Biodiversity Journal, 2018, 9 (1): 19–24

Reproductive cycle of the gilthead sea bream *Sparus aurata* Linnaeus, 1758 (Pisces Perciformes Sparidae) in the Gulf of Skikda (Algerian East coast)

Chebel Fateh[1,3*], Mezedjri Lyamine[2] & Boulahdid Mostefa[1]

[1]Ecole Nationale Supérieure des Sciences de la Mer et de l'Aménagement du Littoral (ENSSMAL) B.P. 19, Campus Universitaire de Dely Ibrahim, 16320 Alger, Algeria; email: chebelfateh@gmail.com
[2]Département SNV, Faculté des Sciences, Université du 20 août 55, 21000 Skikda, Algeria; email: mezedjri.lyamine@gmail.com
[3]Centre National de recherche et de développement de la Pêche et l'Aquaculture (CNRDPA) 11, Bd Colonel Amirouche, 42415 Bou Ismail, W. Tipaza, Algeria; email: mennad.moussa@gmail.com
[*]Corresponding author

ABSTRACT

Specimens of the gilthead sea bream *Sparus aurata* Linnaeus, 1758 (Pisces Perciformes Sparidae) have been the subject of a study on the reproductive biology in the Gulf of Skikda, which extends from Cape Bougaroune (06°27'10"E) to Cape of Iron (07°10'02"E), from March 2014 to February 2015, in order to describe the sex distribution, sexual cycle and size at first sexual maturity. A total of 576 specimens of which 391 males and 185 females were analyzed. The numerical proportion of males (68%) differs significantly from that of females (32%) ($\varepsilon > 1.96$, $\alpha = 5\%$). The gonadosomatic (GSI) and hepatosomatic (HSI) indices of females and males indicate a single reproduction period. This Spawning period ranges from December to January. Oocyte maturation occurs when the HSI is high. On the other hand, spawning causes a decrease in the HSI. The size at first sexual maturity (Lm50) is 18.3 cm for males and 19.6 cm for females.

KEY WORDS Algerian East coasts; reproductive biology; sex distribution; *Sparus aurata*.

Received 11.09.2017; accepted 09.01.2018; printed 30.03.2018

INTRODUCTION

The gilthead sea bream *Sparus aurata* Linnaeus, 1758 (Pisces Perciformes Sparidae) has an economical importance both in Algeria and throughout the Mediterranean Sea. Thus, numerous studies have been devoted to its study, notably concerning its biology (Lasserre & Labourg, 1974; Arnal et al., 1976; Lasserre, 1976; Suau & López, 1976; Ferrari & Chieregato, 1981; Wassef & Eisawy, 1985; Rosecchi, 1985; Mosconi & Chauvet, 1990; Magoulas et al., 1995; Pita et al., 2002; Stergiou & Karpouzi, 2002; Almuly et al., 2005; Rossi et al., 2006; Parati et al., 2011).

On the coast of Algeria, fishing of S. aurata is mainly assured by trawl, trammel, gillnets and palangrots. The last three gears target *S. aurata* even during periods of restricted trawl fishery, from May to August, suggesting a possible overexploitation of its stock and a scarcity of spawners. For this reason, the study of the renewal of populations is essential and knowledge of the phenomena related to the reproduction of species is of fundamental interest.

In Algeria, the gilthead sea bream has been the subject of some studies in the lagoon environment (Chaoui et al., 2005; Chaoui et al., 2006; Chaoui et al., 2009; Chaoui et al., 2012). However, its reproductive biology in marine environment has never been studied. In our research on the biology of S. aurata from the catches of the Gulf of Skikda (Algeria), it is important to characterize its reproductive cycle.

The present work aims to better know the different phases of the reproductive cycle of *S. aurata* and to determine its size at first sexual maturity in a natural environment.

MATERIAL AND METHODS

Sampling of this study was possible thanks to the catches of the commercial fishing fleet of the Gulf of Skikda (Algeria) (Fig. 1). Sampled specimens of the gilthead sea bream come from private trawlers. During the period from March 2014 to February 2015, a total of 576 specimens were collected (391 males and 185 females).

For each specimen sampled, sex and total length (Lt) were expressed in cm with an accuracy of 1 mm. Total weight (Wt), eviscerated weight (We), gonad weight (Wg) and liver weight (Wf) were expressed in g with an accuracy of 0.01 g and recorded. The hermaphrodite individuals in the process of sex change are characterized by sex of which the gonad is the most developed (Anonymous, 1998).

The maturity stages of the gonads were determined using the scale proposed by Hadj-Taieb et al. (2013):

Stage I (immature or sexual rest): the testes are whitish, with a round section and a few blood vessels. The ovaries are transparent, slightly pinkish and filamentous with fine membrane; the vascularization is barely visible.

Figure 1. Study site: Gulf of Skikda, Algeria.

Stage II (beginning of maturation): the testes are milky white with a flat section leaving to flow no liquid into the incision. The ovaries are less transparent, better vascularized and yellowish in color; the oocytes are visible to the naked eye.

Stage III (full maturation): the testicles are more voluminous, in knife blade, leaving to flow whitish semen into incision and pressure on the abdomen. The ovaries are orange-yellow and very big; the oocytes are clearly visible with a net cytoplasmic membrane.

Stage IV (sperm emission / spawn): the testicles are big and soft, releasing milt with many lumps. The ovaries are highly vascularized with translucent ova perfectly individualized and expelled at the lesser pressure on the abdomen.

Stage V (post-emission/post-spawn): the testes are exhausted, richly vascularized, leaving to flow traces of sperm giving the organ an appearance of curdled milk. The ovaries are much vascularized, empty and flaccid, dark red, with brown spots corresponding to zones of sclerosis or atresic residual oocytes.

The sex ratio, expressed in femininity and masculinity rates (Kartas & Quignard, 1984), were determined each season:

$$\text{masculinity rate} = \frac{M}{F+M} \times 100,$$

$$\text{femininity rate} = \frac{F}{F+M} \times 100,$$

where F is the number of females and M is the number of males.

Temporal variations of gonadosomatic (GSI) and hepatosomatic (HSI) indices have been followed to describe the sexual cycle and to determine the spawning period:

$$\text{GSI} = \frac{Wg}{We} \times 100,\ \text{HSI} = \frac{Wf}{We} \times 100.$$

The condition factor K (Postel, 1973) was used to express the fish condition according to seasons and sex. This condition factor was calculated according to the formula:

$$K = \frac{Wt}{Lt^3} \times 100.$$

According to Fontana & Le Guen (1969), the size of first maturity is that at which 50% of individuals are capable to reproduce. The size of first maturity (Lm50) was determined for males and females. The estimate of the Lm50 was applied only on the individuals fished during the reproduction period. We calculated by sex and size class of 1 cm the percentage of mature specimens grouped from stage II of sexual maturity. A logistic function linking the proportions of mature individuals and total length was used. This function of sigmoid shape allows to follow the degree of sexual maturity according to the size and to estimate with precision the length Lm50 from the following equation (Pauly, 1980):

$$P = \frac{1}{1+e^{-r(Lt-Lm50)}}$$

with P = proportion of mature individuals; Lt = total length (cm); r being a constant.

RESULTS

Sex ratio

Seasonal distribution of the sexes according to the season (Table 1) shows a clear predominance of males in summer, autumn and winter ($\varepsilon > 1.96$, $\alpha = 5\%$), with a maximum numerical proportion in winter. The spring season shows a sex ratio in favor of females (period of sexual rest) ($\varepsilon > 1.96$, $\alpha = 5\%$). Overall, the percentage of males, which is about 68%, differs significantly from that of females (32%) ($\varepsilon > 1.96$, $\alpha = 5\%$).

The distribution of the proportions of each sex according to the size is represented in figure 2. In the females, the observed sizes are between 18 and 29.3 cm while that of the males are between 17.5 and 28.7 cm. At a size less than 22 cm, the dominance is for the males then from 23 to 24 cm the females dominate. Beyond this range up to a size of 28 cm, the proportions of the males become important. At 29 cm in total length, females dominate.

Gonado-somatic index

The figure 3 shows for both sexes, maturation of the gonads starting from the month of October; the GSI value is higher than in September with values of 0.29 for males and 0.69 for females. In December, the index reaches 1.5 and 3.23 respectively; the gonads are at their maximum weight. The spawning and emissions start causing a decrease of the GSI in January and February.

Hepato-somatic index

For females, HSI reaches its peak in November with a value of 2.2, before the maturation of the ovaries. A low value is observed in February (HSI = 0.9), from the end of the spawning period. In males, the peak of the HSI appears during the month of October, estimated at 1.15 (Fig. 4).

Condition factor K

The values of the condition coefficient K are higher for males than for females (Fig. 5). In females, the K index increases significantly between spring and summer ($\varepsilon = 4.55$, $\alpha = 5\%$) and then stabilizes at a maximum value of 0.46 between summer and autumn. In winter, the K index slowly and significantly decreases to 0.41 ($\varepsilon = 6.96$, $\alpha = 5\%$). For the males, the K factor is stable between spring and summer seasons and then increases significantly from 0.75 to 0.79 between summer and autumn ($\varepsilon = 4.45$, $\alpha = 5\%$). In winter, K significantly decreases to 0.73 ($\varepsilon = 7.73$, $\alpha = 5\%$).

Size at first sexual maturity

The results are shown graphically in the figures 6, 7. The size at first sexual maturity (Lm50) is about 18.3 cm for males and 19.6 cm for females.

DISCUSSION

The exploitation of a fish stock is possible with the proviso that the catches by the fishery remain compatible with the maintenance of the reproductive capacity of a population. In this study, we examined spawners captured in the Gulf of Skikda (Algeria).

In *S. aurata*, the sex ratio observed for all catches shows a dominance of the males (68%). This result is similar to that of Hadj-Taieb et al. (2013) in the Gulf of Gabes (Tunisia). This predominance of one sex is a relatively frequent phenomenon in many teleost fish species (Ben Slama et al., 2010; Mezedjri et al., 2013; Hadj-Taieb et al., 2013; Boufersaoui & Harchouche, 2015; Zo-

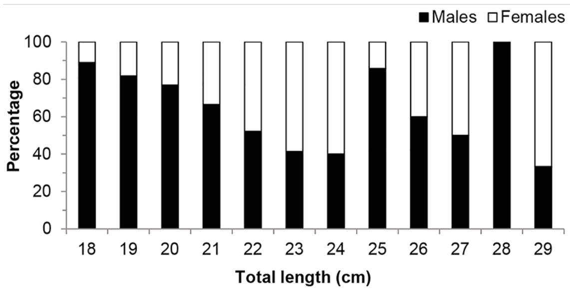

Figure 2. Length-frequency distribution of *Spaurus aurata* from the Gulf of Skikda (Algeria).

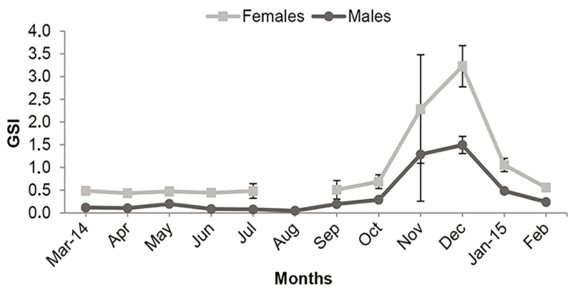

Figure 3. Variation of the gonadosomatic index for *Spaurus aurata* from the Gulf of Skikda (Algeria).

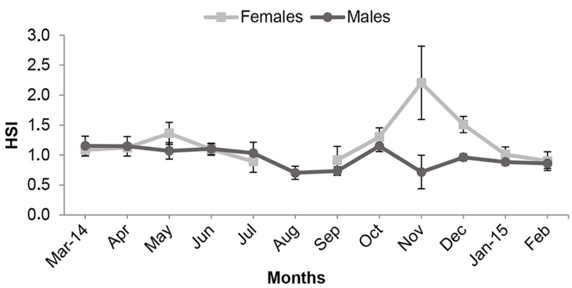

Figure 4. Variation of the hepatosomatic index for *Spaurus aurata* from the Gulf of Skikda (Algeria).

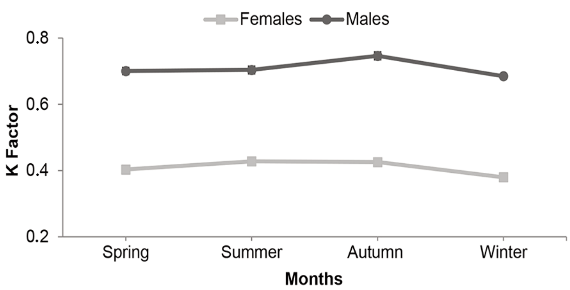

Figure 5. Variation of the condition factor (K) for *Spaurus aurata* from the Gulf of Skikda (Algeria).

uakh et al., 2016). Several hypotheses, including reproduction, displacement for food search and differential growth, may explain this trend.

The GSI allowed to follow the dynamics of the reproductive activity of *S. aurata* in the Gulf of Skikda. The reproduction period takes place over a short period; the reproduction of this species presents a single mode during an annual cycle. The reproduction period occurs from December to January. Our observations are close to those of the main authors having worked on *S. aurata* of the Mediterranean. In the Mellah lagoon (Algeria), according to Chaoui et al. (2006), spawning of *S. aurata* occurs between December and January. For Mehanna (2007), in the coasts of Port Said (Egypt), spawning spread from December to February. Hadj-Taieb et al. (2013) specify that the spawning of the gilt sea bream of the Gulf of Gabes (Tunisia) takes place from November to January.

The monthly variations of the HSI in both sexes of the sea bream on the coast of Skikda indicate that the storage of energy reserves in the liver takes place at the same time as the maturation of the gonads. The end of this last phase of the sexual cycle coincides, in the females, with the exhaustion of their liver reserves.

The seasonal evolution of the condition coefficient (K) revealed significant variations in both sexes, indicating that this coefficient is affected by the maturation of genital products. This is the case for this species of fish in the Mellah lagoon (Chaoui et al., 2006).

Knowledge of the size at first sexual maturity in fishes is essential to determine the minimum size of catch with a view to rational stock management. In *S. aurata* of the Bardawil lagoon (Egypt), Salem (2011) reported that the first sexual maturity is reached at the size of 20.5 cm for males and 22.8 cm for females. Hadj-Taieb et al. (2013) find in the Gulf of Gabes (Tunisia) a Lm50 of 17.6 cm for the males and 18.8 cm for the females. In our study, sizes of first sexual maturity are estimated to be between18.3 and 19.6 cm respectively for males and females. However, males reach sexual maturity faster than females. This would be due to the protandrous hermaphroditism observed in most sparids (Chaoui et al., 2006; Benchalel, 2010; Lechekhab et al., 2010; Hadj-Taieb et al., 2013; Boufersaoui & Harchouche, 2015).

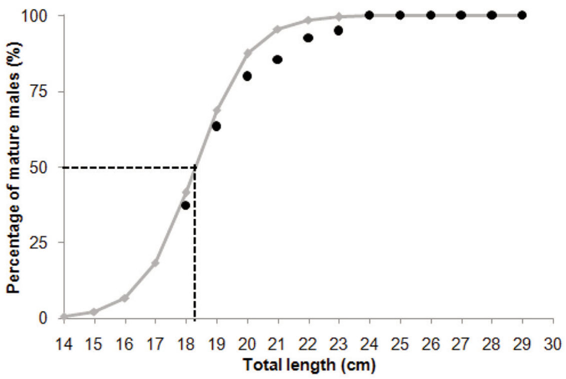

Figure 6. Size at first sexual maturity in males of *Spaurus aurata* from the Gulf of Skikda (Algeria).

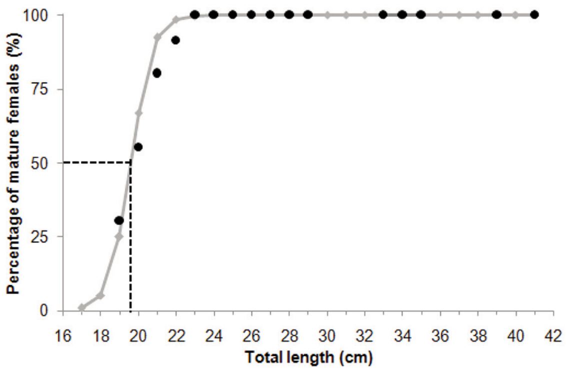

Figure 7. Size at first sexual maturity in females of *Spaurus aurata* from the Gulf of Skikda (Algeria).

In conclusion, *S. aurata* of the Gulf of Skikda spawns eggs in the winter. The warming of surface water can affect the spawning period in many marine species, including subtropical species (Boufersaoui & Harchouche, 2015). Spawning is triggered by lower water temperatures. The restriction of industrial fishing ranges from May to August according to Algerian legislation, the coastal artisanal fleet continues to target individuals during the same period. It could be recommended to limit catches of small trades in this season; fisheries management should together leave sufficient numbers of juveniles to reach sexual maturity but also preserve a substantial contribution of older females to reproduction.

ACKNOWLEDGMENTS

The authors would like to thank their colleague Messeded Moustafa for providing precious help to translate this manuscript and they are grateful to the staff of National Research and Development of Fisheries and Aquaculture Centre for their generous assistance in the field work.

REFERENCES

Almuly R., Poleg-Danin Y., Gorshkov S., Gorshkova G., Rapoport B., Soller M., Kashi Y. & Funkenstein B., 2005. Characterization of the 5’ flanking region of the growth hormone gene of the marine teleost, gilthead sea bream S*parus aurata*: analysis of a polymorphic microsatellite in the proximal promoter. Fisheries Science, 71: 479–490.

Anonymous, 1998. Campagne internationale de chalutage démersal en Méditerranée (MEDITS): manuel des protocoles. Biologia Marina Mediterranea, 5: 515–572.

Ben Slama S., Menif D., Fehri-Bedoui R. & Ben Hassine O.K., 2010. Cycle de reproduction de *Symphodus* (*Crenilabrus*) *tinca* sur les côtes nord-est de la Tunisie. Cybium, 34: 387–395.

Benchalel W., 2010. Biologie et dynamique du sar commun *Diplodus sargus sargus* (Linnaeus, 1758) des côtes de l’est algérien. Thèse de doctorat, Université de Badji Mokhtar, Annaba, 218 pp.

Boufersaoui S. & Harchouche K., 2015. Dynamique de la reproduction et fécondité de *Pagellus acarne* (Sparidae) de la région Centre du littoral algérien. Cybium, 39: 59–69.

Chaoui L., Gagnaire P.A., Guinand B., Quignard J.P., Tsigenopoulos C., Kara M.H. & Bonhomme F., 2012. Microsatellite length variation in candidate genes correlates with habitat in the gilthead sea bream *Sparus aurata*. Molecular Ecology, 21: 5497–5511.

Chaoui L., Kara M.H. & Quignard J.P., 2005. Alimentation et condition de la dorade *Sparus aurata* (Teleostei: Sparidae) dans la lagune du Mellah (Algérie Nord-Est). Cahiers de Biologie Marine, 46: 221–226.

Chaoui L., Kara M.H., Faure E. & Quignard J.P., 2006. Growth and reproduction of the gilthead seabream *Sparus aurata* in Mellah lagoon (north-eastern Algeria). Scientia Marina, 70: 545–552.

Chaoui L., Kara M.H., Quignard J.P., Faure E. & Bonhomme F., 2009. Strong genetic differentiation of the gilthead sea bream *Sparus aurata* (L., 1758) between the two western banks of the Mediterranean. Comptes Rendus Biologies, 332: 329–335.

Ferrari I. & Chieregato A.R., 1981. Feeding habits of juvenile stages of *Sparus auratus* L., *Dicentrarchus labrax* L. and *Mugilidae* in a brackish embayment of the Po River delta. Aquaculture, 25: 243–257.

Hadj-Taieb A., Ghorbel M., Hadj-Hamida N. B. & Jarboui O., 2013. Sex ratio, reproduction, and growth of the gilthead sea bream, *Sparus aurata* (Pisces: Sparidae), in the Gulf of Gabes, Tunisia. Ciencias Marinas, 39: 101–112.

Lasserre G. & Labourg P.J., 1974. Comparison of growth of *Sparus aurata* in regions of Arcachon and Sete. Vie et Milieu, 24: 357–363.

Lasserre G., 1976. Dynamique des populations ichthyologiques lagunaires, application à *Sparus aurata* L.. Thèse de doctorat, Université des Sciences et Techniques du Languedoc, France, 299 pp.

Lechekhab S., Lechekhab H. & Djebar A.B., 2010. Évolution des gonades hermaphrodites lors du cycle sexuel de *Pagellus bogaraveo* (Sparidae) du golfe d'Annaba, côtes Est d'Algérie. Cybium, 34: 167–174.

Magoulas A., Sophronides K., Patarnello T., Hatzilaris E. & Zouros E, 1995. Mitochondrial DNA variation in an experimental stock of gilthead sea bream (*Sparus aurata*). Molecular Marine Biology and Biotechnology, 4: 110–116.

Mehanna S.F., 2007. A preliminary assessment and management of gilthead bream *Sparus aurata* in the Port Said fishery, the Southeastern Mediterranean, Egypt. Turkish Journal of Fisheries and Aquatic Sciences, 7: 123–130.

Mezedjri L., Kerfouf A. & Tahar A., 2013. Reproductive cycle of the European anchovy *Engraulis encrasicolus* (Linnaeus, 1758) (Clupeiformes Engraulidae) in the gulf of Skikda (Algerian East coasts). Biodiversity Journal, 4: 269–274.

Mosconi P. & Chauvet C., 1990.Variabilité spatio-temporelles de la croissance des juvéniles de *Sparus aurata* entre les zones lagunaires et marines du Golfe du Lion. Vie et milieu, 40: 305–311.

Parati K., Chavanne H., Pozzi A., Previtali C., Cenadelli S. & Bongioni G., 2011. Isolation and characterization of novel microsatellite DNA markers in the gilthead seabream (*Sparus aurata*). Conservation Genetics Resources, 3: 83–85.

Pita C., Gamito S. & Erzini K., 2002. Feeding habits of the gilthead seabream (*Sparus aurata*) from the Ria Formosa (southern Portugal) as compared to the black seabream (*Spondyliosoma cantharus*) and the annular seabream (*Diplodus annularis*). Journal of Applied Ichthyology, 18: 81–86.

Rosecchi E., 1985. L'alimentation de *Diplodus annularis*, *Diplodus sargus*, *Diplodus vulgaris* et *Sparus aurata* (Pisces, Sparidae) dans le golfe du Lion et les lagunes littorales. Revue des Travaux de l'Institut des Pêches maritimes, 49: 125–141.

Rossi A.R., Perrone E. & Sola L., 2006. Genetic structure of gilthead seabream, *Sparus aurata*, in the Central Mediterranean Sea. Central European Journal of Biology, 1: 636–647.

Salem M.A., 2011. Population dynamics and fisheries management of Gilthead sea bream, *Sparus aurata* (f. Sparidae) from Bardawil lagoon, North Sinai, Egypt. Egyptian Journal of Aquatic Biology and Fisheries, 15: 57–69.

Stergiou K.I. & Karpouzi V.S., 2002. Feeding habits and trophic levels of Mediterranean fish. Reviews in Fish Biology and Fisheries, 11: 217-254.

Suau P. & López J., 1976. Contribución al estudio de la dorada, *Sparus aurata*. Investigacion Pesquera, 40: 169–199.

Wassef E.A. & Eisawy A., 1985. Food and feeding habit, of wild and reared gilthead bream *Sparus aurata* (L.). Cybium, 9: 233–242.

Zouakh D.E., Chebel F., Bouaziz A. & Kara M.H., 2016. Reproduction, age and growth of *Tilapia zillii* (Cichlidae) in Oued Righ wetland (southeast Algeria). Cybium, 40: 235–243.