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Across Sectional Analysis Studies on Sea Bream (*Rhabdosargus haffara)* at Gulf of Suez, Red Sea, Egypt

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ABSTRACT
This study was conducted in the Gulf of Suez from 2021 to 2022 on the Haffara seabream (*Rhabdosargus haffara*), which belongs to the family Sparidae. The relative fecundity of *R. haffara* ranged from 345.1 to 631.2 oocytes/g, with an average of 391.7 oocytes/g. A unimodal winter peak was observed in advanced gametogenesis (stages IV and V) for both male and female *R. haffara*. A significant difference was recorded in the monthly average gonado-somatic index (GSI), which ranged from 0.5 to 4.0% for males and 0.8 to 10.0% for females. The monthly hepatosomatic index (HSI) for males ranged from 0.86 to 1.95% (mean: 1.23 ± 0.07%), while for females it ranged from 0.56 to 1.22% (mean: 0.99 ± 0.04%). Histological analyses were performed to determine the maturity of *R. haffara*, using samples from 100 individuals (50 males and 50 females) collected in 2021 and 2022. The histological analysis confirmed the biological observations of fish maturity discussed in earlier sections of this study. The length at 50% maturity was found to be 14.50cm. A total of 120 individuals of *R. haffara* were analyzed from eight populations.

INTRODUCTION

Parasitic diseases are a significant factor affecting fish reproduction, leading to damage to fish populations and posing a risk of a sharp decline in the number of fish produced from natural fisheries **(Mahdy *et al.*, 2021; Salem *et al.*, 2024)**. The economic damage caused by parasitic diseases in fish populations from both natural waters and fish farms is significant **(Abd-ELrahman *et al.*, 2023)**. Therefore, parasites can cause considerable economic losses in fish production due to mortality and tissue damage **(Thomas *et al*., 2014; Mahdy *et al*., 2024a, b)**. Approximately 70% of diseases that affect fish are represented by parasitic diseases, and of these, 40% are of protozoan origin, as demonstrated by **Ojocaru (2006)**. Parasites affect the survival of fish by reducing their size, altering the behavior of infected fish and making them vulnerable to other infections, resulting in higher mortality. Nevertheless, it is crucial to emphasize the existing deficiency in comprehensive investigations concerning the morphological ultrastructure and immunological facets concerning the various fish parasites such as micro and macro-metercercarial infections that are found in the Egyptian freshwater fish **(Mahdy *et al.*, 2022, 2024c, d)**. In Egypt, there are prolonged periods of optimum warm weather that favor the multiplication of different parasites, which, in turn, affects the health of fish **(Osman *et al.*, 2015)**. Generally, parasites can act as one of the factors regulating host populations, affecting host survival and reproduction directly, or indirectly influencing host behavior. On the other hand, the host immune response represents a great selective force against parasites. The seasonal pattern of host reproduction is an important factor influencing population dynamics of host-parasite interactions **(White *et al*., 1996)**.

Based on the importance of the blue economy in Egypt, both freshwater and marine, it was necessary to understand the aspects of studying the reproductive biology of fish in general, then try to explain the production factors and causes of the current deterioration in the numbers produced from natural fisheries for one of the Red Sea fish in the Gulf of Suez region.

The Gulf of Suez is considered as one of the major sources of fish production in the Egyptian sector of the Red Sea and in Egypt. Its importance as a fish resource can be attributed to the shallowness and sandy bottom which make it suitable for trawling **(Mehanna *et al*., 2023)**.

Family Sparidae (commonly known as porgies and sea bream) is a relatively large family with 38 genera and 159 species according to FishBase (2019) **(Osman *et al*., 2020a)**. Family Sparidae is represented in Suez Bay by seven species; the most dominant species of them is the *R. haffara* **(Osman *et al*., 2020b)**. Fish reproduction is an applied science which supports the production of aquatic seeds from commercial aquatic species for the purpose of sustainable aquaculture production. The overexploitation of natural fish resources is representing a global concern for food security and nutrition security according to **FAO (2011)**. Family seabream has been shown to continue to spawn even when starved during the spawning season, with no effect of starving on fecundity, fertilization success and egg quality **(Chatzifotis *et al*., 2021)**. Seabreams family Sparidae are ubiquitous fish found in tropical and temperate environments. This family currently has 159 species belonging to 38 genera **(Froese & Pauly, 2020)**. The major components of Sparidae catch in the Egyptian Red Sea are *R. haffara, R. sarba, D. noct,* and *A. bifasciatus* **(El-Mahdy *et al.*, 2019)**. The fish reproduction research aims to maximize the success of sustainable seed production from aquatic species. Some finfish species may exhibit different reproduction systems including hermaphroditism, gonochorism, or combination of the three systems **(Lowerre-Barbieri *et al.*, 2011)**. One of the main characteristics of egg quality is fertility, hatching percentages, growth, and survival of hatched larvae **(Bachan *et al.*, 2012)**.

The culture of the high-value species *Rhabdosargus haffara* should be encouraged in Egypt due to its significant market demand. However, one of the major challenges hindering the development of *R. haffara* culture in Egypt is the lack of seedlings. Although captive rearing techniques are well developed, effective breeding methods for *R. haffara* have yet to be established, primarily because the breeding physiology is not fully understood.

Research focused on developing biotechnological tools to assess the gender and maturation status of *R. haffara* which is essential. To advance *R. haffara* culture technology, it is crucial to develop seed production techniques. The success of seed production activities depends on the gonadal maturity of the broodstock, which is influenced by factors such as age, size, diet, environmental conditions, season, and broodstock management.

The problem is the severe decline in fisheries in the Gulf of Suez region as a result of chemical and physical pollution from factories, electric power plants and other pollutants, as well as authorized illegal fishing. With the great challenges facing the country and with the scarcity of freshwater, the study conducted the reproductive biology on the excavator fish in a lab. In an active attempt to achieve food safety from marine fish that meets the needs of the population for animal protein.

In Egypt and many developing countries, the collection of wild seeds is still prevalent for fisheries and environmental stocking, which can have drastic effects on ecological balance. Hatcheries have become increasingly important for producing healthy seeds of economically significant species, contributing to the conservation of living resources. They produce larvae and juveniles for finfish, shellfish, and invertebrate farming, supporting the aquaculture industry by transferring these young fish to grow-out systems.

The study area is located in the Gulf of Suez, where random samples of *Rhabdosargus haffara* will be collected from landings during the fishing season from 2021 to 2022. Adult individuals of *R. haffara* will be sampled in spring, summer, autumn, and winter to conduct a study on the reproductive biology of this burrowing fish.

MATERIALS AND METHODS

Study area and collections of samples

The Gulf of Suez is the study area where *R. haffara* populations were collected from various sites, including Attaka, AL Salakhana, AL Sokhna, AL Zaafran, Ras Sudr, Abu Zenima, Ras Abu Rudeis, and AL Tur (Table 1 & Fig. 1). The fish *R. haffara* populations were identified according to **Forsskål (1775)**. Average sizes ranged from 10.7 to 29.3cm (TL), with individuals randomly selected from each collection site on a bi-monthly basis from September 2021 to August 2022.

Site code	Sampling location	Latitude	Longitude	Total no of fish bi monthly collected	
				♂	♀
Att001	Attaka	29.911090	32.462780	164	186
Alsa002	AL Salakhana	29.956195	32.533444	162	188
Also003	AL Sokhna	29.636202	32.309061	170	180
Alz004	AL Zaafrana	29.110446	32.659245	169	181
Ras005	Ras Sudr	29.587431	32.711884	168	182
Abz006	Abu Zenima	29.044044	33.108006	168	182
Abr007	Abu Rudeis	28.912610	33.191280	165	185
Alt008	AL Tur	28.232052	33.604872	176	174

Table 1. Details of sampling sites from Gulf of Suez during September 2021 to August 2022

Fig. 1. Map of the Red Sea showing the study area

Fig. 2. Investigated *R. haffara* (family Sparidae) collected from different geographical location of Gulf of Suez

Sex of the fish and maturity stages

The sex of *R. haffara* fish was determined through macroscopic examination of their gonads. Maturity stages of males and females *R. haffara* were determined according the maturity scale described by **Elganainy (1992)**. It was as follows: immature - maturing virgin - developing - gravid mature - spawning - fully spent.

Sex ratio

The sex ratio of the *R. haffara* was determined by calculating the ratio of males to females (M: F) in the fish population collected bi-monthly according to **Ochieng *et al.*, (2015)**.

Gonado somato index

G.S.I was analyzed following the method outlined according to **Sokal and Rohlf (1969)**.

G. S. I = gW*100/ GW

Length at first sexual maturity

The males and the females were identified according to **Pauly's (1983)** method, which involves plotting the cumulative curve for the probability of capture by length.

Fecundity

Absolute fecundity (AF) was computed based on the approach outlined according to **Sujatha *et al.* (2015)**:

$$AF = (X*OW) / SW$$

The calculation of relative fecundity was determined using the formula provided according to **Qadri *et al*. (2015)**. The relative fecundity (RF) was computed by dividing the absolute fecundity (AF) by the total weight of the fish:

$$(RF) = (AF) / \text{Total fish weight}$$

The length at which males (♂) and females (♀) first reach sexual maturity was determined using specimens collected exclusively during the gonad maturation phase. The proportion of mature individuals was modeled using the following logistic function: P = 1/ (1+e-b (TL–TL50).

Histological investigation

Small pieces of gonad were fixed for 48h in Bouin's solution and then transferred to 70% ethyl alcohol for preservation. Clearing and paraffin embedding were performed using standard histological techniques; sections were cut at 7µm thickness by using automatic microtome LKB and stained by hematoxylin and eosin **(Bancroft & Stevens 1996)**. The tissues were investigated using a Leica microscope, equipped with a digital camera. Maturity stages scales for each sex were determined according to **Elganainy (1992)**.

RESULTS

1- Seasonal shifts in sex categories

The data depicted in Table (2) illustrate the percentages and distributions of sex categories observed during 2021-2022. Across all collection sites, females (52.07%) outnumbered males (47%), a trend consistent across all sites and sampling periods.

Table 2. Percentage (%) distribution of sex categories across sampling sites during the observation period

Six	Attaka		Al salakhana		Al sokhna		Al zafarana		Ras sudr		Abu zenima		Ras Abu Rudeis		Al tour	
	N	%	N	%	N	%	N	%	N	%	N	%	N	%	N	%
M	164	46.8	162	46.2	170	48.5	169	48.2	168	48	168	48	165	47.1	176	50.2
F	186	53.1	188	53.7	180	51.4	181	51.7	182	52	182	52	158	52.8	174	49.7
Total	350	100	350	100	350	100	350	100	350	100	350	100	350	100	350	100

2- Sex ratio and fish length categories

The percentage of males and females was calculated for various length groups and months. In length categories, females (F) comprised the largest proportion of fish, indicating that females exceeded males in length groups ranging from 12 to 16cm, while males (M) dominated in smaller length categories from 9 to 11cm (Table 3). Additionally, the male to female sex ratio averaged 1:1.09. With a *P*-value of 0.001, the chi-square value indicated a significant difference between the sexes.

Table 3. The count of male a and female *R. haffara* across diverse length ranges from different sampling locations in the Gulf of Suez during September 2021 to August 2022

Length C.M	**Attaka**		**Al Salakhan**		**Al Sokhna**		**Al zafarana**		**Ras sudr**		**Abu zenima**		**Ras abuRades**		**El Tour**	
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀
9	30	24	32	19	33	17	35	17	26	17	32	18	22	31	29	19
10	22	12	30	13	19	23	31	26	26	21	26	14	26	22	27	22
11	29	15	23	22	31	19	15	11	16	31	23	17	29	17	21	15
12	11	16	19	14	23	16	13	18	21	23	20	16	22	21	23	17
13	11	20	11	23	21	33	32	31	11	15	22	37	18	41	13	26
14	33	22	14	17	22	24	18	20	16	23	22	22	15	22	14	31
15	14	52	21	36	19	23	11	33	33	20	12	31	11	15	33	22
16	14	25	12	44	2	25	14	25	19	32	11	27	22	25	5	22
total	**164**	**186**	**162**	**186**	**170**	**180**	**169**	**181**	**168**	**182**	**168**	**182**	**165**	**185**	**165**	**174**

The overall male-to-female ratio (1:1.09) significantly favored females ($\chi^{2,}$ n = 1777, *P* <0.05), and regardless of size class, mature females (n = 1188) consistently outnumbered mature males (χ^2, n = 589 *P* <0.05). From December to January, the sex ratio was nearly balanced ($\chi^{2,}$ n = 700; *P* >0.05), but from February to March, females were more abundant than males (χ^2, n = 700, *P* <0.05) (Table 4).

Table 4. Percentage and sex ratio of *R. haffara* M and F according to the different sexual cycle periods in the Gulf of Suez

Period	**% Male**	**%Female**	**Six ratio M:F**	**X^2**	**P**
Sexual activity period from **Dec to Jan**	40.63	59.37	1:1.09	2.25	>0.05
Sexual activity period from **Feb to Mar**	17.74	82.26	1:1.3	26.04	<0.05

3-Fish length at first sexual maturity Lm_{50}

The length at first maturity of *Rhabdosargus haffara* illustrates that males reach maturity before females. Specifically, the length at 50% maturity (Lm50) for males ranged from 11 to 16cm, while for females, it ranged from 13 to 16cm (Table 5). The mean length of mature females (TL = 14.5 ± 1.29cm) was significantly higher (P< 0.001) than that of males (TL = 13.5 ± 1.87cm) (P< 0.05). Fish length emerged as a significant predictor of sex category (Kruskal-Wallis; χ^2 = 2.6720; df = 7 (P <0.001), suggesting that fish size played a role in determining sex. Throughout the 2021-2022 sampling period, a notable disparity was observed in the number of males and females. Analysis using contingency tables revealed significant variations in sex category ratios across different collection sites χ^2 = 26.557;
df = 7; (P< 0.0001).

The size at 50% maturity was reached for both males and females at 14.5cm. (s.e.<0.001, n = 1777). Additionally, a significant difference in the length at first maturity was observed between the sexes Hotelling's T^2 test, d.f. = 1776, T = 2.432, (P <0.05) (Table 5).

Table 5. Length at first sexual maturity Lm_{50} of *R. haffara* at the various collection sites

Length category cm	**Attaka**		**Al salakhana**		**Al sokhna**		**Al zafarana**		**Ras sudr**		**Abu zenima**		**Ras Abu Rudeis**		**Al tour**	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
9.St1	0	0	5	0	0	0	1	0	0	0	1	0	0	0	0	0
10 St1	0	0	11	3	7	3	11	7	13	9	9	5	5	3	9	0
11 St2	11	5	27	19	17	17	16	13	17	13	13	11	9	5	12	9
12 St2.	24	22	29	22	19	21	21	17	23	21	22	15	23	17	19	13
13 St3	29	35	33	29	23	29	28	29	27	23	27	27	37	35	26	31
14 St4	31	40	15	35	21	33	27	33	32	35	31	39	31	33	29	33
15 St4	33	39	25	39	39	43	30	37	31	38	39	41	33	45	33	41
16 St5	36	45	17	41	44	34	35	45	25	43	26	44	27	47	37	47
9 St1	164	186	162	188	170	180	169	181	168	182	168	182	165	185	165	174

4- Fecundity for female

4.1 Absolute fecundity

During the spawning season, the absolute fecundity of *R. haffara* in the Gulf of Suez was assessed, varying from 31,088 to 64,301 ova. On average, it was approximately 51,230 ova for fish lengths ranging between 12.3 and 15.1cm.

4.2 Relative fecundity

The relative fecundity of *R. haffara* ranged between 345.1 to 631.2 oocytes per gram, averaging at 391.7 oocytes per gram.

4.3 Correlation between total length and absolute fecundity

A positive correlation was observed between absolute fecundity and total length in female *R. haffara.* Details regarding the length and absolute fecundity estimates for males, females, and all individuals are provided. The regression parameters for the relationship between absolute fecundity and total weight in female *Rhabdosargus haffara* are displayed, along with the derived regression equation:

$$\mathbf{y = 0.2076x - 0.0631\ (R^2 = 0.8472)}$$

5- The length-weight relationships

The length-weight relationships were found to be statistically significant (ANOVA, $P< 0.001$) across all sample collection sites. Additionally, there were significant differences in slopes or intercepts observed between males and females (ANOVA, n = 2788, $P< 0.05$). The isometry was tested by t-test (H0: t = 3). The growth patterns of females and males were found to be isometric (t-test, $P= 0.19$ and 0.90, respectively), while for pooled individuals, they exhibited positive allometry ($P= 0.03$) (Table 6).

Table 6. The isometry for growth of males and female *R. haffara* collected from various sampling sites from the Gulf of Suez

Six	A	B	s.e.(b)n	N	R^2	t-test	P
M	0.013	3.022	0.089	1342	0.983	1.303	0.19
F	0.026	2.889	0.053	1485	0.985	0.119	0.90

A: intercept, **B**: slope, **s.e. (b)**: standard error of b, **N**: sample size, **R^2**: coefficient of determination.

6- Gonado somatic index (G.S.I.)

During the period of gonad maturation, there was a significant difference between the mean testis weight (5.30 ± 1.22g) and the ovarian weight (12.01 ± 1.27g), as determined by the Mann-Whitney test n = 2779, ($P< 0.001$). Monthly mean GSI values ranged from 0.5 to 4% for males and from 0.8 to 10% for females, with a significant disparity between the two genders (Wilcoxon test, n= 2779, ($P< 0.005$)). The monthly

GSI curves exhibited variation, following a unimodal pattern for both males and females, indicating that *R. haffara* reproduced once year.

The male and female gonadal development durations were similar, with a period of rest from July to November. Activity in the male and female gonads resumed in December, peaking in January and February. The highest female gonad somatic index was recorded in January. The spawning season commenced in January, with the majority of *R. haffara* being post-spawners by March. A significant negative correlation was observed between mean GSI values and sea surface temperature (r_s = -0.916, n= 2779, *P*< 0.05). Complete gonad maturation occurred at the lowest sea surface temperatures, ranging from 14 to 16°C. There was no significant difference in mean condition factors between sexes (Mann-Whitney test, n= 2779, *P*= 0.18). However, for all mature males and females, the condition factor varied significantly between months Kruskal-Walli's test, n= 2779, (*P*= 0.001), being the highest in summer and the lowest in winter SNK (*P*< 0.05).

7- Hepato somatic index (H.S.I*)*

Monthly mean hepatosomatic index ranged from 0.86 to 1.95% (1.23 ± 0.07%) for males and from 0.56 to 1.22% (0.99 ± 0.04%) for females. There was a significant difference in mean HSI between sexes (Mann- Whitney test, n= 2779, *P*= 0.02). However, HSI means for males and females did not significantly differ between months (Kruskal-Walli's test, n= 2770, *P*= 0.43 and 0.32, respectively).

8- Macroscopic gonad maturity staging in *R. haffara*

The percentage of fish exhibiting oocytes in the spawning-capable phase increased from December to March between the years 2021 and 2022 (25.70% for male and 51.85% for female, respectively) and then decreased from April till September (10.65% for male and 11.78% for female, respectively). According to **Elganainy (1992)**, the differences between males and females can be explained through the stages of sexual maturity, as illustrated in the following Figs. (3-14).

Table 7. Stages of sexual maturity

I Immature	**M**	**The testes appeared as thin transparent cord extending to 1/3 of body cavity (Fig. 3).**
	F	**The ovary appeared as thin transparent cord extending to 1/3 of body cavity (Fig .9.**
II Maturing virgin	**M**	**Translucent white-gray testes its length about 1/2 of body cavity no milt exuded by presser on it (Fig. 4).**
	F	**Translucent red-reddish gray ovary with compact wall under binocular microscope eggs can be distinguished as polygonal shaped (Fig. 10).**
III Developing	**M**	**Opaque, white with blood capillaries evident compact testes with occupying about 2/3 the body Cavity (Fig. 5).**
	F	**Opaque, reddish-orange ovary, thicker than in stage 2, extending about 2/3 length of body Cavity. Eggs are clearly recognizable. (Fig. 11)**
IV Gravid mature	**M**	**Opaque white testes with definite length of 2/3 body length, very compact and with pressure white milt runs out slowly (Fig. 6).**
	F	**Opaque orange ovary very compact filling 3/4 body cavity, immature, maturing and mature ova present mature ova are more numerous (Fig. 12).**
V spawning	**M**	**Soft and creamy white testes milt oozes out on pressing the gonad, extended about 3/4 body cavity (Fig. 7).**
	F	**Long and broad, ovary filling the body cavity red or reddish-yellow in color, opaque mature ova more numerous than maturing ova (Fig. 13).**
VI Fully spent	**M**	**Very loose wall and rich blood capillaries testes the color gray with no milt comes out (Fig. 8).**
	F	**Ovary with loose walls sometimes with folds very much shorter and bloody deep red in color (Fig. 14)**

8.1 The first of the males

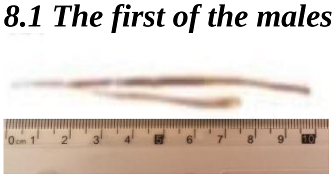

Fig. 3. St.I Immature

Fig. 4. St.II Maturing virgin

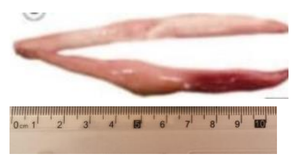

Fig. 5. St.III Developing

Fig. 6. St.IV Gravid mature

Fig. 7. St.V spawning

Fig. 8. St.VI Fully spent

8.2 The second of the female

Fig 9: St.I Immature

Fig. 10. St.II Maturing virgin

Fig. 11. St.III Developing

Fig. 12. St. IV Gravid matures

Fig. 13. St.V Spawning

Fig. 14. St.VI Fully spent

9- Histological structure and gonad maturation

Through histological examination, every *R. haffara individual* was categorized with a maturity stage number, indicating the extent of its gonad development **(**Figs. 15, 16).

The gonads histological analyses were used for determinations of *R. haffara* maturity on 100 fish (50 males and 50 females) collected in 2021 and 2022. The histological analysis confirms the biological observations of fish maturity in the previous sections of this study.

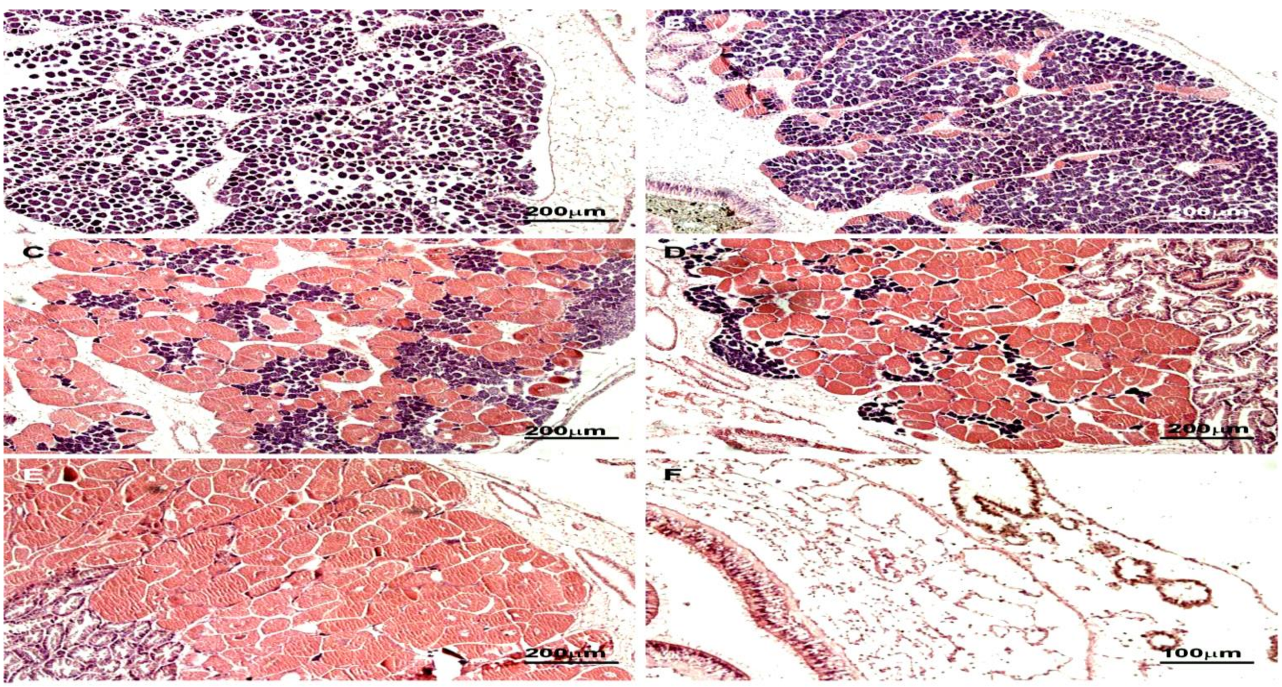

Fig. 15. Micrographs of histological sections of *R. haffara,* showing all six male maturity stages. **A.** Immature, **B.** Maturing virgin, **C.** Developing, **D**. Gravid mature gonad, **E**. spawning, and **F**. Fully spent

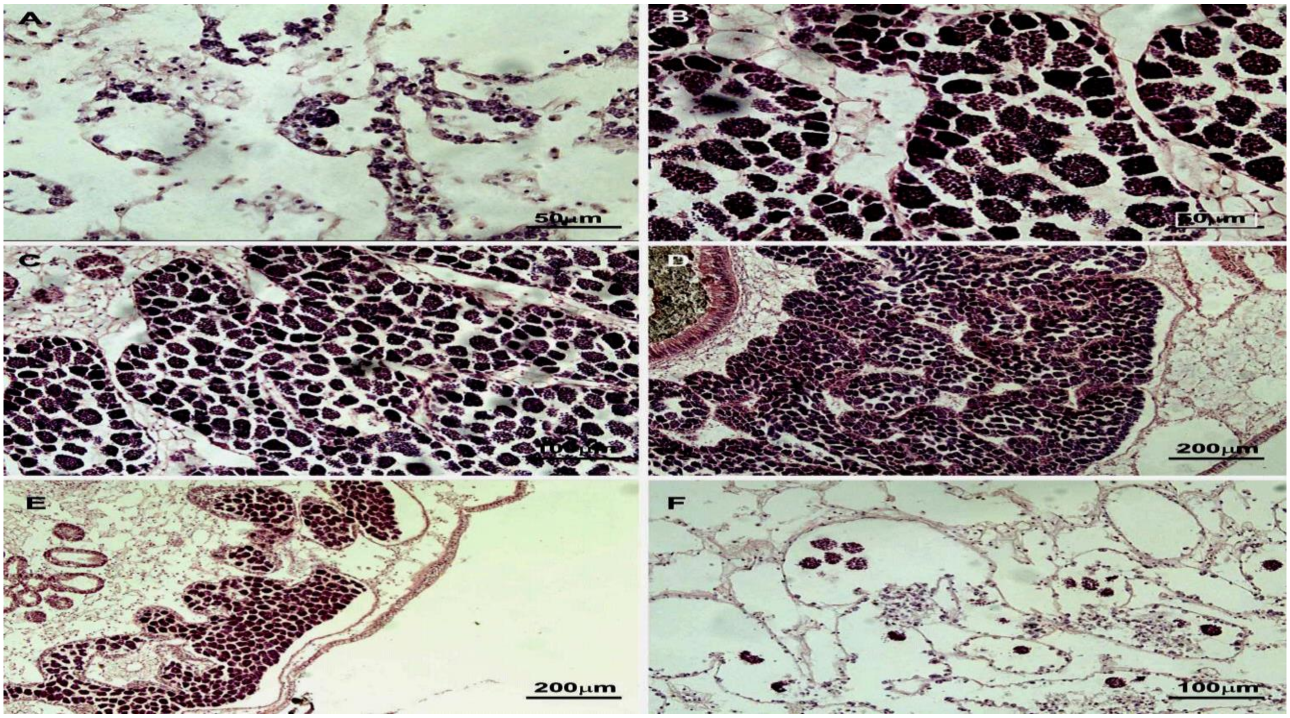

Fig. 16. Micrographs of histological sections of *R. haftara* showing all six female maturity stages: **A** Immature, **B**. Maturing virgin, **C**. Developing, **D**. Gravid mature, gonad, **E.** Spawning, and **F**. Fully spent

DISCUSSION

The reproductive biology of any fish species is crucial for fishery management, as it provides insights into future recruitment in the fishery **(Osman, 2016)**. In the Gulf of Suez, *Rhabdosargus haffara* reaches first maturity at lengths ranging from 11 to 16cm for males and 13 to 16cm for females. These measurements align with those reported for the white sea bream in northern Spain (21cm) **(Martinez & Villegas, 1996)** but are smaller than those observed in South Africa (24.3cm) **(Mann & Buxton, 1998)** and the Lion Gulf (23cm for females and 20cm for males). However, they are larger than lengths found in Egypt (18cm) **(El Maghraby *et al.*, 1982)** and the Azores (16.7cm) **(Morato *et al.*, 2003)**. Variations in age and length at first maturity across populations are likely influenced by environmental factors such as temperature, food availability, demographic structure, and predation **(Duponchelle & Panfili, 1998)**. Notably, around 70% of the fish caught in the Gulf of Suez were smaller than the length at first maturity, indicating a need for increased minimum legal capture lengths to enhance stock management and species conservation.

In this study, a b-value of 3 indicates isometric growth, while deviations suggest allometric growth. Both females and males exhibited positive allometric growth, with b-values of 3.022 and 2.889, respectively, differing from previous studies **(Mehanna, 2001; Al Abdulhadi & Osman, 2007; ElDrawany, 2015)**.

The spawning season, length composition, and sampling period also affect growth patterns **(Moutopoulos & Stergiou, 2002; Mehanna & Al Mamry, 2012; Mahé *et al.*, 2017)**. Age estimation based on scale readings ranged from four years for lengths between 9 and 24.2cm TL **(Mehanna, 2001)** to 9.0 and 21.0cm TL **(El-Drawany, 2015)**. Differences in age estimates stem from ecological parameters, sex, age determination method, fish size range, and habitats. In this study, four eolith morphometric variables significantly correlated with *R. haffara* age, consistent with findings from other authors linking otolith weight to fish age **(McDougall, 2004; Arjes *et al*., 2008; Ochwada *et al.*, 2008; Doering- Steward *et al*., 2009; Matić-Skoko *et al*., 2011; Mahé *et al*., 2016)**. Analysis of models applied to *R. haffara* reproductive metrics, including development, maturity, oocyte characteristics, fecundity, and GSI, highlighted significant positive correlations with fish size or age. This suggests that larger, older females play a more significant role in reproductive success compared to their smaller, younger counterparts, a trend observed in various fish species **(Field *et al*., 2008)**. Research in cod also indicates a positive link between pre-spawning condition and oocyte diameter **(Ouellet *et al.*, 2001)**. Discrepancies among studies could stem from differences in methodologies, sample sizes, age distributions, environmental factors, biomass, prey availability, and fishing pressure, necessitating further investigation and standardization of laboratory techniques to analyze fecundity patterns consistently. During gonad maturation, mean testis and ovarian weights were recorded, with monthly GSI fluctuating between 0.5 and 4% for males and 0.8 to 10% for females. GSI curves exhibited monthly variations, suggesting *R. haffara* reproduces annually, with gonad development commencing in December, peaking in January and February, and spawning beginning in January. A significant negative correlation existed between mean GSI values and sea surface temperature (r_s = -0.916), with complete gonad maturation occurring at lower temperatures (14-16°C). Mean condition factors did not significantly differ between sexes, but for mature individuals, they varied by month, being the highest in summer and the lowest in winter. Monthly mean hepatosomatic index ranged from 0.86 to 1.95% for males and 0.56 to 1.22% for females, with no significant differences observed between sexes or months. In many sparids studied, gonadal tissue typically differentiates as ovo-testis. The findings of this study reveal that macroscopically, *R. haffara* gonads range from 15 to 17.5cm in total length, which is consistent with the findings of **Wassef (1973)**. Histological examination of *Rhabdosargus haffara* revealed the presence of spermatozoa in ripe males, observed in November. Similarly, **Abdellah (1996)** reported the initial detection of spermatozoa in testes during this month. During the same period, females exhibited oogenic activity characterized by the presence of both early and late perinucleolus oocytes. This pattern has been noted in several species, including *Sparodon durbanensis* **(Buxton & Garratt, 1990)**, *Pachymetopon grande* **(Buxton & Clarke, 1991)**, and *Diplodus cervinus hotteniotus* **(Mann & Buxton, 1998)**. The functional aspect of the ovo-testis appears to be the testicular portion, which ripens early as the seminiferous lobules become distended with spermatozoa.

CONCLUSION

Studying the reproduction of *R. haffara* in the Gulf of Suez played an important and useful role in knowing the mechanism by which these species reproduce in their natural environments and then simulating the natural environment in which they reproduce in an attempt to spawn and multiply these fish, especially in light of the current situation of a large gap between production and consumption. There is also bulldozing and a sharp decrease in numbers as a result of environmental factors such as overfishing and pollution of the aquatic environment.

ABBREVIATION

G.S.I = Gonado-Somatic Index.
H.S.I = Hepato-Somatic index.
gW = Weight of the gonad, either testes (♂) or ovaries (♀).
GW = Weight of the gutted fish.
TL =Total length.
AF = Absolute fecundity.
X = Average number of ova in the subsample.
OW=Total weight of the ovary.
SW= Weight of the subsample.
RF = Relative fecundity.
AF = Absolute fecundity.
P = represents the proportion of mature fish for the given length.
b = denotes the slope of the maturity curve.
50TL $_{50}$ = signifies the size at which 50% of the fish are mature.

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