J. mar. biol. Ass. India, 1997, **39** (1 & 2) : 89 – 96

MATURATION AND SPAWNING BIOLOGY OF *AMBLYGASTER SIRM* FROM PARANGIPETTAI, SOUTHEAST COAST OF INDIA

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ABSTRACT

Studies on the maturation and spawning biology of the trenched sardine ***Amblygaster sirm*** (Walbaum) from Parangipettai coast revealed three distinct stages of ova *viz.* immature, mature and matured respectively with ova diameter of 0-19 mm, 0.19-0.42 and above 45 mm. Running gonads indicated a peak spawning during September-November and another spawning during February-April. Also females were abundant during these peak spawning period (September-November). Females attain maturity at length of 160 mm and males at 150 mm. Fecundity ranged from 21,800 to 1,24,800 and was directly proportional to length and weight of the fish.

INTRODUCTION

FISHES exhibit a periodic or cyclic reproductive behaviour. The success of any species is ultimately determined by the ability to reproduce successfully in a fluctuating environment and thereby to maintain variable populations. A thorough knowledge of maturation cycle and depletion of gonads will help to understand and predict the annual changes that population undergoes.

There is very little information available on the breeding biology of *Amblygaster sirm* (Ronquillo, 1960; Chacko and Gnanamekalai, 1963; Gnanamekalai, 1963a, 1963b; Lazarus, 1973, 1987a, 1987b, 1990; Bennet *et al.*, 1986), With a view to supplementing this, a detailed investigation was undertaken along Parangipettai coast on the breeding biology of *A.sirm.*

MATERIAL AND METHODS

Fresh specimens were collected from the fish landing centres along the Parangipettai coast during January to December 1994. After recording the total length, weight, sex and state of maturity the gonads were dissected out, weighed and preserved for further analysis.

Since the spawning habit has to be studied through indirect methods, the method of analysis of growth of ova by measuring their diameters as developed by Thompson (1915) and successfully employed by subsequent workers like Clark (1934), Hickling and Rutenberg (1936) and De Jong (1940) was followed. The ovaries were preserved in modified Gilson's fluid (Simpson, 1951). Measurements were taken as described by Clark (1934), June (1953) and Yeun (1955). A total of 600 ova drawn with equal representation from the three regions of both the lobes were examined for frequency distribution. Ova of 0.14 mm size and above were measured for all the stages except stages I and II. The different stages of maturity were distinguished following the scale adapted by International Council for the Exploration of the Seas (Lovern and Wood, 1937) with suitable modification.

The gonado-somatic index (GSI) for the individual fish was determined as described by Bhaskara Raju *et al.*, (1986-87).

For the fecundity studies, the method described by Grimes and Huntsman (1980) was followed, by which counting the number of mature ova (used only IV and V stages) in a portion of known weight and then calculating the total numbers of mature ova by the formula

$$\text{Fecundity} = \frac{\text{Weight of the ovary}}{\text{Weight of the sub-sample}} \times \text{No. of mature ova in sub-sample}$$

Relationship between total length and fecundity, total weight and fecundity were established.

RESULTS

Ovary was classified into 7 stages as in conformity with those recommended by ICES scale (Lovern and Wood, 1937).

Development of ova to maturity

Ovaries of seven stages were selected for the ova diameter frequency polygon. Three portions of the left ovary, *i.e.* anterior, middle and posterior regions were removed and teased on microslides. The diameter measurements of ova in each part were noted separately and the frequencies were plotted (Fig. 1a). The frequency curves showed a similar pattern of distribution of the immature, maturing and mature ova. Similarly the distribution of ova in the right ovary was also found uniform. The frequencies from all the three regions of one ovary were then pooled and plotted (Fig. 1b). The same type of distribution of ova was apparent in the three different portions.

The ova diameter frequency polygon of a mature ovary (Fig. 1b) showed the presence of three distinct groups of ova. The first group, which might be termed the immature stock, varied in size upto a maximum of 0.19 mm. The second group, which might be called the maturing ova ranged in size between 0.19 and 0.42 mm. The third group of ova which were considered to be mature, measured more than 0.45 mm. Ova diameter measurements of as many as 100 ovaries in different stages of maturity showed three groups of ova depending on their stage of maturity.

Spawning frequency and spawning season

The study of ova diameter frequencies of mature ovaries of *A. sirm* indicated that they contained the early stages of maturation. As the fish approaches the spawning season, the mature group of eggs appeared to grow at a

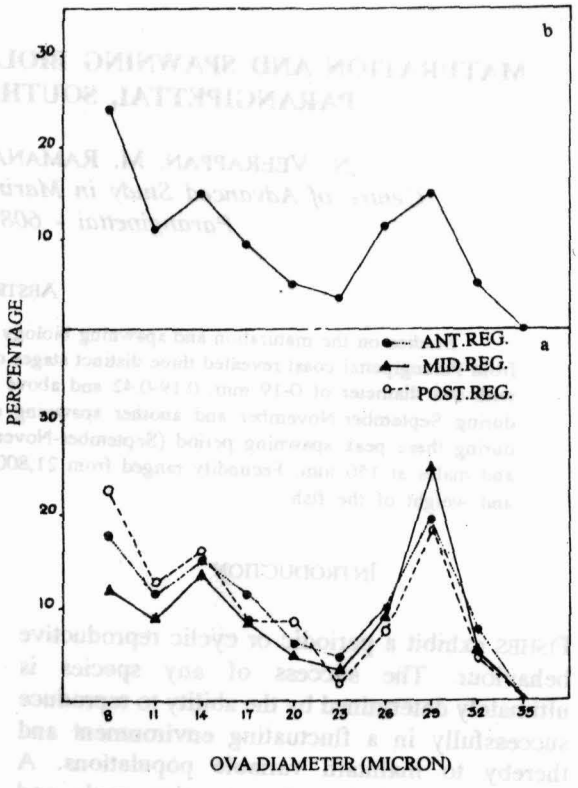

FIG. 1 a. Ova diameter frequency polygons of the anterior, middle and posterior regions of mature ovary of *Amblygaster sirm*.

b. Combined ova diameter frequency polygon of the three regions

faster rate and go distinctly separate off from the maturing group of eggs and another group which has undergone about half of the maturation process immediately following it, leading to two spawning in a season. The fish with running gonads (Stage VI) occurred during September, October and November. The high values of gonado-somatic index obtained for these months also testified this fact. Actually, two spawning season occur *viz.*, February to April and September to November. The latter was the peak spawning period (Table 1).

Size at first maturity

The percentage occurrence of mature females and males in each size group of *A.*

sirm was calculated for different stages of maturity (Fig. 2 and 3).

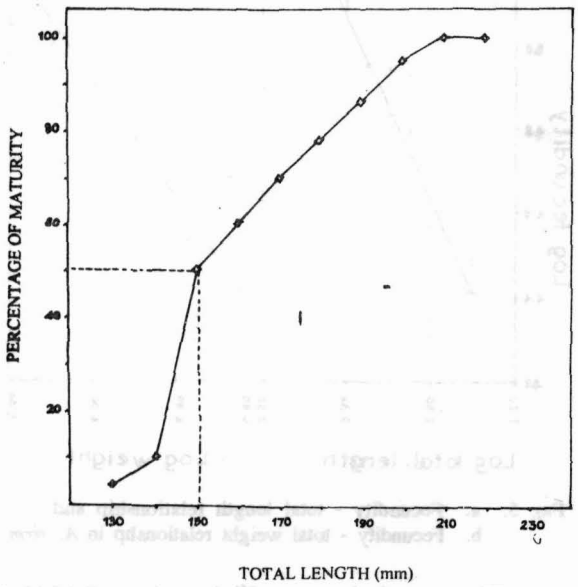

FIG. 2 Size at first maturity of males

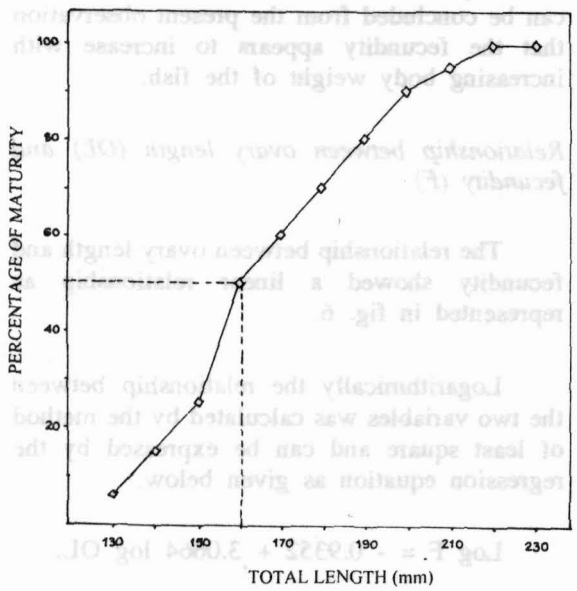

FIG. 3 Size at first maturity of females

The minimum size at which *A. sirm* attains maturity was determined for both male and female. The percentage occurrence of mature male and female increased steadily with the length.

From the maturity curve it is seen that 50% of males were mature at 150 mm length and 50% of the females attained maturity at 160 mm length. When compared with females, males matured at a smaller length. In majority of fishes, males have been found to mature at a smaller length than females (Royce, 1972).

Gonado-somatic index

Monthly trends in the gonado-somatic index are given in Fig. 4. High values are seen

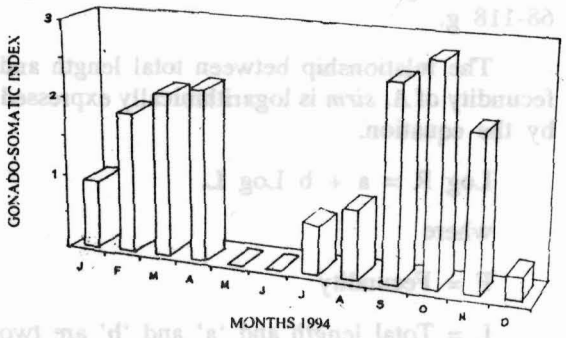

FIG. 4 Monthly variations in the gonado-somatic index (O)

for both males and females during the months February to April coinciding with the months of spawning. From September to November there is an increase in the gonado-somatic index values. This suggests that the increase in gonad weight is associated with the progress of maturity in this species. Further, the fish starts spawning during or just after the South West monsoon (Post-monsoon) and there appear to be a pre-monsoon spawning, just by the end of Northeast monsoon.

Sex Ratio

There are no secondary sexual characters. During this study, a total of 320 specimens comprising 116 males and 204 females of *A. sirm* were examined covering a wide range of sizes to determine the sex ratio. The sex ratio was calculated for various months and for different length group during January to December, 1994. The percentage occurrence of

male and female was calculated by employing the chi-square test (χ^2-test) to test the homogeneity of the distribution of female and male and the details are presented in Tables 2 and 3.

Fecundity

The relationship between total length and fecundity, total weight and fecundity and ovary length and fecundity of *A. sirm* were estimated by least square method. The fecundity varied from 21,800 to 1,24,800 based on 30 ovaries (only mature and ripe stages) of fishes ranging in total length from 191-226 mm and weight 68-118 g.

The relationship between total length and fecundity of *A. sirm* is logarithmically expressed by the equation.

$$\text{Log } R = a + b \text{ Log } L.$$

where

F = Fecundity

L = Total length and 'a' and 'b' are two constants examined by the method of least square and expressed by the following equation.

$$\text{Log } F = -3.7720 + 3.6676 \text{ log } L.$$

Based on this formula, the expected fecundity values were calculated for different lengths and a linear relationship is evident as shown in fig. 5a. The correlation co-efficient (r = 0.7676) between total length and fecundity was found to be significant at P < 0.001 level. Hence, the present study suggests that the fecundity increase with increasing length of the fish.

Relationship between total weight (W) and fecundity (F)

The relationship between total weight (W) and fecundity (F) showed a linear relationship as represented in fig. 5b. Logarithmically the relationship between the two variables was calculated by the least square method as expressed by the regression equation.

$$\text{Log } F = 2.7385 + 1.5094 \text{ log } W$$

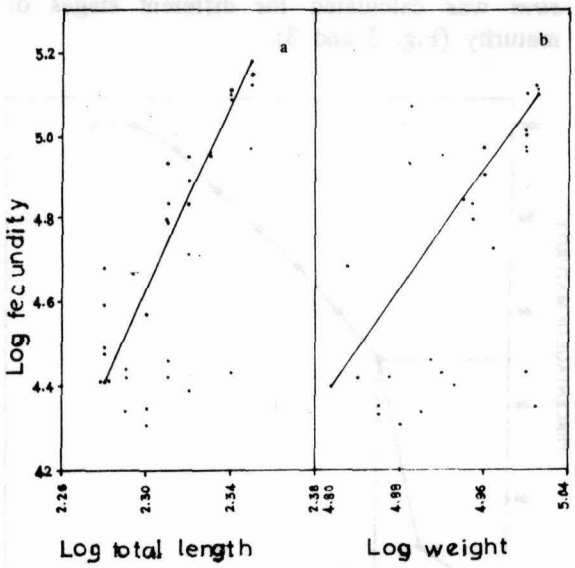

FIG. 5. a. Fecundity - total length relationship and
b. Fecundity - total weight relationshp in *A. sirm*

The correlation co-efficient (r = 0.6241) between total weight and fecundity was found to be significant at P < 0.001 level. Hence, it can be concluded from the present observation that the fecundity appears to increase with increasing body weight of the fish.

Relationship between ovary length (OL) and fecundity (F)

The relationship between ovary length and fecundity showed a linear relationship as represented in fig. 6.

Logarithmically the relationship between the two variables was calculated by the method of least square and can be expressed by the regression equation as given below.

$$\text{Log } F = -0.9352 + 3.0664 \text{ log } OL.$$

The correlation co-efficient (r = 0.9858) value between ovary length and fecundity was found to be significant at P < 0.001 level indicating a high degree of relationship between these two variables.

Relationship between ovary weight (OW) and fecundity (F)

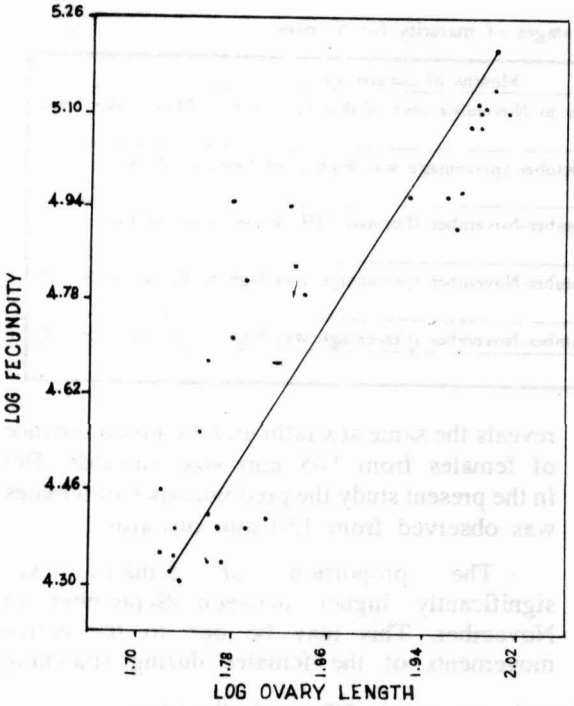

FIG. 6 Fecundity - ovary length relationship in *A. sirm*

The relationship between ovary weight and fecundity in *A. sirm* showed a linear relationship (Fig. 7). Logarithmically the relationship between these two variables was calculated by the method of least square and can be expressed by the regression equation as given below.

$$\text{Log } F = 1.9309 + 0.7582 \text{ Log OW.}$$

The correlation coefficient (r) value between ovary weight and fecundity was found to be 0.9219 ($P < 0.001$) indicating a high degree of relationship between these two variables.

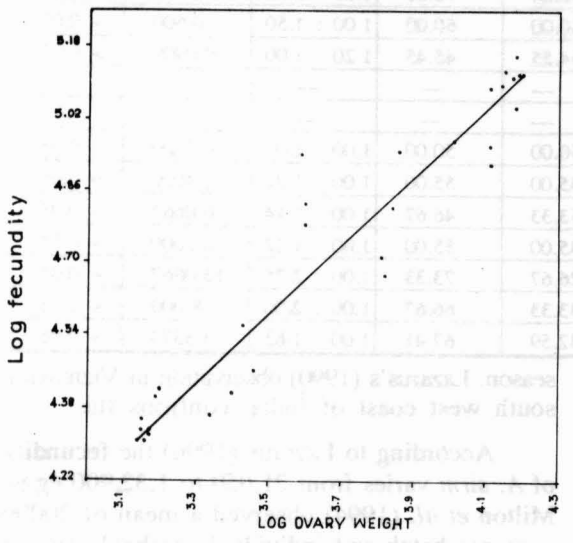

FIG. 7 Fecundity - ovary weight relationship in *A. sirm*

DISCUSSION

Conand (1991) from New Caledonia have observed that the spawning season of *A. sirm* is from October to December, before the hot, rainy season. There are probably several spawnings. Jayasuriya (1989) observed that the spawning occured twice a year *viz.*, April/May and August/September in Sri Lankan waters. Milton *et al.* (1994) in Australia observed protracted spawning in *A. sirm* with periods of intense spawning activity and fish spawned from August to October and also during May and June. Lazarus (1990) based on the presence of more than two distinct batches of ova in the ovaries suggested that the fish spawns twice in a season. The spawning season extended from December to February off Vizhinjam. In the present study also the two distinct batches of ova indicated that the spawning occur twice in a year *viz.*, February to April and September to November along Parangipettai coast. The study indicates two recruitment and spawning pulses separated by an interval of two months. These periods were coinciding with the beginning and latter part of the northeast monsoon.

The earlier authors have reported that the fish attains sexual maturity at a slightly smaller length of 140-150 mm (Chacko and Gnanamekalai, 1963). According to Conand (1991) first maturity is attained when fish attains one year of age and is about 175-179 mm and 180-184 mm for males and females respectively. However, based on the present study the size at 50% maturity for males and females were

150 and 160 mm respectively. These variations in length at first maturity may perhaps be related to ecological factors, food supply and assimilation.

Lazarus (1990) has observed the monthly trends in the gonado-somatic index showing low values for both males and females in the months of January and February. According to James (1967) the gonado-somatic index varied significantly between months in fish with short spawning period. During these investigations high values are seen for both males and females in the months of February to April and September to November.

From Tables 2 and 3 it is clear that females are abundant than males. This coincides with the earlier observation by Jayasuriya (1989) from Sri Lanka. Lazarus's (1990) observation reveals the same sex ratio and the predominance of females from 105 mm size onwards. But in the present study the predominance of females was observed from 150 mm onwards.

The proportion of females was significantly higher between September to November. This may be due to the active movements of the females during spawning season. Lazarus's (1990) observation in Vizhinjam, south west coast of India, confirms this.

According to Lazarus (1990) the fecundity of *A. sirm* varies from 21,050 to 1,32,900 eggs. Milton *et al.* (1994) observed a mean of 20000 eggs per batch and individuals probably spawn

TABLE 1. Seasonal changes in stages of maturity for *A. sirm*

Stages	Percentage	Months of occurrence
I & II (Immature)	12.85	February-April, September to November (out of this 11% was in March, April and September)
III & IV (Developing)	10.3	February-April, August-October (percentage was high from February-April)
V & VI (Mature)	25.4	February-April and September-November (Formed 21% in the latter period)
VII (Spent)	23.4	February-April and September-November (percentage was high in the latter period)
Resting	28.05	February-April and September-November (percentage was high in the latter period)
Total	100.00	

TABLE 2. Sex ratio and chi-square values of *Amblygaster sirm* in different months during January, 1994 to December, 1994

Months	No.of specimen	Male	Female	% of male	% of Female	Ratio M : F.	Chi-square value	Probability
January	47	15	32	31.91	68.09	1.00 : 2.13	6.1489	< 0.01
February	30	9	21	30.00	70.00	1.00 : 2.33	4.8000	< 0.01
March	15	6	9	40.00	60.00	1.00 : 1.50	0.600	> 0.05
April	11	6	5	54.55	45.45	1.20 : 1.00	0.0909	> 0.05
May	—	—	—	—	—	—	—	—
June	—	—	—	—	—	—	—	—
July	10	5	5	50.00	50.00	1.00 : 1.00	0.0000	> 0.05
August	40	18	22	45.00	55.00	1.00 : 1.22	0.4000	> 0.05
September	15	8	7	53.33	46.67	1.00 : 1.14	0.0667	> 0.05
October	20	9	11	45.00	55.00	1.00 : 1.22	0.2000	> 0.05
November	60	16	44	26.67	73.33	1.00 : 2.75	13.0667	< 0.01
December	72	24	48	33.33	66.67	1.00 : 2.00	8.000	< 0.01
Total	320	116	204	32.59	67.41	1.00 : 1.63	3.3373	> 0.05

more than one batch of eggs (Conand, 1988). However, in the present study the fecundity increases not only with length but also with weight of the fish. Fecundity ranged from 21,800 to 1,24,800 eggs with wide variation among individuals of the same size. This may probably be due to a number of factors such as abundance of food, density (Bagenal, 1966) and age (Hanson and Wickwire, 1967; Winters, 1971) but so far no definite reason could be indicated for the fluctuation in fecundity.

TABLE 3. Sex ratio and Chi-square values of *Amblygaster sirm* in relation to various length groups

Sl. No.	Length groups	No. of specimen	Male	Female	% of male	% of Female	Ratio M:F	Chi-square value	Probability
1.	135-145	14	9	5	64.29	35.71	1.80 : 1.00	1.1429	> 0.05
2.	145-155	13	7	6	53.85	46.15	1.17 : 1.00	0.0769	> 0.05
3.	155-165	54	26	28	48.15	51.85	1.00 : 1.08	0.0741	> 0.05
4.	165-175	69	28	41	40.58	59.42	1.00 : 1.46	2.4493	> 0.05
5.	175-185	88	27	61	30.68	69.32	1.00 : 2.26	13.1364	< 0.01
6.	185-195	46	12	34	26.09	73.91	1.00 : 2.83	10.5217	< 0.01
7.	195-205	20	4	16	20.00	80.00	1.00 : 4.00	7.2000	< 0.01
8.	205-215	9	2	7	22.22	77.78	1.00 : 3.50	2.7778	> 0.05
9.	215-225	5	1	4	20.00	80.00	1.00 : 4.00	1.8000	> 0.05
10.	225-235	2	0	2	00.00	100.00	0.00 : 2.00	2.0000	> 0.05
	Total	320	116	204	32.59	67.41	1.00 : 1.63	3.3373	> 0.05

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