www.trjfas.org
ISSN 1303-2712
Turkish Journal of Fisheries and Aquatic Sciences 18: 1-7 (2018) DOI: 10.4194/1303-2712-v18_1_01

RESEARCH PAPER

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

Hadjer Mahdi[1,*], Lotfi Bensahla Talet[1], Zitouni Boutiba[1]

[1] University of Oran, Ahmed Benbella, Laboratoire Réseau de Surveillance Environnementale (LRSE), Oran 31000, Algeria.

* Corresponding Author: Tel.: +213670317225 ;
E-mail: mahdihadjer@hotmail.fr

Received 9 August 2016
Accepted 2 May 2017

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.

Keywords: 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, & Kinacigil, 2011). It is a gregarious demersal species living on rocky and muddy–sandy bottoms, between 20 and 300 m depth (Whitehead., Bauchot & Hureau 1986; Mytélineou, 1989; Santos, Monteiro, & Erzini, 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 (Tomiyama, 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, Agean sea (Hossucu & Çakır., 2003 ; Metin *et al*., 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 67.3 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 HIS, 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 (Figure 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 Figure 2. Sex was recorded after opening the abdominal cavity and maturity stages were determined macroscopically based on morphology

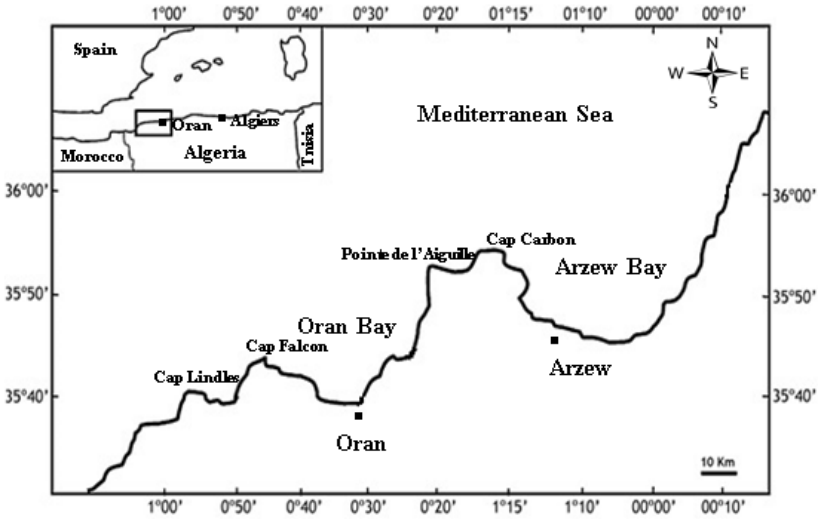

Figure 1. Location of the sampling area.

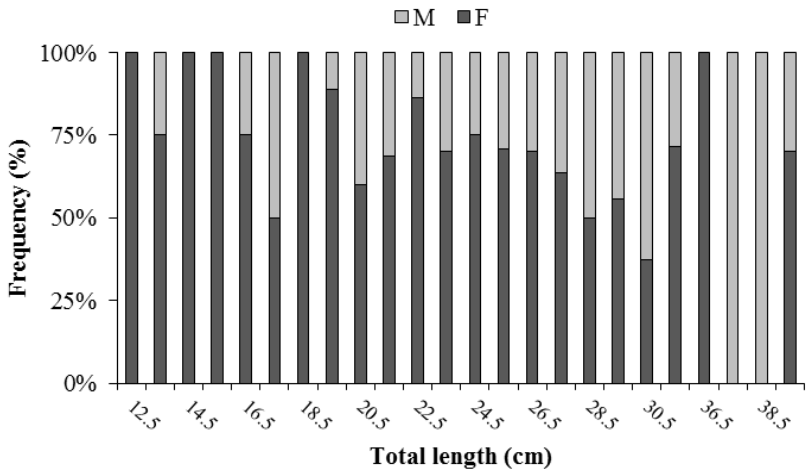

Figure 2. Length frequency distribution males and females of *P.erythrinus* caught in Oran Bay. M:males, F:females.

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 x^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:

$$GSI = GW/TW100 \text{ (Htun-Han,1978).}$$

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:

$$HSI = LW/EVW$$

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

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> χ^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. Figure 3.

The analysis of the mean gonado somatic index

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

Months	M	F	SR%	χ2
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

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 & Papacanstantinou. 1986; Ghorbel, 1996., Pajuelo & Lorenzo 1998., Busalacchi *et al*, 2014). The predominance of females can be explained

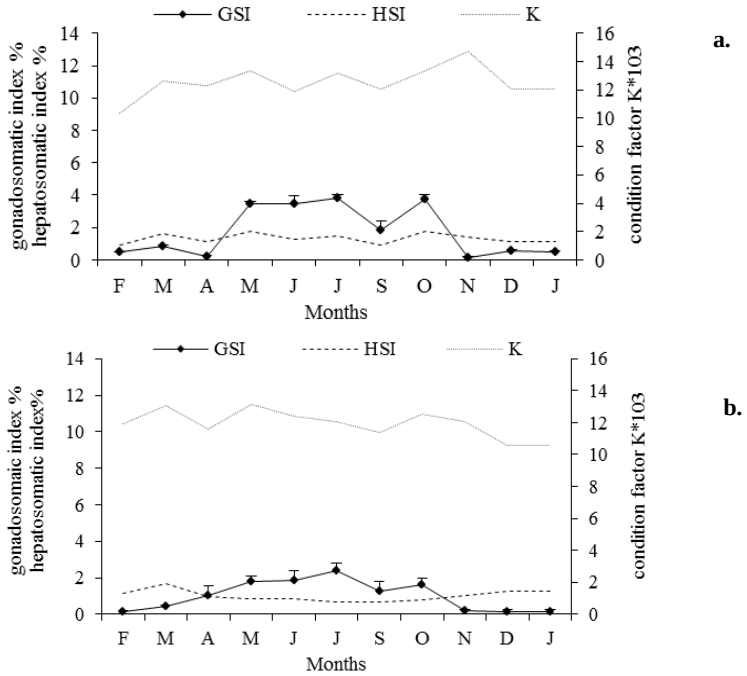

Figure 3. Monthly changes in the gonadosomatic index, hepatosomatic index and condition factor of *P. erythrinus.* (mean± SD): a. Females; b. Males GSI: gonadosomatic index, HSI: hepato somatic index, K: condition factor.

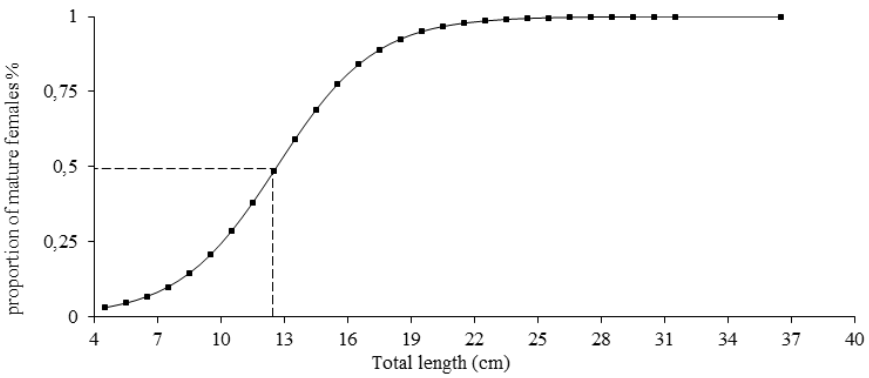

Figure 4. Length at first maturity L_{50} for females of *P. erythrinus.*

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.

References

Abella, A., Colloca, F., Sartor, P., & Mannini, A. (2010). General fisheries commission for the Mediterranean (GFCM). *SAC SCSA. WG on Stock Assessment of Demersal Species. Stock Assessment Forms*.

Al Mamry, J. M., McCarthy, I. D., Richardson, C. A., & Ben Meriem, S. (2009). Biology of the kingsoldier bream (Argyrops spinifer, Forsskål 1775; Sparidae), from the Arabian Sea, Oman *Journal of Applied Ichthyology*. *25*(5), 559-564, https://dx.doi.org/10.1111/j.1439-0426.2009.01260.x

Bensahla Talet, L., Gherram, M., Dalouche, F., Bensahla Talet, A., & Boutiba Z. (2017). Reproductive biology of *Pagellus acarne* (Risso, 1927) (Teleostei, Sparidae) of western Algerian waters (W. Mediterranean). *CAHIERS DE BIOLOGIE MARINE* 58-4 *accepted in press.*

Ben smida, M.A., & Hadhri, N. (2014**)**. Reproductive Cycle and size at first sexual maturity of common pandora *Pagellus erythrinus* (sparidae) from the Bay of Monastir (Tunisia, central Mediterranean). *Annales, Series Historia Naturalis·* 24. (1), 31-40. UDK 597.556.33:591.16 (262.26).

Bonnet, M. (1969). Les sparidés des côtes nord-ouest africaines. *Revue des Travaux de l'Institut des Pêches maritimes*, *33*(1), 97-116.

Busalacchi, B., Bottari, T., Giordano, D., Profeta, A., & Rinelli, P. (2014). Distribution and biological features of the common pandora, *Pagellus erythrinus* (Linnaeus, 1758), in the southern Tyrrhenian Sea (Central Mediterranean). *Helgoland Marine Research*, *68*(4), 491-501. http://dx.doi.org/10.1007/s10152-014-0404-5

Cherabi, O. (1987). *Contribution a l'étude de la biologie du pageot commun Pagellus erythrinus et a l'écologie de la famille des Sparidés de la baie d'Alger*. These de magister, USTHB université . Alger, Algérie.*(in french)*

Coelho, R., Bentes, L., Correia, C., Gonçalves, J., Lino, P. G., Monteiro, P., & Erzini, K. (2010). Life history of the common pandora, *Pagellus erythrinus* (Linnaeus, 1758)(Actinopterygii: Sparidae) from southern Portugal. *Brazilian Journal of Oceanography*, *58*(3), 233-245. https://dx.doi.org/10.1590/s1679-87592010000300006

Dieuzeide, R., Novella, M. & Roland, J. (1955). Catalogue des poissons des côtes algériennes. III. Bulletin des Travaux. Station d'Aquaculture et de Pêche de Castiglione. Alger., n. spec., 6, 384 (in french)

El Habouz.H, Bhar.L, Rafik.J et Yousra.M., (2009). Biologie des principales espèces ciblées par les chalutiers côtiers dans la zone Atlantique Centre Marocain, travaux techniques et scientifiques 2TS, Edition février 2015. (www.inrh.ma). 57p

European Commission. (2006). Council Regulation (EC) No 1967/2006 of 21 December 2006 concerning management measures for the sustainable exploitation of fishery resources in the Mediterranean Sea, amending Regulation (EEC) No 2847/93 and repealing Regulation (EC) No 1626/94. *Official Journal* L 409, 30/12/2006, pp. 9–86.

Fassatoui, C., & Romdhane, M.S. (2010). Variabilité génétique entre les classes d'âge chez le pageot commun (*Pagellus erythrinus*, Sparidae) des côtes nord tunisiennes. *Bulletin de l'Institut National des Sciences et Technologies de la Mer*, Salammbô, 37, 1–12. (in french)

Fiorentino, F., Knittweis, L., Gancitano, V., Mifsud, R., Gravino, F. & Gristina, M. (2012). General fisheries commission for the Mediterranean (GFCM). Scientific Advisory Committee (SAC). *Report of the 14th of the Working Group on Stock Assessment of Demersal Species*, Chania (Crete), Greece.

Fischer, W., Bauchot, M-L. & Schneider, M. (1987). Fiches FAO d'identification des espèces pour les besoins de la pêche (Révision 1). Méditerranée et mer Noire. Zone de pêche 37. Vol II. Vertébrés. *FAO et Commission des Communautés Européennes,* Rome, 2, (761–1530)

Fredj, G., & Maurin, C. (1987). Les poissons dans la banque de données MEDIFAUNE: Application à l'étude des caractéristiques de la faune ichthyologique méditerranéenne. *Cybium*, *11*(3), 217-299.

Froese, R., & Pauly, D. (2014). *Pagellus erythrinus*. FishBase Editors World Wide Web electronic publication. http://www.fishbase.fr.

Ghorbel, M. & Ktari, M.H. (1982**)**. Etude préliminaire de la reproduction de *Pagellus erythrinus* des eaux tunisiennes. *Bulletin de L`Institut National Scientifique et Technique D`Océanographie et de Pêche de Salammbo.* 9. 23-38. *(in french)*

Ghorbel, M. (1996). *Le Pageot commun Pagellus erthrinus (poisson, sparidae): ecobiologie et etat d'exploitation dans le golfe de Gabes* PhD thesis, Faculté des Sciences de Sfax, Tunisie.

Ghorbel, A. O., Bradai, M. N., & Bouain, A. (2002). Période de reproduction et maturité sexuelle de Symphodus (Crenilabrus) tinca (Labridae), des côtes de Sfax (Tunisie). *Cybium*, *26*(2), 89-92.

Girardin, M., & Quignard, J. P. (1985). Croissance de *Pagellus erythrinus* (Pisces: Teleostéen, Sparidae) dans le Golfe du Lion. *Cybium*, *9*(4), 359-374.

Gurbet, R., Akyol, O. & Yalcin, E. (2012). Catch per unit effort and mortality rates of two sparid species, *Pagellus acarne* and *Pagellus erythrinus* from bottom trawl fishery in Izmir Bay, Aegean Sea. *Journal of Animal and Veterinary Advances1*. 681–686. http://dx.doi.org/10.3923/javaa. 2012.681.686

Holden, M.J., & Raitt, D.F.S., (1975). Manual of Fisheries Science Part 2 - Methods of Resource Investigation and their application. Rome, Italy. FAO corporate document repository. Food and agriculture organization of the united nations, 115-211

Hoşsucu, B. & Çakir, D.T. (2003). Some parameters about population biology of the common Pandora (*Pagellus erythrinus* L., 1758) (Sparidae) in Edremit Bay (Turkey). *Ege University Journal of Fisheries and Aquatic Sciences*. 20, 329–336 http//:dx.doi.org/ 10.12714/egejfas.2003.20.3.500015 7078.g

Htun-Han, M. (1978). The reproductive biology of the dab *Limanda limanda* (L.) in the North Sea : Gonosomatic index, hepatosomatic index and condition factor. *Journal of Fish Biology*,13 :369-378. http://dx.doi.org/ 10.1111/j.1095-8649.1978.tb03445.x.

Jarboui, O., Ghorbel, M. & Bouain, A. (1998). Stock of common pandora (*Pagellus erythrinus*) in the Gabes Gulf (Tunisia): fishing situation and management possibilities. *Cahiers Options Mediterraneennes* (CIHEAM), 35. 251–260.

J.O.R.A.D.P. (2004). fixant les tailles minimales marchandes des espèces Biologiques. (rapport No 18). Alger, Algérie. *Journal Officiel de la Republique Algerienne Démocratique et Populaire* 5pp. (*in french)*

Linné, C. von. (1758). Caroli Linnaei...Systema naturae per regna tria naturae :secundum classes, ordines, genera, species, cum characteribus, differentiis, synonymis, locis. http://dx.doi.org/10.5962/bhl.title.542

Livadas, R. J. (1989). A study of the biology and population dynamics of pandora (*Pagellus erythrinus* L., 1758), family Sparidae, in the Seas of Cyprus. *FAO. Fish. Rep*, *412*, 58-76.

Mehanna, S. (2011). General fisheries commission for the Mediterranean (GFCM). Scientific Advisory Committee (SAC). *Report of the 13th of the SCSA Working Group on Stock Assessment of Demersal Species.* Istanbul, Turkey, 2010, pp 38–39

Metin, G., İlkyaz, A.T., Soykan, O. & Kinacigil, H.T. (2011**)**. Biological characteristics of the common pandora, *Pagellus erythrinus* (Linnaeus, 1758), in the central Aegean Sea. *Turkish Journal of Zoology*, 35(3) 307-31. http://dx.doi.org.3906/zoo-0904-4.

Mytilinéou, C. (1989). Données biologiques sur le pageot, *Pagellus erythrinus*, des côtes orientales de la Grèce centrale. *FAO Fisheries Report*, 412 pp.

Orsi Relini, L. & Romeo, G. (1985). Vertical distribution, age, growth and mortality of *Pagellus erytrinus* on trawled areas of Ligurian Sea. *Rapport Commission Internationale de la Mer Méditerranée*., 29 (8), 103–106.

Pajuelo, J.G., Lorenzo, J.M., Méndez-Villamil Nespereira. & Mata, M. (1996). Determinación del estado de explotación de la breca *Pagellus erythrinus* (Linnaeus, 1758) en aguas de Gran Canaria a través del analisis de cohortes en longitud. *Boletín del Instituto Español de Oceanografía* 12(2), 115–130.

Pajuelo, J. G. & Lorenzo, J.M. (1998). Population biology of the common pandora *Pagellus erythrinus* (Pisces: Sparidae) off the Canary Islands. *Fisheries Research*., v.36, n.2-3, 75-86, http://dx.doi.org/10.1016/S0165-7836(98)00110-6

Papaconstantinou, C., Mytilineou, C. & Panos, T. (1988). aspects of the life history and fishery of red pandora, *Pagellus erythrinus* (sparidae) off western greece. *Cybium*. 12 (4), 267-28

Ricker, W. E. (1975). The Fisheries Research Board of Canada — Seventy-Five Years of Achievements. *Journal of the Fisheries Research Board of Canada*, 32(8), 1465–1490. http://dx.doi.org/10.1139/f75-17

Rouidi, S. (2011). *Contribution à l'étude du pageot rose (Pagellus erythrinus., Linnaeus, 1758) dans la région de Jijel : les associations ichtyologiques, la biologie et l'exploitation*. Magister en sciences biologiques, Océanographie Biologique et Environnement Marin. Université des Sciences et Technologies Houari BOUMEDIENE. Alger, Algérie 147 p. (*in french*)

Santos, M.N., Monteiro, C.C. & Erzini, K. (1995). Aspects of the biology and gillnet selectivity of the axillary seabream (*Pagellus acarne*, Risso) and common pandora (*Pagellus erythrinus*, Linnaeus) from the Algarve (South Portugal). *Fisheries Research*. 23,

223–236. http://dx.doi.org/10.1016/0165-7836(94)00354-Y

Somarakis, S. & Machias, A. (2002). Age, growth and bathymetric distribution of red pandora (*Pagellus erythrinus*) on the Cretan shelf (eastern Mediterranean). *Journal of Marine Biological Association of the United Kingdom.* 82: 149- 160. http://dx.doi.org/ 10.1017/S002531540200526X

Spedicato, M. T., Greco, S., Sophronidis, K., Lembo, G., Giordano, D., & Argyri, A. (2002). Geographical distribution, abundance and some population characteristics of the species of the genus Pagellus (Osteichthyes: Percirformes) in different areas of the Mediterranean. *Scientia Marina*, 66(S2), 65–82. http:// dx.doi.org/10.3989/scimar.2002.66s265

Tomiyama, T. (1974). Fisheries in Japan: Sea Bream, Vol. 3. The Japan Marine Products Photo Materials Association, Tokyo.

Valdés, P., García-Alcázar, A., Abdel, I., Arizcun, M., Suárez, C. & Abellán, E. (2004). Seasonal changes on gonadosomatic index and maturation stages in common pandora *Pagellus erythrinus* (L.). *Aquaculture International*, 12, 333–343. http:// dx.doi.org/10.1023/B:AQUI.0000042136.91952.9e

Vassilopoulou, V, Mytilineou C, Papaconstantinou C (1986) Preliminary biological data on the red pandora (Pagellus erythrinus L., 1758) in the Greek seas. *FAO. Fish.Rep* 361:107–112

Vassilopoulou, & Papaconstantinou, C. (1990). Growth by weight, condition factor and reproductive cycle of red pandora *Pagellus erythrinus* in the Saronicos Gulf. *In: Proceedings of 3rd Hellenic symposium on Oceanography and Fisheries*, Athens, vol 3, pp 584–591.

Whitehead, P.J. P., Bauchot, M.-L., Hureau, J.-C., Nielsen J., & Tortonese, E. (1986). Fishes of the North-eastern Atlantic and the Mediterranean. *Journal of the Marine Biological Association of the United Kingdom*, 68(01), 1013–1473. http ://dx.doi.org10.1017/s0025315400050360

Zarrad, R., Cherif M., Gharbi H., Jarboui, O. & Missaoui, H. (2010). Reproductive cycle and sex reversal of *Pagellus erythrinus* (Linnaeus, 1758) in the gulf of Tunis (central Mediterranean). *Bulletin de l'Institut National des Sciences et Technologies de la Mer Salammbô*, 37, 13–20. *(in french*)