A STUDY OF THE SEED RESOURCE OF THE INDIAN SAND WHITING *SILLAGO SIHAMA* (FORSKAL) IN THE PALK BAY

P. S. B. R. JAMES, R. SOUNDARARAJAN AND JOSEPH XAVIER RODRIGO
Mandapam Regional Centre of CMFR Institute, Mandapam 623520.

ABSTRACT

The fry and fingerlings of the Indian sand whiting, *Sillago sihama* (Forskal), which can serve as seed, have been found to occur in the coastal waters of the Palk bay throughout the year, with at least three months of peak abundance, January, May and October. From the year-round availability of these it appears that *S. sihama* breeds throughout the year, probably with three peak periods, namely, May-June, August-September and November-December. These were observed to be more during day than in night, and more during the receding and low tides than during the incoming tides. The overall abundance was highest during full moon period. While a direct relationship of the abundance of the fry and fingerlings could be noticed with the increase in temperature and dissolved-oxygen content, no such relationship was seen with changes in the salinity of sea water.

INTRODUCTION

The Indian sand whiting, *Sillago sihama* (Forskål), one of the important culturable fin fishes, occurs along both the east and west coasts of India, and its distribution, fishery and biology have been studied by various authors. Radhakrishnan (1961) recorded heavy catches as occurring frequently during May to December along the Palk Bay and Gulf of Mannar in the Mandapam region. However, a knowledge on the abundance of its fry and fingerling is very meagre. While selecting suitable seeds of fin fishes for culture experiments in cages and ponds, the authors found *S. sihama* to be one of the species of which the seed was abundantly available in the inshore waters of Palk Bay at Pullamadam, about 10 km away from Mandapam. A detailed study was carried out on the occurrence and abundance of this from May 1979 to April 1982, the results of which are presented in this paper.

MATERIAL AND METHODS

Collections were made from inshore waters of Palk Bay at Pullamadam. A drag net was fabricated out of nylon mosquito net. The mouth of the net measured 8 m across and 2.5 m vertically. The net was made to taper into a bag-like portion measuring 3 m in length. Lead sinkers were attached to the

cotton foot rope and floats to the nylon head rope, to facilitate opening of the net during dragging. Cotton rope was used for foot rope because, unlike nylon, it would evenly scrape the bottom while dragging.

The net was usually operated at one-metre depth. The bottom of the collection area was sandy with sandbar formation. The sandbars were on many occasions partially exposed during low tide. About one km away from the collection site there was a bar mouth, connecting a lagoon with the sea, which would be closed for most part of the year, especially between May and October. Also there was an estuary about 10 km away which would be connected to the sea only during rainy season.

During every haul the net was made to sweep an area of about 30 m from the shore. Apart from this net, a gillnet made of cotton yarn, which is used for catching squids, was also used initially, in which bigger juveniles of *S. sihama* were caught in good quantities. However, the use of this net could not be continued as it had been borrowed from a private fisherman. In place of this net, a same type of gillnet made of nylon yarn was however tried though without much success.

Temperature (both atmospheric and sea water), salinity and dissolved oxygen were recorded periodically. Apart from the occurrence of *Sillago* seed, the occurrence of medusae, other fish and prawn seed, and fragments of sea weeds were also noted.

During the first year of study (May 1979 to April 1980), the collections were frequently made during morning hours and the number of hauls were not restricted. The study was started in May 1979 as the occurrence of *Sillago* seed in good numbers was then observed for the first time. Afterwards (May 1980 to April 1982), the number of hauls were restricted to five. Apart from collecting these weekly morning samples, a few months were selected, based on the results obtained in the first year of study, and diurnal (24 h) collections were made covering four lunar periods. The months were May and October in 1980; March, April, May, June and October in 1981; and March in 1982. Each lunar period was classified into four phases: new moon (7-8 days), first quarter (7-8 days), full moon (6-8 days) and last quarter (6-8 days), based on the Indian Tide Tables. In each lunar phase, diurnal collections were made covering four tidal phases: high (2), receding (2), low (2) and rising (2) tides. Of the five hauls made during each one of the eight tidal phases during a 24 h, the third haul was timed in such a way that it fell during the peak of each high or low tide and in the middle of each receding or rising tide.

Results

Occurrence and seasonal abundance of seed: The morning collections made during different months in the three-year period, from May 1979 to April 1982,

showed that the fry and fingerlings of *S. sihama* were available throughout the year, though the relative abundance varied in different months (Table 1).

TABLE 1. *Details of the seed of* S. sihama *collected from inshore waters of the Palk Bay from May* 1979 *to April* 1982 (*morning collections only*).

	No. of hauls	No. of seed	Average No. of seed/hauls	Size range (mm)	Dominant size groups (mm)
1979					
May	3	3000	1000.0	13-13	23-26
Jun	12	29	2.4	—	—
Jul	187	3487	18.7	13-35	15-18
Aug	186	4499	24.2	12-37	19-22
Sep	109	6891	63.2	11-50	19-22
Oct	75	14186	189.5	12-61	15-18
Nov	28	1107	39.5	14-63	23-26
Dec	10	40	4.0	17-52	23-26
1980					
Jan	10	118	11.8	17-35	15-18;19-22
Feb	17	nil	nil	—	—
Mar	15	1400	93.4	16-45	19-22
Apr	26	889	34.2	16-56	23-26
May	20	2713	135.7	16-69	23-26
Jun	10	189	18.9	16-35	19-22
Jul	20	123	6.2	16-33	19-22
Aug	20	138	6.9	12-41	15-18
Sep	20	524	26.2	14-45	19-22
Oct	20	436	21.8	14-44	15-18
Nov	15	56	3.7	15-55	19-22
Dec	16	15	0.9	15-24	15-18
1981					
Jan	15	1853	123.5	12-62	11-14;27-30
Feb	16	34	2.1	15-61	23-26;39-42;59-62
Mar	20	2	0.1	32-36	—
Apr	15	350	23.3	14-64	23-26;39-42;59-62
May	20	521	26.1	17-68	27-30;43-46;59-62
Jun	20	384	19.2	20-70	19-22;43-46;63-66
Jul	25	80	3.2	12-70	11-14;19-22;51-54
Aug	20	39	2.0	30-65	31-38;59-62
Sep	20	15	0.8	19-52	27-30;39-42
Oct	15	115	7.7	14-51	27-30;35-38
Nov	20	99	5.0	17-62	31-34;39-42
Dec	11	333	30.3	21-65	27-30;35-38
1982					
Jan	20	1464	73.2	16-70	19-22
Feb	20	217	10.9	14-38	27-30
Mar	20	12	0.6	21-60	19-22;43-46
Apr	20	378	19.0	16-60	27-30

As can be seen in Table 2, during 1979, the year in which the collections were started in May, the maximum seeds occurred in May when the average number of seeds per haul was 1000, and a secondary peak of 189.5 occurred in October. During 1980 also the peak occurred in May, with an average of 135.7 seeds per haul. During 1981 peak occurrence of seeds was in January, the average number per haul being 123.5. Occurrence of seed was negligible during February-March period. During April and May the average number of seed per haul only ranged from 23.3 to 26.1. During 1982 also, in the four months of study up to April, maximum number of seed occurred in January, the average number of seed being 73.2. From the table it may also be seen that the variations in the quantity of seed occurring in different months were considerable. Even though the seed occurred all through the year, the seed was abundant mostly during January, March to May, September, October and December, and of these months, January, May and October seemed to be peak months of abundance.

TABLE 2. *Average number of seed of* S. sihama *per haul from May* 1979 *to April* 1982.

Months	1979	1980	1981	1983	Mean
Jan	——	11.8	123.5	73.2	69.5
Feb	——	nil	2.1	10.9	4.5
Mar	——	93.4	0.1	0.6	31.4
Apr	——	34.2	23.3	19.0	25.7
May	1000.0	135.7	26.1	——	387.3
Jun	2.4	18.9	19.2	——	13.5
Jul	18.7	6.2	3.2	——	9.4
Aug	24.2	6.9	2.0	——	11.0
Sep	63.2	26.2	0.8	——	30.1
Oct	189.5	21.8	7.7	——	73.0
Nov	39.5	3.7	5.0	——	16.1
Dec	4.0	0.9	30.3	——	11.7

Size distribution of seed: In the collections of nylon mosquito net the sizes of fry and fingerlings ranged from 11 mm to 70 mm, each month showing one to three modes but with only a single dominant one (Table 1). Since the size range of the seed had been small and since in the majority of the months same size groups repeatedly dominated, no inference could be drawn on the growth rate of fry and fingerlings, but it was indicated that prolonged and repeated spawnings of *S. sihama* took place in almost all the months. Even so, from the size distribution of fry and fingerlings, the peak months of occurrence of which were

January, May and October, it could be inferred that *S. sihama* has three peak spawning periods, November-December, May-June and August-September.

It was also indicated that *S. sihama* spawn in the sea, probably in inshore waters. The lagoon close by and the estuary some distance away established connection to the sea only during heavy rains of N.E. monsoon, which normally would start in October/November. As the bar mouth would remain closed from March-April until next monsoon the possibility of spawning occurring in the estuary at least during April to October and the migration of fry and fingerlings to the inshore are ruled out, since there would then be no connection between the sea and the lagoon|estuary. The occurrence of fry of *S. sihama* in inshore waters throughout the year may therefore indicate that the fish spawn in the sea.

Diurnal variations and lunar periodicity: The study from May 1979 to April 1980 indicated that some variations in the relative abundance of seed could be attributed to diurnal and lunar periodicities. The seed appeared to occur more during early morning hours, more so during the first quarter of the lunar phase. Led by this observation a few months were selected between May 1980 and April 1982 for a more detailed study. The diurnal collections were made during 24 hours of a day in the months of May and October in 1980, March, April, May, June and October in 1981 and March in 1982, covering the four lunar phases of the respective months. Under the four lunar phases as described in the introduction, additional collections were made during each tidal phase, namely, high tide, receding tide, low tide and rising tide. Thus during a 24 h duration in each lunar phase eight collections (5 hauls each) were made at an approximate interval of about three hours each, covering two peak high tides and two lowest low tides and in the middle of two receding tides and two rising tides.

The collections indicated that seed abundance was normally more during day time than in the night (Table 3). In May 80 highest average number per haul (194) was recorded between 1500 hrs. and 1800 hrs. followed by next highest (183) between 1200 hrs 1500 hrs. The lowest (24) was recorded between 0300 hrs. and 0600 hrs. In October 80 highest average number (40) was recorded during 1500-1800 hrs and lowest (1) during 0000-0300 hrs. In March 81 the seed was not abundant but nevertheless the highest number of 3 was recorded during 1200-1500 hrs and seed did not occur at night. In April 81, the highest average number (29) occurred during 0600-0900 hrs. and the lowest (0.5) during 0000-0300 hrs. During May, June and October 1981, highest average number of seed per haul (21 to 29) occurred during 0900-1200 hrs and lowest (0.4 to 0.9) during 0000-0300 hrs. In March 82 also it was similar, highest (13) during 0900-1200 hrs. and the lowest (0.8) during 0000-0300 hrs. Thus, collections made during day time (0600-1800 hrs.) showed to have markedly higher rate of occurrence than those made during night time (1800-0600 hrs.).

TABLE 3. *Average number of seed of* S. sihama *per haul during* 24-*hour collections.*

Hrs.	0000-0300	0300-0600	0600-0900	0900-1200	1200-1500	1500-1800	1800-2100	2101-2400
May 80	34.5	23.9	151.1	71.1	182.5	194.0	43.2	35.5
Oct 80	1.2	17.1	3.3	12.8	11.7	40.2	19.6	12.3
Mar 81	0.0	0.2	2.0	1.7	2.5	0.6	0.4	0.0
Apr 81	0.5	1.6	29.4	13.8	7.2	6.4	5.4	1.3
May 81	0.9	9.4	21.9	25.0	12.4	12.2	11.5	6.3
Jun 81	0.4	0.6	16.5	20.8	14.5	7.0	3.3	1.9
Oct 81	0.4	0.1	5.7	29.0	5.5	12.9	3.9	0.3
Mar 82	0.8	1.0	6.7	13.1	6.0	3.6	3.4	4.1
Average for 8 months	4.8	6.7	29.6	23.4	30.3	42.1	11.2	7.7

The analysis of 24-h collections made during each phase of a lunar period for the eight months showed that the average number per haul ranged between 1.0 and 70.3 during new moon phases in different months; 0.5 and 79.6 in the first quarter lunar phases; 0.6 and 161.3 in full moon phases; and 0.6 and 51.1 in the last quarter lunar phases (Table 4). The overall abundance of seed was highest (30|haul) during full moon and lowest (13|haul) during last quarter of the lunar period. During the new moon and first quarter the overall abundance was same (17|haul). The average number per haul was highest during full moon in May 80, May 81 and March 82. Whereas, it was highest during the last quarter in October 80, March 81 and April 81. The average number per haul was highest during first quarter in June 81 and during new moon in October 81.

Abundance in relation to tides: The overall average for the number of seed per haul could be said to be high during law tide even though there was not much difference in the average when compared to the other tidal heights (Table 5). Maximum occurrence was during high tide in May 80 while it was during low tide in October 80, March 81, October 81 and March 82. The maximum occurrence was during receding tide in April, May and June in 1981. Thus, it appears that comparatively better collections could be made during receding and low tides. The fry and fingerlings of *S. sihama* have been generally found to congregate (slightly burried in the bottom) in shallow water around exposed sandy areas, especially at low tides.

TABLE 4. *Average number of seed of* S. sihama *per haul during different lunar periods for the selected eight months.*

	New moon	1st quarter	Full moon	Last quarter
May 80	70.3	79.6	161.3	51.1
Oct 80	8.4	3.7	9.7	36.1
Mar 81	1.0	0.5	0.6	2.4
Apr 81	12.9	8.4	no data	15.1
May 81	15.2	7.8	16.0	15.1
Jun 81	9.5	11.5	4.4	8.0
Oct 81	17.1	no data	2.3	3.6
Mar 82	3.2	5.9	12.5	0.6
Average for eight months	16.8	16.8	29.5	12.8

TABLE 5. *Average number of seed of* S. sihama *per haul and mean (given in parantheses) during different tides.*

	High tide	Receding tide	Low tide	Rising tide
May 80	2.0-520.2 (93.7)	5.8-176.0 (59.9)	23.0-240.6 (88.3)	8.2-256.2 (87.2)
Oct 80	0.3-20.4 (8.5)	0.9-29.8 (8.5)	6.0-132.4 (22.0)	0.2-15.2 (5.0)
Mar 81	0.0-3.0 (0.5)	0.0-4.8 (1.0)	0.0-4.8 (1.3)	0.0-4.4 (1.0)
Apr 81	0.0-14.4 (5.1)	1.6-28.2 (18.9)	0.6-58.6 (18.7)	0.0-10.0 (3.4)
May 81	0.8-20.2 (7.2)	3.4-64.6 (20.5)	0.8-38.8 (12.0)	0.0-31.2 (8.2)
Jun 81	0.0-18.6 (7.8)	0.2-52.8 (9.9)	0.0-37.4 (8.8)	0.2-17.0 (6.9)
Oct 81	0.0-29.2 (6.5)	0.0-19.6 (6.8)	0.0-73.6 (17.1)	0.2-9.2 (3.6)
Mar 82	0.2-13.0 (2.5)	0.0-10.4 (3.2)	0.6-26.0 (9.9)	0.0-25.4 (6.7)
Average humber|haul for eight months	17.2	16.8	22.6	16.1

Abundance in relation to environmental parameters: The same eight month's data of the 24-h collections were used to study the possible relationship of abundance to the different environmental parameters as follows:

Temperature: The surface water temperature at the collection area varied between 23°C and 34°C, with maximum temperature recorded in May 80 and minimum in June 81. The average number of seed per haul varied between nil and 220.8 at different temperatures in different months (Table 6). It is of interest to note that the number of seed in the collections increased as temperature increased, as was evident in May 80 and more so in March 81 and March 82. The overall analysis showed a clear increasing trend in the average number per haul as the temperature increased, especially between 26°C and 30°C. It is likely that as the surface water temperature increased the seed tended to settle more at the bottom, facilitating better collections.

TABLE 6. *Average number of seed of* S. sihama *per haul in relation to average surface temperature* (°C) *of sea water in 24-hour collections.*

	Average number of seed								Average for
Temperature (°C)	May 1980	Oct 1980	Mar 1981	Apr 1981	May 1981	Jun 1981	Oct 1981	Mar 1982	eight months
23	—	—	—	—	—	4.6	—	—	4.6
24	—	—	—	—	—	0.4	—	—	0.4
25	—	—	—	—	—	—	—	—	—
26	—	—	—	1.0	—	5.1	—	2.8	2.6
27	—	11.8	0.5	0.8	17.9	5.2	0.4	0.5	7.6
28	—	11.0	0.1	10.0	29.2	13.3	—	6.0	8.8
29	28.9	132.4	1.2	22.5	9.3	—	5.4	8.7	17.1
30	74.0	13.2	1.9	14.4	15.5	10.5	4.2	11.8	25.1
31	77.5	7.4	0.3	0.0	5.5	15.8	—	—	28.4
32	110.1	20.4	2.9	6.9	22.1	—	—	—	47.4
33	230.8	9.0	4.4	—	17.8	—	—	—	82.0
34	128.3	—	—	—	—	—	—	—	128.3

Dissolved-oxygen content of sea water: The dissolved-oxygen content of sea water ranged between 2 ml|l and 10 ml|l during different months. Minimum was recorded during May 80 and May 81 and maximum during April 81. The average number of seed of *S. sihama* per haul varied between 0.3 and 169.3 at different values of dissolved-oxygen content in sea water (Table 7). Considerable variations have been noticed in the quantity of seed in different months and, even though no consistent direct relationship could be established between the abundance of seed and values of dissolved-oxygen content in sea water in any particular month, some indication of a direct relationship could be noticed in overall analysis. When the data for all the eight months

were pooled together, it was found that at higher values of dissolved-oxygen content in sea water the average number of seed per haul had also been higher. However, it has also been observed that the average number of seed per haul was high at the minimum dissolved-oxygen, while it was low at the maximum.

TABLE 7. *Average number of seed of* S. sihama *per haul in relation to average dissolved-oxygen content in sea water in 24- hour collections.*

Dissolved oxygen content (ml|l)	Average number of seed								Average for eight months
	May 1980	Oct 1980	Mar 1981	Apr 1981	May 1981	Jun 1981	Oct 1981	Mar 1982	
2	65.2	—	—	—	28.7	—	—	—	40.9
3	50.4	1.1	—	—	7.1	0.4	—	9.8	11.1
4	74.0	5.4	0.3	8.3	9.0	2.2	1.1	—	12.6
5	169.3	19.5	1.4	20.7	11.6	11.2	3.9	0.5	23.4
6	117.9	9.9	—	7.9	16.3	12.3	3.2	—	29.9
7	48.8	132.4	0.4	2.8	38.8	17.0	—	—	41.3
8	70.3	—	—	14.4	—	15.8	—	—	42.7
9	119.0	—	—	—	—	—	—	—	119.0
10	—	—	—	10.0	—	—	—	—	10.0

TABLE 8. *Average number of seed of* S. sihama *per haul in relation to average salinity (‰) of sea water in 24-hour collections.*

Salinity ‰	Average number of seed								Average for eight months
	May 1980	Oct 1980	Mar 1981	Apr 1981	May 1981	Jun 1981	Oct 1981	Mar 1982	
27	—	—	—	—	—	—	—	10.4	10.4
28	17.2	—	—	—	8.9	—	—	3.8	7.8
29	64.3	6.5	1.0	—	13.8	—	—	16.3	15.2
30	219.2	29.4	1.0	17.7	11.8	37.4	—	—	28.5
31	114.3	—	—	4.4	9.0	4.3	—	—	30.0
32	—	0.0	—	30.1	—	7.0	1.4	—	8.5
33	—	5.6	—	2.8	18.1	—	3.2	—	12.0
34	—	5.0	—	—	12.1	—	0.4	—	7.1
35	—	29.6	—	—	—	—	—	—	29.6
36	—	19.5	—	—	16.0	—	—	—	17.5
37	—	6.1	—	—	—	—	—	—	6.1

Salinity: The salinity of sea water ranged between 27 ‰ and 37 ‰ in different months, the maximum recorded in October 80 and minimum in March 82 (Table 8). At different salinities, the average number of seed of *S. sihama* per haul varied between nil and 219.2. No direct relationship could be established between the abundance of seed and salinity of seawater. Nevertheless, it could be noticed that the average number of seed per haul had been higher at salinities of 30-31 ‰ and also at 35 ‰ than at other salinity values.

Discussion

Radhakrishnan (1957) recorded small-sized juveniles measuring 2-4 cm in the Gulf of Mannar and the Palk bay only during rainy season (August to February, with a peak in October). But in the present study it has been observed that the young ones of similar size occurred in Palk Bay throughout the year, with peak abundance during January, May and October. Gopinath had (1942) observed that April was the peak period of abundance along the Trivandrum coast for the young ones of *S. sihama* measuring above 25 mm. He subsequently (1946) found that post-larvae appeared from the end of December with abundance in February. Palekar and Bal (1960) had found that very young juveniles occurred in Karwar waters in fairly large numbers in the inshore catches by Rampani only during December-January. However, they also had stated that small and medium-sized fish were generally found in the inshore waters in all the months. James et al (1976) had found that the young ones of this fish were available in Gangoli estuary and they were more abundant in January-February, compared to other months up to July. Thus, it appears that the seasonal abundance of the seed of *S. sihama* may be similar in both east and west coasts of India with only slight variations in the peak months of abundance.

Regarding breeding habits of *S. sihama* various views had been expressed by different workers. Chauduri (1923) had stated that breeding season of *S. sihama* was probably around the month of February in the Chilka lake. Gopinath (1946) recorded post larvae from the end of December along Trivandrum coast, majority of the smaller size in February. According to Chacko (1950), the spawning season of the fish was from November to March. Radhakrishnan (1957 and 1961) had observed, based on ova-diameter studies, that the fish spawned only once a year in Palk Bay and Gulf of Mannar and that spawning season was not restricted to a short period but was prolonged. He felt that spawning took place in colder months (probably October to February). Palekar and Bal (1960) indicated the spawning season of *S. sihama* occurring in Karwar waters as August-October. James et al (1976) had shown that the mature ovaries of *S. sihama* along the Mangalore coast as containing three distinct groups of ova and concluded that the spawning period of *S. sihama* was a prolonged one, extending over several months from August to April.

These observations support our findings that *S. sihama* breeds throughout the year, though it was difficult to demarcate clearly any particular peak. From the distribution of size groups during the peak months of abundance it could be inferred to some extent that peak spawning periods may be around May-June, the second during August-September and the third, probably a major one, during November-December.

Similarly, various views had also been expressed regarding the spawning grounds of *S. sihama*. Chauduri (1923) stated that *S. sihama* occurring in Chilka lake would go into the sea or near the mouth of the lake to breed. Radhakrishnan (1957 and 1961) also supported the above view without giving any evidence. However, according to Chacko (1949), the fish would ascend the river to a distance of 30 miles beyond tidal zone for spawning. James et al (1976) concluded, from collections of large *S. sihama* in advanced stages of maturity and in spawning condition from the estuaries in South Kanara, that it would spawn in the estuary. Juveniles also had been collected from the estuaries. Palekar and Bal (1960) observed that eggs and larvae of *S. sihama* drifted with the fast moving current of the river during the monsoon into the inshore waters of the Karwar Bay and developed there. The larvae grew into post larvae and juveniles, restricting themselves to the inshore waters or to the river bank from where it would be possible for them to move up the streams. They found that small and medium sized fish were generally occuring in the inshore waters in all the months. The present collections made in the inshore waters have shown that small-sized fry and fingerlings occurred in inshore waters throughout the year. Even though it was possible during rainy season for *S. sihama* to spawn in the lagoon|estuary close by and the juveniles then to migrate to inshore waters, it could not be so during summer months as the connection between the lagoon|river and the sea was then cut by sandbar formation. The year-round occurrence of fry and fingerlings in the inshore waters therefore could only indicate that *S. sihama* spawned in the estuaries and coastal waters.

The seed of *S. sihama* could be collected in better numbers during morning hours. It was also found that the number of seed in the collections increased with the increase in the surface-water temperature as well as the dissolved-oxygen in sea water. It may be presumed that as surface water temperature increased, especially in the afternoons, the fry and fingerlings tended to lie slightly burried at the bottom and as the dragging of the net along the bottom disturbed them they could be easily trapped into the net. During night hours, on the other hand, they would easily escape the net. The collections were generally better during receding tides and low tides than during the other tides. James et al (1976) had observed that young ones of *S. sihama* could be more effectively collected at low tide. It had also been found that young ones of *S. sihama* tolerated wide range of salinity. However, no direct relationship could be established between the abundance of the seed and the salinity range. The

overall abundance was comparatively high during the full moon period. The variations were not significant between the other quarters of lunar phase, including new moon, even though the abundance was low during the last quarter of the lunar phase.

The availability of the seed in most of the months makes *S. sihama* an ideal species for culture purposes. James et al (1980) have pointed out that they thrive well in cages. It may be possible to culture them also in ponds as they seem to tolerate a wide range of temperature, salinity, etc. Stocking the seed at the right size and proper management of the culture system may yield good results, and make the culture of *S. sihama* economically viable.

ACKNOWLEDGEMENT

The assistance rendered by Shri V. S. Rengaswami, Scientist, Central Marine Fisheries Research Institute, during a few collections and while analysing the data is gratefully acknowledged.

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