

Research Article

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# Determination of Reproductive Period and Sex Inversion *Pagellus bogaraveo* (Sparidae) in Syrian Marine Waters



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## Abstract

This study was carried out on /306/ individual fish of *Pagellus bogaraveo*, which were caught from the Syrian marine waters, with the various fishing methods used locally at a depth of up to 300 m, from May 2020 to May 2021 to identify of evolution stages of maturation sexual (morphological and Histological), and determine the period and the peak of sexual maturity. The results showed that fish species *P. bogaraveo* begin to reach sexual maturity from the beginning of February and extend until May, with a single peak of sexual maturity in March, where the highest average value of the gonado-somatic index (GSI%) was  $(2.45 \pm 0.43)$  % for the males and  $(3.46 \pm 0.33)$  % for female. The results of the morphological and histological study of the stages of development of maturity of male and female gonads agreed with the breeding season of this fish species, and some of individuals appeared in the stage of sex inversion of the Protandry type.

**Keywords:** *Pagellus bogaraveo*; Reproductive period; Sex Inversion; Syrian marine waters

## Introduction

*Pagellus bogaraveo* (Brünnich, 1768) belongs to the economically important Sparidae family. It is one of the migratory species from the Atlantic Ocean [1-8] and was recorded for the first time in February 2019 in the Syrian marine waters [9].

The blackspot seabream (*P. bogaraveo*) is an important in the commercial fisheries of the Eastern Mediterranean. Specifically, in the Eastern Ionian and Aegean Sea it is fished by both recreational and commercial fisheries [10]. A study assessing the response of marine populations exploiting the Strait of Gibraltar indicates that there is growing concern about the decline of fisheries and potential deterioration due to climate change [11].

It was found that few works have been published on the reproductive biology [12,13] and length-weight relationship of *P. bogaraveo* in the Mediterranean Sea [5,14,15]. In addition to a recent study on Some Aspects of the biology of *P. bogaraveo* in Umm al-Rizam Coast, Eastern Libya [16].

Later, it became present in large quantities in commercial catches throughout the year, this is evidence that this the western

part of the Mediterranean to the far eastern part of it this species have started to establish a population and its threat to local fish stocks and its competition for food and habitat. Therefore, it was necessary to conduct a biological study to determine the reproductive period for this species, because no detailed study has been conducted on the reproductive biology of this species in its original habitat. Hence the importance of this study regarding this species migrating to Syrian marine waters.

## Material and Methods

Specimens of *P. bogaraveo* were caught from the Syrian marine waters (Raas Al-Bassit, Lattakia, Jableh, and Tartus) (Figure 1), with the various fishing methods used locally (gill nets, trawl nets) at a depth of up to 300 m, from May 2020 to May 2021.

A total of 306 individuals were sampled. For each fish, total length (TL) and standard length (SL) were measured to the nearest mm, and total body weight (TW), eviscerated body weight (EW), and gonad weight (GW) were weighed to the nearest 0.01 g. Spawning period was determined by measuring monthly changes in gonado-somatic indices, gonad weight and maturity

stage fluctuations. (GSI) was calculated by expressing gonad weight (Gw) as a percentage of total body weight (Tw):  $Gw \times 100 / Tw$  [17]. In order to confirm the assignment of the macroscopic

maturity stage, a histological analysis was requested. After the photo of the fresh gonad was taken, a piece of its central part of the fresh gonad was stored according to different protocols.

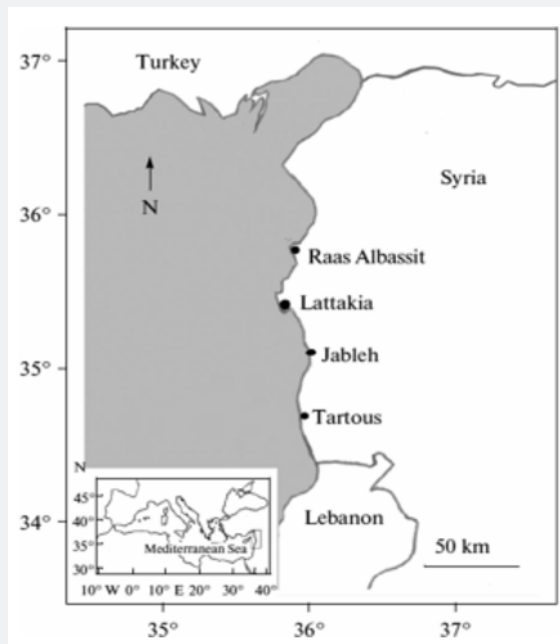


Figure 1: Sites of sampling area.

For the histological maturity staging of ovaries and testes, the applied technique is described in [18]:

- a) Fixate in 10 percent buffered formalin solution.
- b) Dehydrate in graded alcohols.
- c) Embed in paraffin.
- d) Cut into 5  $\mu\text{m}$  transverse sections.
- e) Stain with haematoxylin/eosin (H and E).

f) Observe under a light microscope equipped with a Canon EOS at different magnifications (40x, 100x, 400x).

Fish having only male or female gonads were determined to be male or female, and fish having both gonads (gonotestis) were determined to be hermaphrodites, and the stages of sexual maturity were classified based on the gonadal development criteria described by [19], then modified to include immature stages I and II, mature stages III and IV, ripe and spawning stages V, VI.

Table 1: Characteristic features of different maturity stages of gonads as found in *Pagellus bogaraveo*.

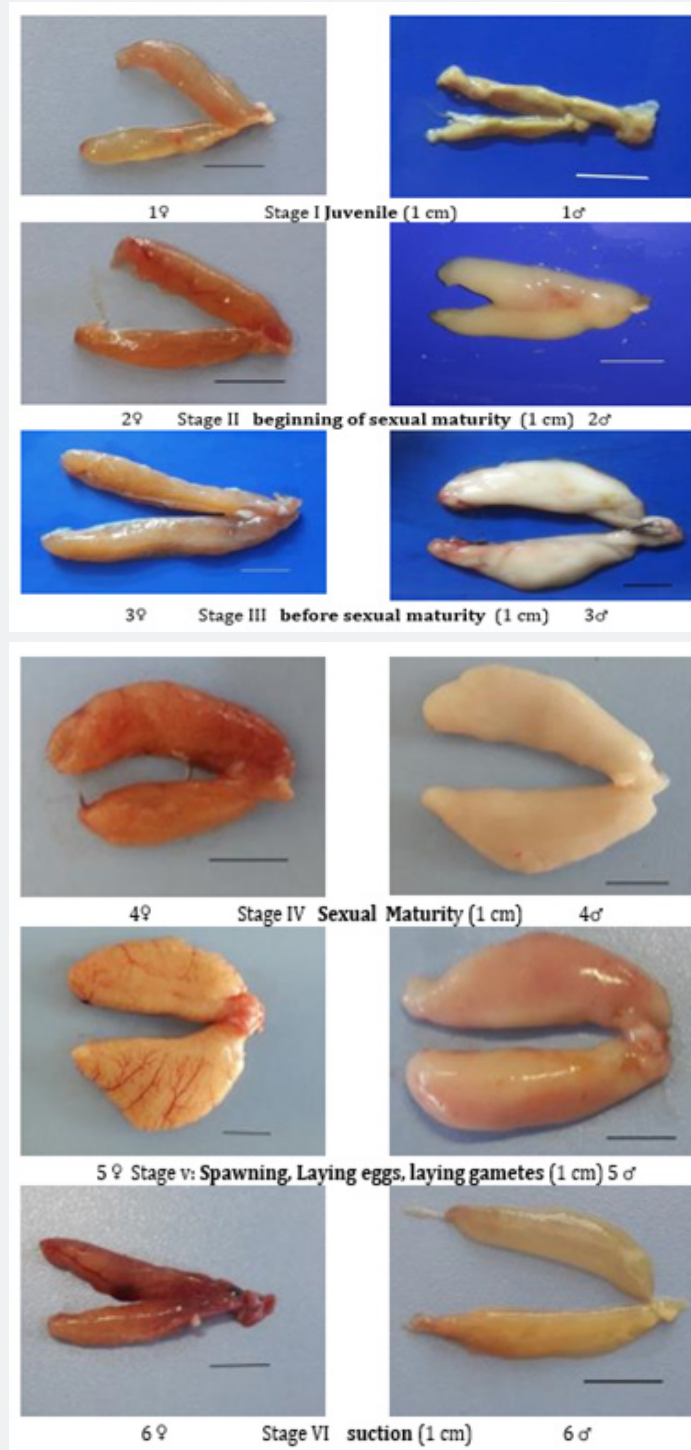
Stage	Female (♀)	Male (♂)
Juvenile	Pinkish, occupying 1/4 <sup>th</sup> to 1/2 body cavity; ova irregular and transparent.	Whitish, ribbon- shaped, occupying 1/2 body cavity
beginning of sexual maturity	Yellowish, occupying 1/2 to 2/3 <sup>rd</sup> body cavity; ova round and completely filled with yolk.	Whitish, occupying 2/3 body cavity
before sexual maturity	Yellowish, occupying 2/3 <sup>rd</sup> to 3/4 body cavity; ova round and completely filled with yolk.	Whitish, occupying 2/3 <sup>rd</sup> to 3/4 body cavity
Sexual Maturity	Yellowish, occupying nearly entire body with some ova visible outside; yolk vacuolated; perivitelline space present.	Creamy white, occupying the entire body cavity
Spawning, laying eggs, laying gametes	In the oozing stage	In the oozing stage
Suction	Flaccid, with blood vessels prominent all over surface - occupying not more than 1/2 body cavity	Flaccid, occupying about 1/2 body cavity.

**Results and Discussion**

**Maturity stages**

Based on the macroscopic observations of the gonads and

their maturity degree, the gonads were classified into Sex stages according to [19], (Table 1), (Figure 2):



**Figure 2:** Evolution of gonad morphology during the reproductive cycle of *Pagellus bogaraveo* in the Syrian marine waters.

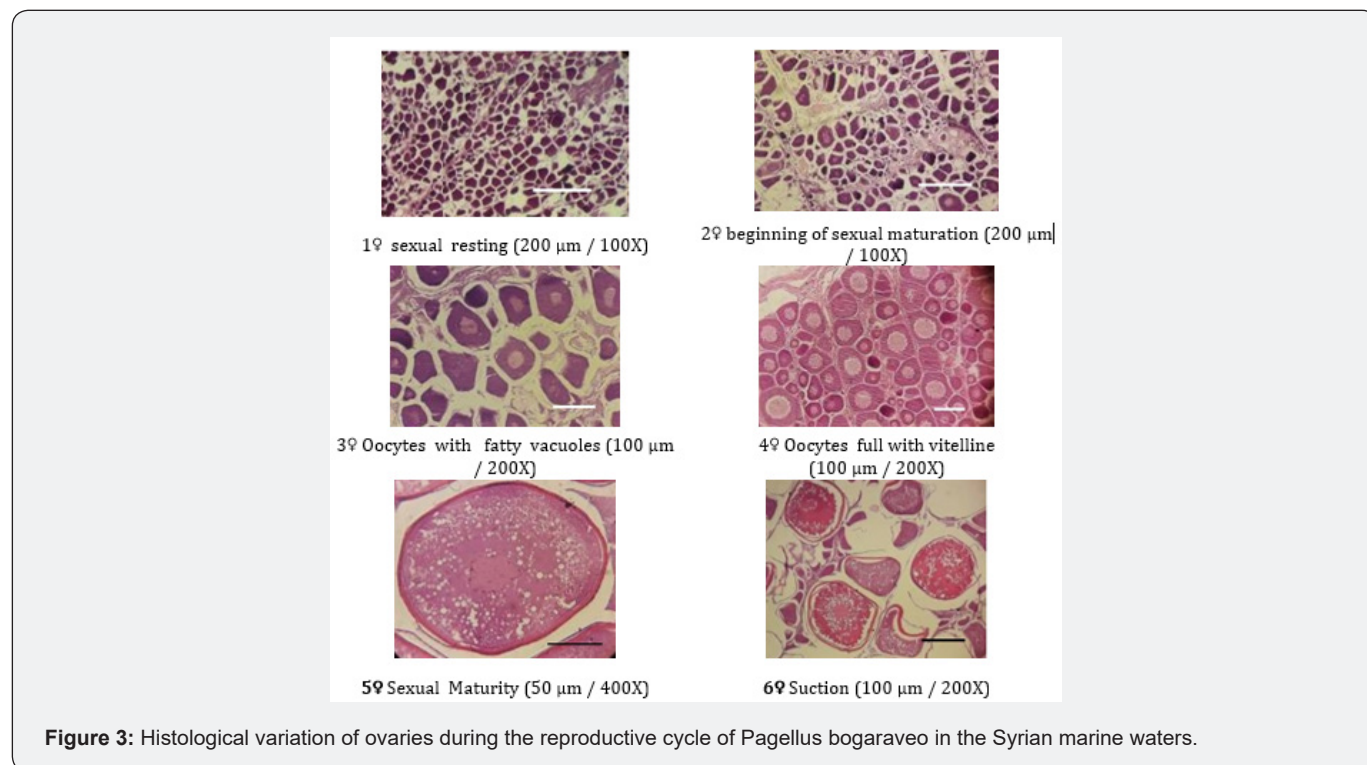
Different stages in the histological evolution of Ovary and Testis in *Pagellus bogaraveo*: (Tables 2 & 3) (Figures 3 & 4).

**Table 2:** Histological description of microscopic ovarian phases of the gonads of *Pagellus bogaraveo*.

Stage	Histological
Sexual Resting	Small ovarian cavity, chromatin- nucleolus stage and perinucleolar oocytes Some oocytes (but scarce) at lipid globule stage during the entire year
Beginning of sexual Maturation	Numerous primary oocytes, together with secondary oocytes
Oocytes with Fatty Vacuoles	Oocytes at all stages of developing, including batches of secondary vitellogenic oocytes at Yolk granule stage 1, 2 and 3. Very few, mainly of advanced vitellogenic oocytes (VO).
Oocytes full with Vitelline	Oocytes at final maturation). Oocytes in all stages development. Few (or none) O. A large population of oocytes remains in the PG phase. Ovarian cavity increases in size as spawning proceeds.
Sexual Maturity	Wide ovarian cavity. Vascularized, empty and irregular ovigerous lamellae, together with residual healthy, yolked oocytes. A large population of primary oocytes present at the periphery of the ovigerous folds
Suction	Wide ovarian cavity and thick ovarian wall. Primary oocytes numerous. No vitellogenic oocytes. Abundant stroma in the inner of bloodshot ovigerous folds. No vitellogenic oocytes

**Table 3:** Histological description of microscopic Testes phases of the gonads of *P. bogaraveo*.

Stage	Histological
Spermatogonie	Very mall gonads with well-developed tubules. Abundant spermatogonia. Spermatogenic activity during all year, more intense in the reproductive season. Spermatozoa are present in the lumen of tubules and vas deferens during the reproductive season.
Spermatocytes I	Spermatogenic activity is generalized in testes, with abundant spermatocytes. Spermatozoa can be observed in tubules but not in all of them
Spermatocytes II	Intense spermatogenic activity. Abundant spermatids. Spermatozoa are present in the tubules but do not fill all the lumen.
Spermatides	Intense spermatogenic activity Dilated tubules and vas deferens fully filled with spermatozoa
Laying gametes	No spermatogenic activity or very limited. Tubules and vas deferens continue full of residual spermatozoa.
Suction	Wall of spermatogenic tubules is full of spermatogonia. Residual spermatogenic activity and scattered residual spermatozoa are still present in the tubule and vas deferens Abundant storm in the testes.



**Figure 3:** Histological variation of ovaries during the reproductive cycle of *Pagellus bogaraveo* in the Syrian marine waters.



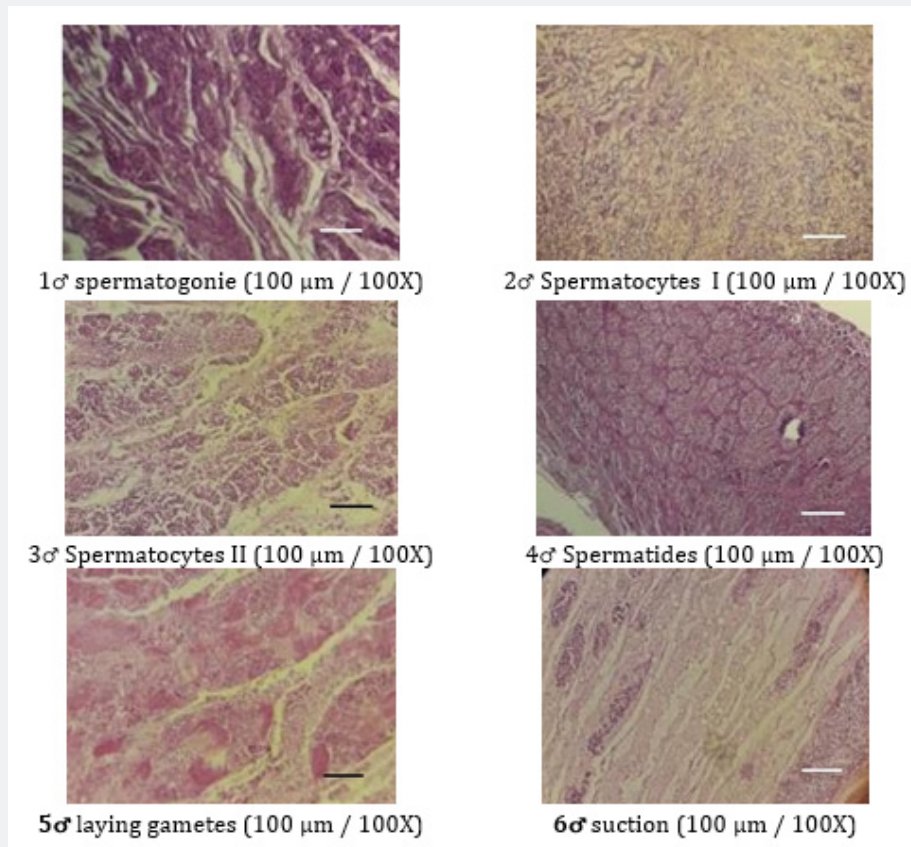


Figure 4: Histological variation of testis during the reproductive cycle of *Pagellus bogaraveo* in the Syrian marine waters.

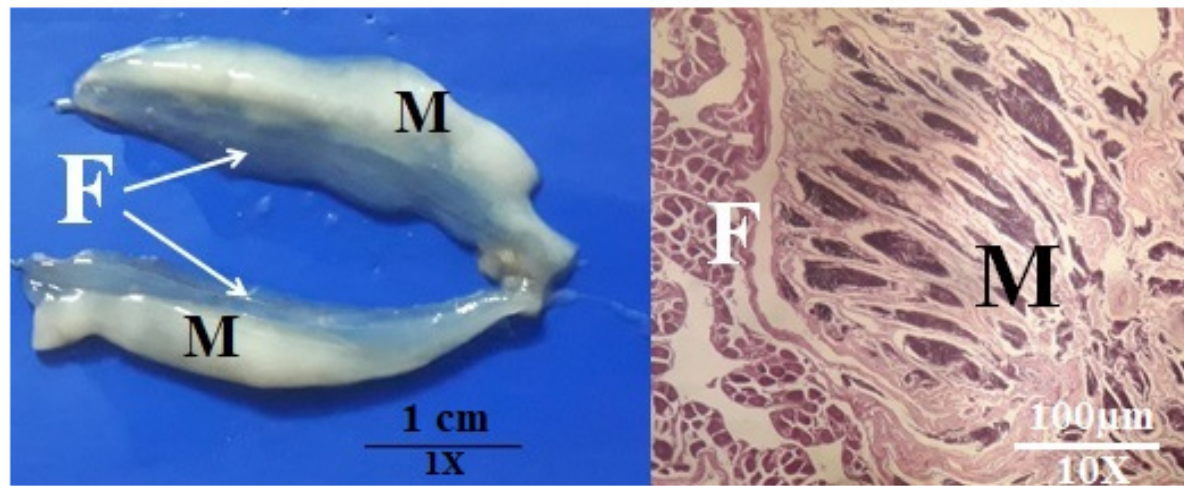


Figure 5: Protandry hermaphroditic gonads of *P. bogaraveo*. M: male, F: female.

### Sex Inversion

The individuals of this species are characterized by the phenomenon of sex reversal. The results of the morphological

and histological study of the gonads showed the presence of individuals possessing gonads in a state of sex reversal from male to female, where the decline of the male tissue appeared clearly at the expense of the dominance of the female tissue (Figure 5).

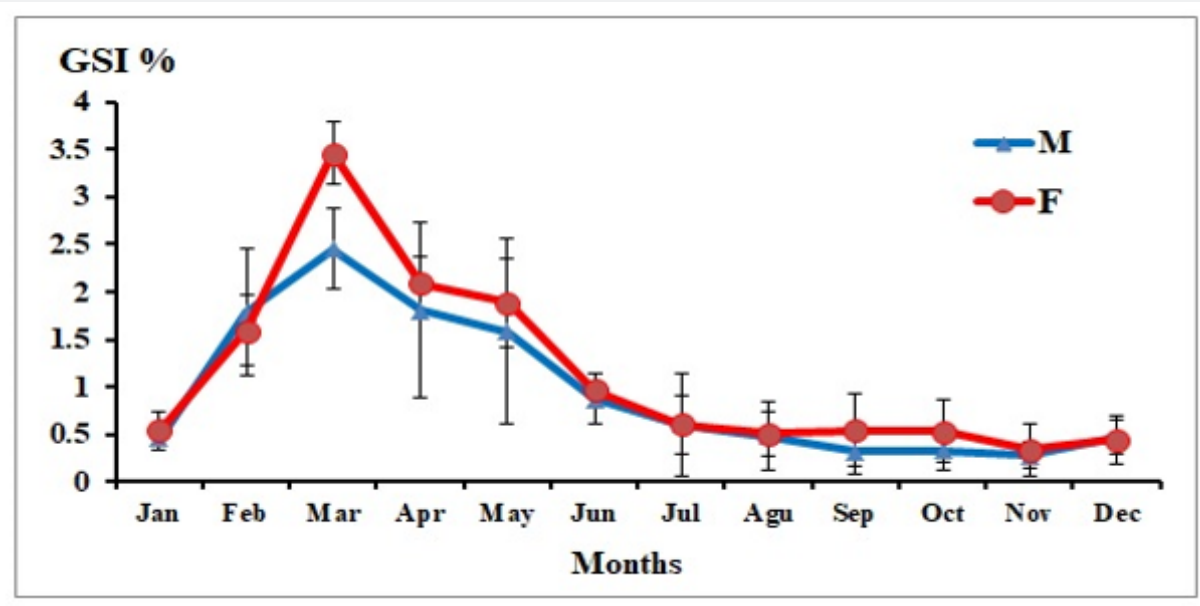


Figure 6: Monthly variations of Gonado-somatic index GSI (%).

Protandrous hermaphroditism appeared to be the prevalent sexual pattern in *P. bogaraveo*, it develops as male, but can later reproduce as female although a fraction of the population never changes sex [10], although a high incidence of gonochorism occurred, as in the wild [1] and cultured [20].

### Spawning period

This study showed that the *P. bogaraveo* had one spawning season that extends from February to June with a clear peak in March for both females and males, (Figure 6), where the peaks of GSI% coincided with the spawning period as determined by the study of maturity stages.

The spawning period in Syrian marine waters extends from March to June (spring season). These results were similar to other studies [20].

### Conclusion

The study concluded by determining the peak maturity of males and females in March, and this corresponds to the stages of development of maturation of the male and female gonads. Our study also indicated the identification of the type of sex inversion (Protandry type) in *P. bogaraveo*, especially since it is the first biological study of this fish species.

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