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Reproductive Biology of the Spotted Sea bass, *Dicentrarchus punctatus*, in Bardawil Lagoon, North Sinai, Egypt

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ABSTRACT

Fish populations in their natural habitats depend on the spawning and recruitment of fingerlings, two processes that are critical to the survival of fish populations. Reproduction is one of the most significant part of fish biology. To offer a biological foundation for managing the spotted sea bass (*Dicentrarchus punctatus*) fishery in Bardawil Lagoon, North Sinai, Egypt, this study aimed to explore the reproductive biology of this species. Monthly specimens of the spotted sea bass (n= 2050) were obtained from the commercial catch from selected landing sites of the Bardawil Lagoon during January 2020 to December 2021. The fish sex ratio recorded 1 male: 1.587 females and 1 male: 1.584 females during 2020 and 2021 fishing seasons, respectively. A stability of sex ratio was noticed, whereas the female ratio was 61.3% and male ratio was 38.7% during both 2020 and 2021 fishing seasons. Gonadosomatic index (GSI) increased progressively from September to February; the highest values were recorded in December at 6.76 and 8.17 for females and 4.46 and 5.59 for males during the two fishing seasons 2020 and 2021, respectively. Thus, the spawning season for the spotted sea bass is between November and February. The length at the first maturity was estimated at an average length of 21.6cm for both sexes. Fecundity was estimated for 78 ripe ovaries ranging between 29475 (15cm in total length and 38.3g in weight) and 621440 eggs (34.7cm in total length and 368.4g in weight). Based on ovarian histological examination, December is the period of maturation. To prevent overfishing and enable female spotted sea bass (*D. punctatus*) to reproduce, grow, and recruit into the fishery, we suggested permitting the use of mesh sizes larger than those used at Bardawil Lagoon.

INTRODUCTION

Within Bardawil Lagoon, the sea basses, locally referred to as Karous and Nokt, dominate among the demersal fish species *Dicentrarchus labrax* and *D. punctatus*. Research on the reproductive biology of fish is crucial for examining key life-history data and determining how environmental variability affects fish population dynamics

(Schlosser, 1990). According to **Muchlisin (2014)**, reproductive biology knowledge is highly helpful in choosing potential wild fish targets for fish species diversification in aquaculture. It is crucial to research reproductive behaviors in order to understand fish population dynamics and spawning seasons. According to **Tsikliras *et al.* (2010)**, information on spawning, maturity, and fecundity, along with understanding the spawning time, could be extremely helpful for fisheries management.

Planning improved maintenance and management techniques for fishing resources requires a thorough understanding of the reproductive biology of fish, as demonstrated by studies conducted by **Brewer *et al.* (2008)**, **Grandcourt *et al.* (2009)**, and **Muchlisin *et al.* (2010)**. The spotted sea bass reproduces in Egypt from November to February, with December showing the highest activity. Hepatocytes produce vitellogenin and zona radiata proteins during gonadal maturation, which are then delivered to the ovaries via the circulation through receptor-mediated pinocytosis **(Arukwe & Goksøyr, 2003)**. The tunica albuginea coats the fish ovaries and releases septa into the organ, creating ovigerous lamellae where oocytes grow **(Rizzo & Bazzoli, 2020)**.

An essential tool for analyzing the biological data on exploited species and ecosystems is a biological research. Many researchers have examined biological factors in Bardawil Lagoon, including age, growth, reproductive analysis, food and feeding in addition to death **(Salem *et al.*, 2010; Mosabh, 2013; Alaa, 2016; Merezek, 2021; Abd Elnabi *et al.*, 2022).** Studies on the spotted sea bass (*D. punctatus*) in Bardawil Lagoon are scarce. There has never been any research done on the reproductive biology of spotted sea bass in the Mediterranean Sea or Bardawil Lagoon. The aim of this study was to provide an insight into the reproductive biology of spotted sea bass to better manage fisheries for this species in Bardawil Lagoon.

MATERIALS AND METHODS

The study area

D. punctatus specimens were collected from Bardawil Lagoon to examine their reproductive biology. Bardawil Lagoon (Fig. 1) is a shallow, hyper saline lagoon, located in the northern part of Sinai Peninsula and the southern east side of the Mediterranean Sea. Its coordinates are 31°02'54.9"N 32°40'05.1"E to the West, 31°07'26.3"N 33°29'18.7"E to the East, 31°13'43.3"N 33°09'04.6"E to the North, and 31°02'18.6"N 33°08'37.0"E to the South. It extends for about 85,200 meters from west to east and 21,100 meters from north to south, and it has a maximum depth of about 3 meters **(El-Menhawey *et al.*, 2021)**.

Seasonal water quality

Seasonal water quality at the study area was determined during seasons 2020 and 2021. Water temperature and dissolved oxygen (mg l^{-1}) were measured by dissolved oxygen meter MD21820 USA Washington Ave. Water salinity (ppt) was measured by TDSmeter Box329. Chesterton. 21620. Lamotte. pH was measured using Box329.

Chesterton. LOT 04812 Maryland. These values were 15 to 30ºC; 5 to 5.6mg l^{-1}; 48 to 51ppt, and 7 to 8, respectively, during the study seasons.

The study samples

Monthly specimens of spotted sea bass *D. punctatus* were collected from the commercial catch from selected landing sites of Bardawil Lagoon during the fishing seasons from January 2020 to December 2021. In the laboratory, total fish length and total fish weight were taken for 1014 and 1036 fish during seasons of 2020 and 2021, respectively. To determine their maturity stages and sex, fish samples were dissected. The ovaries were kept in a solution of 10% formalin for further examination, and the gonads were measured to the exact 0.01g.

Reproductive indices

The morphological alternation occurring in the gonads throughout maturity development provided the basis for the adoption of maturity phases (**Nikolsky, 1963).**

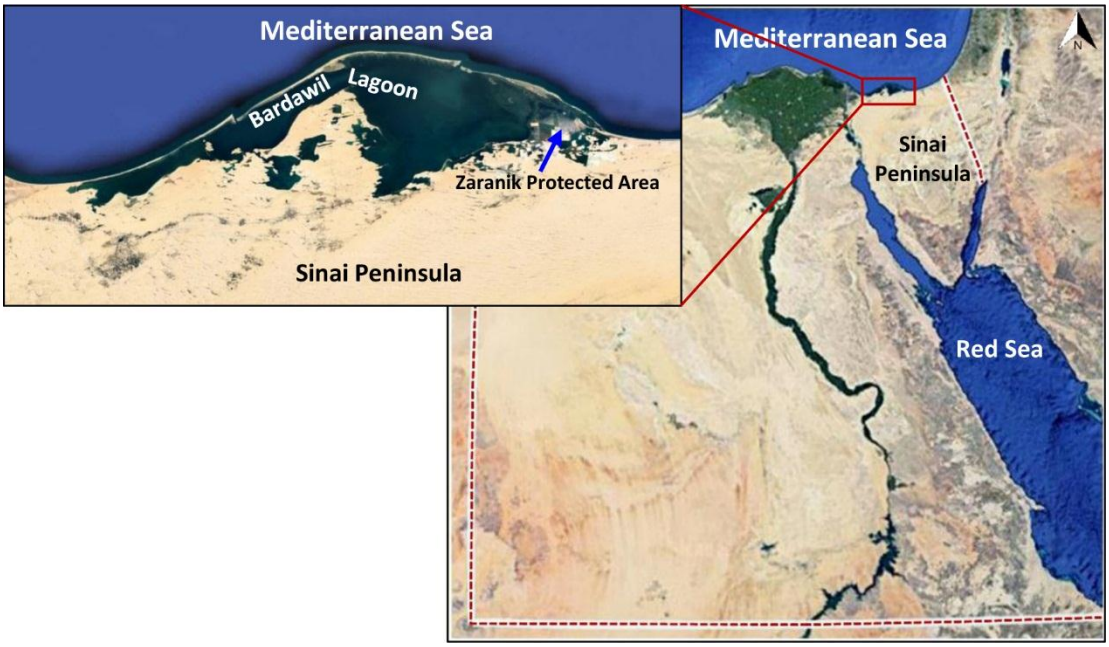

Fig. 1. Map of Egypt (right) showing Bardawil Lagoon study area (left)

Gonadosomatic index (GSI)

Following the methods of **Albertine-Berhaut** (**1973**), gonadosomatic index (GSI) was calculated using the following equation: $GSI = \left({}^{GW}/_{BW}\right) \times 100$, where GW is gonad weight, and BW is body weight.

Length at the first sexual maturity (L_m)

Plotting the total body length against the frequency percentage of mature individuals during the spawning season allowed for the determination of the length at first maturity (L_m), with the length at 50% being considered the first maturity **(Sendecor, 1956).**

Fecundity

Fish fecundity was assessed using seventy-eight mature ovaries. Ovaries were cleaned, dried and weighed. After removing the ovarian tissue, the weight of the net eggs was determined. Three subsamples were weighed and counted after the eggs were well mixed. Total fecundity was calculated as:

$$F = \text{Gonad weight} \times \text{Egg number in the subsample} / \text{weight of subsample}$$

According to the methods of **Yeldan and Avsar (2000)**, the relative fecundity (F_{rel}) was calculated as:

$$F_{rel} = F_{abs} / \text{body length in cm or body weight in grams}$$

Histological investigation

An automated tissue processor was used to process the fish ovaries after keeping them in formalin during November, December 2020 and January 2021. The first two steps of the process were fixation and dehydration. The tissue was fixed by soaking it in a solution of 10% formalin for 48 hours. After that, distilled water was used to remove the fixative for 30 minutes. The tissues were then subjected to a graduated series of ethyl alcohol (70%, 90%, and 100%) to dehydrate them. Initially, the tissue was subjected to 70% ethyl alcohol for 120 minutes. Then, it was treated with 90% ethyl alcohol for 90 minutes. Finally, it underwent two cycles of 100% pure ethyl alcohol, each lasting an hour. The samples were then cleared in numerous changes of xylene after dehydration. The procedure involved immersing tissue for an hour in a combination of 50% alcohol and 50% xylene, then for 1.5 hours in pure xylene. Afterward, samples were imbedded and blocked out after being impregnated with melted paraffin wax. Hematoxylin and eosin staining was applied to paraffin sections (4–5 µm) for histological features **(Suvarna *et al*., 2012; Bancroft & Gamble, 2013)**. Ten microscopic fields of five slides, each containing sections derived from five distinct fish within each group, were examined.

The statistical analysis of mean values of GSI and correlation between absolute fecundity and weight or length was measured using SPSS program version 25. Other data were analyzed via Microsoft Excel Spreadsheet Software program 2016.

RESULTS

1. Sex ratio

Two thousand and fifty samples of spotted sea bass were collected during the study period. They varied in weight from 10.7 to 363.4g and in length from 10.5 to 34.4cm. Figs. (2, 3) show the length frequency distribution. The group of 16.9cm is the most prevalent in the catch, with percentages of 13.88, 13.15 and 10.68 % for the groups 15.9, 17.9, and 14.5cm following the order of abundance.

In fishing season of 2020, a total of 1014 specimens were detected, including 392 males and 622 females, with a sex ratio of 1: 1.587. During 2021, the samples' number

was 1036, including 401 males and 635 females, with a sex ratio of 1: 1.584 (Table 1). Table (1) spots light on two sexes that did not distribute in the same proportion during different months. Females prevailed throughout the study period, except for two months; April (1 male: 0.96 female) and September (1 male: 0.90 female) during 2020 fishing season, and September (1 male: 0.97 female) during 2021 fishing season, where the males were dominant. The data presented in Table (1) show the stability of sex ratio in 2020 and 2021 fishing season. Whereas, the ratios were 61.3 and 38.7 % for female and male, respectively.

Table 1. Monthly variation in sex ratio of *D. punctatus* in Bardawil Lagoon during 2020 and 2021 fishing seasons

Month	2020 Fishing season						2021 Fishing season					
	Total	Females	F%	Males	M%	M:F	Total	Females	F%	Males	M%	M:F
January	153	115	75.2	38	24.8	1:3.03	203	109	53.7	94	46.3	1:1.2
February	146	99	67.8	47	32.2	1:2.11	51	34	66.7	17	33.3	1:2.0
March	100	66	66.0	34	34.0	1:1.94	93	58	62.4	35	37.6	1:1.7
April	94	46	48.9	48	51.1	1:0.96	60	43	71.7	17	28.3	1:2.5
May	109	61	56.0	48	44.0	1:1.27	63	44	69.8	19	30.2	1:2.3
June	100	53	53.0	47	47.0	1:1.13	66	47	71.2	19	28.8	1:2.5
July	62	36	58.1	26	41.9	1:1.38	68	39	57.4	29	42.6	1:1.3
August	44	25	56.8	19	43.2	1:1.32	52	30	57.7	22	42.3	1:1.4
September	38	18	47.4	20	52.6	1:0.90	138	68	49.3	70	50.7	1:0.97
October	79	40	50.6	39	49.4	1:1.03	66	47	71.2	19	28.8	1:2.5
November	50	32	64.0	18	36.0	1:1.78	109	70	64.2	39	35.8	1:1.8
December	39	31	79.5	8	20.5	1:3.88	67	46	68.7	21	31.3	1:2.2
	1014	622	61.3	392	38.7		1036	635	61.3	401	38.7	

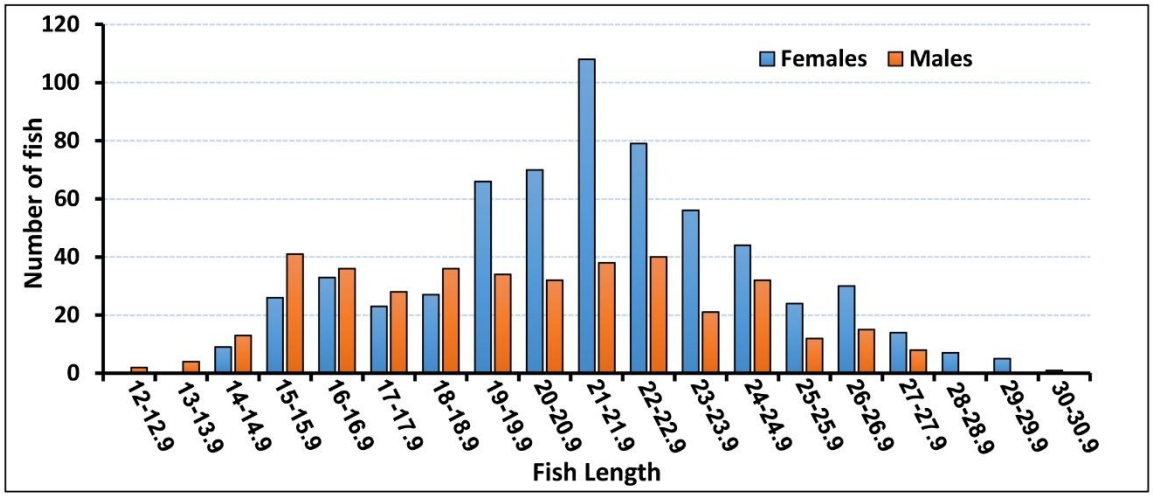

Fig. 2. Sex ratio for various length groups of *D. punctatus* in Bardawil Lagoon during 2020 fishing season.

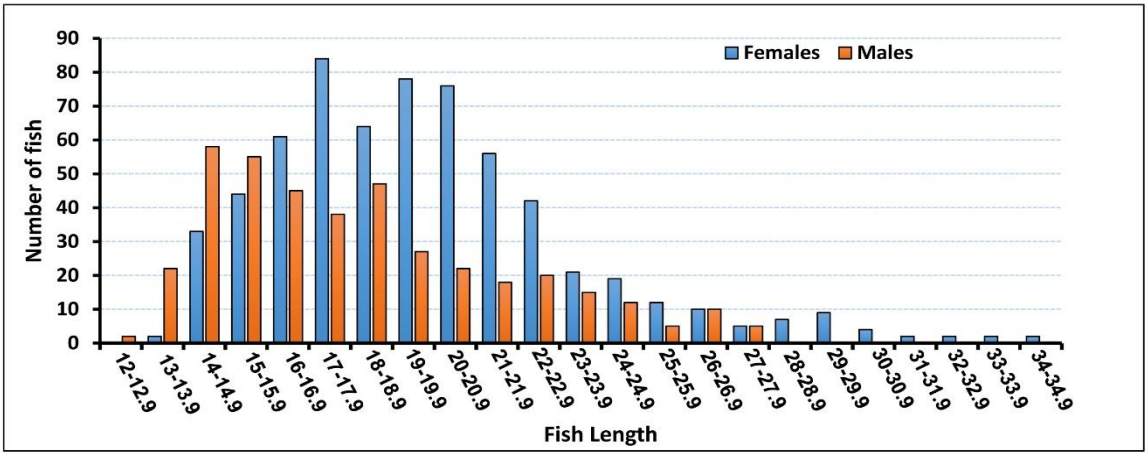

Fig. 3. Sex ratio for various length groups of *D. punctatus* in Bardawil Lagoon during 2021 fishing season

2. Gonadosomatic index (GSI)

Results of gonadosomatic index of the spotted sea bass, *D. punctatus*, are displayed in Fig. (4). In males and females, gonadosomatic indices were progressively increasing beginning from September, and the maximum values were recorded in December. These results indicate that the spawning season for the spotted sea bass , *D. punctatus*, lies between November and February. The highest GSI values were recorded in December with 6.76 for females, and 4.46 for males during 2020 fishing season. In both males and females, the minimum GSI values were recorded in June during the 2020 fishing season (Fig. 4). The highest GSI values were recorded in December (8.17) for females, and values of 5.59 were registered for males during 2021 fishing season. In both males and females, the minimum GSI values were recorded in May, June, and July during 2021 fishing season (Fig. 4).

3. Length at the first sexual maturity (L_m)

In 2020 and 2021, the first sexual maturity of *D. punctatus* at Bardawil Lagoon was identified through gonad examination, which revealed the sex and maturity stage. The length at first maturity was estimated at 21.7cm for both sexes during 2020 fishing season and 21.5cm for both sexes during 2021 fishing season, with an average length of 21.6cm (Fig. 5).

4. Fecundity

Fecundity was estimated for 78 ripe ovaries with ranges between 29475 (15cm in total length and 38.3g in weight) and 621,440 eggs (34.7cm in total length and 368.4g in weight). The relationship between fecundity (absolute and relative) and the body size (total body length and body weight) of *D. punctatus* was calculated. The number of eggs gradually increased with the increase of mean fish length or mean fish weight as 15cm (38.3g) to lay eggs about 29475, reaching a maximum number of about 621,440 eggs for the fish of 34.7cm (368.4g). The relative fecundity gradually increased from 397 to 1934 eggs/g, with an average of 1160 eggs/g. Regarding to the body length, the relative

fecundity gradually increased from 1366 to 18905 eggs/cm, with an average of 7996 eggs/cm. The relation between fecundity and size was shown in Figs. (6, 7). With an increase in overall length, the absolute fecundity was expressed as $F = 0.0407\ L^{4.7313}$ in the power equation $F = a\ L^{b}$.

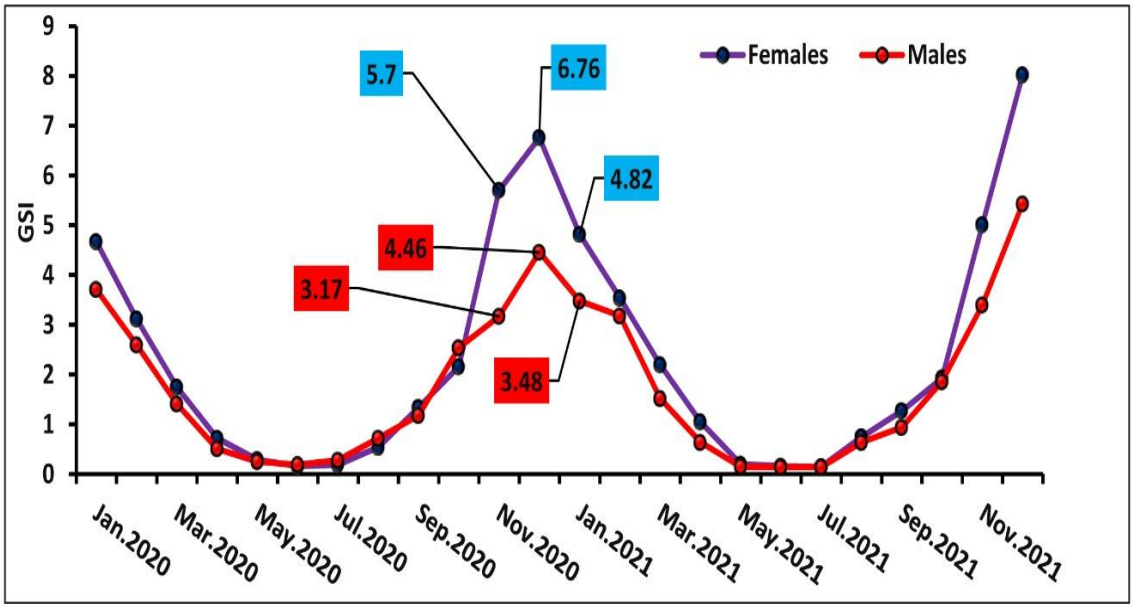

Fig. 4. Monthly average gonadosomatic index of the spotted seabass, *D. punctatus*, during 2020 and 2021 fishing seasons

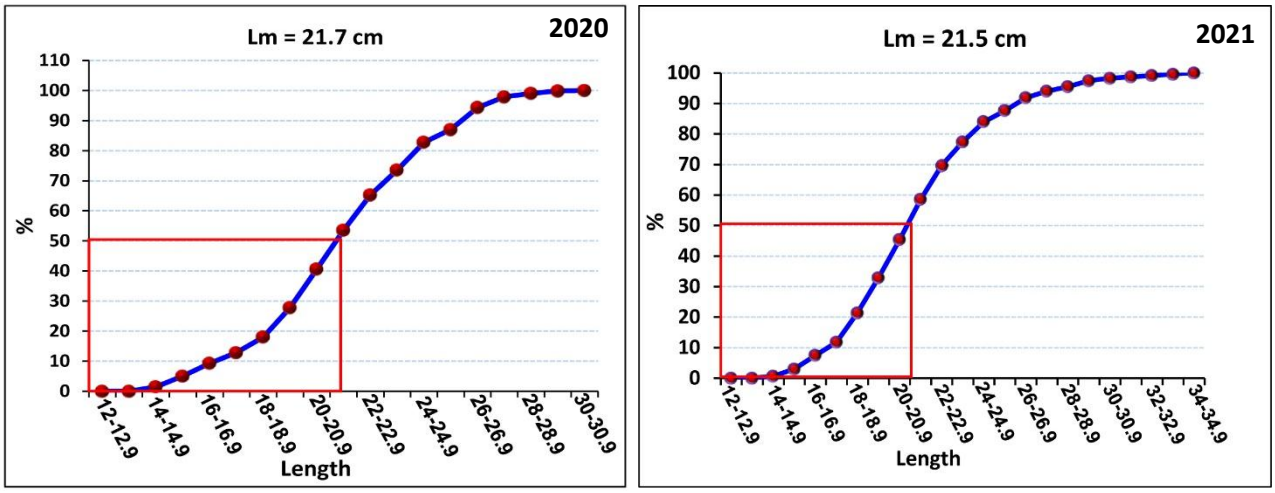

Fig. 5. Length at first maturity (Lm) of both sexes of the spotted seabass, *D. punctatus*, in Bardawil Lagoon during 2020 and 2021 fishing seasons

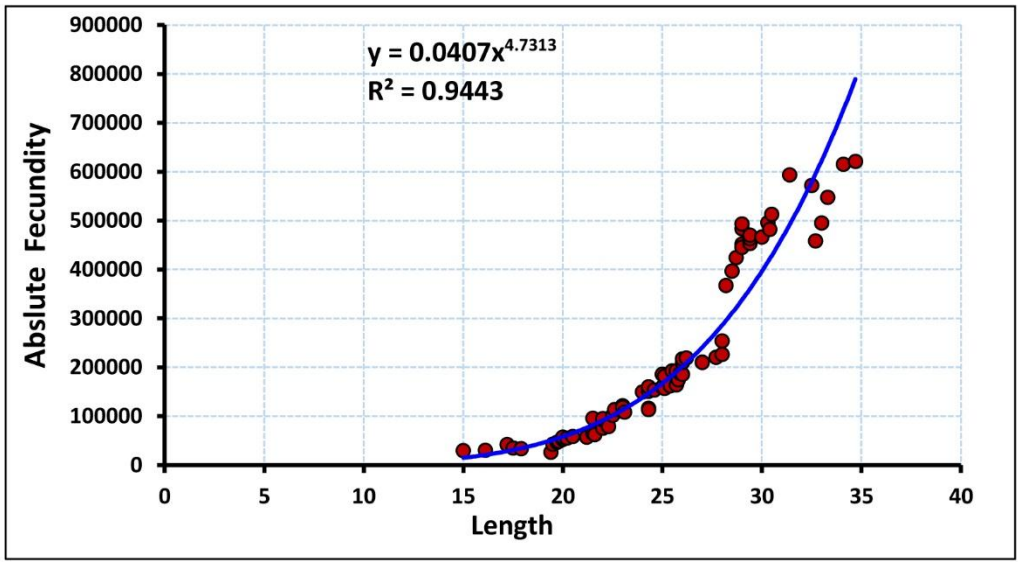

Fig. 6. Total length (cm) and absolute fecundity relationship of *D. punctatus* in Bardawil Lagoon during 2020 and 2021 fishing seasons.

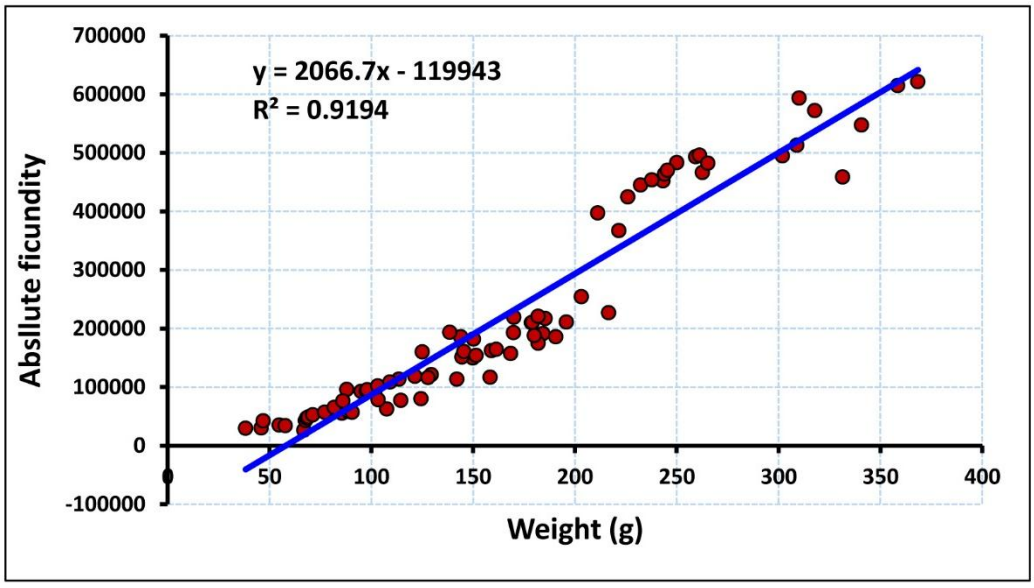

Fig. 7. Body weight (g) and absolute fecundity relationship of the spotted seabass, *D. punctatus*, in Bardawil Lagoon during 2020 and 2021 fishing seasons

5. Histological observation of the ovary

At the pre-mature stage (November 2020), the spotted sea bass ovary seen in Fig. (8) seems to be wrapped in a thin fibro collagen capsule with vascular networks. It is rich in multinucleolar type (PGmn) primary growth oocytes, or oogonia (Oo). Oogonia and oocyte nests at various developmental stages are observed; these are of the primary growth oocyte perinucleolar type (PGpn). The ovary's periphery close to the ovarian

capsule is home to the primary oocyte stage 1 type (POC1). In the center are the primary growing previtellogenic oocyte (POC3) and primary growth oocyte stage 2 (POC2). The latter lacked the zona pellucida and zona radiata, and only had a central germinal vesicle (GV) and a few oil droplets (OD). A portion of these previtellogenic eggs (10–15%) showed signs of incomplete ooplasm and germinal vesicle degradation. Fibroplasia and focal interstitial edoema were also seen. Underneath the foundation membrane and the ooplasm is a follicular epithelium (FE).

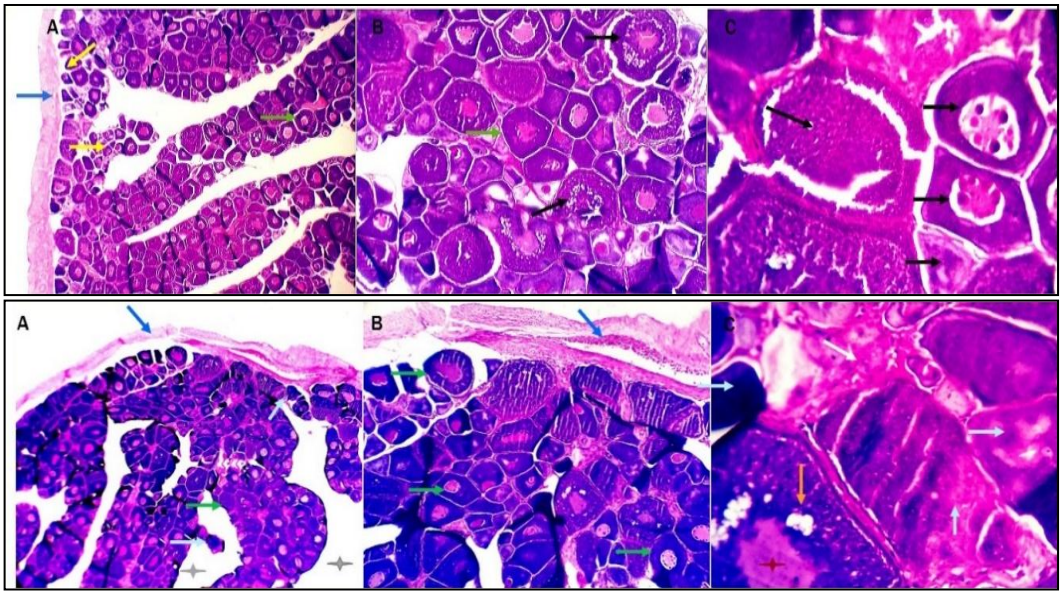

Fig. 8. Photomicrograph of *D. punctatus* ovary during November 2020 showing thin fibro collagen capsule containing vascular structures (blue arrows), PGpn (yellow arrows), POC1 (yellow arrows), POC2 (green arrows), and POC3 (orange arrows). Some of such previtellogenic ova appears with partial degeneration of the ooplasm and the germinal vesicles (black arrows). Focal interstitial edema and fibroplasia are seen (white arrows). H & E (X 100 for A, 200 for B and 400 for C).

The mature stage of the spotted sea bass ovary (December 2020) is shown in Fig. (9). The spotted sea bass's mature ovaries have more actively dilated capsular blood vessels and a higher concentration of vitellogenic (POC-4) and prevtellogenic (POC-3) oocytes. The central germinal vesicle (GV) follows the large size ooplasm that contains acidophilus round yolk globules (YG), oil droplets (OD), and cortical alveoli in the peripheral ooplasm (CA). The zona pellucida is composed of two strata. Squamous type follicular cells (FC) are present. A moderate number of oogonia, primary and secondary developing oocytes (POC1, POC2), and an ovarian capsule are displayed in Fig. (9).

The spotted sea bass ovary at the post-mature stage (January 2021) is shown in Fig. (10). Some of the examined spotted sea bass showed substantial number (75-80%) of developing follicular atrophic alterations (atresia) (Fig. 10C), degenerative and interstitial edematous changes. A portion of these developing oocytes collapsed. Their germinal

vesicles were partially degenerated, and they were predominantly malformed. The pathologically dilated capsular blood vessels were clearly visible (Fig. 10).

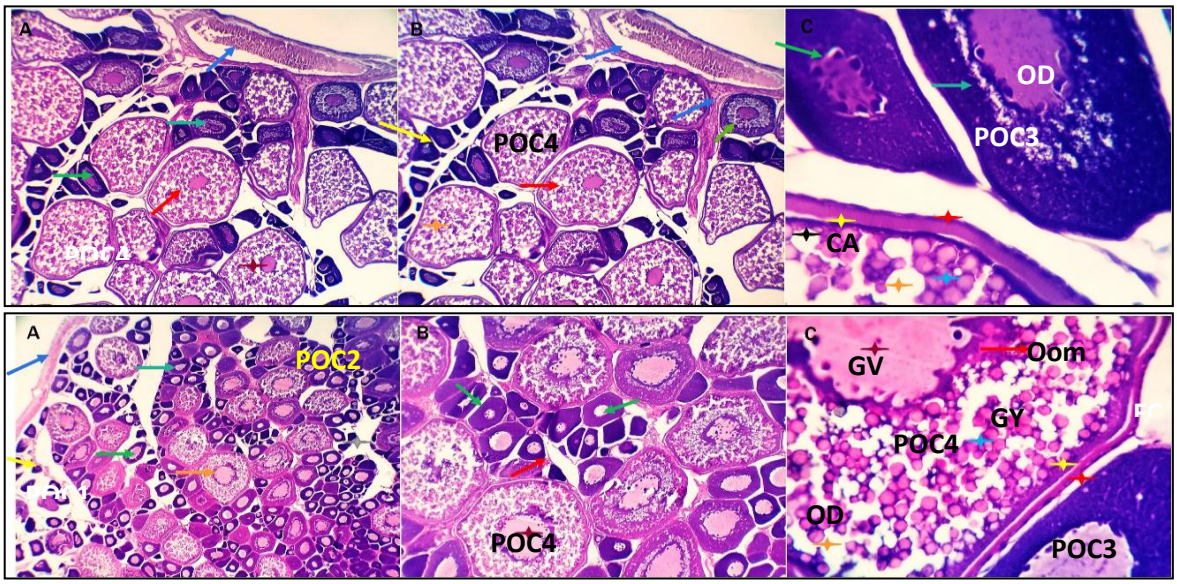

Fig. 9. Photomicrograph from the spotted seabass ovary during December 2020 showing actively dilated vascular blood vessels (blue arrows), POC3 (orange arrows), and POC 4 (red arrows), GV (brown star), ooplasm (Oom) filled with yolk globules (YG, blue star) oil droplets (OD, orange star) and cortical alveoli (CA). In all species, the pellucid zone consists of two layers, (yellow star). The follicular cells (FC, red star) are squamous type An ovarian capsule (blue arrow) followed by moderate number of oogonia, primary growing and secondary growing oocytes (POC1, POC2, yellow and green arrows). H & E (X 100 for A, 200 for B and 400 for C).

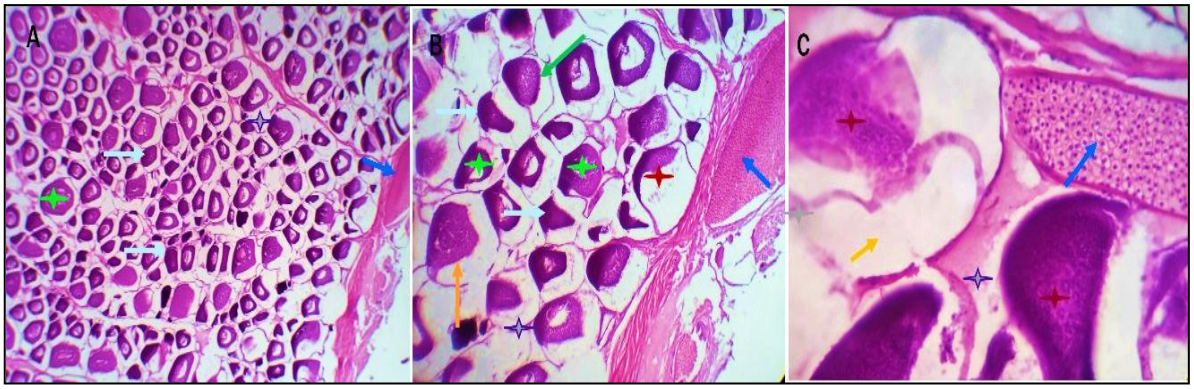

Fig. 10. Photomicrograph from the spotted seabass ovary during January 2021 showing, large number of growing follicular atrophic changes (atresia) (light blue arrows), degeneration (green stars), interstitial edematous changes (gray stars), and some collapsed oocytes (orange arrows). Degeneration of the germinal vesicles (brown stars). The capsular blood vessels are markedly dilated (pathologic) (blue arrows). H & E (X 100 for A, 200 for B and 400 for C).

DISCUSSION

According to **Tsikliras *et al.* (2013),** fish reproductive biology, including spawning time, sex ratio, maturity stages, length at first maturity (Lm), and fecundity, is crucial for fish management, stock assessment, and fisheries research. In data analysis and research planning, it could be helpful. Fish population parameters, particularly those related to reproduction, are crucial inputs for managing and assessment of fish stocks **(Froese & Pauly, 2023).** Fish sex ratios are an important stock trait for fisheries management according to **Marshall *et al.* (2006)**. In the present study, there were 1014 specimens in this investigation during season 2020, with a sex ratio of 1:1.587, consisting of 392 males and 622 females. During 2021, the total number of samples (1036) included 401 males and 635 females, with a sex ratio of 1:1.584. These findings concur with those of **Abd Elnabi *et al.* (2022)**, who observed that females outnumbered males. In Bardawil Lagoon, the male to female ratio of *D. labrax* was 1: 1.472, with 195 males and 287 females.

There is just one mating season every year for the spotted sea bass (*D. punctatus*), and it takes place in the winter from November to February. This season is distinguished with the highest percentages of ripe gonads and GSI values. In this study, December had the highest GSI levels for both sexes. The spotted sea bass spawns in the Mediterranean waters that are offshore. The spotted sea bass, *D. punctatus*, reached its first sexual maturity in Bardawil Lagoon in 2020 and 2021, measuring 21.7 and 21.5cm, respectively. The data we found about the spawning season agree with those reported by **Mehanna (2006)**, who reported that the highest percentages of developed gonads were recorded during the *D. punctatus* spawning season, which extends from November to early March. These findings concur with those of **Abd Elnabi *et al.* (2022)** who found that, the female *D. labrax*'s GSI values ranged from the lowest in May (0.18) to the highest in December (13.5). The GSI in males peaked in May at 0.10, and then gradually grew to reach its highest value in December at 7.04. In addition, the findings of **Bruslé and Roblin (1984)** who said that *D. labrax* spawns once a year during 1-2 months of the winter season agree with the present study. That could be traced back to the gonad somatic indice's mean monthly variation which is used to define the spawning season. According to **Shankar and Kulkarni (2005)**, the GSI reaches its greatest value in the Mediterranean population during only one breeding season, which occurs from December to March each year.

According to **Fahim *et al.* (2016),** the findings from the monthly variations of the development stages are consistent with the swings in GSI. Thus, as the spawning seasons approached, GSI gradually rose along with the percentage of ripe individuals. According to **Barnabè (1994)**, the spawning season is when sea bass's GSI peaks the highest. Conversely, **Nandikeswari and Anandan (2013)** documented that, the rapid decline in GSI signaled the end of the spawning season and the advancement of follicular atresia **(El-Gamal *et al.*, 2021).** 21.6cm for both sexes was the length at first maturity,

indicating that first maturity happened in the second year of life. This is consistent with the findings of **Ayman and Ezzat (2023)** for the same lagoon, which found that *D. punctatus* has a short lifespan, with a maximum age of only four years based on average lengths of 20.2, 25.3, 29.7, and 33.5 cm for the age groups. **Mehanna (2006)** found that, for the same species of Bardawil Lagoon, sexual maturity happens at 1.46 year of age, with a length range of 17– 24cm for males and 20– 27cm for females at 1.75 year of age. According to **Abd Elnabi *et al.* (2022)**, the European sea bass's length at first maturity (L_m) was found to be 30.0cm for females and 29.9cm for males. Male fish that are between 3 and 6 years old mature at about 35cm, whereas female fish mature at about 40 cm. **Omar (2022)** observed that, of all the spotted sea bass that were captured during the 2021 fishing season, 54.8% of them were immature, and this was the case with the bulk of the fish caught from the Bardawil Lagoon. Therefore, the mesh sizes need to be re-evaluated to safeguard this species and give it the chance to participate in reproduction at least once. The number of juvenile fish in relation to the overall capture suggests that the fishing gear utilized on this species may be quite dangerous. According to **Cetini *et al.* (2002)**, fishing gear is deemed extremely hazardous if the proportion of immature specimens in the overall catch is greater than 50%; it is deemed moderately harmful if the proportion is between 20 and 50%; and it is deemed acceptable if the proportion is less than 20%.

This study cleared that relative fecundity for weight of *D. punctatus* gradually increased from 397 to 1934 eggs/g, with an average of 1160 eggs/g. The relative fecundity for length gradually increased from 1366 to 18905 eggs/cm, with an average of 7996 eggs/cm. These findings concur with those of **Abd Elnabi *et al.* (2022)** who reported that, raising the length or weight of fish in Bardawil Lagoon led to a progressive increase in the quantity of *D. labrax* eggs. The fish, weighing 354.9g and measuring 32.4cm, may hold up to 222,500 eggs, with a maximum of 1,669,360 eggs for a fish with a body length of 66.1cm (2889.6 g). According to **Kapoor and Khanna (2004)**, fecundity is crucial for understanding fish life history and population dynamics. Because of the high energy required for reproduction, the animals will need to put on weight again in the same year **(dos Santos *et al.*, 2020)**.

Based on the two generalized scales of such maturity stages, which were represented as the following: immature, maturing, nearly ripe, ripe, spawning, and spent stages, these histological investigation results of spotted sea bass in Bardawil Lagoon agree with those of **El-Gharabawy (1996)** who found that the pattern of gonadal development in females is divided into six stages. Based on the classification of teleost fish by **Wallace and Selman (1981)** and **van Dyk (2006)**, there are five distinct developmental stages for oocytes. The first step is the oocyte. They reside in clusters amongst fully developed follicles. Second, stage 2 oocytes, also known as peri-nucleolar oocytes, are marginally bigger and have several nucleoli around the edge of the nucleus. Thirdly, compared to stage 2, stage 3 oocytes or cortical alveoli are noticeably larger; several lipid vesicles (cortical alveoli) are found towards the periphery. At this point, the

chorion, also known as the zona radiata, and perifollicular cells, which together create the oocyte's three-layered envelope, are visible. Fourth, stage 4 oocytes, also known as vitellogenic oocytes, are bigger than stage 3 oocytes and have a central nucleus with little yolk globules located on the cytoplasm's edge. The yolk globules or vitellogenic granules grow and nearly fill the cytoplasm during the late vitellogenic stage. The oocyte envelope surrounds the thick chorion, which is easily visible, and the cortical alveolar material is still discernible, pushed against the cytoplasm's edge. Finally, stage 5 oocytes are slightly bigger than stage 4 and have numerous large yolk globules dispersed throughout the cytoplasm; completely developed oocytes lack the germinal vesicle due to its breakdown. While all five of the oocyte stages mentioned above were seen in this investigation, the majority of the fish's ovaries contained more stage 4 (vitellogenic) and 5 (mature) oocytes. Nearly all the fish also had degenerating or atretic oocytes, which can be identified by the follicular wall collapsing, dissolving, or shrinking completely with visible yolk material inside. Macrophages break down the egg envelope and phagocytize the oocyte's degenerating yolk material during the atresia process. Stage 4 (vitellogenic) was the atretic oocytes that were observed **(Nibamureke & Wagenaar, 2021)**.

Wintertime correlates between gonad development and histology. This is mostly because of the lagoon's current environmental conditions, which are in balance and promote spotted sea bass growth, development, and reproduction. Furthermore, the water in the lagoon is extremely salinized, which could be a crucial element in the existence and procreation of this particular species.

CONCLUSION

The sex ratio was found to be stable, with the male ratio being 38.7 and the female ratio being 61.3% throughout the fishing seasons of 2020 and 2021. The gonadosomatic index increased gradually in both males and females between September and February. It correlates with the months-long histology analysis of female ovaries. For both sexes, the length at initial maturity was anticipated to be 21.7cm in the 2020 fishing season and 21.5cm in the 2021 fishing season. To prevent overfishing and enable female spotted sea bass (*D. punctatus*) to procreate, grow, and recruit into the fishery, we suggested permitting the use of mesh sizes larger than those utilized in Bardawil Lagoon.

Ethical approval

The authors followed all relevant national, international, and/or institutional requirements for the handling and use of fish. It was accepted by Arish University's scientific research ethics committee with code number AGRI01.

Declaration of interest

None of the all authors disclosed any financial, personal, or other connections to individuals or groups that might improperly affect or be interpreted as influencing their work.

REFERENCES

Abd Elnabi, H.E; Desouky M.G.; Mokbell, S.A. and Omar, S.A. (2022). Some biological measurements on the European sea bass in Bardawil Lagoon, Egypt. Egyptian Journal of Aquatic Biology and Fisheries, 26(5): 571-593. DOI: 10.21608/EJABF.2022.264478

Alaa, A.M. (2016). Biological and fisheries studies of the Thinlip grey mullet *Liza ramada* fish in Bardawil Lagoon. M.Sc Thesis, Faculty of Environmental Agricultural Sciences, Suez Canal University.

Albertine-Berhaut, J. (1973). Biologie de stades juveniles de téleostéens mugilidae *Mugil auratus* Risso 1810, *Mugil capito* Cuvier 1829, et *Mugil salines* Risso 1810: I. Régime alimentaire. Aquaculture 2: 251–266. DOI: 10.1016/0044-8486(73)90158-0.

Arukwe, A. and Goksøyr, A. (2003). Eggshell and egg yolk proteins in fish: hepatic proteins for the next generation: oogenetic, population, and evolutionary implications of endocrine disruption. Comp. Hepatol. 2: 1-21.

Ayman, S.A. and Ezzat, M.A. (2023). Assessing fishery status and sustainable exploitation of spotted sea bass (*Dicentrarchus punctatus*) in Bardawil Lagoon, Eastern Mediterranean, Egypt, The Egyptian Journal of Aquatic Research, 49 (3): 353-359. https://doi.org/10.1016/j.ejar.2023.06.001

Bancroft, J.D. Gamble, M. (2013). The hematoxylin and eosin. In: "Theory and practice of histological techniques, 7th edn". Suvarna SK, Layton C, Bancroft JD (eds) Churchill Livingstone, Edinburgh, New York, USA, pp 179–220.

Barnabè, G. (1994). Biological basis of fish culture. Aquaculture: Biology and ecology of cultured species (ed. G. Barnab 6 & F. I-1orwood). New York. pp. 227-372.

Brewer, S.K.; Rabeni, C.F. and Papoulias, D.M. (2008). Comparing histology and gonadosomatic index for determining spawning condition of small-bodied riverine fishes. Ecology of Freshwater Fish, 17: 54-58.

Bruslé, J. and Roblin, C. (1984). Sexualité du loup *Dicentrarchus labrax* en condition d'élevage controlé. In L'Aquaculture du Bar et des Sparidés. pp. 4–33. Edited by G. Barnabé and R. Billard. INRA, Paris.

Cetini, P.; Soldo, A.; Dul, J. and Pallaoro, A. (2002). Specific method of fishing for Sparidae species in the eastern Adriatic. Fish. Res., 55(1-3): 131-139.

dos Santos, R.A.; da Silva, A.R.; de Moraes, I.R.; Antunes, M.; Lopes, A.E.; da Costa, R.C. and Castilho, A.L. (2020). Gonadosomatic index and weight/ length relationship in females of three penaeoidean shrimps impacted by fisheries on the southeastern Brazilian coast. Nauplius, 28: e2020045. DOI 10.1590/2358-2936e2020045.

El-Gamal, A.E.; El-Sayyad, H.; Sheha, M.A. and Barakat, R.O. (2021). Histological and histochemical studies on the ovarian development of the grass carp,

Ctenopharyngodon idella, with special references to atretic phenomena. Egyptian Journal of Aquatic Biology and Fisheries, 25(1): 477-492.

El-Gharabawy, M.M. (1996). Histomorphology of ovarian changes during the reproductive cycle of *Lithognathus mormyrus* (Teleoste; Sparidae) J. Egypt. Ger. Soc. Zool., 19(A): 97-115.

El-Menhawey, W.; Badawi, A. and Sinoussy, K.S. (2021). The influence of environmental conditions on the benthic for aminiferal distribution from the recent sediments of Lake Bardawil, Eastern Mediterranean Sea, Egypt. The Egyptian Journal of Aquatic Research, 47(4): 357-363.

Fahim R. M.; Assem, S.S.; Omar E. A. and Srour T. M. (2016). Reproductive biology and histological characteristics of the European Sea bass, *Dicentrarchus labrax* (Linnaeus, 1758) females from the Egyptian Mediterranean water. Mediterranean Aquaculture Journal, (8): 107-121.

Froese, R. and Pauly, D. (2023). Fish Base. World Wide Web Electronic Publication. www.fishbase.org.

Grandcourt, E.M.; Al-Abdessalaam, T.Z.; Francis, F.; Al-Shamsi, A.T. and Hartmann, S.A. (2009). Reproductive biology and implications for management of the orange-spotted grouper *Epinephelus coioides* in the southern Arabian Gulf. Journal of Fish Biology, 74: 820-841.

Kapoor, B.G. and Khanna, B. (2004). Ichthyology handbook. Springer-Verlag, Berlin. 952 pp.

Marshall, C.T.; Needle, C.L.; Thorsn, A.; Kjesbu, O.S. and Yaragina, N.A. (2006). Systematic bias in estimates of reproductive potential of an atlantic cod (*Gadus morhua*) stock: implications for stock–recruit theory and management. Can. J. Fish Aquat. Sci., 63: 980-994.

Mehanna, S.F. (2006). Fisheries regulations based on yield per recruit analysis for the spotted sea bass *Dicentrarchus punctatus* (Moronidae) at Bardawil Lagoon, Mediterranean coast of Sinai, Egypt. Egyp. J. Aquat. Biol. & Fish., 10(4): 129-145.

Merezek, T.M. (2021). Studies on Occurrence and Biological of Golden Grey Mullet (*Liza aurata*) Fish in Bardawil Lagoon. MSc Thesis, Faculty of Environmental Agricultural Sciences, Arish University.

Mosabh, M. (2013). Studies on the effect of some environmental factors on fish production in Bardawil Lagoon. MSc Thesis, Faculty of Agriculture, Al-Azhar University, Cairo.

Muchlisin, Z.A. (2014). A General Overview on Some Aspects of Fish Reproduction. Aceh In t. J. Sci. Technol., 3(1): 43-52.

Muchlisin, Z.A.; Musman, M. and Siti-Azizah, M.N. (2010). Spawning seasons of *Rasbora tawarensis* (Pisces: Cyprinidae) in Lake Laut Tawar, Aceh Province, Indonesia. Reproductive Biology and Endocrinology, 8: 49. https://doi.org/10.1186/1477-7827-8-49

Nandikeswari, R. and Anandan, V. (2013). Analysis on Gonadosomatic Index and Fecundity of *Terapon Puta* from Nallavadu Coast Pondicherry International Journal of Scientific and Research Publications, 3(2): 1-4.

Nibamureke, U.M. and Wagenaar G.M. (2021). Histopathological changes in *Oreochromis mossambicus* (Peters, 1852) ovaries after a chronic exposure to a mixture of the HIV drug nevirapine and the antibiotics sulfamethoxazole and trimethoprim. Chemosphere 274: 129900.

Nikolsky, G.V. (1963). The ecology of fishes. Academic press, London and New York. 352 pp.

Omar, Sh. A. (2022). Biological and Fisheries studies on the Spotted sea bass *Dicenrarchus punctatus* in Bardawil Lagoon North Sinai Egypt, PhD Thesis, Faculty of environmental agricultural sciences, Arish University, Egypt.

Rizzo, E. and Bazzoli, N. (2020). Reproduction and embryogenesis. In: "Biology and Physiology of Freshwater Neotropical Fish". Elsevier Inc. Chapter 13, pp 287-313. https://doi.org/10.1016/B978-0-12-815872-2.00013-0

Salem, M.; El Aiatt, A. A. and Ameran, M. (2010). Age, growth, mortality and yield per recruit of *Liza ramada* in Bardawil Lagoon, North Sinai, Egypt. Abbassa Intern. J. Aqua. The third sci. Conf., Al-Azhar University, Cairo, 17-18 October).

Schlosser, I.J. (1990). Environmental variation, life -history attributes, and community structure in stream fishes: implications for environmental management and assessment. Environmental Management, 15: 621-628.

Sendecor, G.W. (1956). Statistical methods applied to experiments in agriculture and biology. Iowa State College Press, 5th ed. 534 pp.

Shankar, D.S. and Kulkarni, R.S. (2005). Somatic condition of the fish, *Notopterus notopterus* (Pallas) during phases of the reproductive cycle. Journal of Environmental Biology. 26(1): 49-53.

Suvarna, K.S.; Christopher, L. and Bancroft, J.D. (2012). Bancroft's Theory and Practice of Histological Techniques, 7th Edition. Elsevier Ltd. 637 pp.

Tsikliras, A.C.; Antonopoulou, E. and Stergiou, K.I. (2010). Spawning period of Mediterranean marine fishes. Rev Fish Biol Fisheries, 20: 499-538.

Tsikliras, A.C.; Stergiou and K.I. Froese, R. (2013). Editorial note on reproductive biology of fishes. Acta. Ichthyol. Piscat., 43(1): 1-5.

van Dyk, J.C. (2006). A Qualitative and Quantitative Assessment of the Normal Histology of Selected Target Organs of *Clarias gariepinus* and *Oreochromis mossambicus*. University of Johannesburg, Johannesburg. PhD. Thesis. http://hdl.handle.net/10210/201436.

Wallace, R.A. and Selman, K. (1981). Cellular and dynamic aspects of oocyte growth in teleosts. Integr. Comp. Biol. 21 (2): 325e343. https://doi.org/10.1093/icb/21.2.325.

Yeldan, H. and Avşar, D. (2000). A preliminary study on the reproduction of rabbit fish, *Siganus rivulatus* (Forsskål, 1775), in the northeastern Mediterranean. Turk. J. Zool., 24: 173-182.

ARABIC ABSTRACT

بيولوجيا التناسل لأسماك النقط (*Dicentrarchus punctatus*) في بحيرة البردويل، شمال سيناء، مصر

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يُعد التكاثر أحد أهم جوانب بيولوجيا الأسماك، ويعتمد نجاحه على تفريخ وتجميع الإصبعيات، وهي عناصر أساسية في استدامة أعداد الأسماك في بيئاتها الطبيعية. تهدف الدراسة الحالية إلى دراسة بيولوجيا التناسل لأسماك النقط، *Dicentrarchus punctatus*، لتوفير قاعدة بيانات بيولوجية لإدارة مصايد الأسماك في بحيرة البردويل، شمال سيناء، مصر. ولهذا الغرض، تم تجميع عينات شهرية من أسماك النقط من المصيد التجاري في مواقع الإنزال المختلفة بالبحيرة خلال الفترة من يناير 2020 إلى ديسمبر 2021. وأظهرت النتائج أن النقط لديه موسم تفريخ طويل يمتد بين أشهر نوفمبر وفبراير، مع تسجيل أن ذروة هذا التفريخ تكون عالية خلال شهر ديسمبر. وسجلت النسبة الجنسية لهذه الأسماك 1 ذكر: 1.587 أنثى و1 ذكر: 1.584 أنثى خلال موسمي الصيد 2020 و2021 على التوالي. وتم ملاحظة استقرار نسبة الجنس خلال موسمي الصيد 2020 و2021 حيث بلغت في الإناث 61.3% وفي الذكور 38.7%. في كلا الذكور والإناث، تم ملاحظة ارتفاع المؤشر التناسلي الجسدي (GSI) تدريجيًا من شهر سبتمبر إلى شهر فبراير، مما يشير إلى أن موسم التكاثر لأسماك النقط بين أشهر نوفمبر وفبراير. كما تم تسجيل أعلى قيم GSI في شهر ديسمبر 6.76 للإناث و4.46 للذكور خلال موسم الصيد 2020. وتم تسجيل أعلى قيم GSI في شهر ديسمبر 8.17 للإناث و5.59 للذكور خلال موسم الصيد 2021. ويقدر الطول عند النضج الأول بـ 21.7 سم للجنسين خلال موسم الصيد 2020 و21.5 سم لكلا الجنسين خلال موسم الصيد 2021 بمتوسط طول 21.6 سم. وتم تقدير الخصوبة لـ 78 مبيضًا ناضجًا حيث تراوحت القيم بين 29475 بويضة (15 سم طولًا و38.3 جرامًا وزنًا) و440,621 بويضة (34.7 سم طولًا و368.4 جرامًا وزنًا). وأظهر الفحص النسيجي للمبيض في هذه الأسماك أن مرحلة النضج تم تسجيلها في شهر ديسمبر. وعليه نوصي باستخدام شباك ذات فتحات أكبر من المستخدمة لصيد أسماك النقط *D. punctatus* في بحيرة البردويل لحماية هذه الأسماك من الاستغلال والسماح للإناث بالتكاثر والنمو مرة واحدة كل عام.