summer environmental factors, long period of sunlight, high temperature and abundant food are to maintain a normal metabolic activity for fishes (Brett, 1979).

Maturity stages of saddled bream identified into 6 stages, likewise Hassan (1990), who showed 6 developmental stages of *Boops boops* and *Boops salpa* (family Sparidae) in Egyptian Mediterranean water. The beginning and continuance of the spawning period is mainly determine by stages of gonad development, the dietary activity of fish and lay eggs (Hamwi, 2006, 2009); in the other hand, the spawning seasons may reflect different some abiotic factors, such as temperature regimes or feeding dominance among the areas (Kashiwagi *et al*., 1987). However, ripe ovaries indicated that the spawning period of *O. melanura* occurred during summer in Tripoli coast. This result was similar to report by Bauchot and Hureau (1986), who observed that this period of saddled bream was between April and June in the Mediterranean sea, then Jardas (1996) reported that the spawning season of

saddled bream in the Adriatic Sea was during the second part of summer.

The food and feeding habits of sparid fishes have been studied in Mediterranean sea by many authors (Rosecchi, 1987; Rosecchi and Nouaze, 1987; Papaconstantinou and Caragitsou, 1989; Quignard and Tomasini, 2000; Tomac *et al*., 2000; Abdel-Rahman and Abdel-Barr, 2003; Kallianiotis *et al*., 2004; Osman and Mahmoud, 2009), as well as, especially in Libyan coast (Shtewi, 2003; Ben-abdullah, Al-turk, 2005; Ansher, 2007; El-Fergani and El-Mor, 2014; Agbali and El-Mor, 2015; El-Maremie and El-Mor, 2015 ; El-Maremie *et al*., 2015).

The major food groups for *O.melanura* were shrimp and fish larvae, as well as, polychaete, but the main food was shrimp representing 50% of total IRI (Rosecchi and Nouaze, 1987). Other prey groups, *i.e*. green algae and nematoda, were less important in the diet of saddled bream. Other reports recorded that the stomachs of *O.melanura* were dominated by benthic organisms: Crustacea, Polychaete and Mollusca in Tyrrhenian Sea (Ara, 1937), the Adriatic Sea (Pallaoro *et al.*, 2003) and Mediterranean coast of France (Lenfant and Olive, 1998); they noticed that planktonic copepods constituted more than 50% of total stomach content. The differences in food composition between saddled breams are mainly due to different distribution, abundance, density and availability of prey. The saddled bream stomachs imply feeds on forage from various trophic levels, including benthic organisms as polychaete and zooplanktonic organisms as shrimp and fish larvae. This species has relatively big eyes, which might be an adaptation to nocturnal activity near sea bottom, as well as to prey the small planktonic organisms (Pallaoro, 1995). So, Ara (1937) mentioned that the food composition of saddled bream confirms the hypothesis of its opportunistic behaviour.

**Conclusion**

According to our findings in this study, *O. melanura* spawns during summer, and length weight relationship was positive allometric growth for sexes, while the length at first maturity ($L_{50}$) was 181.9 mm TL and sex ratio was 1:1.45 in favour of females. Also this species belongs to carnivorous species.

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