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TIMING OF SPAWNING AND FECUNDITY OF MEDITERRANEAN *Siganus rivulatus* FORSK.

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ABSTRACT

The collected samples of S. rivulatus collected during the period from May 1985 to May 1986 in Alexandria region showed that the onest of spawning starts in June with a magnitude extending to September. Spawning was determined from the gonosomatic index and egg diameter variations. Fecundity was found to range from 103.2 to 396.6 thousands for fish length between 15 to 28 cm, and was observed to be related to total fish length, fish weight and gonad weight. Diameter of yolked eggs ranged from 0.23 to 0.50 mm, with an average of 0.48 mm. The frequency of egg diameter showed that S. rivulatus is a monocyclic fish laying eggs once a year.

INTRODUCTION

Siganids are highly esteemed fish in several parts of the world. The successfull trials of induced spawning, rearing and farming of siganids made them as potential candidates for mariculture (George 1972, Soh and Lam 1973, Popper et al. 1973, May et al. 1974, Popper and Gundermann 1975 and Bryan and Madrasau 1977).

Although some siganids were successfully spawned in the laboratory (mainly, **S. oramin = S. canaliculatus**), there are few reports on the spawning in nature and on fecundity.

Reliable knowledge of timing and magnitude of spawning and fecundity represents a legitimate base for the development of an effective management strategy and further for the controlled collection of young demanded for mariculture. The expected numbers of recruits are mainly predicted by the numbers of developing eggs or fecundity. A count of yolked eggs is a common criterion to determine the fish fecundity. This criterion was used by Solomon et al 1984, Amin et al. 1984, and Hussein 1984.

The purpose of the present work is mainly concerned with the determination of time and magnitude of spawning and fecundity of Mediterranean **S. rivulatus.**

MATERIAL AND METHODS

From May 1985 to May 1986, regular monthly sampling of **S. rivulatus** was conducted in the vicinity of Eastern Harbour (Alexandria). Additional samples were also taken from the fish market. Total fish lengths were grouped in 1-cm intervals, and weights in 1-gm intervals. Gonads were weighed on a sensitive balance of 0.001 gm accuracy.

Maturity state of females ranged from resting to spent ovaries. For fecundity estimation, gravid females were chosen carefully so that only matured but unspawned fishes of different lengths and weights were taken. Fecundity estimation was done by counting the yolked ova of 43 specimens. The two lobes of an ovary were carefully removed and preserved in 5% formalin to permit hardening of ova to facilitate the counting. The gravimetric method was applied. Egg diameter was measured by an eye - piece micrometer at a magnification of X40.

The gonosomatic index was calculated for 180 females from the formula:

$$GSI = (\text{Gonad weight} / \text{Gutted fish weight}) \, 100$$

The spawning season was defined by following the monthly changes in both gonosomatic index and egg diameter.

RESULTS

Timing and magnitude of spawning

One of the reliable methods for determining the time and magnitude of spawning is the use of gonosomatic index (GSI) as an indication to ovarian development and consequently to the spawning season. This index was calculated (Table 1), and graphically represented in Fig. 1. The index began to increase from March where the mean of GSI and standard deviation was 1.5 $\pm$ 0.09. In April, a further increase was noticed (3.1 $\pm$ 0.33). In May, the GSI was still increasing, the mean and standard deviation was 5.1 $\pm$ 0.43. With the beginning of summer, a characteristic high value of GSI was obvious (12.6 $\pm$ 0.69). In July, it was 11.4 $\pm$ 0.64. A maximum GSI (15.1 $\pm$ 0.82) was denoted in August. In September, the GSI was still high amounting to 10.3 $\pm$ 0.51. In autumn and winter (October to February) a drastic fall in GSI occured.

From the above observations, it appears that **Siganus rivulatus** is a summer spawner, its spawning extends from June to September.

Fecundity

Potential annual fecundity for the season was given by the total number of those eggs which were yolked in mature ovaries during the spawning season (Table 2). The estimation of fecundity was made by utilizing the obtained information that the eggs are spawned once a year.

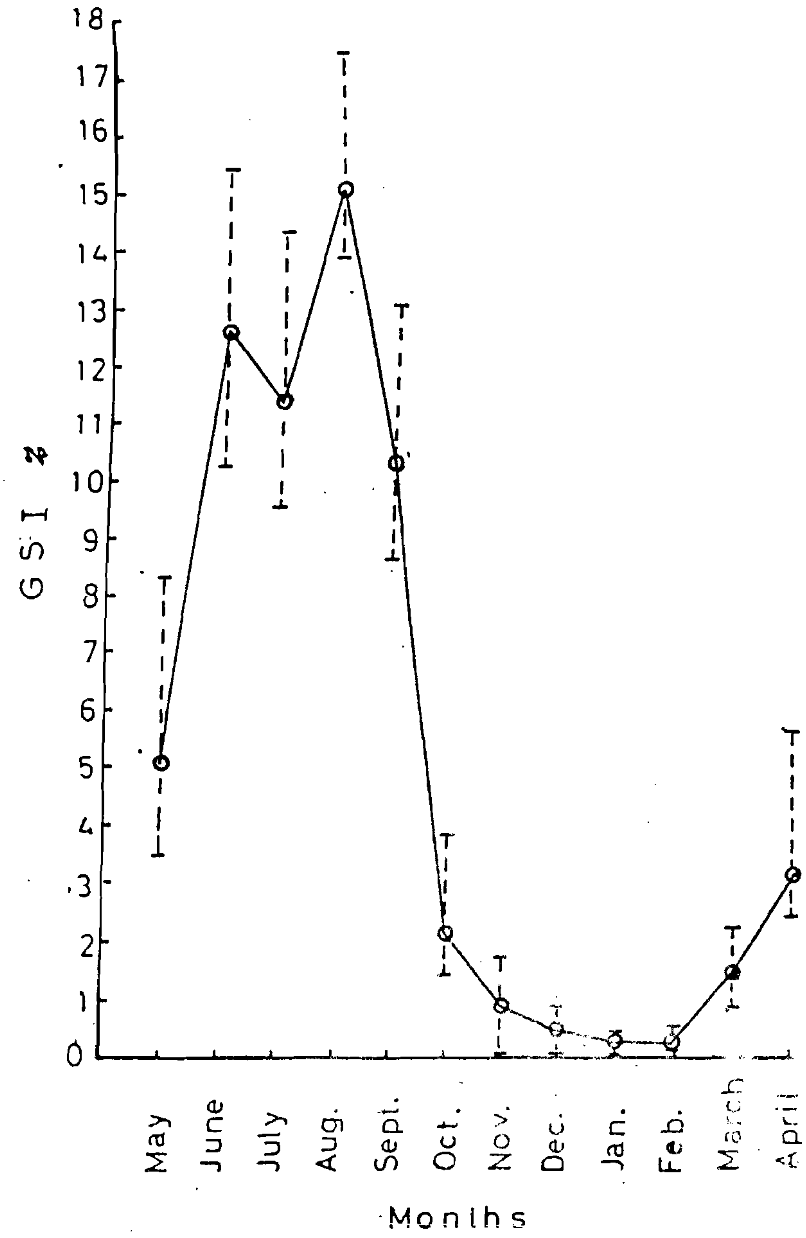

Fig. (1)
The variations of GSI values in different months.

TABLE 1
The monthly variations of GSI of S. rivulatus
(Range, mean and standard deviation).

Month	Fish number	GSI		Standard deviation
		Range	Mean	
May	13	3.5 - 8.3	5.1	± 0.43
June	17	10.3 - 15.4	12.6	± 0.69
July	15	9.5 - 14.3	11.4	± 0.64
August	16	13.9 - 17.4	15.1	± 0.82
September	17	8.6 - 13.1	10.3	± 0.51
October	15	1.5 - 3.9	2.2	± 0.41
November	10	0.1 - 1.8	0.9	± 0.39
December	14	0.1 - 0.9	0.5	± 0.03
January	15	0.1 - 0.5	0.3	± 0.02
February	17	0.2 - 0.6	0.3	± 0.04
March	12	0.9 - 2.0	1.5	± 0.09
April	19	2.5 - 5.7	3.1	± 0.33

TABLE 2
Absolute and relative fecundity of S. rivulatus and corresponding fish length, weight and gonad weight.

Fish length cm	Gutted weight gm	Av. gonad weight gm	Absolute fecundity	Relative fecundity
15	45.6	10.03	103214	2160
16	56.7	11.15	120516	2152
17	67.5	11.90	140006	2089
18	75.2	12.74	152285	2030
19	98.3	13.11	195467	1994
20	106.1	14.85	210497	1985
21	115.7	15.56	235720	1962
22	136.4	17.22	264624	1945
23	150.2	18.93	286666	1942
24	162.5	20.11	295810	1813
25	190.6	24.07	332744	1740
26	250.9	25.19	357450	1427
27	278.0	27.81	387921	1395
28	285.4	28.19	396630	1391

S. rivulatus is obviously a fecund fish, and variations were found in the fecundity of equal sized fishes. The estimated number of yolked eggs varied in average from 103.2 thousands at a total fish length of 15 cm and gutted body weight of 45.6 gm to 396.6 thousands at a total fish length of 28 cm and gutted body weight of 285.4 gm.

The comparative relationship of absolute fecundity with total length and body weight were curvilinear when the preliminary plots were conducted. Generally, the relationship between number of eggs (F) and body length (L) was expressed by the equation;

$$F = a\,L^{b},$$

where, a and b are constants. This equation was converted to the linear form by a logarithmic (base 10) transformation to become; log F = log a + b log L, and all data were fitted using the least squares regression procedures. The following equations were obtined for fecundity - total length (1) and fecundity - total body weight (2) relations.

$$\text{Log } F = 2.4380 + 2.2051 \log L \qquad (1)$$

$$F = 26.79\,L^{2.20}$$

$$r = 0.9950$$

$$\text{Log } F = 3.7952 + 0.7471 \log W \qquad (2)$$

$$F = 62.40\,L^{0.74}$$

$$r = 0.9898$$

The data plots are found in Fig. 2 and Fig. 3, respectively.

Preliminary data plots showed that the relations between total fish length and gonad weight, and total fish weight and gonad weight were linear over the ranges of values observed (Fig. 4 and Fig. 5). Regression formulae for both relations are shown on the graph.

Relative fecundity

Relative fecundity was estimated as the number of yolked eggs per gram of fish weight (Table 3).

It is obvious that the relative fecundity decreased with increasing fish length, or in other words, the increase in fish size is not compensated with a proportional increase in gonad weight. The production of eggs in the season decreased from 2160 egg/gm of fish weight at a total fish length of 15 cm to 1391 egg/gm of fish weight at a total fish length of 28 cm. A gradual decrease in relative fecundity took place as the fish increased in size.

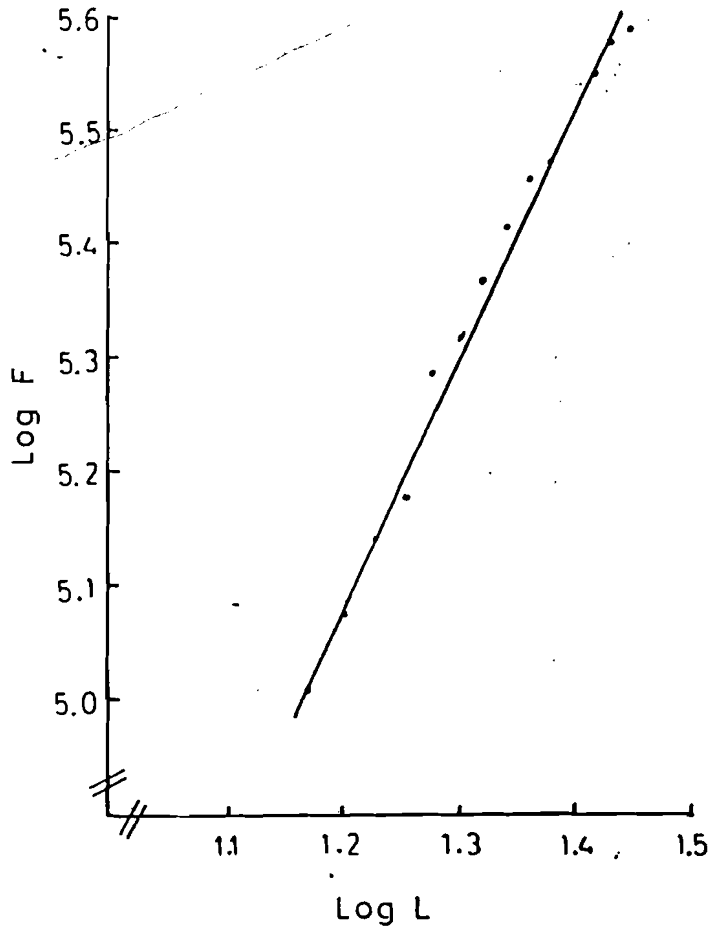

Fig.(2) .
Relation between absolute fecundity (Log F) and fish length (Log L).

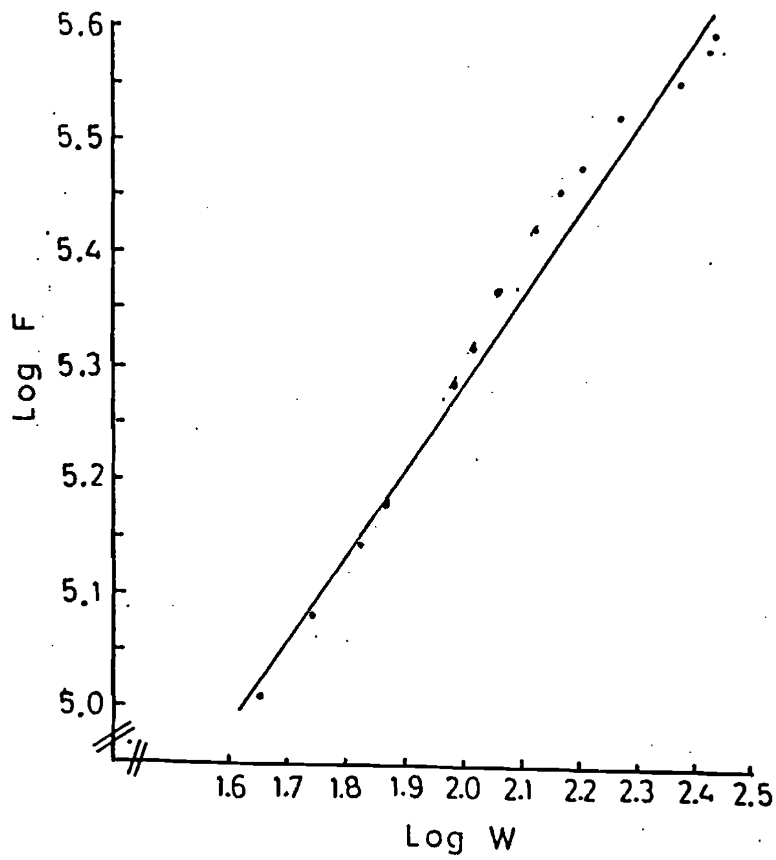

Fig. (3)
Relation between absolute fecundity (Log F) and fish weight (Log W).

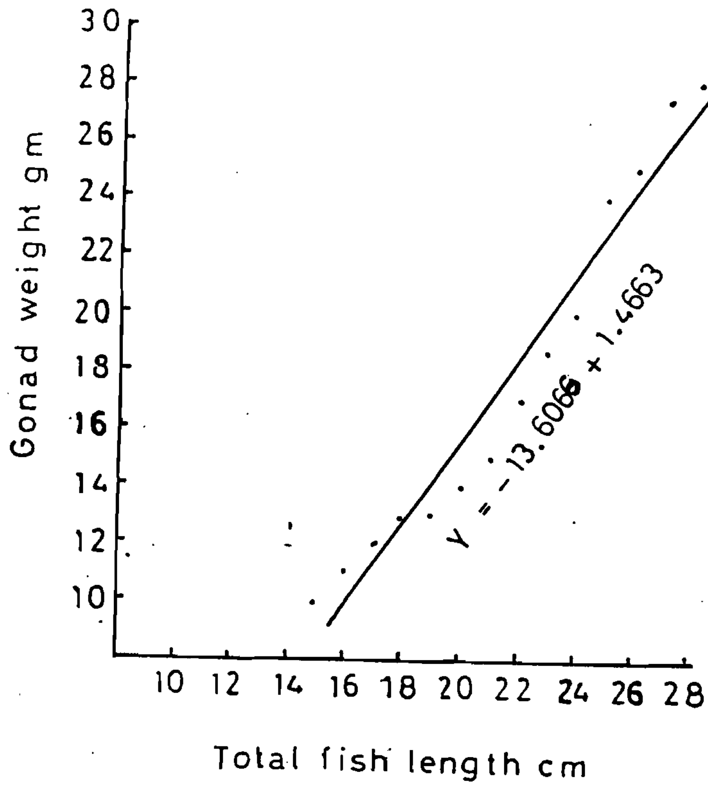

Fig. (4)
Relation between total fish length and ovarian weight.

Egg diameter

Diameter of yolked eggs was measured and defined into seven groups in the period from May to September 1985, and from March to April 1986. Monthly percentages of eggs related to each group were noted in Table (3) and Fig. 6. Yolked eggs varied in diameter from 0.23 to 0.50 mm. In May, a maximum percentage (47.8) was related to an egg diameter of 0.48 mm. In June, the maximum percentage of yolked eggs (30.5) was related to bigger diameter measuring 0.48 mm. A small percentage (4.0) was encountered at 0.50 mm egg diameter. In July, August, and September, the percentages of counted yolked eggs (23.4, 35.6 and 26.0 respectively) were related to 0.48 mm egg diameter. This revealed that the definite egg size or average egg diameter achieved by **S. rivulatus** is about 0.48 mm.

In March, the measured eggs were still developing and did not attain

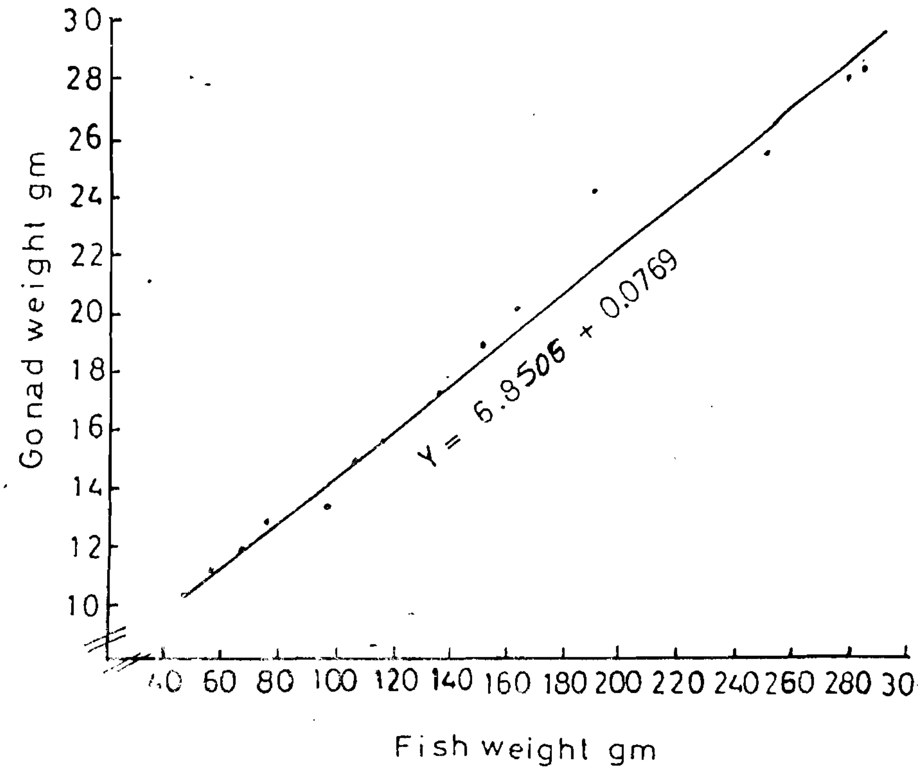

Fig. (5)
Relation between total fish weight and ovarian weight.

TABLE 3
The monthly distribution of percentages of yolked eggs in the ovaries of **S. rivulatus.**

Month	Egg diameter mm						
	0.23	0.27	0.33	0.37	0.42	0.48	0.50
May 1985	4.0	5.9	13.9	28.4	47.8		
June	2.1	6.5	11.4	17.0	25.5	30.5	4.0
July	7.2	11.6	13.5	16.4	18.5	23.4	9.4
August	8.5	8.5	10.4	18.2	23.3	35.6	4.0
September	3.9	6.6	9.6	17.8	20.1	26.0	16.0
March 1986	26.5	53.0	20.5				
April	6.3	22.9	45.5	25.3			

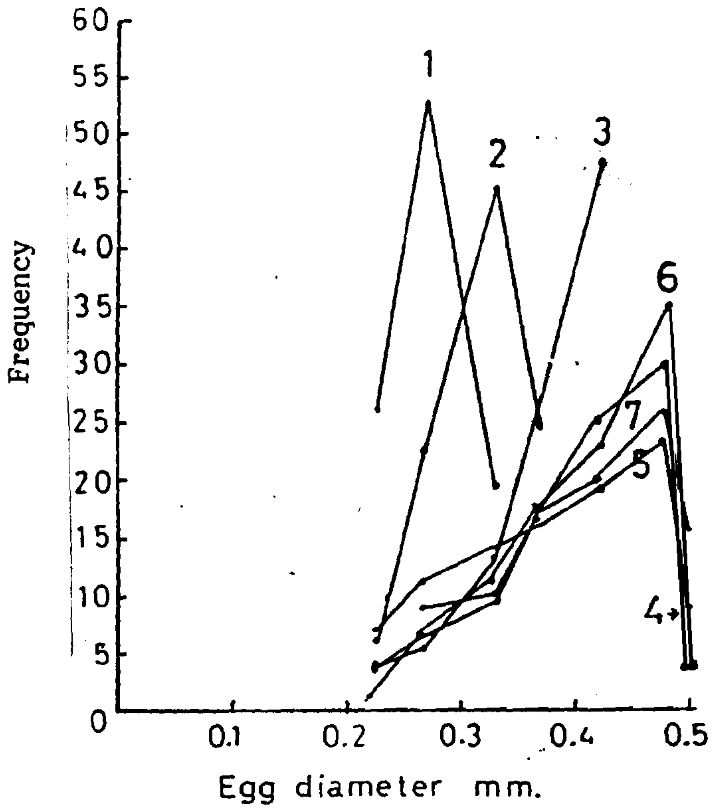

Fig. (6)
The frequency of yolked eggs in the period from March (1) to September (7).

the detinite size, maximum diameter was 0.33 mm and maximum percentage was 53.0. In April, a slight increase in egg diameter was encountered and the eggs were still developing.

The representation of egg diameter measurements against percentages during the spawning season (Fig. 6) revealed that **S. rivulatus** lay eggs once a year, i.e. it is a monocyclic fish.

The appearance of eggs with maximum diameter of 0.48 - 0.50 mm in June, July, August, and September, represents another confirmation that **S. rivulatus** performs its spawning within this period (four months). The obtained samples in October appeared with spent ovaries indicating the accomplishment of spaening season.

DISCUSSION

There is no existing opinion regarding the spawning of S. **rivulatus** in the Mediterranean. The work of Popper and Gundermann (1975) concerned mainly with the spawning of Red Sea siganids. They observed that the spawning in nature, together with the results of spawning experiments, suggest that the spawning season in the Gulf of Aqaba starts with that of S. **luridus** in March, S. **rivulatus** starts to reproduce in Jnue, while S. **argenteus** does not spawn before July. In Jeddah region (Saudi Arabia), the Red Sea S. **rivulatus** was reported by Hashem (1983) and Al-Elyani (1983) to reproduce at March. The different latitudes certainly affect the onset of spawning in the two different localities.

Mediterranean S. **rivulatus** was found, according to the present study, to spawn in June, a time similar to that in the Gulf of Aqaba and later than in the Saudi Arabian Coast.

The magnitude of spawning extends to September representing a shorter spawning season than in the southern region of the Red Sea where it extends from March to September.

The gonad maturation is shown to be activated by the increase in water temperature during summer. The prolongation of photoperiod was also found to play a significant role in the acceleration of gonadal maturation of the summer spawning siganid S. **canaliculatus** under laboratory conditions (Lam and Soh 1975).

Fecundity of S. **rivulatus** is considered high as compared to other fish species in the area (Hussein 1974). The obtained linear relationships between fecundity with length andweight, when logarithmic values used, represent a frequently found phenomenon (Solomon et al. 1984).

There is a scant information on fecundity of Mediterranean siganids, fecundity reported in the Red Sea S. **rivulatus** is comparatively smaller than the present data (Al-Elyani 1983). Data reported by Hashem (1983), show considerably higher values than the present values. Such existing differences may be due partly to difference in the used technique for counting and estimation of the ova, and partly to the differernce in the available food in the Red Sea and the Mediterranean.

High spawning activity of S. **rivulatus** was indicated by high values of GSI. The variations of the GSI in the different periods of the year represent accurate parameters for determinig the spawning season of fish species (Latif and Shenouda 1973). Another indication of such high activity was the existance of eggs with maximum egg diameter in the ovaries of unspawned females. The variations of egg diameter throw the light on the peculiarity of the spawning season. The opinion of Hickling and Rutenberg

(1936) is that, when the spawning season is short, only a single group of egg matures, and a long season is charcterized by the presence of more than one group successively develop in the female ovaries.

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