



Reproductive Biology of the Common Pandora *Pagellus erythrinus* (Linnaeus, 1758) of Oran Bay (Algerian west coasts)

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Abstract

A reproductive study was conducted on 320 individuals of common Pandora *Pagellus erythrinus*, from Oran Bay providing information for a more understanding of the reproductive cycle. These specimens were sampled monthly during the landing of coastal fisheries among the whole samples, 86 (29.86%), were males and 202 (70.14%) were females. The monthly sex ratio showed significant differences between males and females. Females outnumbered males at size 16.5cm and 28.5cm. high gonad index values associated with advanced stages of maturity were observed in *P.erythrinus* females between April and July, less important values were recorded in October while size at first maturity L_{50} for females occurred at 12.5cm.

Key words: Sparidae, Common Pandora, *Pagellus erythrinus*, Reproduction, Oran Bay

Introduction

The common pandora, *Pagellus erythrinus* (Linnaeus, 1758), which belongs to the family of Sparidae, is a valuable species for aquaculture and fisheries (Metin, İlkyaz, Soykan, & Kinacıgil, 2011). It is a gregarious demersal species living on rocky and muddy-sandy bottoms, between 20 and 300 m depth (Whitehead., Bauchot & Hureau 1986; Mytélinoú, 1989; Santos, Monteiro, & Ezzi, 1995). It has been reported in the Black Sea, the Mediterranean Sea and the eastern Atlantic from Norway to Angola (Bonnet, 1969; whitehead et al, 1986; Fischer et al, 1987; Fredj & Maurin, 1987; Froese & Pauly, 2014).

Investigations carried out in different Mediterranean areas showed that common pandora, preferably, inhabits on the continental shelf (Spedicato, Greco, Sophronidis, Lembo, Giordano, & Argyri, 2002) Depending on size, common pandora is widely distributed from shallow coastal waters to 300 m depth. (Orsi Relini & Romeo, 1985; Somarakis & Machias, 2002; Spedicato et al, 2002).

P. erythrinus is among the most captured species for the small-scale fishing fleet in many Mediterranean countries, playing an important role in the local micro economy by the volume of catches and by its high price (Ghorbel, 1996; Pajuelo, J.G., Lorenzo, J.M., Méndez-Villamil Nespereira. & Mata, M. 1996., Hoşsucu & Çakır., 2003). On the other hand, this Sparidae is well known and appreciated also in the Japanese market which has been importing large quantities of Mediterranean pandora for many years (Tomiya, 1974). The result is that this Sparidae is currently severely overfished in several Mediterranean countries (Hadjistephanou, 1992; Ghorbel, 1996; Pajuelo et al, 1996).



Signs of overexploitation of the species standing stock have been reported in diverse Mediterranean geographical sub-areas (GSAs) (Vassilopoulou, & Papaconstantinou, 1986; Jarboui et al, 1998; Abella, Colloca, Sartor, & Mannini, et al, 2010; Mehanna 2011; Gurbet et al, 2012) and also in Sicilian waters (Fiorentino, Knittweis, Gancitano, Mifsud, Gravino, & Gristina, 2012). The current conservation legislation on fisheries sets the minimum size limit for this species at 150 mm TL (EU Regulation 1967/2006). Also in Algerian waters this length is the same (J.O.R.A.D.P, 2004).

Valdés, García-Alcázar, Abdel, Arizcun, Suárez, & Abellán (2004), reported that the common pandora is a suitable species for aquaculture in the Mediterranean and that the correct determination of the species spawning period is also very important. Spawning period, sex-ratio, GSI, length at first maturity and length weight relationship were studied in different regions such as, Aegean sea (Hossucu & Çakır., 2003 ; Metin, İlkyaz, Soykan, & Kınacıgil, 2011), southern Portugal (Coelho, Bentes, Correia, Gonçalves, Lino, Monteiro, & Erzini, 2010) the western Mediterranean (Valdes et al, 2004) ; Tyrrhenian sea (Busalacchi, Bottari, Giordano, Profeta, & Rinelli, 2014). In Tunisia, studies were conducted from Gulf of Gabès (Ghorbel & Ktari., 1982) also in the Gulf of Tunis (Fassatoui & Romdhane, 2010; Zarrad, Cherif, Gharbi, Jarboui, & Missaoui, 2010), and the Bay of Monastir (Ben smida & Hadhri, 2014), El Habouz, Bhar, Rafik & Yousra. (2009) studied the reproduction of *P.erythrinus* in Morocco in Agadir's Bay.

To date there is no information published on the biology of this Sparid in Oran Bay, nevertheless a number of studies were conducted, we mention (Dieuzeide, Novella, & Roland, 1955); Cherabi, (1987) in the Bay of Algiers and Rouidi., (2011) in the Bay of Jijel.

In Oran Bay, the common pandora is of commercial importance and has been captured by trawl and artisanal fleet. The landings of this species reached 673 t in 2014, which corresponds to 23.9% of total production of demersal fishes in Oran's fishery according to D.P.R.H., (2014). The economic value of this species in the Algerian waters and lack of sufficient research on this subject for Oran Bay make necessary a better understanding of its reproductive cycle. The present paper consists of an original study of some reproductive characteristics of the Algerian sea common pandora including size at first maturity, sex-ratio for males and females, variation of Hepato somatic index (HSI), condition factor K and the reproduction period during one year.

Material and methods

In total 320 samples of *P. erythrinus* were collected, 86 males, 202 females and 32 unsexed, were caught by trawlers fishing in Oran Bay -35°41'27" N - 0°38'30" W (Fig.1), between February 2014 and January 2015. They were brought to the laboratory and for each specimen measurements included total length (TL) to the nearest millimeter, total weight (TW) and gonad's weight to the nearest 0.01g. Fish lengths were classified in 1 cm group intervals Fig.2. Sex was recorded after opening the abdominal cavity and maturity stages were determined macroscopically based on morphology and color of gonads according to (Holden & Raitt, 1975) as follows: stage I, immature; stage II immature or in resting phase; stage III, pre-spawning; stage IV, spawning; stage V, post-spawning.



Sex ratio of males and females was monthly calculated according to the following formula:

$$\text{Sex ratio F} = (F/(F+M)) \times 100$$

$$\text{Sex ratio M} = (M/(F+M)) \times 100$$

F: number of females,

M: number of males.

The sex ratio was analyzed by 1cm length class. Deviation from 1:1 null hypothesis was statistically tested by χ^2 test. In order to understand the sexual cycle and determine the spawning period the gonad somatic index (GSI) was calculated monthly for females and males:

$$\text{GSI} = \text{GW}/\text{TW} \times 100 \text{ (Htun-Han, 1978).}$$

During reproduction fish undergoes physiological changes due to the mobilization of its energetic reserves. Thus, the monthly variation of hepato somatic index (HSI) and the monthly variation of the condition factor (K) were calculated for females and males:

$$\text{HSI} = \text{LW}/\text{EVW}$$

$$\text{K} = \text{TW}/\text{TL}^3 \times 1000 \text{ (Ricker, 1975).}$$

GW: gonad weight

LW: liver weight

EVW: eviscerated weight

TW: total weight

TL: total length

Size at first maturity (L_{50}) was estimated for females from the percentages of mature individuals (stage III, IV, V) and the proportion of mature individuals in each size class (1 cm intervals) was calculated. A logistic function relating the proportions of mature individuals to total length of the fish (Ghorbel et al, 2002) was used. This function makes possible to monitor the degree of sexual maturity by size and to accurately estimate the ($L_{50\%}$), ($L_{25\%}$) and ($L_{75\%}$) lengths often used in the majority of stock assessment models. This function of sigmoid shape is expressed as follows:

$$P = 1 / (1 + e^{-(b + aTL)}) \text{ (Ghorbel., 2002)}$$

P: proportion of mature individuals;



a and b: constants.

TL: total length in cm.

Results

Total length of males and females ranged from 120 to 380 mm. Of 320 specimens, 86 (29.86%) were males and 202 (70.14%) were females, 32 were unsexed.

Sex ratio

The overall ratio of males to females was 1:2.34 and χ^2 analysis showed a significant difference from expected ratio 1:1 ($\chi^2= 46.72 > \chi^2_{1,0.05}=3.84$) Table 1. Sex ratio by size class showed a dominance of females in sizes ranging between 12.5cm and 28.5cm while statistic test didn't reveal any significance for size class 16.5cm where males and females were equal and in size class 30.5cm where males outnumbered females.

Gonado somatic index GSI, hepatosomatic index HSI, and condition factor K

The evolution of mean GSI of males and females shows similar patterns. The monthly values of GSI ranged between 0.13 and 3.80 in females and from 0.11 and 2.38 in males. From May to July the mean values reached the highest values, a second peak was observed on October. Those values are low from November to April. Fig.3.

The analysis of the mean gonado somatic index indicates that the spawning period extends from May to July and that there is a secondary spawning period on October. The sexual resting period takes place between November and April.

In females, the curve of the HSI showed the same trend as the GSI. Maximal values were observed between May and July; a second peak was observed on October. These values decrease between November and April.

The condition factor K curve shows difference between males and females. Higher values of this factor were observed from May to November and lower values from February to April in females. In contrast, male's condition factor shows fewer variations than females with two peaks on March and May.

Size at first maturity

During our study period from February 2014 to January 2015 size at first maturity was reached at 12.5cm for females as shown in Figure.4

Discussion

This study is the first to provide detailed information on the biology of *Pagellus erythrinus* in Oran Bay. Common pandora is a hermaphrodite protogynous sparidae (Girardin & Quignard, 1985; Papaconstantinou, Mytilineou, & Panos, 1988; Livadas, 1989; Pajuelo & Lorenzo 1998), without sexual dimorphism and presents a sex ratio with a significant difference between females and males.



The sex ratio was unbalanced in favor of females, which is in accordance with the results reported for Mediterranean and Atlantic populations (Vassilopoulou & Papacostantinou, 1986; Ghorbel, 1996., Pajuelo & Lorenzo 1998., Busalacchi et al, 2014). The predominance of females can be explained by protogynous hermaphroditism and an abundance of young individuals among the stock (Metin., 2011). The presence of small sized males (primary males) and large females in our samples suggests that sex change does not occur in each individual (Busalacchi et al, 2014).

The common pandora of the western Algerian coast shows a spawning period extending from May to July with a second peak on October. In different areas of Mediterranean Sea as Bay of Monastir (Ben Smida., 2014), Gulf of Tunis (Zarrad et al,2010), Gulf of Gabès (Ghorbel., 1996), Southern Portugal (Coelho et al, 2010) and Canary Islands (Pajuelo & Lorenzo., 1998), the common pandora have the same behavior and generally spawns in spring/summer, a second spawning period in autumn has also been reported by some authors (Dieuzeide et al. 1955; Ghorbel & Ktari 1982; Vassilopoulou & Papaconstantinou 1990).

For females, the curve of HSI followed the same pattern as the GSI. Out of the reproduction period the values are low, increase during the gonadal maturation and decrease again in spawning period. This could be explained by the fact that this fish probably stores its energetic reserves in liver during the gonadal maturation period. Such reserves might be used for the energetic requirements of the spawning.

In contrast, males have high HSI values out of the reproduction which decreased and keep constant during the period of reproduction, this is presumably due to the lower energetic investment in sperm production in some species (Al Mamry, McCarthy, Richardson, & Ben Meriem., 2009), which is a common characteristic already observed for the same species from the Bay of Monastir (Ben Smida & Hadhri., 2014).

Length at first maturity (L_{50}) estimated in western Algerian coast for *Pagellus erythrinus* is lowest than those observed in Tunisia 15.32cm (Ben smida & Hadhri., 2014); Tyrrhénian sea 15.7cm (Busalacchi et al, 2014); Portugal 17.29cm (Coelho et al, 2010); and higher than those found by (Metin et al, 2011) in the central Aegean Sea 11.30cm.

The minimum landing size MLS regulation set at 150 mm TL adopted within the European Union Common Fisheries Policy (EU Regulation 1967/2006) and the Algerian Ministry of Fisheries and Fish Resources (M.P.R.H., 2004) for the common pandora is to our opinion insufficient to ensure stock renewal and should be increased, a suggestion already proposed concerning a congener species *Pagellus acarne* (Bensahla Talet, Gheram, Dalouche, Bensahla Talet, Boutiba., forthcoming, 2017).

Conclusion

At the light of this first data about the reproductive cycle of *P.erythrinus* in the Bay of Oran we conclude that there is a significant difference between males and females with a predominance of females. The spawning period



extends from May to July with a second peak on October. Length at first maturity L_{50} for females is reached at 12.5cm.

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Table 1. Monthly variations of sex ratio for *P.erythrinus* in the west Algerian coast.

Months	M	F	SR%	χ^2
F	8	16	66.67	2.67
M	8	22	73.33	6.53*

A	8	23	74.19	7.26*
M	11	22	66.67	3.67
J	7	17	70.83	4.17*
J	6	21	77.78	8.33*
S	9	19	67.86	3.57
O	9	19	67.86	3.57
N	16	9	36.00	1.96
D	2	17	89.47	11.84*
J	2	17	89.47	11.84*

*statistically significant ($P < 0.05$). SR: sex ratio

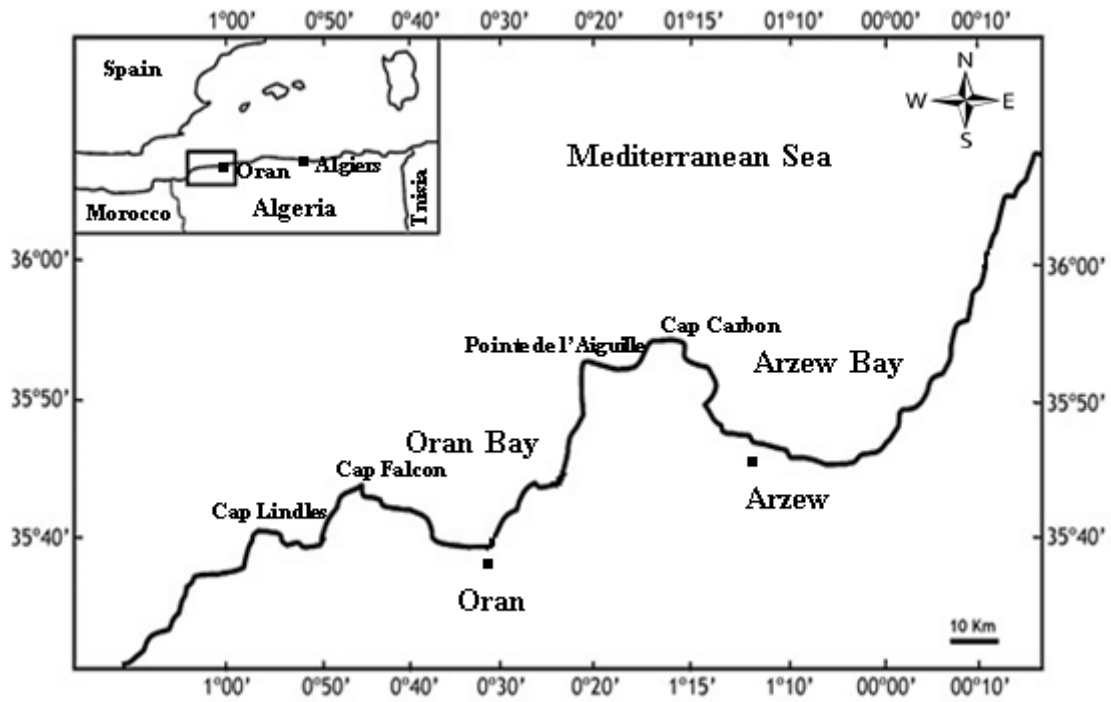


Figure 1. Location of the sampling area.

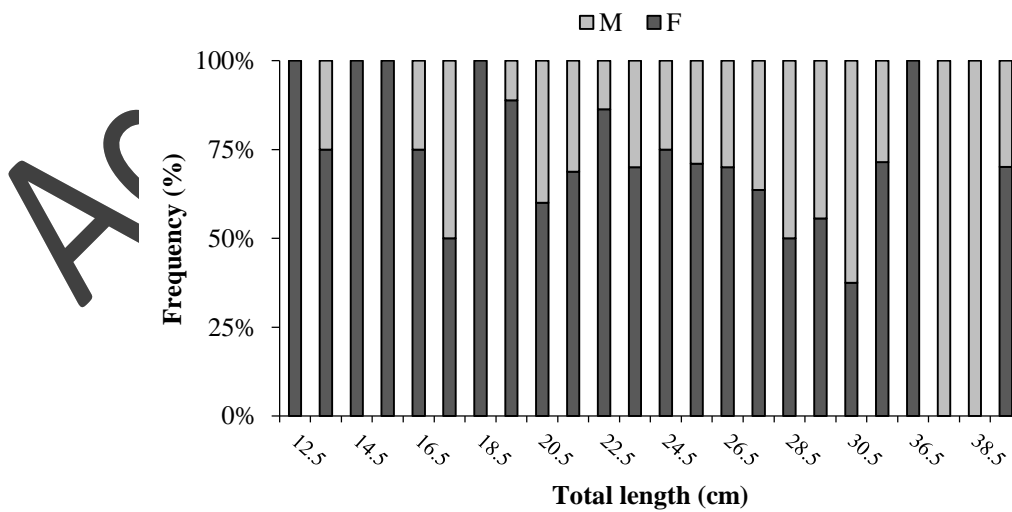


Figure 2. Length frequency distribution males and females of *P.erythrinus* caught in Oran Bay.



M:males, F:feamles

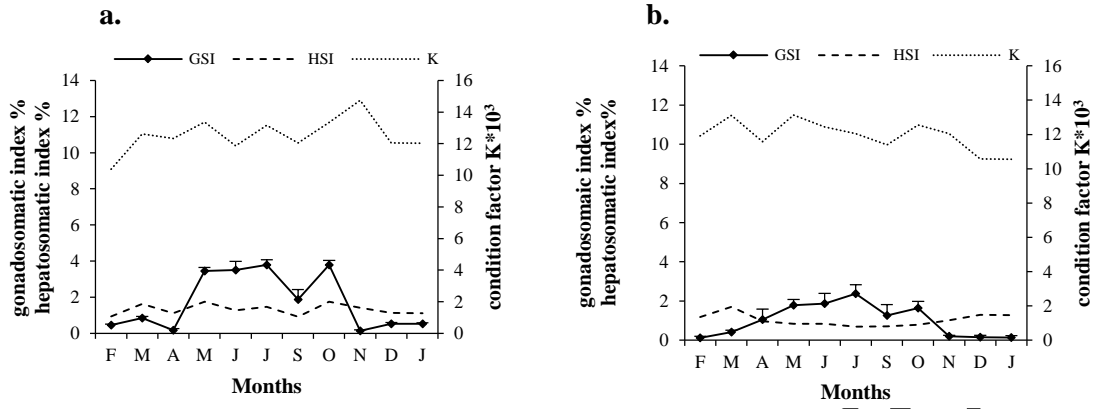


Figure 3. Monthly changes in the gonadosomatic index, hepatosomatic index and condition factor of *P. erythrinus*. (mean±SD):

a. Females; b. Males

GSI: gonadosomatic index, **HSI:** hepato somatic index, **K:** condition factor.

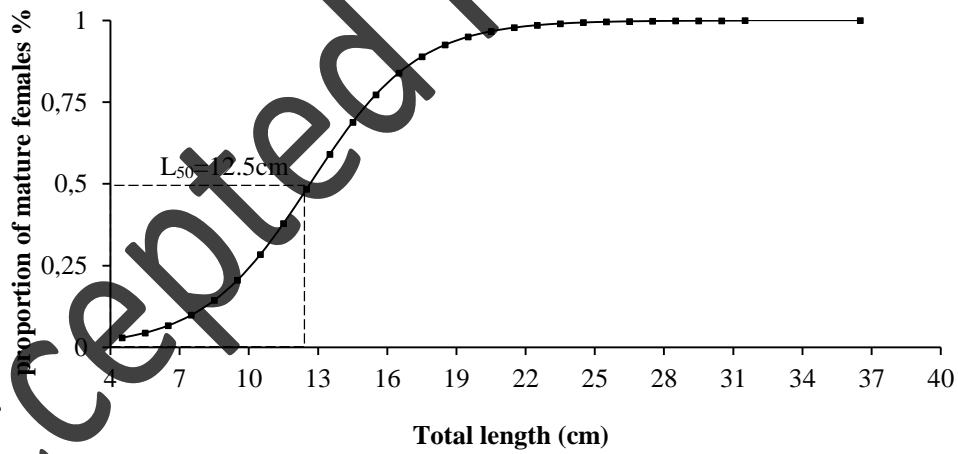


Figure 4. Length at first maturity L_{50} for females of *P. erythrinus*