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MATURATION, SPAWNING AND FECUNDITY OF TWO SPARID FISH DIPLODUS SARGUS,L. AND DIPLODUS VULGARIS,GEOFF. IN THE EGYPTIAN MEDITERRANEAN WATERS.

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ABSTRACT

The spawning seasons of both **Diplodus sargus** and **Diplodus vulgaris** are appointed. The probability of fractional or prolonged spawning habit is discussed. Size and age at first sexual maturity were studied. Absolute and relative fecundities were estimated according to fish length, weight and age.

INTRODUCTION

Diplodus sargus and **Diplodus vulgatris** are common throughout the Mediterranean. They are found on the eastern Atlantic coasts from the British Isles to the Cape of Good Hope and also found along the South African coats of the Indian Ocean (Fowler, 1936). Inspite of their wide distribution, the biology of these fish species have received very littel studies.

The present work aims to gain more information about the maturity, reproduction and fecundity of the two species. This may be useful for the management of their fisheries in our waters.

MATERIAL AND METHODS

All the material used in the present study were obtained from the commercial catch of Anfoushi and Abukir fish markets, Alexandria, during the period from October 1969 to July 1970. For both **Diplodus sargus** and **Diplodus vulgaris** the total body length was measured to the nearest millimeter and the total, as well as the gutted, weights were recorded for every fish to the nearest gram. Scales were also taken for age determination, and the maturity stages were determined according to Cassie's Code (1956). Gonads were carefully removed and weighed to the nearest milligram, and placed in 10% neutral formalin solution. After hardening for at least 48 hours, the ovaries were thoroughly washed in water. Both lobes were then dried to constant weight. The number of

eggs in both lobes were estimated by counting a weighed sample and the count was adjusted to the total ovary weight. Egg diameters of the subsample were also measured.

RESULTS AND DISCUSSION

Maturation and Spawning:

The percentage distribution of the different maturity stages for **Diplodus sargus** and **Diplodus vulgaris** are given in Tables (1) and (2), respectively. It is evident that the spawning season, as indicated from the first appearance of ripe individuals in the catch, differs according to the species. The spawning season of **Diplodus vulgaris** however is during winter, fish spawns from November to February with a peak in January, while **Diplodus sargus** is a spring spawner; its spawning period extends from January to the end of April with a peak in March.

Gonadosomatic Index:

The percentage of gonad weight to gutted fish weight is referred to as gonadosomatic index and is used as an indication to the spawning season. Variations of gonadosomatic index of the two species during their spawning season are shown in Tables (3) & (4) for **Diplodus sargus** and **Diplodus vulgaris** respectively.

It is clear that the climax of the breeding activity in **Diplodus vulgaris** coincided in both sexes, while in **Diplodus sargus,** the peak of maturation of males comes a month later than in females. The gonadosomatic indices of males are generally less than those of females, but sometimes they become nearly or even exceed those of females. The percentage distribution of gonadosomatic indices is in accordance with the percentage distribution of the different maturity stages previously given in Tables (1) & (2), and so both results verify each other.

Breder and Rosen, (1966) stated that **Diplodus vulgaris** on the Algerian coasts have two spawning seasons, and they attempted to relate this fact to the particular conditions of temperature and salinity prevailing there. However; in Alexandria waters, the data showed that it spawns once a year but over a long period of time.

Probability of Fractional Spawning:

The ripe overies of the two species under investigation contain yolked ova of two or more size groups, with no sharp separation between them. This means, according to Hickling & Rutenberg (1936), that the mature fish discharges its ova in batches during the spawning period. The withdrawal of eggs from the egg-stock to undergo maturation will be a continuous process and there will be no sharp separation between the general eggstock and the maturing eggs. Macgregor (1957), discussed the probability of multiple spawning in Pacific Sardine **(Sardinella caerulea)** and pointed out that the presence of two or more modes in the size

TABLE (1)

The percentage distribution of different maturity stages during the spawning season of **Diplodus Sargus.**

Month	Percentage (Females)						Percentage (Males)					
	Mature	N.Ripe	Ripe	Spent partially	Spent completely	N.Nof Fish	Mature	N.Ripe	Ripe	Spent partially	Spent completely	No. of Fish
December	92.31 (36)	7.69 (3)	-	-	-	39	68.18 (15)	31.82 (7)	-	-	-	22
January	44.00 (11)	32.00 (8)	24.00 (6)	-	-	25	72.72 (8)	72.72 (8)	27.28 (3)	-	-	11
February	-	36.00 (9)	64.00 (16)	-	-	25	-	50.00 (8)	50.00 (8)	-	-	16
March	-	-	88.89 (24)	11.11 (3)	-	27	-	-	94.44 (34)	5.56 (2)	-	36
April	-	-	43.50 (10)	34.77 (8)	21.73 (5)	23	-	-	50.00 (8)	25.00 (4)	25.00 (4)	16
May	-	-	-	-	100 (14)	14	-	-	-	-	100 (14)	14
Total number of fish						153						115

TABLE (2)

The percentage distribution of different maturity stages during the spawning season of **Diplodus vulgaris.**

Month	Percentage (females)						Percentage (males)					
	Mature	N.Ripe	Ripe	Spent partly	Spent Compl.	No. of Fish	Mature	N.Ripe	Ripe	Spent partly	Spent Compl.	No. of Fish
October	22.72 (5)	77.28 (17)	-	-	-	22	16.67 (5)	83.33 (15)	-	-	-	18
November	-	19.04 (4)	80.96 (17)	-	-	21	27.78 (5)	72.22 (13)	-	-	-	18
December	-	-	100 (29)	-	-	29	-	11.53 (3)	88.47 (23)	-	-	26
January	-	-	100 (41)	-	-	41	-	-	100 (33)	-	-	33
February	-	-	-	62.50 (5)	37.50 (3)	8	-	-	-	80.00 (8)	20.00 (2)	10
March	-	-	-	50.00 (20)	50.00 (20)	40	-	-	-	33.30 (9)	66.60 (18)	27
April	-	-	-	-	100 (13)	13	-	-	-	-	100 (10)	10
Total number of fish						174						142

TABLE 3
Variation of gonad index during the spawning season of **Diplodus sargus** (number of fish between brackets).

Month	C.I. (Females)			C.I. (Males)		
	Minimum	Maximum	Average	Minimum	Maximum	Average
December	0.89	3.36	1.85(4)	2.28	3.36	2.82(2)
January	3.02	6.68	4.98(8)	2.93	5.00	4.31(5)
February	3.09	8.33	5.90(5)	4.22	6.08	5.15(2)
March	1.33	7.69	4.30(19)	4.02	7.25	5.87(4)
April	2.15	5.80	3.10(6)	-	-	4.00(1)
May	1.32	2.58	1.95(2)	-	-	2.50(1)

TABLE 4
Variation of gonad index during the spawning season of **Diplodus vulgaris** (number of fish between brackets).

Month	C.I. (Females)			C.I. (Males)		
	Minimum	Maximum	Average	Minimum	Maximum	Average
October	1.17	2.33	1.50(3)	-	-	-
November	2.32	6.72	3.86(13)	1.04	3.83	2.41(12)
December	3.40	9.69	5.71(30)	3.33	5.96	4.51(12)
January	3.45	14.50	5.84(35)	2.69	7.88	5.06(20)
February	1.13	3.66	2.07(4)	-	-	3.00(1)
March	1.02	3.60	1.67(4)	-	-	-

distribution of the developing eggs may indicate that multiple spawning will occur but does not necessarily mean that all groups of eggs mature.

Nikolsky (1963) stated that the occurrence of small eggs together with large ones in the ovary does not always indicate fractional spawning and in many fish the small eggs remain in the ovary after spawning and are gradually resorbed.

Higham & Nicholson, (1964)& Yoshida, (1966) stated that the presence of two or more modes of the ova size freqency in the ovary shortly before spawning has been accepted as indicating either a long spawning season or a fractional-spawning character.

On the basis of egg diameter measurements in the fully ripe ovaries, the probability of fractional spawning in the two species were tested throughout their breeding periods. Due to the difficulty in distinguishing between the modes in the graphs (Fig. 1 & 2), it is more reasonable to say that, the two species were characterized by a prolonged spawning rather than a fractional spawning habits.

Size and Age at First Maturity:

A knowlege of the size and age at first maturity has its practical application in determining the minimum size, or age that may be needed to protect an adequate spawning stock and to ensure at least one spawning for mature individuals. However, Love (1970) has pointed out that many fish mature when they reach a critical size rather than a particular age.

In the present study, gonads were examined all the year round, and the data obtained for **Diplodus sargus** and **Diplodus vulgaris** in relation to fish length are respectively given in Tables (5 & 6). It is obvious that in **Diplodus sargus,** fish smaller than 165 mm. in length are always immature and the frequency of mature individuals increased with increase of fish length and all fish over 195 mm. are mature. For **Diplodus vulgaris,** fish smaller than 155 mm. are always immature, while all fish over 175 mm. are sexually mature.

As regards the age at first sexual maturity, it has to be mentioned that both of the two species should pass their first year of life before attaining sexual maturity. This is attained in some fishes during the second year of life but all fish were found to be sexually mature during their third year of life.

Fecundity

Fecundity / Length :

Many investigators working on the fecundity of fish showed that in many species the fecundity increases with the size of fish. The mean observed

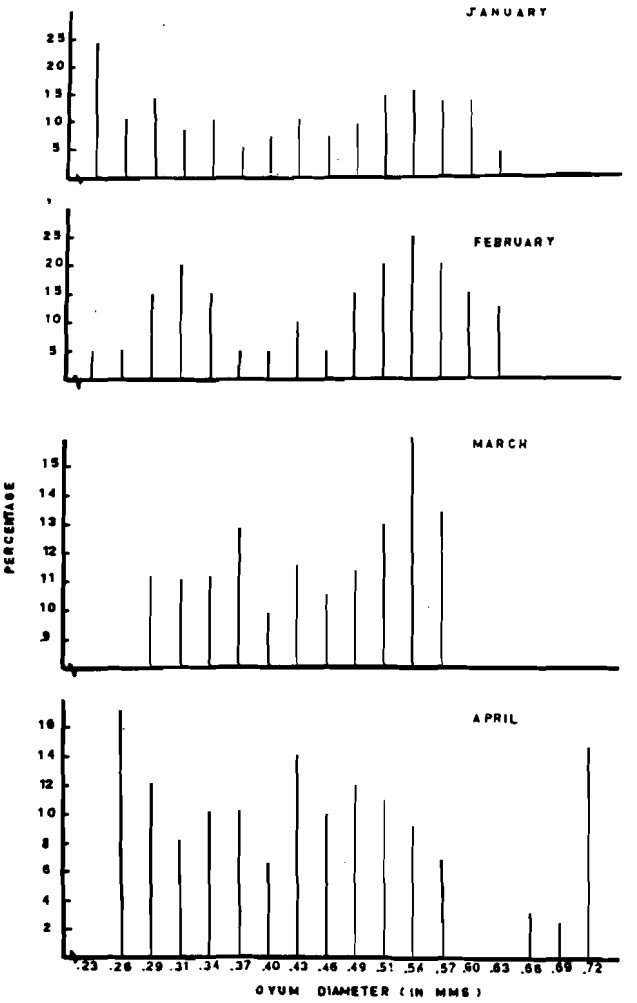

Fig. (1)
Ovum diameter frequencies distribution during the spawning season of **Diplodus sargus.**

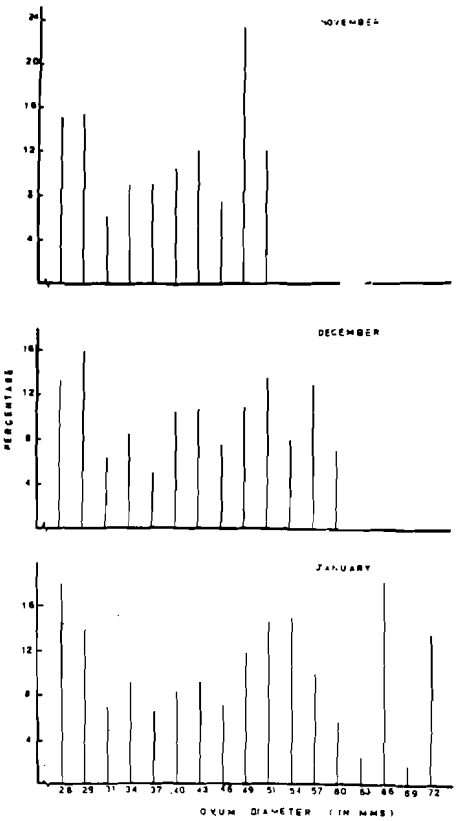

Fig. (2)
Ovum diameter frequencies distribution during the spawning season of **Diplodus vulgaris.**

Table (5)

Length of first sexual maturity of **Diplodus sargus.**

Length range (mm)	Number of specimens	% Females		Number of specimens	% Males	
		Immat.	Mature		Immat.	Mature
155-164	6	100	-	6	100	
165-174	7	86.0	14.0	12	66.67	33.33
175-184	10	60.0	40.0	8	50.00	50.00
185-194	4	25.0	25.0	6	16.67	83.33
195-204	10	-	100	10		100

Table (6)
Length of first sexual maturity of **Diplodus vulgaris.**

Length range (mm)	Number of specimens	% Females		Number of specimens	% Males	
		Immat.	Mature		Immat.	Mature
145-154	4	100	-	5	100	
155-164	3	66.67	33.33	8	62.50	37.50
165-174	4	25.00	75.00	7	28.57	71.43
175-184	3	100	100	2	100	100

number of eggs in different length groups of respectively **Diplodus sargus** and **Diplodus vulgaris** are given in Tables (7) & (8) . It is obvious that the number of eggs produced by each species rises with the increase of fish length.

The data of fecundity against length showed a linear trend on a log.log.plot for the two species. This indicates that a simple allometry formula on logarithmic basis would hold in each case and the following equations were derived expressing the relation between fecundity and fish length:

$\log F_A = -1.8923 + 2.9195 \log L$ for **Diplodus sargus,** and
$\log F_A = -4.6600 + 4.1450 \log L$ for **Diplodus vulgaris.**

It is thus evident that egg production in relation to fish length is higher in **Diplodus vulgaris** than in **Diplodus sargus.** For the former species both the observed and calculated fecundity are generally higher than that of the latter species at the corresponding length. However, the data for **Diplodus sargus** should be regarded with some caution since they are based on fewer number of females.

As regards the relative fecundity of the two species in relation to fish length, the following equations are obtained:

$\log F_R = -1.0302 + 1.9741 \log L$ for **Diplodus sargus,** and
$\log F_R = -3.6530 + 3.1421 \log L$ for **Diplodus vulgaris.**

A good agreement between the observed and calculated values of the relative fecundity is obvious, indicating the fitness of the equations arrived at. It is also evident that for the two species the relative fecundity increases with the increase in fish length and the values are considerably lower in **D. sargus** than in **D. vulgaris** at the corresponding length groups.

Fecundity / Weight:

The relationship between fecundity and fish weight for **D. sargus** and **D. vulgaris** are respectively given in Tables (9) & (10). It is clear that the number of eggs produced by each of these species increases with the increase in fish weight. A linear relationship was however evident between the values of egg number and fish weight. Therefore, regression equation was calculated directly by the least square method, and the resultant equations are:

$F_A = -15.2500 + 0.4651 W$ for **D. sargus,** and
$F_A = -27.6310 + 0.8365 W$ for **D. vulgaris.**

As regards the relative fecundity of the two species in relation to fish weight, a clear linear trend is also observed, and the formulae experssing these relationship are:

TABLE (7)

Relation between Fecundity and Length of **Diplodus sargus**.
(Number of fish in parentheses)

(Mean) Length (mm)	Absolute Fecundity		Relative Fecundity	
	Observed	Calculated	Observed	Calculated
190 (2)	67,772	57,620	3566.95	2941
200 (1)	72,846	66,910	3642.30	3253
210 (2)	92,582	77,160	3674.92	3582
220 (1)	100,390	88,370	4547.23	3925
230 (1)	112,809	100,700	4904.74	4285
240 (2)	116,173	114,000	4840.54	4662
250 (1)	119,723	128,300	4788.92	5053
260 (1)	128,807	144,000	4954.12	5462
270 (2)	136,639	160,800	5060.70	5883
280 (2)	140,244	178,700	5008.71	6322
290 (1)	145,807	198,000	5027.83	6774
300 (3)	155,286	218,600	5176.20	7241
310 (2)	168,454	240,600	5434.00	7729
320 (1)	231,991	263,800	7249.72	8224
330 (2)	306,049	288,700	8274.21	8742
340 (2)	346,907	315,100	10203.15	9272
350 (1)	419,900	343,000	11997.14	9797
360 (1)	457,153	372,200	12698.69	10380
370 (1)	494,406	403,200	13362.32	10960
380 (2)	505,276	435,900	13296.74	11550
390 (1)	525,494	470,300	13474.21	12160

TABLE (8)

Relation between Fecundity and length of **Diplodus vulgaris.**

(Number of fish in parentheses)

Mean length (mm)	Absolute Fecundity		Relative Fecundity	
	Observed	Calculated	Observed	Calculated
160 (1)	32,715	29,242	2044.7	1873
179 (1)	33,913	38,494	1994.9	2268
180	-	-	-	-
190 (5)	54,126	61,038	2848.7	3215
200 (7)	87,301	75,440	4365.1	3776
210 (10)	92,325	92,263	4396.4	4401
220 (20)	100,712	111,990	4577.8	5094
230 (20)	137,072	134,650	5959.7	5857
240 (10)	167,586	160,650	6982.8	6695
250 (8)	207,876	190,240	8315.0	7610
260 (1)	255,513	223,970	9827.4	8614
270 (1)	280,506	262,040	10389.1	9709
280	-	-	-	-
290 (1)	281,505	352,040	9707.1	12130

TABLE (9)

Relation between Fecundity and Weight of **Diplodus sargus**.

Mean Weight (gm)	No. of Fish	Absolute Fecundity		Relative Fecundity	
		Observed	Calculated	Observed	Calculated
130	1	67,772	45,213	521,32	441,00
150	1	72,846	54,515	485,64	441,78
163	2	92,582	60,561	569,74	439,88
170	1	100,039	63,817	588,47	439,46
230	1	112,809	91,723	490,47	441,68
270	2	116,173	110,327	430,27	443,04
280	1	119,723	114,978	427,58	443,10
315	1	128,807	131,257	408,91	443,52
350	2	136,639	147,535	390,40	443,94
414	2	140,244	177,301	335,19	445,18
435	1	145,807	187,068	335,19	445,18
463	3	155,286	200,091	335,17	445,19
582	2	168,454	255,438	289,44	446,22
591	1	231,991	259,624	392,54	443,89
710	2	306,049	314,971	431,05	443,02
736	2	346,907	327,064	471,66	442,10
907	1	419,900	406,596	462,95	442,30
950	1	457,153	426,595	481,21	441,88
1010	2	505,276	454,501	489,51	441,70
1100	2	505,276	496,360	459,34	442,38
1150	1	525,494	519,615	456,95	442,43

TABLE (10)

Relative between fecundity and weight of **Diplodus vulgaris.**

Mean weight (gm)	No. of Fish	Absolute Fecundity		Relative Fecundity	
		Observed	Calculated	Observed	Calculated
68.50	2	33,314	29,669	486,34	538.08
116.40	5	54,126	69,738	465,00	579,94
144.44	7	87,301	93,160	604,58	604,42
148.00	10	92,325	96,338	623,82	607,56
172.11	20	100,712	116,339	585,16	628,63
197.06	18	137,072	137,210	695,59	650,44
228.88	10	167,586	163,827	732,20	678,25
239.88	8	207,876	173,029	866,59	687,87
327.00	1	255,513	245,905	781,39	764,01
335.00	1	280,506	252,597	837,33	771,00
417.00	1	281,505	321,189	675,07	842,67

$F_R = 452.76 + 0.0226\ W$ for **D. sargus,** and
$F_R = 478.21 + 0.8740\ W$ for **D. vulgaris.**

Analysis of the data obtained shows that; the relative fecundity is nearly constant in almost all different weight groups recorded for **D. sargus,** while for **D. vulgaris** it increases slightly with the increase in fish weight.

Comparing the data of the two species, the values of relative fecundity is usually higher for D. **vulgaris** than that of D. **sargus** at the corresponding weights.

Fecundity / Age:

The relations between fecundity and age in D. **sargus** and D. **vulgaris** are respectively shown in Tables (11) & (12). These relations showed that in both fish species the fecundity increases with the increase in age. Therefore, these relations can be described according to Bagenal, 1957; Hodder, 1963 & May, 1967; in terms of the general allometry equation, i.e log fecundity against log age. In the present study the formulae expressing the relation between fecundity and age are:

Log F = 4.7266 + 0.1286 log Age for D. **sargus**, and
Log F = 4.8110 + 0.1245 log Age for D. **vulgaris**.

However, it has to be mentioned that the increase of fecundity with the increase in fish age, may be due to the increase in fish length or fish weight.

TABLE (11)

Relation between Fecundity and age of Diplodus

Age Group	Number of Fish	Absolute Fecundity	
		Observed	Calculated
II	5	77,733	71,640
III	4	109,673	96,340
IV	3	124,265	129,500
V	5	140,897	174,200
VI	6	185,244	234,200
VII	5	357,619	314,900
VIII	4	490,649	323,500
Total No. of Fish	32		

TABLE (12)

Relation between fecundity and age of **Diplodus vulgaris**.

Age Group	Number of Fish	Absolute Fecundity	
		Observed	Calculated
II	13	68,009	86,198
III	36	116,876	114,820
IV	23	188,083	152,940
V	1	255,513	203,700
VI	1	280,516	271,330
VII	1	281,505	361,410

SUMMARY

1- The spawning season of **D. sargus** in the South-eastern Mediterranean waters starts in January and continues till the end of April, while that of **D. vulgaris** starts in November and ends in February.

2- Examination of ripe ovaries of the two species revealed the presence of more than one size group of eggs. The probability of fractional spawning of the two species (**D. sargus** and **D. vulgaris**) were discussed and it was found to be more reasonable to say that the two species are characterized by a prolonged spawning rather than a fractional spawning habits.

3- **D. sargus** exert their first sexual maturity at length of 195-204 mm., while **D. vulgaris** become mature at 175-184 mm., in length. By referring those lengths to age groups, it is clear that the two species start first maturation during their second year of life.

4- The absolute and relative fecundity of the two species showed considerable variations according to fish-length or fish-weight. Regression equations were derived by the least squares method to express the fecundity-length and fecundity-weight relationship. As for fecundity-age relationship, it was also found that fecundity increases with the increase of fish age. However, this increase may be due to the increase of fish length or fish weight.

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