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REPRODUCTIVE BIOLOGY OF SPARID FISH, *DIPLODUS NOCT*, (VALENCIENNES, 1830) FROM SOUTHERN SINAI, GULF OF SUEZ, RED SEA, EGYPT

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ABSTRACT

The reproductive biology of *Diplodus noct*, (family: Sparidae) Red Sea species inhabiting the Gulf of Suez, was studied. There were monthly variations in sex ratio, and a tendency for more females (206 fish, 51.9%) than males (191 fish, 48.1%) for the whole population. Overall sex ratio was 1: 1.08 for males to females. Morphologically four stages of maturity were identified as follows; Virgin / resting – developing – active and post spawning. All male *Diplodus noct* over 12.2 cm in total length were found mature. while all female over 13.0 cm were mature. The gonadosomatic indices of males were lower than that of females. All individuals have a definite breeding season which extends from November to March. Males were virgin in April and active in the period from November to March whereas the females were virgin in April , May and June and active in the same period as the males. An increase in oocyte diameters was evident in July (with an average of 209µ) and this increase continued in the following months till January, with an average value of 411µ. The absolute fecundity ranged from 539 to 5112 for fish total length ranging from 12.5 to 21.1 cm. whereas absolute fecundity varied from 725 to 5898 for fish total weight from 36.8 to 109.5 gm, whereas relative fecundity ranged from 43 to 242 for fish total length from 12.5 to 21.1 cm. and varied from 20 to 54 for fish total weight from 36.8 to 109.5 gm.

Keywords: Sparidae, *Diplodus noct*, Reproductive biology, Maturity Stages, Gonadosomatic index , Egg diameter, Fecundity

INTRODUCTION

The Gulf of Suez is flat-bottomed with a depth of 55 to 73 m. A gradual fall appears to the mouth of the gulf, where it drops abruptly to a depth five times greater. The gulf represents, therefore, a shallow shelf filled with the surface water of the Red Sea. El-Tur bank lies in the fairway of the gulf, with a general depth ranging from 20 to 35 m (Morcos, 1970). The Gulf of Suez is the principal fishing ground of the Egyptian Red Sea. Fishes landed contributed about 95% of the Egyptian Red Sea catch (Ahmed, 1999). Sparid fishes inhabit tropical and temperate coastal water. They found near the shore in shallow inlet and bays less often at moderate depth. Family Sparidae comprise about 22 genera in four subfamilies containing 41 species (Bauchot and Smith, 1983). Twelve species of Sparid fishes are reported from Red Sea. Three of them are frequently observed in the reef environment; these are *Rhabdosargus sarba*, *Acanthopagrus bifaciatus* and *Diplodus noct* (Randall, 1983). From the available literature, it was found that few works have been published on the biology of spaird fishes. Ahmed (1999) studied the biology and ecology on some Sparid fishes in southern Sinai coasts. Al-Hassan and El-Silini, (1999) recorded about 14 species were in the Libyan coast, on the Mediterranean, such as *Pagrus pagrus, Dentex dentex ,Diplodus vulgaris, Lithognathus mormyrus, Oblada melanura, Sarpa salpa , Crenidens crenidens* and *Diplodus noct*. Laith (2003) found asymmetry in some morphological characters of four sparid fishes in Benghazi Mediterranean coast. Hammoud and Moujahed (2004) studied the

food and feeding habits of *Diplodus sargus* in the Mediterranean Lattakia coast. Chaves and Mesegur (2005) detected the breeding season of *Sparus aurata* in the central Mediterranean Sea. Chilari and Evaggelos (2006) conclusied the biology of *Pagellus bogaraveo* in the Ionian Sea, Greece. and the fisheries and biology of *Diplodus sargus* in Benghazi Mediterranean coast (Abugrara, 2008). The present work aims to investigate the important aspects of the reproductive biology of the *Diplodus noct* in the Southern Sinai coasts, Gulf of Suez, Red Sea.

MATERIALS AND METHODS

Monthly samples of *Diplodus noct* were collected during the period from January to December 2004 by trammel, gill net and fixed trap (Manasib) from fishing landing site in El-Tur City, South Sinai, Gulf of Suez, Red Sea (Fig. 1) 28° 13′ N and 33° 35′ E. The study area is located on the Eastern Coast of the Gulf of Suez.

A total 397 specimens of *Diplodus noct* were sampled for studying the reproduction. Times a month ranging in total length from 12.5 to 21.1cm. and total weight from 36.8 to 109.5 gm. Fish was dissected to determine sex then the gonads were weighed to the nearest gm. State of maturity for each individual fish was determined into four stages: virgin/resting, developing, active and post spawning (Buxton, 1989). The monthly Gonado-somatic index (GSI) was calculated as a percentage weight of the gonad to the total weight of the fish.

Oocytes were separated from the ovarian tissues and put in saline solution (0.9% NaCl) for 24h, then they were measured under the microscope at a power of magnification of 40 X, then 20 oocytes were taken randomly and their diameters were measured to the nearest 0.01 mm by using an eye – piece

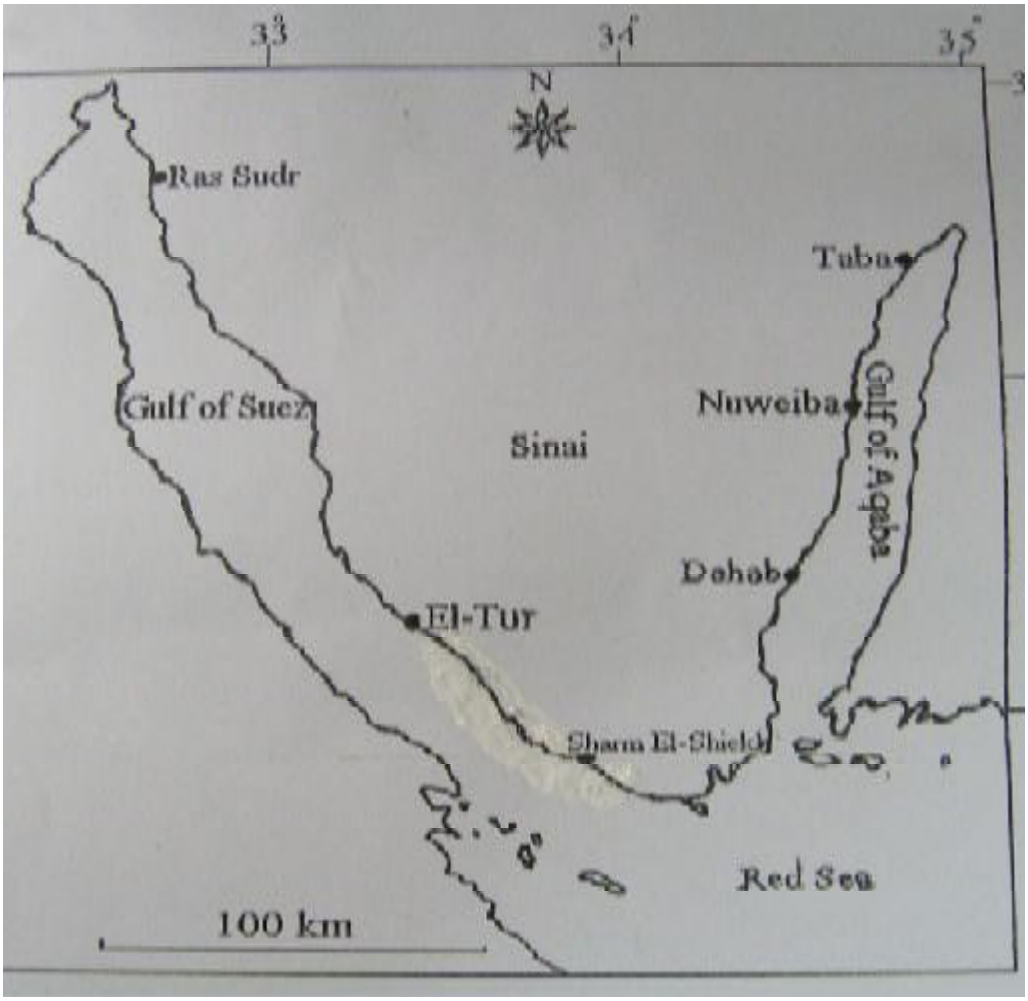

Fig. 1. Map showing the location of the El-Tur fishing site in Southern Sinai, Gulf of Suez, Red Sea, Egypt

micrometer. The average oocyte diameters for mature specimens were calculated.

Two terms are applied in fish fecundity work; the absolute fecundity which is the total number of mature eggs in the ovary and the relative fecundity which is the number of eggs per unit length or weight of the fish (Nikolsky, 1963).

Fecundity was estimated by counting all ripe eggs found in the ripe female ovary just prior to spawning season. Fish ovary was put in small divided Petri-dish; ova were separated from the ovarian tissues, all ripe ova were counted under a binocular microscope. Fish length and total weight were recorded separately for each individual fish and plotted graphically against fecundity. The relationships between these variables and fecundity were estimated according the following formula:

Log F = a ± b Log x (Bagenal, 1978)

Where F = absolute fecundity;

X = independent variables;

a = constant;

b = an exponent.

RESULTS

1- The maturity stages: Gonad morphology

Gonads of both sexes of *Diplodus noct* were highly variable in morphology at different seasons; this is a result of the annual reproductive cycle. Testes are paired flattened and multilobular structure, grayish white in immature and spent specimens, white in developing and active stage. The highest weight reached 5.11 gm (5.74% of the body weight).

Stage I: Virgin and resting:

Testis small, thin and transparent to grayish white, one third of body cavity.

Stage II: Developing:

Testis increases in size, showing a lateral thickening, a marginal increase in length and is a grayish white colour. Sperm visible in main sperm duct if cut, half of body cavity.

Stage III: Active:

Testis creamy white with sperm in the main sperm duct and the tissue. As the breeding season progresses the testis become pinkish, third quarter of body cavity.

Stage IV: Post spawning: testis decreases marginally in size, is reddish gray in colour with no sperm in the tissue but still present in the main duct, full of body cavity.

Females: The ovaries are paired structures, tightly fused together posterior but free interiorly. They extend forward while growing. They are flattened in shape and slightly tapering. Immature and spent ovaries are pink in colour, becoming swollen and developing and active stages and reddish average in colour. The highest weight reached 7.13 gm (6.96% of the body weight).

Stage I: Virgin and resting: Ovary small, long and thin, pink in colour with no visible eggs, one third of body cavity.

Stage II: Developing: ovary increases in size, particularly on the long axis, to half or more of the visceral cavity length. Colour changes from pink to reddish orange and eggs are visible to the naked eye, half of body cavity.

Stage III: Active: Ovary is swollen and yellow-orange and translucent. Eggs are visible in tissue and lumen. May be slightly flaccid and bloodshot if spawning has taken place, third quarter of body cavity.

Stage IV: Post spawning: ovary decreases considerably in size, flaccid and has a large empty lumen. Reddish – orange colour with few clear eggs visible, full of body cavity.

2- Sex ratio

Generally, there is a tendency for more females (206 fish, 51.9%) than males (191 fish, 48.1%) for the whole population. Overall sex ratio was 1 : 1.08 for males to females (Table 1). The sex ratio was not constant throughout the different months; the numbers

Table (1): *Monthly variations in sex ratio of* Diplodus noct *from the South Sinai, Gulf of Suez and Red Sea throughout the period from January to December 2004.*

Months	No. of fish	No. Males	% Males	No. Females	% Females	Sex ratio
Jan.	49	24	49.0	25	51.0	1 : 1.04
Feb.	27	14	51.9	13	48.1	1 : 0.92
Mar.	48	24	50.0	24	50.0	1 : 1.00
Apr.	9	2	22.2	7	77.8	1 : 3.50
May	29	15	51.7	14	48.3	1 : 0.93
Jun.	42	18	42.9	24	57.1	1 : 1.33
Jul.	49	21	42.9	28	57.1	1 : 1.33
Aug.	17	8	47.1	9	52.9	1 : 1.12
Sep.	9	5	55.6	4	44.4	1 : 0.80
Oct.	32	17	53.1	15	46.9	1 : 0.88
Nov.	46	28	60.9	18	39.1	1 : 0.64
Dec.	40	15	37.5	25	62.5	1 : 1.66
Total	397	191	48.1	206	51.9	1 : 1.08

of females exceed males in all months except in July and December. The maximum percentage of females was recorded in April (77.8%), whereas in November (60.9%) males had the maximum percentage.

3- Monthly distribution of maturity stages:

The monthly variation of sexual maturity stages for both sexes *Diplodus noct* throughout the period from January to December 2004 is shown in figure (3). Males were virgin / resting testes (stage I) in April (100%), while the percentage were fluctuated during May, June, July, August, September and October, (93.3%, 94.4%, 52.4%, 62.5, 80% and 70.6% respectively). The active testes appeared in November by 50% and were also recorded during December, January, February and March. Post spawning (stage IV) testes amounted to 73.2% in February and 54.2% in March.

Females with a virgin / resting (stage I) were dominant during March, April, May, June, July, August, September and December, with low percentage in January to February. Developing ovaries were present in July till January, dominant in October by 100%. The active ovaries (stage III) appeared in November by 66.6%, continued in December by 47%, reaching the maximum value in January by 80%.

The percentage distribution of immature and mature fish for each length group was used to determine the size at onset of sexual maturity. All males longer than 13.9 cm in total length are mature. All females longer than 15.9cm in total length are mature. Table 2 shows that male *Diplodus noct* smaller than 11 cm are all immature fish, whereas female smaller than 12cm are all immature fish.

4- The length at First sexual maturity

Table (2): *Percentage frequency distribution of mature and immature fishes per length groups of Diplodus noct from the South Sinai, Gulf of Suez, Red Sea throughout the period from January to December 2004.*

Sex	Males				Females			
	Immature		Mature		Immature		Mature	
Length groups(cm)	No.	%	No.	%	No.	%	No.	%
10-10.9	1	100						
11-11.9	13	52	12	48	6	100		
12-12.9	8	47.1	9	52.9	8	66.6	4	33.3
13-13.9	9	39.1	14	60.9	3	30	7	70
14-14.9			19	100	2	25	8	75
15-15.9			9	100	7	26.9	19	73.1
16-16.9			83	100			6	100
17-17.9			1	100			3	100
18-18.9			1	100			3	100
19-19.9			1	100			3	100
20-20.9							3	100

No.= number of specimens

The percentage of mature male increases to 52.9% at length group 12-12.9cm, while the percentage of mature female increase to 70% at length group 13-13.9cm (Fig.2).

Gonadosomatic indces (GSI)

The monthly changes in GSI are represented in figure (4). *Diplodus noct* have a long spawning season which extends from November to March. GSI male was lower than that of female. In male, gradual increase in were recorded in June (0.31) reach1.29 in October, then increased sharply from November (1.42) to March (2.16). The maximum average value for males GSI was recorded in January (3.01). In females the average GSI values were increased in November (3.13), December (4.09) to reach a maximum value in January (5.05) and February (4.96) with in March (2.99) then decreased sharply in April (0.87) till September (1.74).

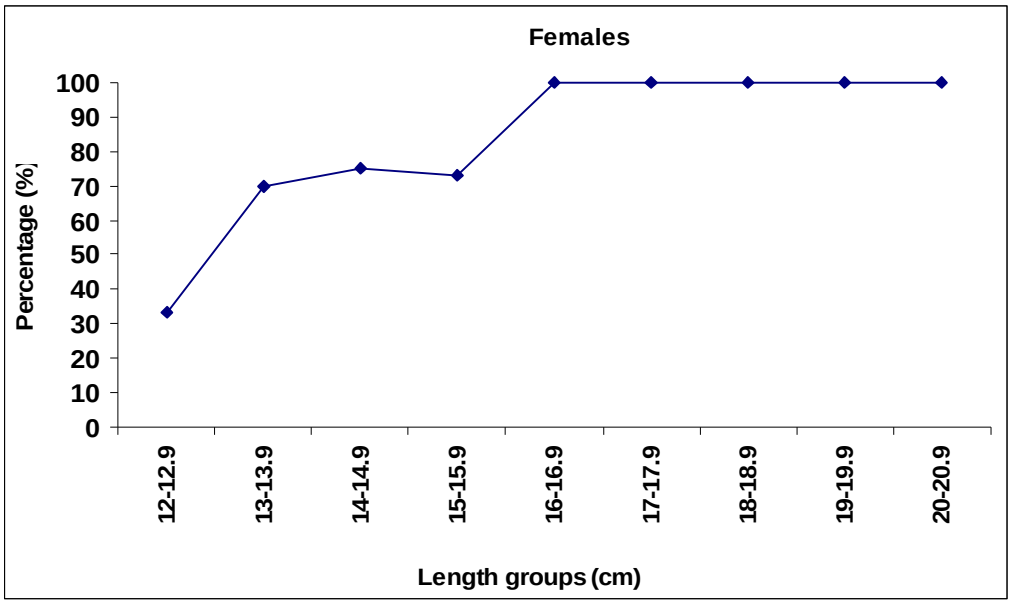

Fig. (2): *Length at first maturity of* Diplodus noct *from the Southern Sinai, Gulf of Suez, Red Sea throughout the period from January to December 2004.*

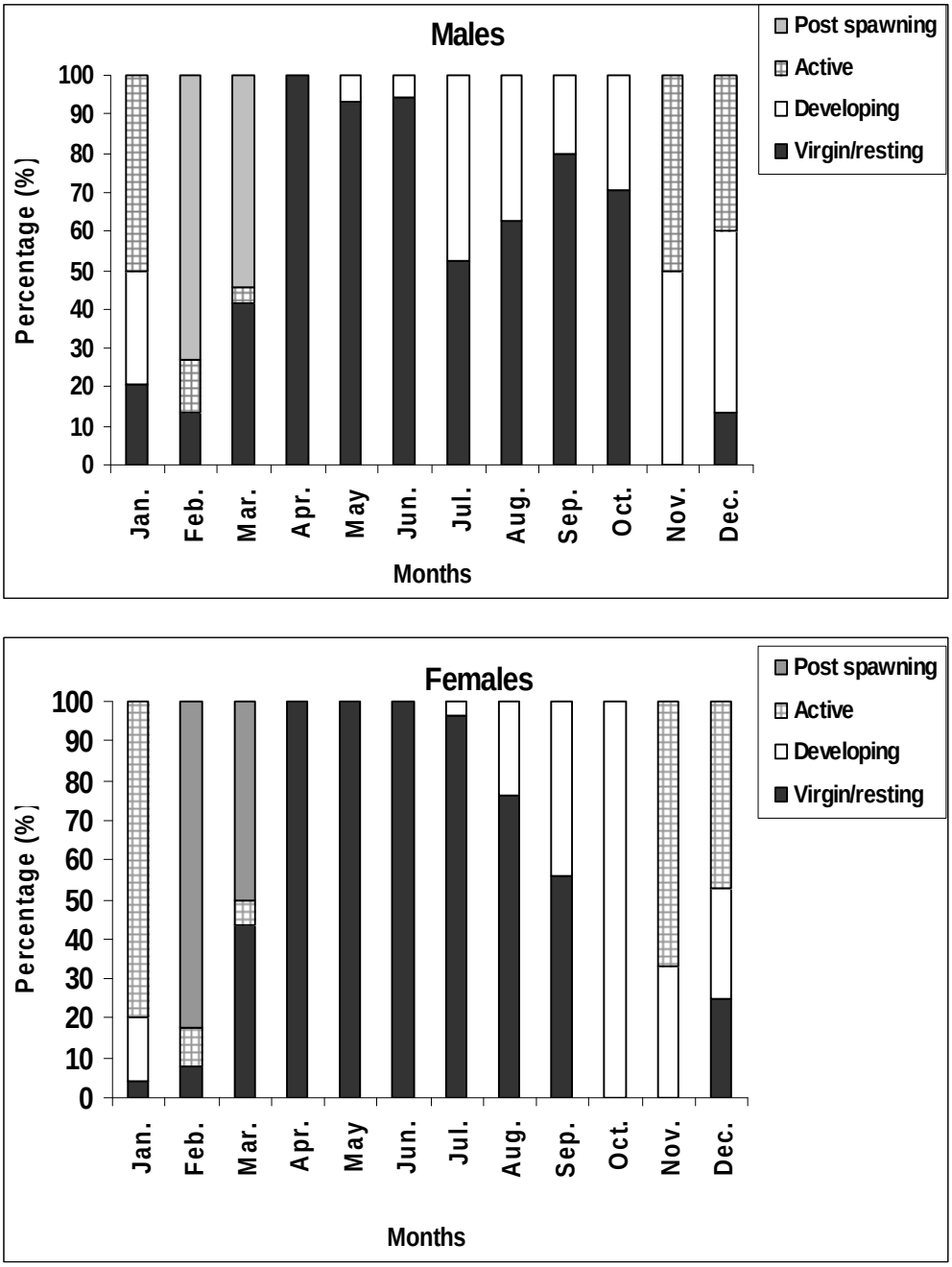

Fig. (3): *Monthly changes in the stages of sexual maturity in* Diplodus noct *from the Southern Sinai, Gulf of Suez, Red Sea throughout the period from January to December 2004.*

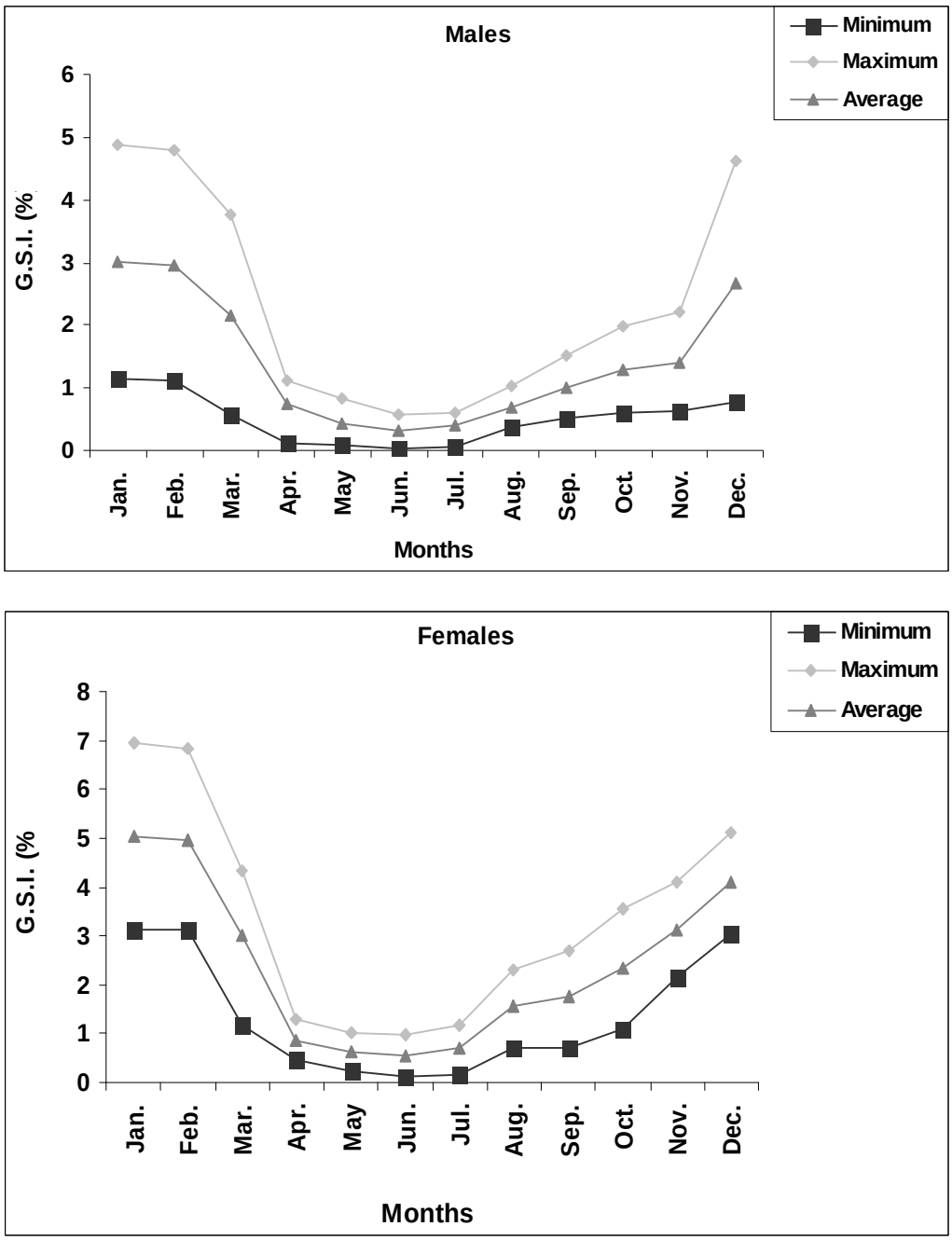

Fig. (4): *Monthly variations in the average gonado-somatic indces of* Diplodus noct *from the Southern Sinai, Gulf of Suez, Red Sea throughout the period from January to December 2004.*

Oocyte diameters

The recorded average oocyte diameters of *Diplodus noct*, during the whole period of the study were represented in table (3). The minimum average oocyte diameter was recorded in July (209 µ), a sharp increase in the average oocyte diameter was evident in August (311 µ) and this increased continued in the following months, reaching the maximum value in January (468 µ)) with an average of (411 µ)). The egg diameters in fish samples were very minute and difficult to measure in the period from April till June.

Fecundity

Ovaries of 42 *Diplodus noct* were examined. The smallest mature female had a total body length of 12.3cm and body weight of 32.4 g. Its ovary weight 1.88 g. (0.058% of the body weight).

Table (3): *Monthly variations of oocyte diameters of Diplodus noct from the South Sinai, Gulf of Suez, Red Sea throughout the period from January to December 2004.*

Months	Number of fish	Egg-Diameters (µ)		
		Minimum	Maximum	Average
Jan.	24	366	468	411
Feb.	12	253	398	364
Mar.	12	201	322	305
Apr.	7	-	-	-
May	14	-	-	-
Jun.	24	-	-	-
Jul.	2	164	277	209
Aug.	3	188	379	311
Sep.	2	204	399	326
Oct.	15	211	405	346
Nov.	18	256	411	363
Dec.	18	314	418	398

- = *The egg diameters were very minute and difficult to measure*

with absolute fecundity of 533 ripe eggs. The largest female had a total body length of 21.1cm and body weight of 102.5gm. Whereas its ovary weight was 7.13gm and its absolute fecundity were 5844 ripe eggs.

The relationship between the length and absolute fecundity of *Diplodus noct* is given in table (4) and figure (5). The absolute fecundity of females ranged from 539 to 5112 with an average of 3503 ripe eggs/fish and with an average relative fecundity length of 197 ripe eggs/cm. It is clear that absolute and relative fecundity increased with the increase of total length. Data of absolute fecundity with total length are represented by the following equation:

$$F = 0.0217 \text{ X } L^{4.2025}$$

The relation is highly significant and a correlation coefficient of 0.7811.

Table (4): *Relation between fecundity and total length (cm) of Diplodus noct from the Southern Sinai, Gulf of Suez, Red Sea, throughout the period from January to December 2004.*

Total length (cm)			Absolute Fecundity				Relative Fecundity
Range	Average length	No.	Minimum	Maximum	Observed average	Calculated	F/T.L. (cm)
11.9-13.1	12.5	3	533	544	539	564	43
13.2-14.4	13.8	5	911	1232	1171	840	85
14.5-15.7	15.1	13	2496	3788	3514	1207	233
15.7-16.9	16.3	7	3100	4259	3763	1643	231
16.9-18.1	17.5	5	4123	4789	4396	2186	251
18.1-19.3	18.7	4	4475	4986	4570	2855	244
19.3-20.5	19.9	4	4633	5016	4966	3667	250
20.5-21.7	21.1	1	5112	5112	5112	4642	242

No. = number of specimens
T.L. = total length

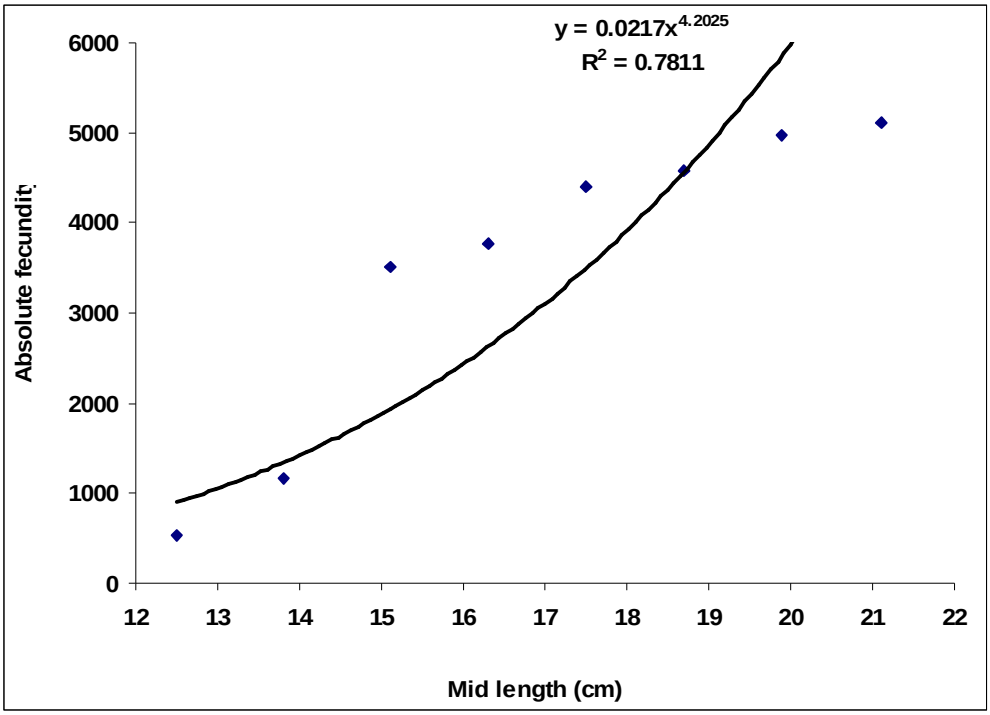

Fig. (5): *Relation between mid length and absolute fecundity of Diplodus noct from the Southern Sinai, Gulf of Suez, Red Sea throughout the period from January to December 2004.*

Results of the relationship between the absolute fecundity and body weight of *D. noct* are given in table (5) and figure (6). Absolute fecundity ranged from 725 to 5898 with an average of 4023 ripe eggs / fish and with an average relative fecundity weight of 53 ripe eggs / gm. it is clear that the fecundity increased with increasing of body weight. The regression relationship is represented by the following equation:

$$F = 2.7099 \text{ X } W^{1.6945}$$

Where, F is absolute fecundity and W is the total body weight. The relationship is highly significant with correlation coefficient of 0.8112.

Table (5): *Relation between fecundity and total body weight (gm) of Diplodus noct from the Southern Sinai, Gulf of Suez, Red Sea, throughout the period from January to December 2004.*

Total weight (gm)			Absolute Fecundity				Relative Fecundity F/T.W. (gm)
Range	Mean	No.	Minimum	Maximum	Observed average	Calculated	
31.0-42.9	36.8	6	511	814	725	1220	20
43.0-54.9	49.1	8	2100	2987	2483	1988	51
55.0-66.9	52.3	11	2978	3785	3230	2213	62
67.0-78.9	73.1	3	3997	5789	5137	3903	70
79.0-90.9	83.8	9	4652	5448	5230	4919	62
91.0-102.9	97	5	4888	5963	5460	6302	56
103.0-114.9	109.5	4	5585	5911	5898	7740	54

No. = number of specimens
T.W. = total weight

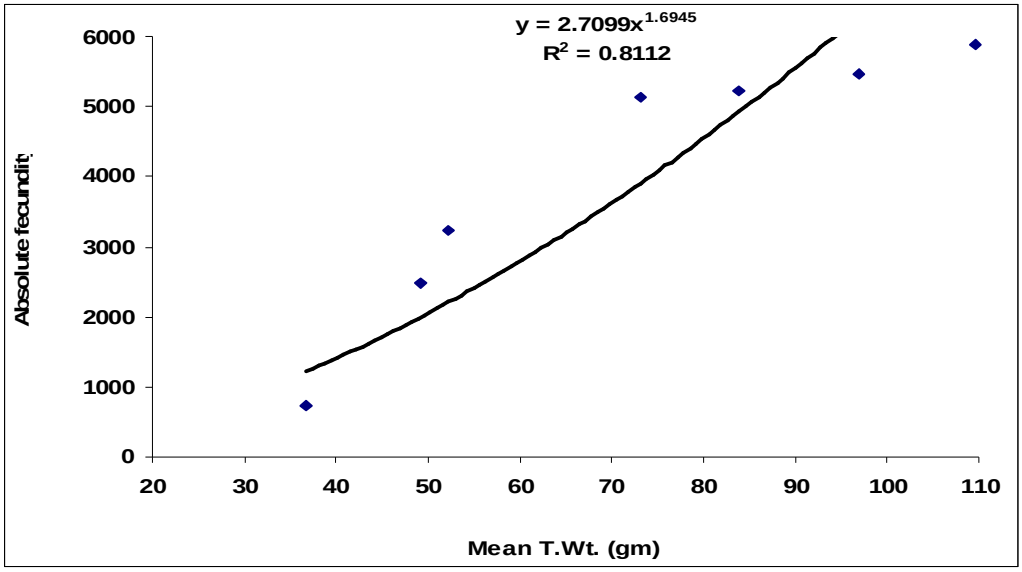

Fig. (6): *Relation between mean total weight and absolute fecundity of* Diplodus noct *from the Southern Sinai, Gulf of Suez, Red Sea throughout the period from January to December 2004.*

DISCUSSION

Sparid fishes inhabit tropical and temperate coastal waters. They are found near the shore in shallow inlet and bays less often at moderate depths (Bauchot and Smith, 1983, Chaves and Mesegur, 2005). *Diplodus noct* (Valenciennes, 1830) occupy sandy lagoons or marsh environments in the Red Sea and this species is the most common in the area of study (Ormond and Edwards, 1987). Sparid fishes are in the second category importance for the artisanal fishing from South Sinai coast, on the Gulf of Suez, representing about 23.5% of the total catch of the fishing area (Azab, *et al.*, 1998). In the present work, the overall sex ratio was 1 : 1.08 for males and females of *Diplodus noct* and these results are in agreement with those of *D. noct* in Kuwait Bay waters (1 : 1.07) recorded by Abou-Seedo *et al.* (1990) and in full agreement with sex ratio of gonochoristic sparids (Nepgen, 1977; Dooley, 1978; Cody and Bortone, 1992; Al-Oraimi, 1996; Ahmed, 1999; Chilari and Evaggelos, 2006 and Abugrara, 2008). The sex ratio was not constant throughout the different months, particularly during the breeding season of each species (Oren, 1975). In the period from September till November (before or ready of the spawning season), the males of *Diplodus noct* were dominant than the females and this agreement with Al-Oraimi, 1996 and Ahmed, 1999 in sparid populations. Also these phenomena arise in other fish species such as mullets (Broadhead, 1953; Peterson & Shehadeh, 1971; Mohammad, 1982; El-Mor, 1993 and Abugrara, 2008). In addition, Wijeyaratne and Costa (1986) concluded that it is possible that males of grey mullets are more active before spawning season and get caught in the gear in

large numbers, resulting in an unbalanced sex ratio.

Generally, in the natural fish community males mature first before the females, and are ready to participate in spawning activity (Broadhead, 1958; Bralhet, 1975; Mohammad, 1982 ; El-Mor, 1993 ; Chaves and Mesegur, 2005). The first appearance of mature males was recorded at length group (11-11.9cm) by 48% and the smallest male of *D. noct* attained its first maturity at the total body length of 12.2cm. On the other hand, the first sign of mature females was recorded at length group of 12-12.9cm representing 33.3% of the females examined and the first sexual maturity of the female was attained at size at which 50% of females were mature could be taken as 13.0cm. This agrees with what have been recorded by Abou-Seedo *et al*. (1990) in *D. noct*.

In the present study, the average gonad somatic indices (GSI) of males were lower than those of females. The males and females of *D. noct* have a definite breeding season, which extends from November till March with maximal G.S.I. (3.01 and 5.05) in January for males and females, respectively. Ahmed (1992) stated that the recruitment of *D. noct* juveniles of Southern Sinai continued from February till July. This is an agreement with the spawning season of *D. noct* in the present study. The increase in GSI during the breeding season is mainly due to the deposition of large amounts of proteins and lipids in the developing eggs and spermatozoa. A part of these materials comes directly from ingested food but a major proportion comes from reserve of food deposits, during the active season, in the organs such as liver,

muscles and fat bodies (Larson, 1974).

In the current work, the increase in the oocyte diameters of *D. noct* was evident in July with an average of 209 µ and this increase continued in the following months till January, with a maximal average value of 411 µ. In the period from April till June, all fish samples were immature and the egg diameters were very minute and difficult to measure. These results coincide with those recorded by Abou-Seedo *et al*. (1990) in *D. noct*, who stated that the egg diameters reached 283 µ and 477 µ in July and January, respectively.

The number of eggs produced by females varies greatly according to species , size, age, region, period and techniques used, thus a considerable variability has been shown in different populations of mullets (Oren, 1975 ; Chaves and Mesegur, 2005).

Abou-Seedo *et al*. (1990) found that the absolute fecundity ranged from 641 to 6111 for females ranging from 12.9 to 23.9cm in total length; also the fecundity increased from 842 to 6445 with the increase in weight from 38.8 to 123.3 gm. In the present study, the absolute fecundity of 42 ripe females ranged from 539 to 5112 with the growth in length from 12.5 to 21.1cm. Also, the fecundity increased from 725 to 5898 with the increase in weight from 36.8 to 109.5gm.

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REPRODUCTIVE BIOLOGY OF *DIPLODUS NOCT* FROM RED SEA, EGYPT

بيولوجية التكاثر لسمكة أبو دقه – (دايبلوتس نقط) في سيناء الجنوبية– خليج السويس – البحر الأحمر

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تم دراسة بيولوجية تكاثر سمكة دايبلوتس نقط من عائلة الأسبرادى وهى من أسماك البحر الأحمر والقاطنة خليج السويس – ولقد أوضحت الدراسة أن أعداد الإناث أكبر من الذكور وأن نسبة الذكور إلى الإناث 1 : 1.08. كما أظهرت الدراسة أن أقل حجم للنضج الجنسي للذكور هو 12.2 سم في حين أن اقل حجم للنضج الجنسي للإناث هو 13.0 سم كما دلت الدراسة أن هذا النوع له موسم تكاثر محدد يبدأ من شهر نوفمبر حتى شهر مارس. وقد أوضحت الدراسة أن هناك زيادة ملحوظة في حجم البويضات في شهر يوليو (209 ميكرون) واستمرت الزيادة في الشهور التالية لتصل البويضات لأقصى حجم لها في شهر يناير (468 ميكرون) بمتوسط (411 ميكرون) . وتبين أن الخصوبة المطلقة تراوحت بين 539 وحتى 5112 بالنسبة للأطوال من 12.5سم وحتى 21.1سم وتتراوح الخصوبة المطلقة بين 725 وحتى 5898 للأوزان مابين 36.8جرام و 109.5جرام وقد أظهرت الدراسة أن هناك تباينا ملحوظا بين عدد البويضات لكل من أطوال وأوزان أسماك هذا النوع.