

BIOLOGY OF CHAETOGNATHS OF THE ESTUARINE WATERS OF INDIA

M. SRINIVASAN

Central Marine Fisheries Research Institute, Cochin

ABSTRACT

A perusal of the literature relating to the estuarine fauna reveals that very little attention has been paid to the study of chaetognaths. A review of the earlier work done on chaetognaths from various estuaries of India is given here. In addition, this account deals with the seasonal fluctuations and abundance of three species of *Sagitta* namely, *S. bedoti* Beraneck, *S. inflata* Grassi and *S. pulchra* Doncaster, occurring in the estuarine areas around Cochin. Material of different maturity stages of *S. inflata* from the estuarine and marine environments are also compared.

INTRODUCTION

CHAETOGNATHS form one of the major constituents of the marine plankton and their indicative nature of specific hydrological conditions has been well established. While chaetognaths inhabiting the seas and oceans has received a good deal of attention from planktologists, little is known about this group from the estuarine waters. Partly this may be due to the fact that the majority of the planktonic species occur in neritic and oceanic waters. This paper deals with 3 species of *Sagitta* Quoy and Gaimard that are primarily marine, but also occur in estuaries.

My sincere thanks are due to Dr. E. G. Silas, for the guidance and critical suggestions offered during the course of this study and to Mr. P. Parameswaran Pillai for passing on to me the material that he collected from the Cochin Backwater, without which this work could not have been done.

RESUME OF WORK ON CHAETOGNATHS FROM INDIAN ESTUARIES

There have been very few records of chaetognaths from the estuarine waters of India. Sewell and Annandale (1922) have not mentioned this group in their exhaustive investigations on the hydrology and invertebrate fauna of Rambha Bay, Chilka lake. Recently, Devasundaram and Roy (1954) recorded *Sagitta* from the Chilka lake where the salinity ranges between 5.61‰ and 24.71‰, though these authors have neither indicated the species involved nor the seasonal cycle of abundance. There is no mention of chaetognaths from the Adayar backwaters and the brackishwater localities of Cooum (Panikkar and Aiyar, 1937).

Lele and Gae (1936) described 3 species of *Sagitta*, namely *S. inflata* Grassi (reported as *S. gardineri*), *S. bedoti* Beraneck and *S. bombayensis*, the last as new to science from Bombay Harbour. They found *S. bedoti* and *S. bombayensis* occurring in Bombay Harbour throughout the year, whereas *S. inflata* was absent during March, April and May. These three species have also been recorded from the Bombay Harbour by Bal and Pradhan (1945) who state that they appear in varying numbers almost throughout the year.

Recently, Silas and Srinivasan (1968) have reported *S. bedoti*, *S. bombayensis*, *S. inflata*, *S. regularis* Aida, *S. pulchra* Doncaster and *Krohnitta pacifica* (Aida) from Bombay Harbour.

From the Cochin Backwater *S. inflata*, *S. bedoti* and *S. robusta* Doncaster, were recorded by George (1958). They are represented sparsely at the beginning of December, reach their maximum in January, February and March and are generally absent from the plankton after the middle of June. The occurrence in the Cochin Backwater of *S. robusta*, an oceanic species which also occurs in neritic waters is interesting.

Dutta *et al.* (1954) have recorded 'Sagitta species' from Hooghly estuary during March, April and May. The estuarine waters of Hooghly are said to be characterised by high salinity during these months with the temperature ranging from 21°C to 32°C.

The occurrence of 2 species of *Sagitta* namely *S. bedoti* and *S. inflata* at Kandla in the Gulf of Kutch was reported by Ramamurthy and Dhawan (1963), pointing out that the former species is more common during March and April. The salinity in the Gulf of Kutch is said to vary from 15.56‰ to 40.57‰.

MATERIAL AND METHODS

Cochin Backwater is a typical estuary the topography and hydrology of which has been reported in a number of recent papers (George, 1958; Ramamirtham and Jayaraman, 1963; Qasim and Gopinathan, 1969). The material for the present study has come from 30 weekly plankton collections made from a fixed station (Pillai, 1972, Fig. 1, a) in the Cochin Backwater, between September 1968 and September 1969. The collections were made with a half metre ring nylon net with mesh size 0.33 mm. towed horizontally at surface for 10 minutes between 0700 and 0800 hrs. As the volume (biomass) of the plankton is low, the entire sample has been examined for chaetognaths. 4005 specimens of *S. inflata* collected from 23 coastal stations (neritic) of the Arabian sea occupied during the cruises of R.V. VARUNA between February 1967 and January 1968 have also been examined for a comparative study of this species from the neritic and estuarine waters.

CHAETOGNATHS OF THE COCHIN BACKWATER

Only the following three species of *Sagitta* occurred in the estuary during the present study :

| Species | No. of samples | No. of specimens | Percentage |
|-------------------|----------------|------------------|------------|
| <i>S. inflata</i> | 14 | 1,381 | 72.0% |
| <i>S. bedoti</i> | 14 | 328 | 16.5% |
| <i>S. pulchra</i> | 10 | 222 | 11.5% |

Chaetognaths were found to occur more or less throughout the year, except during April, July and August. Their absence in July and August is reasonable because of the influx of flood waters due to the south-west monsoon and consequent low salinity conditions (1.4‰ to 0.3‰) in the estuary. However, the reasons for their absence in April when the salinity maxima (33.6‰) occurs are not clear.

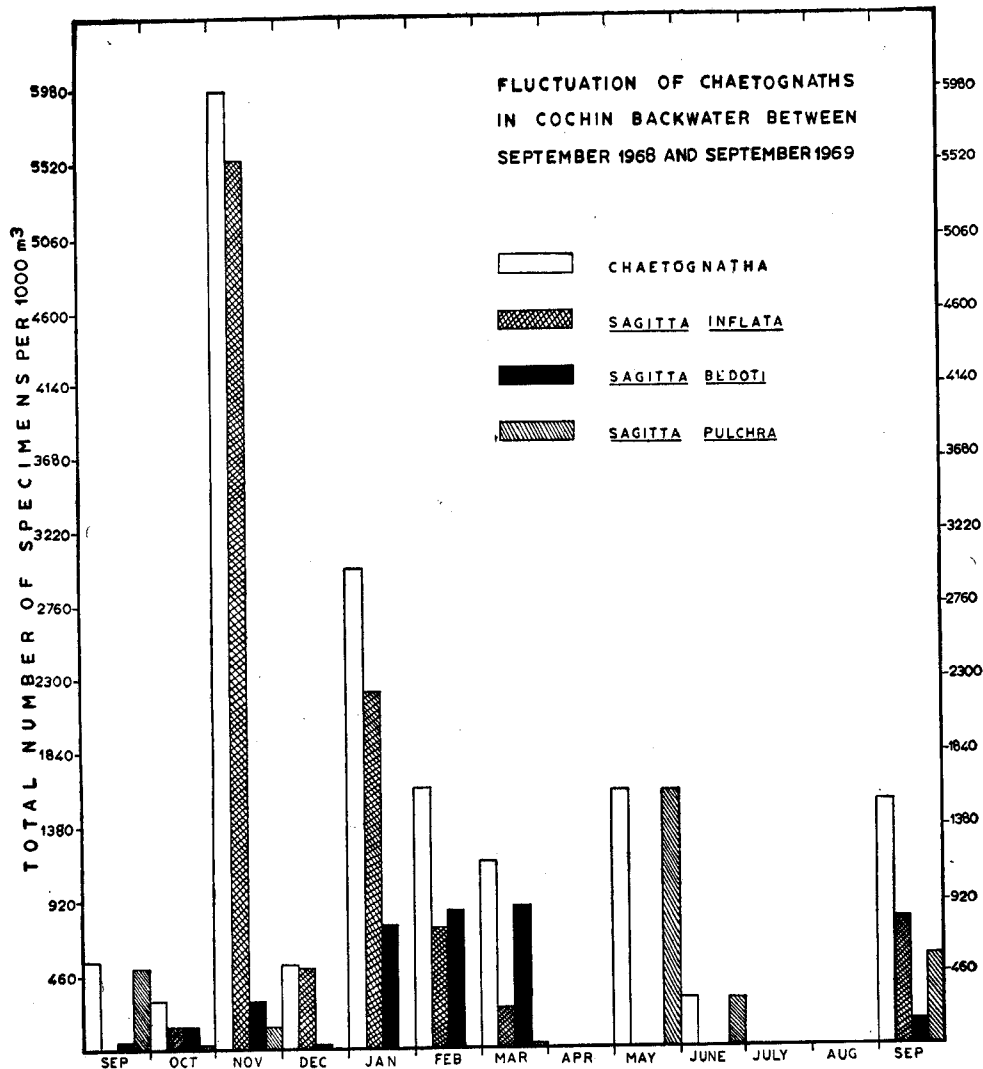


FIG. 1. Seasonal fluctuations of 3 species of *Sagitta* in the Cochin Backwater between September 1968 and September 1969.

TABLE 1. Fluctuations of the maturity stages in 3 species of Sagitta

| Months | Salinity | <i>S. inflata</i> | | | | | | <i>S. bedoti</i> | | | | | | <i>S. pulchra</i> | | | | | |
|------------|----------|-------------------|----|----|-----|----|-------|------------------|----|----|-----|----|-------|-------------------|----|----|-----|----|-------|
| | | 0 | I | II | III | IV | Total | 0 | I | II | III | IV | Total | 0 | I | II | III | IV | Total |
| Sept. 1968 | 5.2‰ | 10 | 12 | — | — | — | 22 | — | 1 | 1 | — | — | 2 | — | — | — | — | — | — |
| Oct. " | 10.7‰ | 1 | 2 | 2 | 1 | — | 6 | — | — | 3 | 3 | — | 6 | — | — | 1 | — | — | 1 |
| Nov. " | 15.6‰ | 30 | 44 | 61 | 73 | 33 | 241 | — | 4 | 4 | 5 | — | 13 | — | — | 3 | 3 | — | 6 |
| Dec. " | 23.3‰ | — | 7 | 9 | 6 | — | 22 | — | — | — | 1 | — | 1 | — | — | — | — | — | — |
| Jan. 1969 | 30.7‰ | 16 | 36 | 25 | 15 | 5 | 97 | — | 14 | 10 | 10 | — | 34 | — | — | — | — | — | — |
| Feb. " | 30.5‰ | — | 8 | 7 | 10 | 7 | 32 | — | 1 | 12 | 17 | 9 | 39 | — | — | — | — | — | — |
| March " | 33.0‰ | — | 3 | 1 | 4 | 3 | 11 | 1 | 6 | 7 | 15 | 10 | 39 | — | — | 1 | — | — | 1 |
| April " | 33.6‰ | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| May " | 31.3‰ | — | — | — | — | — | — | — | — | — | — | — | — | 10 | 25 | 20 | 15 | — | 70 |
| June " | 13.1‰ | — | — | — | — | — | — | — | — | — | — | — | — | — | 3 | 6 | 4 | — | 13 |
| July " | 1.4‰ | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Aug. " | 0.3‰ | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — | — |
| Sept. " | 3.0‰ | 20 | 15 | — | — | — | 35 | — | 3 | 4 | — | — | 7 | — | 15 | 7 | 3 | — | 25 |

SEASONAL FLUCTUATIONS OF 3 SPECIES OF *SAGITTA*

The study of the seasonal fluctuations of the 3 species of *Sagitta* at one station in the Cochin Backwater (Table 1 and Fig. 1) reveals the following :

(1) *S. inflata* is absent during the latter half of the pre-monsoon period (April and May) and during the active monsoon period (June to August) (Fig. 1) but is abundant during November.

(2) The seasonal occurrence of *S. bedoti* in the Cochin Backwater is more or less similar to that of *S. inflata*. It is not found during the latter half of the pre-monsoon period and during the active monsoon period, while it is abundant during January, February and March (Fig. 1).

(3) The maximum numbers of *S. pulchra* occurred during May and June, unlike *S. inflata* and *S. bedoti* which were absent.

Further, the fluctuations in the occurrence of the maturity stages of the 3 species of *Sagitta* were studied and counts obtained for the different maturity stages in the collections (Table 1). From this it will be seen that :

(1) *S. inflata* is absent from April to August, while immature specimens (Stage 0-II) are encountered in the plankton during September and October. Specimens belonging to all the stages (0-IV) were found during November and January. In February and March specimens of all stages except 0-stage were present.

(2) *S. bedoti* is also absent during the months April to August, and predominantly immature specimens (0-II) were obtained from September to January. Specimens in all stages of maturity (0-IV) were found only in March. One interesting feature observed was that specimens of 0-stage were absent throughout, except for stray occurrence in March.

(3) Mature specimens (Stage-IV) of *S. pulchra* were not present in the collections. The presence of all the stages of this species (except stage-IV) during May is interesting.

ASPECTS OF THE BIOLOGY OF *S. INFLATA*

One noteworthy observation during the course of this study was the differences in size (total length) of the specimens, collected from the Cochin Backwater (3.5 to 11.2 mm) and those from the neritic waters (5.0 to 20.0 mm). Immature specimens from the estuarine habitat are from 3.5 to 5.4 mm. (Mean=4.5 mm) in total length whereas, those from the neritic waters are between 5.0 and 9.5 mm (Mean=7.2 mm). Likewise, the difference is maintained in the sizes (total length including the tail fin) during the Ist, IInd, IIIrd, and IVth stages of maturity (Fig. 2). Fully mature specimens of *S. inflata* of the estuarine habitat measure from 6.0 to 11.2 mm (Mean=9.9 mm), whereas in the marine inshore waters they are between 10.0 and 20.0 mm (Mean=14.1). The availability of specimens belonging to various stages of maturity during each month would lead one to conclude that *S. inflata* is a continuous breeder and quite likely the population in the estuary is a resident one. Rao and Kelly (1962) while studying *S. inflata* in Lawson's Bay, Waltair, have also noted the continuous breeding of this species in the Bay.

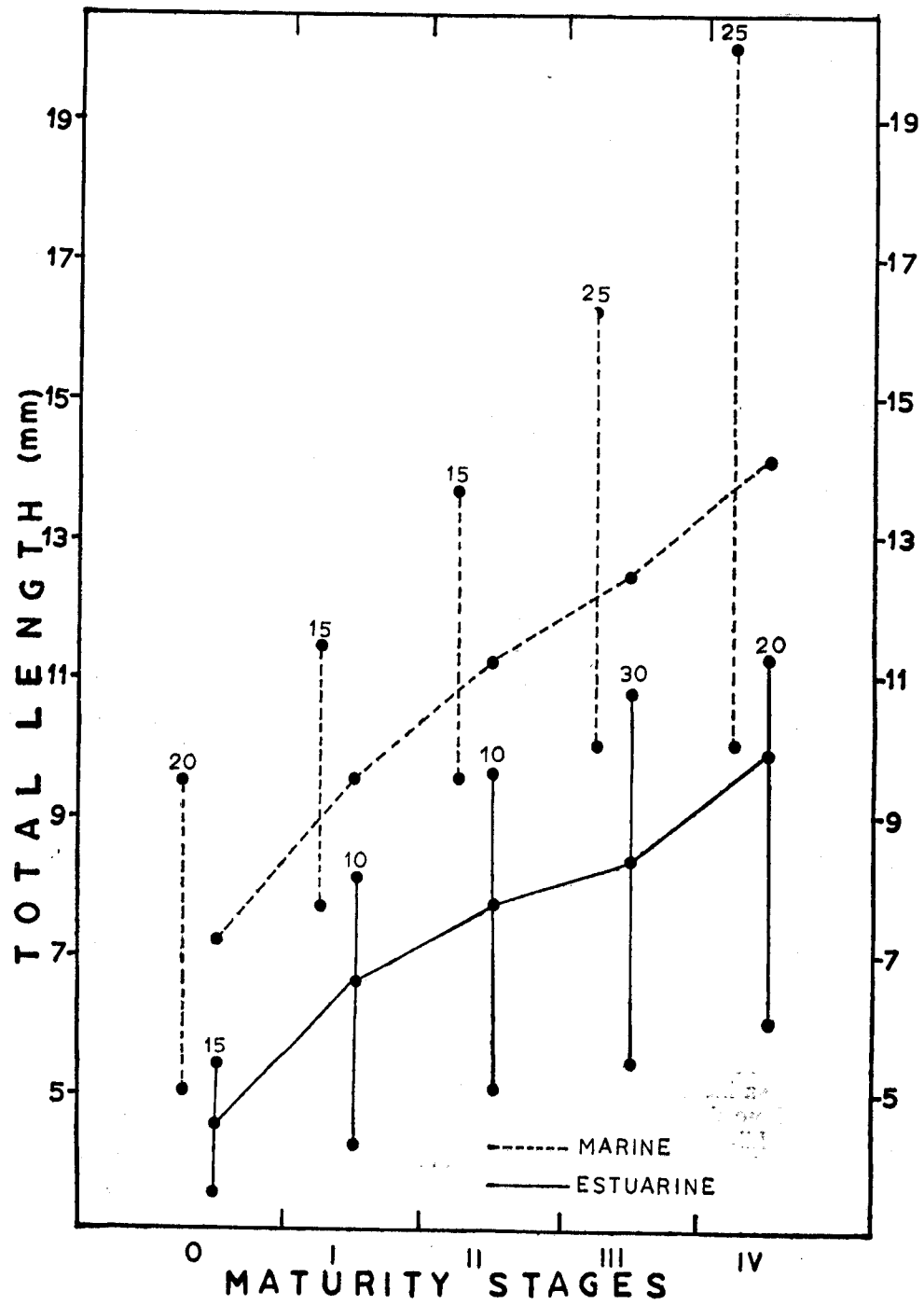


FIG. 2. Maturity stages of *Sagitta inflata* in the Estuarine and Marine environments (The range, mean and the number of specimens examined are given).

Very slight differences between the specimens of *S. inflata* of the estuarine and marine habitats in other morphometric and meristic characters have been noticed (Tables 2 and 3). In the estuarine specimens the tail length (including tail fin) ranges between 17.1% and 20.0% (Mean=18.6%) and in the marine the range is between 17.3% and 20.0% (Mean=18.6%). In specimens from the estuarine and marine habitats, the anterior fin is between 17.0% and 18.8% (Mean=17.9%) and 16.9% and 19.0% (Mean=18.06%) respectively. In the estuarine specimens the posterior fin is from 17.0% to 20.0% (Mean=18.23%) while in those from the sea it is from 17.0% to 20.0% (Mean=18.4%).

The number of hooks varies from 8 to 10 in the specimens from the estuary (Mean=9.08) and the inshore waters (9.24). The anterior teeth vary from 4 to 8 (Mean=5.3 for the estuarine and 6.1 for the marine). Posterior teeth count is from 6 to 12 (Mean=9.7) for the estuarine specimens and 6 to 14 (Mean=10.7) for those from inshore waters. The specimens of comparable sizes were examined irrespective of the stages for variations in the number of hooks and teeth from both the environments (Table 2).

TABLE 2. Variations in number of Hooks and Teeth (mean for the number of specimens examined) in *S. inflata*

| Size | No. of specimens | No. of Hooks | | No. of Ant. Teeth | | No. of Post. Teeth | |
|--------------------------|------------------|--------------|------|-------------------|------|--------------------|------|
| | | Est. | Mar. | Est. | Mar. | Est. | Mar. |
| 5 mm. (5.0 to 5.9) | 7 | 8.6 | 9.0 | 4.2 | 4.5 | 8.4 | 6.3 |
| 6 mm. (6.0 to 6.9) | 7 | 9.0 | 9.0 | 5.6 | 5.1 | 9.8 | 7.2 |
| 7 mm. (7.0 to 7.9) | 7 | 9.1 | 9.0 | 5.6 | 5.8 | 10.0 | 9.0 |
| 8 mm. (8.0 to 8.9) | 8 | 9.3 | 9.3 | 5.6 | 5.6 | 10.6 | 8.7 |
| 9 mm. (9.0 to 9.9) | 8 | 9.1 | 9.1 | 5.6 | 5.3 | 11.0 | 9.1 |
| 10 mm. (10.0 to 10.9) | 8 | 9.3 | 9.4 | 6.5 | 6.0 | 11.5 | 9.9 |
| 11 mm. (11.0 to 11.9) | 8 | 9.0 | 9.5 | 6.0 | 6.4 | 12.0 | 9.9 |
| 5.0 to 11.9 mm. | 53 | 9.1 | 9.2 | 5.6 | 5.5 | 10.5 | 8.6 |

Est. = Estuarine ; Mar. = Marine.

The percentage of ovary length in total length of the specimens of *S. inflata* from the two habitats for the different stages has been studied and was found to be as follows (Table 3) :

TABLE 3. Ovary length during the maturity stages in *S. inflata*

| Stage | No. of Specimens | Estuarine % in total length | No. of Specimens | Marine % in total length |
|-------|------------------|-----------------------------|------------------|--------------------------|
| I | 10 | 3.4% (2.0-4.7%) | 15 | 3.8% (1.7-6.5%) |
| II | 10 | 6.5% (3.5-10.0%) | 15 | 7.0% (3.4-10.0%) |
| III | 30 | 9.4% (5.7-12.5%) | 25 | 9.1% (7.0-12.5%) |
| IV | 20 | 11.0% (5.0-18.6%) | 25 | 11.6% (4.5-18.3%) |

DISCUSSION

In the Cochin Backwater the variations of temperature are small and fall within a range of 1°C to 2°C. (Qasim and Gopinathan, 1969). However, the salinity shows extremes in variation from 0.3‰ to 33.6‰ (Pillai, 1972). The variations in salinity undoubtedly play a more important role in regulating the occurrence, distribution and abundance of chaetognaths in the Cochin Backwater. According to George (1958) the standing crop of zooplankton shows a direct correlation with the increase in salinity in the Cochin Backwater. During the period of the present study, it was seen that the chaetognaths were more abundant in the Cochin Harbour area, during the months, November, January, and February, the dominant species being *S. inflata*.

S. inflata is absent in the collections obtained during the period April to August. The reason for the absence of this species from the surface waters during April and May is not clear, because the salinity is at its peak during these months (33.6‰, 31.3‰). Its absence in July and August samples when the salinity is low (1.4‰ and 0.3‰) is understandable. Stratified samples from different depths will be necessary to see whether these species occur closer to the bottom of the estuary, during these months.

S. bedoti though occurring along with *S. inflata*, is present in fewer numbers. The occurrence of *S. pulchra* is interesting as it is the only species that was obtained from the surface waters during May and June.

The differences seen in the specimens of *S. inflata* collected from the Cochin Backwater and the adjacent neritic waters support the general contention expressed by Kinne (1964) that marine organisms are known to exhibit a reduction in final size

in areas of their distribution, where the salinity is significantly reduced. This phenomenon is also noticed in *S. bedoti* and *S. pulchra*, but the material is not sufficient to compare these species from the two environments. The data presented here for *S. inflata* shows that in both habitats this species is viable. However, information is lacking at this stage about the number of eggs produced by the same species in the two different habitats, natural mortality and survival rates.

REFERENCES

- BAL, D. V. and PRADHAN, L. B. 1945. A preliminary note of the plankton of Bombay Harbour. *Curr. Sci.*, 14 : 211-212.
- DEVASUNDARAM, M. P. and ROY, J. C. 1954. A preliminary study of the plankton of the Chilka lake for the years 1950 and 1951. *I.P.F.C. Symposium, Plankton* : 48-54.
- DUTTA, N., MALHOTRA, J. C. and BOSE, B. B. 1954. Hydrology and seasonal fluctuations of the plankton in the Hooghly estuary. *I.P.F.C. Symposium, Plankton* : 35-47.
- GEORGE, M. J. 1958. Observations on the plankton of the Cochin backwaters. *Indian J. Fish.* 5 (2) : 375-401.
- KINNE, O. 1964. The effects of Temperature and Salinity on Marine and Brackishwater animals. II. Salinity and Temperature combinations. *Oceanogr. Mar. biol. Ann. Rev.*, 2 : 281-339.
- LELE, S. H. and GAE, P. B. 1936. Common *Sagittae* of Bombay Harbour. *J. Uni. Bombay*, 4 : 105-113.
- PANIKKAR, N. K. and AIYAR, R. G. 1937. The Brackishwater Fauna of Madras. *Proc. Indian Acad. Sci.*, 6 (5) : 284-337.
- PILLAI, PARAMESWARAN, P. 1972. Studies on the estuarine copepods of India. *J. mar. biol. Ass. India*, 13 (2) : 162-172.
- QASIM, S. Z., et al. 1969. Organic production in a Tropical estuary. *Proc. Indian Acad. Sci.*, 69 (2) : 51-94.
- and GOPINATHAN, C. K. 1969. Tidal cycle and environmental features of Cochin Backwater (A Tropical estuary). *Ibid.*, 69 (6) : 336-348.
- RAMAMIRTHAM, C. P. and JAYARAMAN, R. 1963. Some aspects of the hydrological conditions of the backwaters around Willington Island (Cochin). *J. mar. biol. Ass. India*, 5 (2) : 170-177.
- RAO, T. S. S. and SARADA KELLY. 1962. Studies on the chaetognaths of the Indian seas. Part II. On the biology of *S. inflata* Grassi in the waters of Lawson's Bay, Waltair. *J. Zool. Soc. India*, 14 (2) : 219-225.
- SEWELL, R. B. S. and ANNANDALE, N. 1922. Fauna of the Chilka lake: The hydrology and Invertebrate fauna of the Rambha Bay in an abnormal year. *Mem. Indian Mus.*, 5 : 679-780.
- SILAS, E. G. and SRINIVASAN, M. 1968. On the little known Chaetognatha *Sagitta bombayensis* Lele and Gae (1936) from Indian waters. *J. mar. biol. Ass. India*, 9 (1) : 84-93.