Reproduction and growth of Axillary seabream \textit{Pagellus acarne} (Risso, 1827) (Perciformes Sparidae) from the western Algerian coasts

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\textbf{ABSTRACT} \textit{Pagellus acarne} (Risso, 1827) (Perciformes Sparidae) represents an important component of Algerian fishery catch. Reproduction and growth parameter of this species are studied during 13 months, from fish caught from western Algerian coasts from December 2015 to December 2016. The sex-ratio (F:M) of the population studied is 1:1.56 and is in favor of male. The reproductive season extends between late spring and autumn. The resting period occurs in winter. Length at first maturity is estimated at 18.63 cm and 16.95 cm for females and males respectively. The length-weight relationship obtained is $TW=0.009TL^{3.086}$ ($R^2=0.983$). The Von Bertalanffy growth equation parameters are $K=0.41$, $L_\infty=29.97$, $t_0=-0.34$ and the $\Phi'=2.57$.

\textbf{KEY WORDS} Algerian; growth; maturity; \textit{Pagellus acarne}; reproduction; Western Mediterranean Sea.

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\textbf{INTRODUCTION}

Axillary seabream, \textit{Pagellus acarne} (Risso, 1827) (Perciformes Sparidae), is a demersal Sparid fish, widely distributed in Mediterranean Sea and Black Sea. It is occurring in eastern Atlantic coasts from Senegal to Denmark and around the Madeira, Azores, Canary and Cape Verde Islands (Fischer et al., 1987). This species inhabits different type of sea bottom up to 500 m depth. However, it is more common between 40 to 100 m depth and is fished by trawling and artisanal fishing.

\textit{Pagellus acarne} was studied for its biological feature in the Atlantic coast of Morocco and western Sahara, (Mennes, 1985; Lamrini, 1986), in the Canary Islands (Pajuelo & Lorenzo, 2000), in Portugal (Santos et al., 1995; Coelho et al., 2005) and in Atlantic coast of Spain (Velasco et al., 2011). The species was studied, also, in Mediterranean coasts (Andaloro, 1982), in Greece (Stergiou et al., 1997), in Turkish (Ozaydin et al., 2007; Soykan et al., 2015), in Mediterranean coasts of Spain (Domínguez, 2000; Valesco et al., 2011), in Mediterranean coasts of Morocco (Zoubi, 2001) and in Algerian water (Bensahla, 2014; Boufarsaoui & Harchouche, 2015).

Sparid fish are one of the important components of fishery in Algeria. Species of this family have a great commercial value and are largely exploited. Moreover, \textit{P. acarne} is listed by the International Union for Conservation of Nature (Russell et al., 2014). The aim of this paper is to give more information about parameters useful to assess biological feature of \textit{P. acarne} (reproduction period, maturity, growth and age) from western Algerian waters.
Reproduction

The spawning period was determined by the monthly variation of the mean gonadosomatic index (GSI) (Pajuelo & Lorenzo, 2000; Velasco et al., 2011, Soykan et al., 2015), calculated as:

\[ \text{GSI} = 100 \times \frac{\text{GW}}{\text{EW}} \]

Size at first maturity (L₅₀) was defined as the size at which 50% of invidious become mature (Batts, 1972), during the reproductive period. It is calculated according to ICES (2008) as:

\[ P = \frac{1}{1 + e^{(a + b \times \text{TL})}} \]

Where P is the proportion of mature individuals in size class of TL (cm), a and b are constants of non linear regression, and L₅₀ is the size where 50% of the individuals are mature.

Growth

The length-weight relationship was estimated as:

\[ \text{WT} = a \times \text{LT}^b \]

Where a and b are coefficients of the equation (Ricker, 1973). When the value is b=3, growth is isometric. Weight increase exhibits positive allometry if b>3 and negative allometry if b<3. The degree of association between variables Weight and length was calculated by the determination coefficient (R²).

The Von Bertalanffy growth function was applied to size-at age data. The function is:

\[ L_t = L_\infty [1 - e^{-kt}] \]

In this equation, Lₜ is the mean fish length at age t (year), k (year⁻¹) is the growth coefficient; Lₐ (cm) is the asymptomatic length; and t₀ (year) is the hypothetic age at which length is equal to zero. All the parameters were calculated using ELEFAN method (electronic length-frequency analysis) integrating in LFDA program (Pitcher, 2002). Growth parameters were compared with other studies using the phi-prime test (Φ') (Munro & Pauly, 1983), where

\[ \Phi' = \log(k) + 2\log(L_\infty) \]
RESULTS

A total of 795 *P. acarne* were collected and examined. Morphometric characteristics are summarized in Table 1 and the frequency distribution of TL of all sample are illustrated in figure 2.

The sex-ratio (F:M) of the sample is 1:1.56. The proportion of female and male grouped among interval size of 1 cm is significantly different (χ² test, P < 0.05) for most size groups except for sizes ranged between 18 and 20 cm (Fig. 3). Significant differences are registered in monthly frequency distribution of males and females (χ² test, P < 0.001) (Fig. 4).

Results on monthly frequency of the gonads maturation stages for males and females are demonstrated in figure 5. Monthly variations of mean GSI for both sexes are illustrated in figure 6. The higher values of GSI occur between May and July for females and one month earlier for male (between April and July) and between October and November for the two sexes, these coincide with presence of gonads at spawning stage. The first peak of GSI occurs in June for female and in May for male and the second peak in October for the two sexes. Between the two peaks, a collapse of mean GSI is recorded in August. That coincides with presence of developing and post spawning gonads stages.

Size at first sexual maturity L₅₀ is estimated at 18.63 cm for females and 16.95 cm for males.

Length-weight relationship parameters are consigned in Table 2. Isometric growth is observed for males and all sample, when slightly negative allometry is observed for females.

The Von Bertalanffy growth parameters are summarized in Table 3 and the curve of length at age is illustrated on figure 7.

DISCUSSION

The sex-ratio in this study is in favor of male. The same results were observed by Arculeo et al. (2000) and Valesco et al. (2011). In contrast and in all the other distribution area of *P. acarne* sex-ratio is in favor of females (Santos et al., 1995; Pajuelo & Lorenzo, 2000; Coelho et al., 2005; Bensahla, 2014; Soykan et al., 2015; Boufersaoui & Harrouchouche, 2015). The sex-ratio registers a seasonal variations, as it appears that in spawning season.
males are dominant and in resting season females are dominant. According to TL, males are dominant in smallest size and female in great size. This is a characteristic of protandric species; the fish are first male and became female.

Reproductive season of *P. acarne* shows two spawning periods. The first, between spring and early summer, with a peak of spawn in later spring and the second, in autumn, with a peak of spawn in October; between the two there is an interruption of spawning in August. The resting period occurs in winter. These results are in agreement with Bensahla (2014) and Boufersaoui & Harchouche (2015) along Algerian coasts. In higher latitudes spawning period occurs between end of spring and early autumn (Lamrini, 1986; Santos et al., 1995; Coelho et al., 2005; Valesco et al., 2011; Soykan et al., 2015). In contrast, in lower latitudes it is occurs between winter and spring (Pajuelo & Lorenzo, 2000). These geographical differences in reproductive season of *P. acarne* could be due to the environmental conditions influencing gonads maturation.

In this study, males attain sexual maturity at a smaller size than female. The same result is observed by Santos et al. (1995); Pajuelo & Lorenzo (2000); Valesco et al. (2011) and Soykan et al. (2015). It appears to be a characteristic of protandric hermaphrodite species. Table 4 summarizes size at first maturity of *P. acarne* registered by different authors. In the present study, first sexual maturity occurs at 16.95 cm for male and 18.63 cm for female (2 years for both sexes). This result agrees with size at first maturity reported in Mediterranean sea by Andaloro (1982) and Boufersaoui & Harchouche (2015) for males only. Even in Mediterranean Sea, smaller sizes at first maturity were obtained in Algerian coasts by Bensahla (2014) and in central Aegean Sea by Soykan et al. (2015). In contrast, Lamrini (1986) in Atlantic Ocean, Santos et al. (1995) in southern Portuguese coasts, Valesco...
et al. (2011) in Atlantic Ocean and Alboran Sea, report higher sizes at first maturity comparing to results obtained in this study. Water temperature is an important factor that influences metabolic activity; it is known that Mediterranean water is warmer than Atlantic water. That could explain that fish reach sexual maturity in Mediterranean at smaller size than fish in Atlantic. In addition, the effect of sampling biases cannot be excluded (Tsikiras & Stergiou, 2014).

Length-weight relationship shows an isometric growth for all individuals of *P. acarne*. Positive allometry is reported for axillary seabream in other distribution area in Mediterranean Sea (Valesco et al., 2011; Bensahla, 2014; Soykan et al., 2015) and in Atlantic (Santos et al., 1995; Pajuelo & Lorenzo, 2000; Coelho et al., 2005) (see Table 5). In this study there is a difference in the length-weight relationship between males and females which register slightly negative allometry. This observation is described by Pajuelo & Lorenzo (2000) and Valesco et al. (2011) for the same species. They explain it by the difference in the size distribution of the two sexes due to the protandric hermaphroditism.

The von Bertalanffy growth parameters allow converting length of *P. acarne* to age. It appears that the younger fish sampled are under 1 year old and the oldest are between 4 and 4.5 years old. The most frequent age reported in the sample is approximately two years.

**Figure 5.** Monthly variation of the frequency of gonads development stages of *P. acarne*.

**Figure 6.** Monthly variation in the mean GSI with standard errors of *P. acarne*.
Table 5 shows the growth parameters of *P. acarne* from different distribution areas. The k value in this study is estimated at 0.5 for female, 0.42 for male and 0.41 for the two sexes combined. These K values indicate a rapid growth of the species in western Mediterranean water of Algeria. These values are close to the one obtained by An- deloro (1982) from Tyrrhenian and Ionian Seas, Zoubi (2001) in Mediterranean coast of Morocco, Bensahla (2014) in Bay of Oran in western Algerian coasts. However, they are higher than those reported by Djabali et al. (1990), Pajuelo & Lorenzo (2000), Coelho et al. (2005), Valesco et al. (2011), and Soykan et al. (2015). The asymptomatic length $L_\infty$ reported in this study is 29.79 for female, 28.43.
for male and 29.97 cm for all samples. These values are reasonable regarding maximum TL registered from sampled fish. The $L_\infty$ values obtained are higher than those observed in Mediterranean Sea by Djabali et al. (1990), Zoubi (2001), Bensahla (2014), and Soykan et al. (2015). However, they are lower than those obtained in Atlantic Ocean by Pajuelo & Lorenzo (2000), Coelho et al. (2005), and Valesco et al. (2011). These differences in K and $L_\infty$ values could be attributable to size range of sampled fish and the fitted growth model. The phi prime values calculated in this study are slightly higher than the ones obtained by majority of works on $P.\ acarne$ from his different distribution area (Table 5), but they are comparable to those obtained by Bensahla (2014) in the same geographic area.

REFERENCES


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