

## CHAETOGNATHS OF THE POTENGI ESTUARY (NATAL, NORTHEAST BRAZIL)

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### ABSTRACT

Variability in distribution and breeding of chaetognaths in the Potengi estuarine system was studied from 1979 to 1981. *Sagitta tenuis* is the true inhabitant of this estuary. *S. helenae* and *S. enflata* constitute occasional immigrant population from the open ocean. Chaetognaths were represented in all the collections with maximum population during July to August. Usually the high tide conditions presented higher abundance of chaetognaths than the low tide. Day-night variation in the incidence of chaetognaths was well defined with rich population collected at night hours. *S. tenuis* breeds continuously in the estuary with three peaks of intense spawning.

PALAVRAS-CHAVE: Chaetognaths, Distribuição, *Sagitta enflata*, *S. helenae*, *S. tenuis*

### RESUMO

Variações na distribuição e reprodução de chaetognatos no sistema estuarino do Potengi foram estudados durante 1979-1981. *Sagitta tenuis* é o verdadeiro habitante deste estuário. *S. helenae* e *S. enflata* constituem populações migrantes ocasionalmente vindos do mar aberto. Chaetognatos estão bem representados em todas as coletas com abundância máxima durante os meses de julho e agosto. Normalmente as marés altas apresentam abundância de chaetognatos contrastando com as marés baixas. Variações diurnas na incidência de chaetognatos estão bem definidas, com maior abundância nos períodos noturnos. *S. tenuis* reproduz-se continuamente no estuário apresentando três períodos de intensa desova.

### INTRODUCTION

Even though chaetognaths form an appreciable part of the marine plankton, the estuaries harbour limited species depending on the gradient in salinity (Nair, 1971, 1975; Montú, 1980). While the general pattern of distribution of chaetognaths in various estuaries is comparable (Nair & Selvakumar, 1979) the species contributing

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to the fauna show glaring differences between the tropics, subtropics and temperate areas (Alvariño, 1965). Usually the more tolerant species of chaetognaths of the coastal area form an immigrant population within an estuarine habitat. There are not many reports on the chaetognaths from the estuaries of Brazil (Nascimento, 1980; Pereira, 1980 & Montú, 1980). Chaetognaths off São Paulo had been reported by Almeida Prado (1968) while off Venezuela Legare & Zoppi (1961) made a study on their abundance. As a part of the detailed investigation on the zooplankton from the estuary of Potengi, studies were carried out during 1979-1981 and the observations on the chaetognaths are presented here. Emphasis is given on the annual variations in the abundance of different species and the reproductive conditions of the populations of chaetognaths in the estuary.

## MATERIAL AND METHODS

The material is from regular collection in the Potengi estuary from a fixed station located about 1 km from the barmouth (Fig. 1). This is a tidal estuary and the conditions in the area are influenced by the sea. Zooplankton samples were collected by vertical haul using a conical net (48 cms diameter; 1.5 m long and mesh size of 0.12 mm) from 3 m to surface. Five samples were obtained each time and average of these had been used to calculate the population. Two types of samples were taken:

1. Regular monthly samples taken during April 1979 to March 1980 except in January 1980. Each month four sets of samples covering low tide (midday and midnight) and high tide (evening and morning) collected.
2. Twenty four hrs sampling in September (25/26-9-'79 when low tide close to midday and midnight) and in February 1981 (5/6-2-'81 when low tide close to midday and midnight; 12/13-2-'81 when high tide close to midday and midnight).

Water samples were collected for evaluating environmental parameters like temperature, pH, salinity and dissolved oxygen. The chaetognaths from the entire samples were studied and they were segregated into the following three stages (Even though Alvariño, 1969 and Boltovskoy, 1984 had identified 4 and 6 groups respectively on the basis of gonadal development, the present selection of three stages can give a fair index to the breeding periodicity of chaetognaths.

1. Juveniles – The germ cells have not started developing.
2. Developing – Testes in different stages of development and may or may not fill in the tail. Ovaries developing with no large ova.
3. Mature – Tail empty, ovaries further developed. A few or all ova fully developed.

## RESULTS

### Environmental conditions

The river Potengi has direct connection to the Atlantic Ocean. The prevailing tide in the estuary is of semi-diurnal type. The depth at the area of collection is about 4 m during low tide and 7 m during high tide.

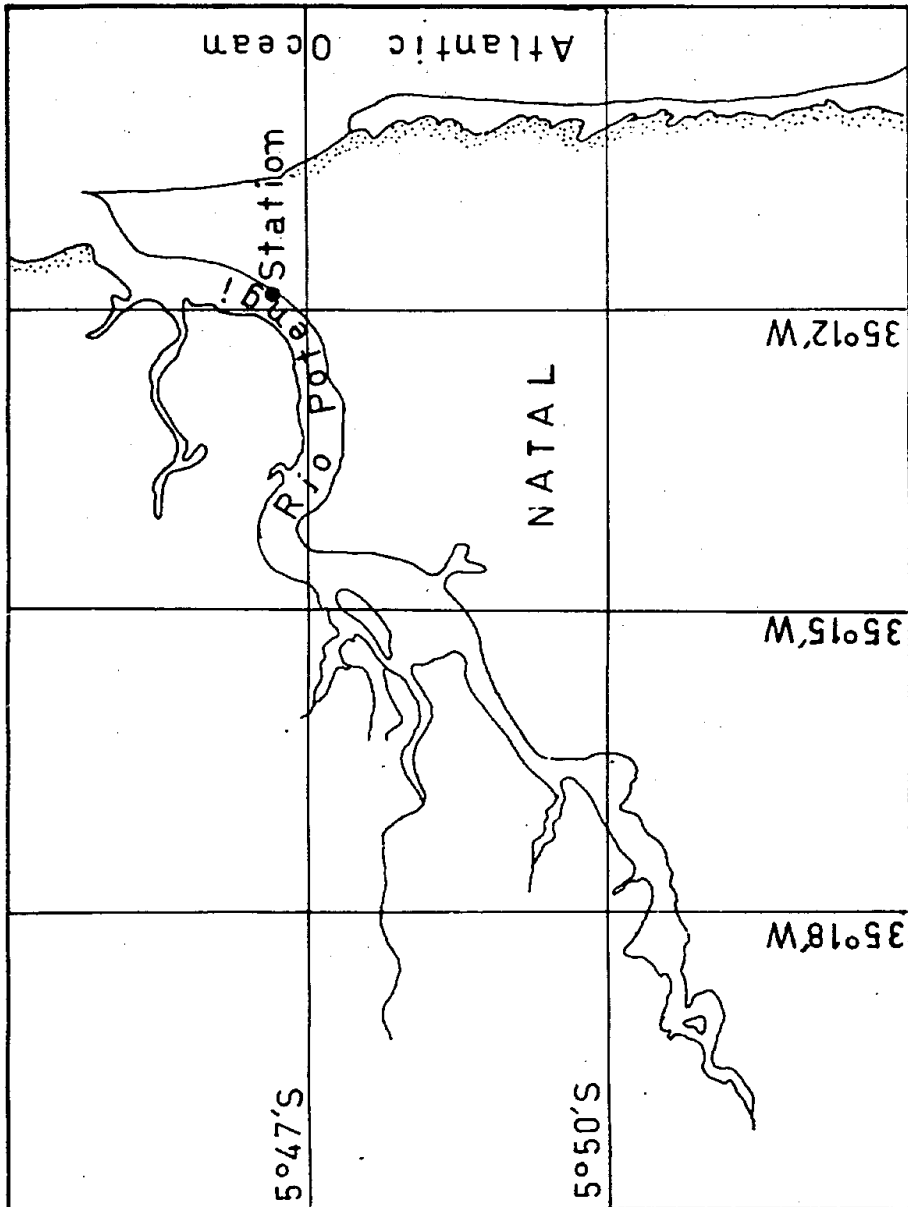


FIGURE 1 — Location of station.

Depending on the variations in salinity the period of study has been divided into three: March-June having relatively low salinity values, July-October with moderate salinity and November-February with maximum salinity comparable to that of the open sea (Table 1). Dissolved oxygen values also showed concomitant fluctuations with relatively low values during March-June than the other months. Salinity and dissolved oxygen values did not show a regular pattern of variation between surface (1.5 m) and bottom (3.4 m). However, surface temperature was always higher. The recorded pH values were either the same for both depths or higher at bottom. The extend of fluctuations for pH and temperature was negligible. There was well defined variation between high tide and low tide values for the different chemical parameters with higher values for high tide than low tide.

TABLE 1 — Variations in physico-chemical parameters during April 1979 to March 1980.

		Period		
		March-June	July-October	November-February
Temperature (°C)	LT	26.2 - 30.0	25.7 - 28.5	27.5 - 30.0
	HT	26.4 - 28.9	25.8 - 28.0	28.0 - 29.9
Salinity (‰)	LT	26.87-30.11	33.1 - 35.27	35.57-36.47
	HT	33.53-36.07	35.17-36.27	36.37-37.52
Dissolved oxygen (ml/l)	LT	1.25- 2.87	1.84- 4.05	3.11- 3.78
	HT	1.41- 3.81	2.25- 4.32	3.97- 4.60
PH	LT	7.95- 8.30	8.05- 8.40	8.23- 8.43
	HT	8.40- 8.55	8.32- 8.50	8.45- 8.63

LT Low tide. HT high tide

During the two series of 24 hour collections in February 5/6 and February 12/13 the recorded salinity and dissolved oxygen values respectively showed variations of 35.0 - 36.4‰; 36.8 - 37.1‰ and 3.69 - 4.40 ml/l; 3.73 - 4.47 ml/l (Fig. 2).

#### Distribution of chaetognaths

Chaetognaths were present throughout the period of collection contributing 0.7% (February) to 11.36% (July) of the total zooplankton population. Maximum population (Av. 74/m<sup>3</sup>) was observed in July/August period. Very often high tide values were higher than low tide/and mean values were 37 and 20/m<sup>3</sup> respectively. Time of collection also influenced the chaetognath population. Among the two series of samples for each month obtained during low tide those collected at midnight contained higher population than those caught during low tide at midday. A similar trend was also observed for the high tide collections with population density of chaetognaths being higher for the evening than the morning (Fig. 3).

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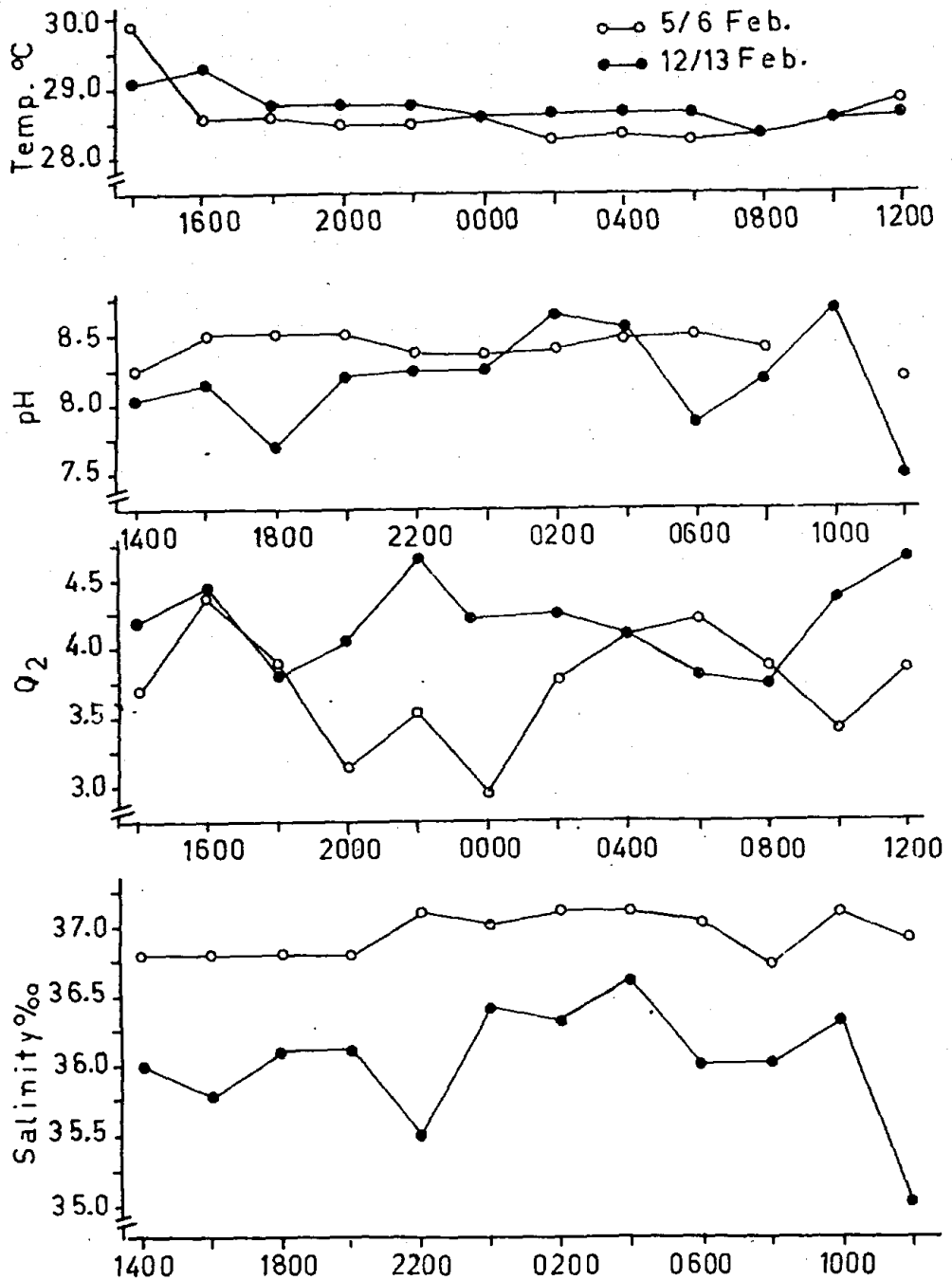


FIGURE 2 — Diurnal fluctuations of physico-chemical parameters on 5/6 and 12/13 February 1981.

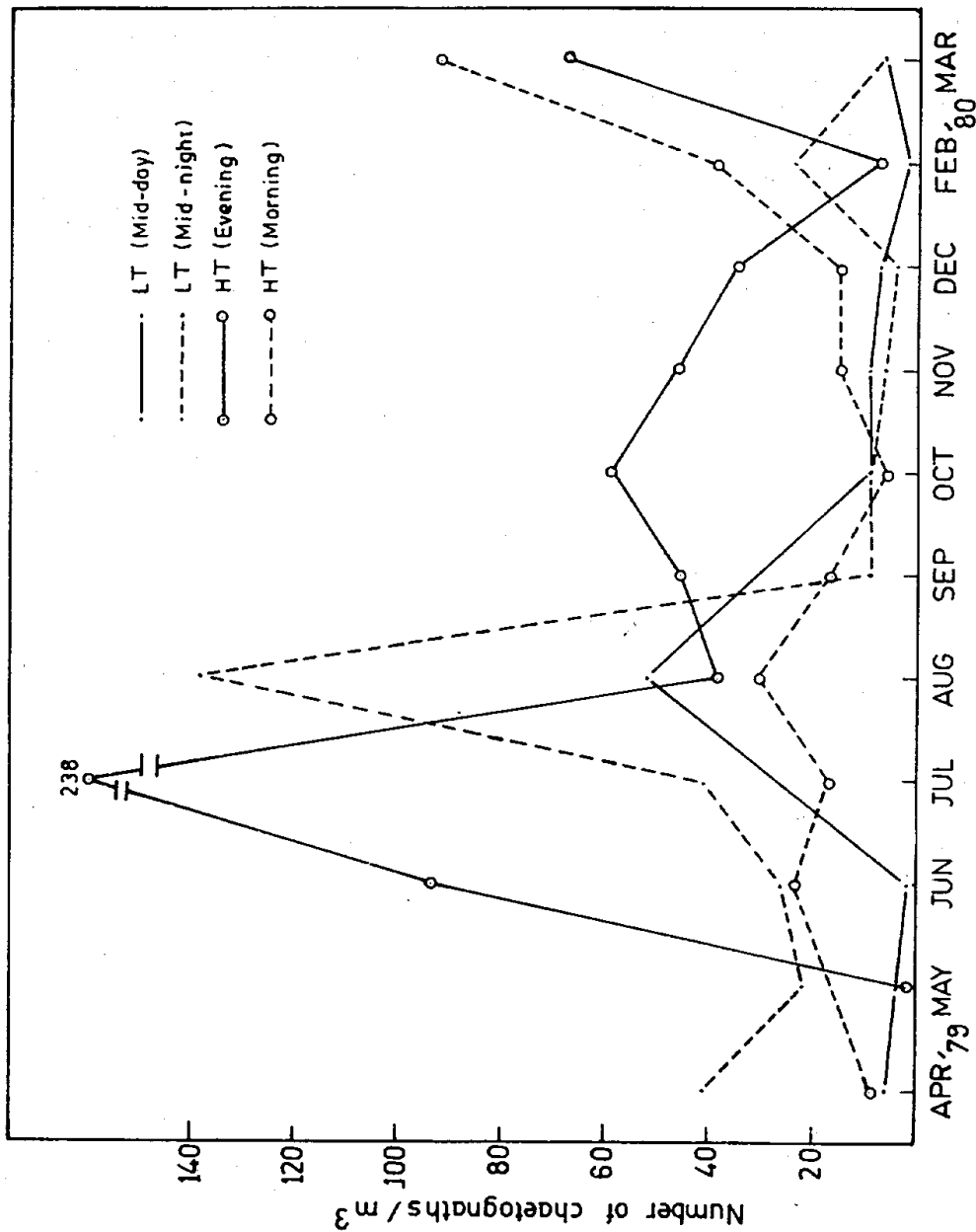


FIGURE 3 -- Fluctuation in the chaetognaths population under different tidal conditions.

The peak population of chaetognaths was observed at 2100 hrs ( $79/m^3$ ) during the 24 hrs study in September 1979 contributing 11.8% of total zooplankton (Fig. 4). During the February 5/6 series the population maximum ( $150/m^3$ ) was recorded at 2000 hrs, but contributing only 1.6% of the total population (Fig. 5). The observed trend was different for the 24 hrs collection of 12/13 with the population peak ( $92/m^3$ ) forming 1.5% of total population at 1400 hrs just after the high tide (Fig. 6).

The species found in the collections were:

1. *Sagitta enflata* Grassi, 1881
2. *S. helenae* Ritter, Zahony, 1910
3. *S. tenuis* Conant, 1896.

#### *S. tenuis*

This was the dominant chaetognath of the Potengi estuary contributing very often to the entire population. Population maxima was observed during July-August with two smaller peaks in October and March when the recorded salinity was moderate. In September the 24 hrs collection showed the build up of the high population starting at 1700 hrs reaching the peak at 2100 hrs (Fig. 4). In February (5/6) the same trend was observed with peak at 2000 hrs and second peak in the morning (Fig. 5). During the second series of diurnal studies two peaks were observed, a larger peak at 1400 hrs and a slightly smaller one between 2200 and 0200 hrs (Fig. 6).

#### *S. enflata*

Even though this was more common than *S. helenae*, its number was very poor (Table 2 and 3). Invariably the entire population was represented by immature stages. During the year round studies they were caught only during high tide conditions particularly in the morning hours. Their representation in the 24 hrs collections was limited to the first series in February with incidence confined mainly to 2000 to 0000 hrs.

#### *S. helenae*

This species was rarely recorded in the collections and was represented only by juveniles (Table 2 and 3). While in the regular monthly sampling specimens of this species were taken only in the evening, in the diurnal studies it was collected only during the night.

#### Breeding period of *S. tenuis*

Percentage contribution of the three stages of maturity during the period of study is shown in Fig. 7. Incidence of immature/mature individuals can be considered as an index of the breeding period of a population. Juveniles and developing stages were represented throughout the period of collection. Periods of abundance of juveniles above the estimated mean percentage (47.4%) was taken as the time of heavy spawning. This would indicate the occurrence of three intense spawning periods — a major one in December, a second one in May and another one in September. Maximum percentage of mature individuals were obtained in August.

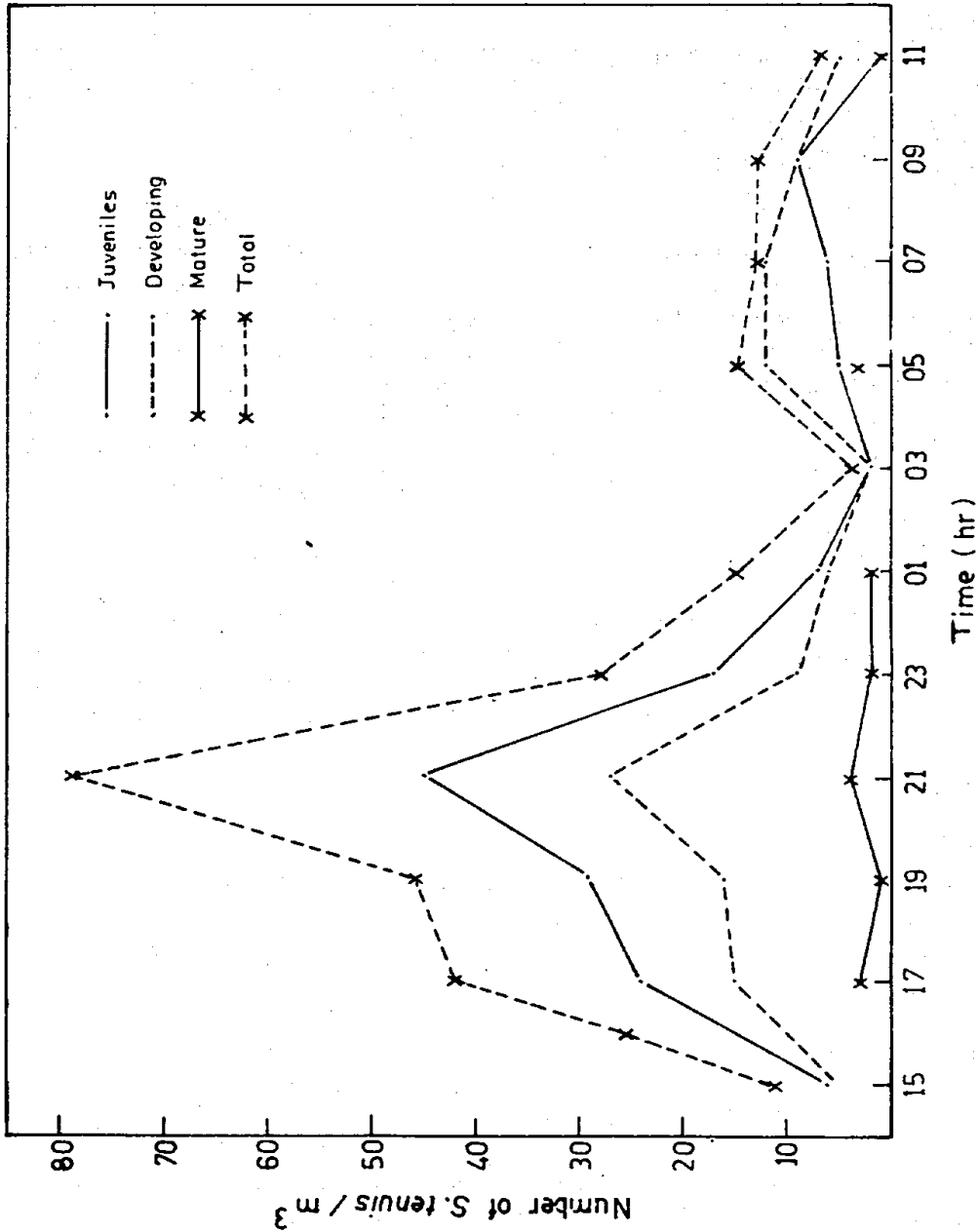


FIGURE 4 — Diurnal variation in different maturity stages of *S. tenuis* during September 1979.



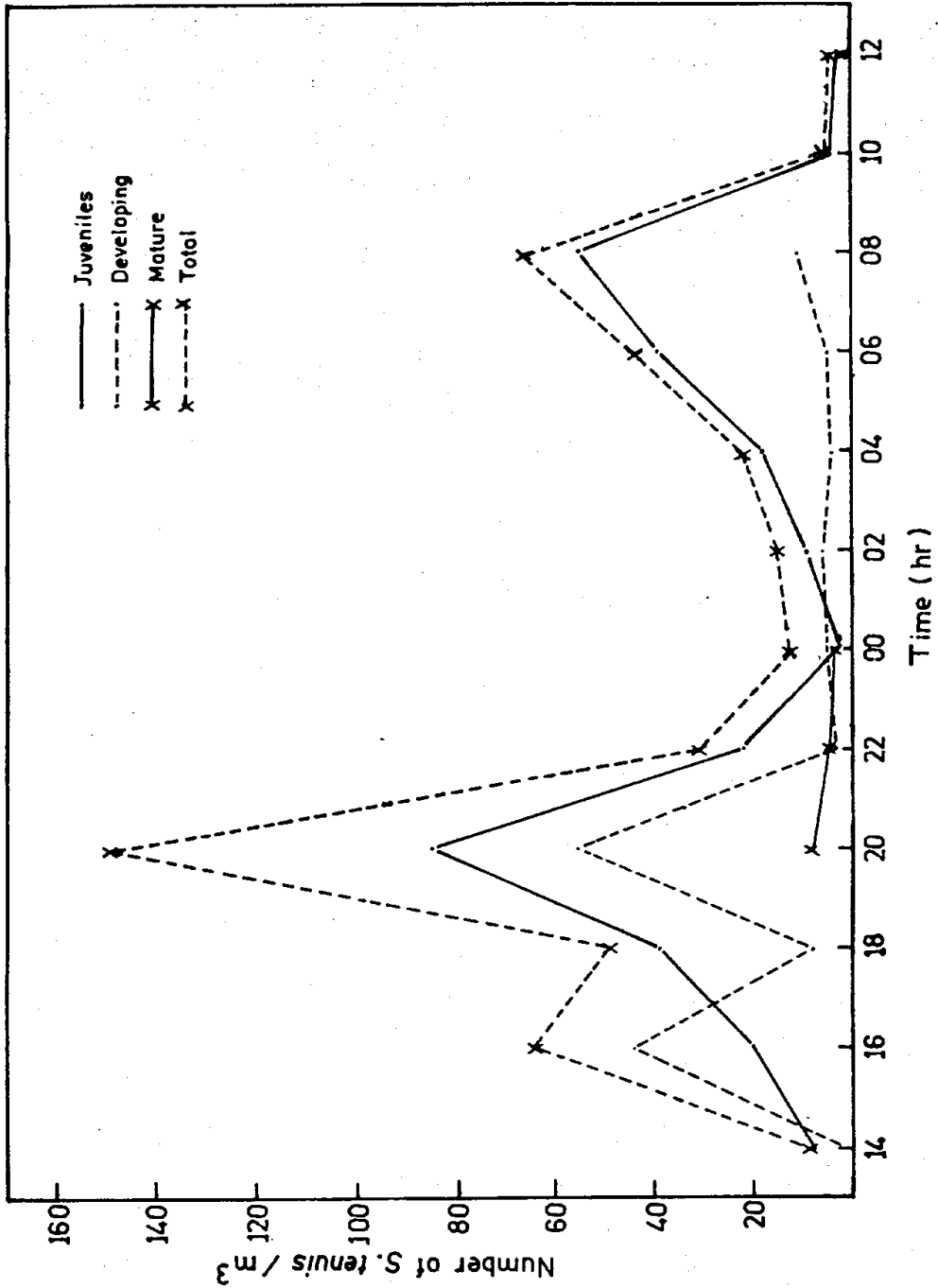


FIGURE 5 — Diurnal variation in different maturity stages of *S. tenuis* during 5/6 February 1981.

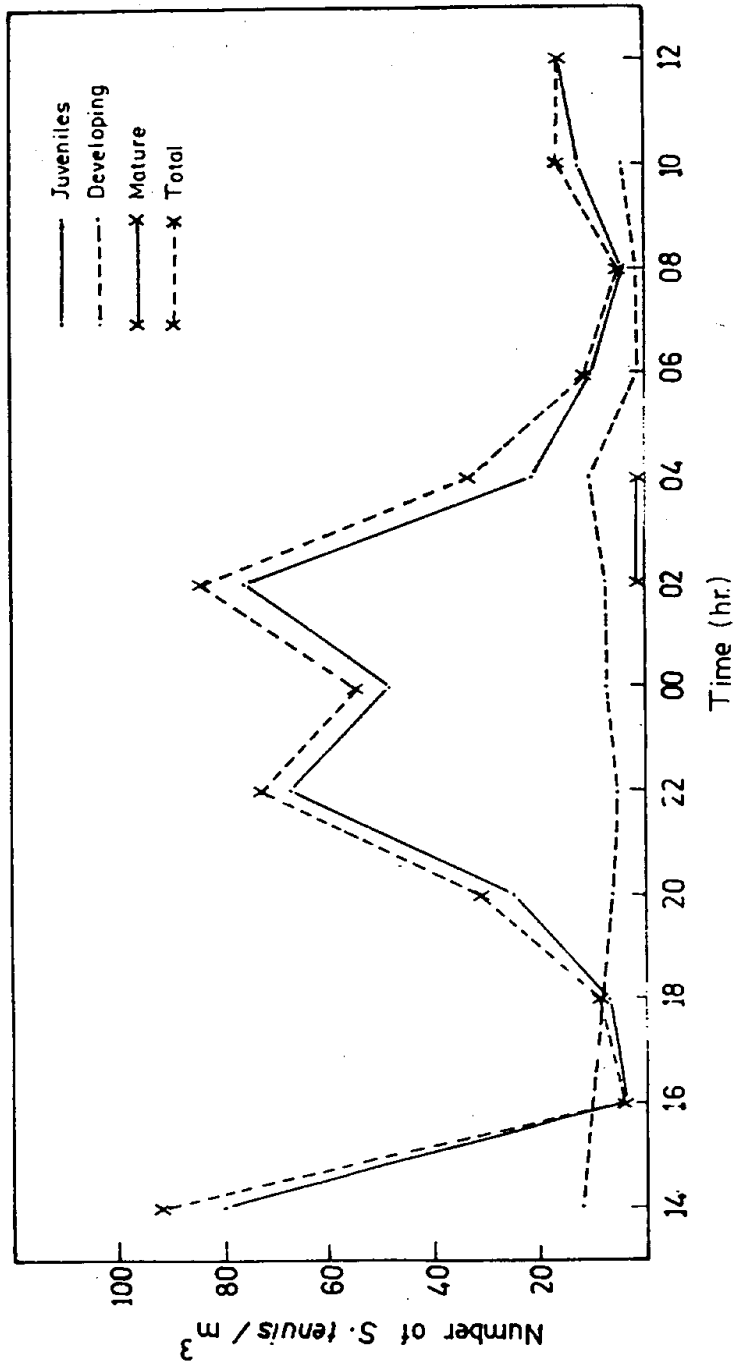


FIGURE 6 — Diurnal variation in different maturity stages of *S. tenuis* during 12/13 February 1981.

TABLE 2 — Diurnal and seasonal fluctuations in chaetognath population. Organisms/cubic meter.

	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	Feb.	Mar.
<i>S. tenuis</i>	Midday	6	4	2	—	52	—	9	7	2	6
	Evening	—	2	94	236	39	46	59	35	7	68
	Midnight	41	22	26	40	138	9	9	4	24	7
	Morning	7	17	24	16	31	17	6	15	38	91
<i>S. enflata</i>	Midday	—	—	—	—	—	—	—	—	—	—
	Evening	—	—	—	2	—	—	—	—	—	—
	Midnight	—	—	—	—	—	—	—	—	—	—
	Morning	1	—	1	1	—	—	—	—	—	—
<i>S. helenae</i>	Midday	—	—	—	—	—	—	—	—	—	—
	Evening	—	—	—	—	—	—	—	—	—	—
	Midnight	—	—	—	—	—	—	—	—	—	—
	Morning	1	—	—	—	—	—	—	—	—	—

TABLE 3 — Diurnal fluctuation in chaetognath population. Organisms/cubic meter.

	1400	1600	1800	2000	2200	0000	0200	0400	0600	0800	1000	1200
	&	&	&	&	&	&	&	&	&	&	&	&
	1500*	1700*	1900*	2100*	2300*	0100*	0300*	0500	0700*	0900*	1100*	1300*
<i>S. tenuis</i>	11	42	46	75	27	15	4	18	17	16	6	—
25-26/09-79*	—	—	—	—	—	—	—	—	—	—	—	—
05-06/02-81	9	63	47	145	28	9	15	22	43	65	4	4
12-13/02-81	92	4	8	31	70	54	83	30	11	6	16	16
<i>S. enflata</i>	—	—	—	2	2	2	—	—	—	—	1	—
25-26/09-79*	—	—	—	—	—	—	—	—	—	—	—	—
05-06/02-81	—	—	—	—	1	—	—	—	—	—	—	—
12-13/02-81	—	—	—	—	—	—	—	—	—	—	—	—
<i>S. helena</i>	—	—	—	—	—	1	—	—	—	—	—	—
25-26/09-79*	—	—	—	—	—	—	—	—	—	—	—	—
05-06/02-81	—	—	—	—	—	—	—	—	—	—	—	—
12-13/02-81	—	—	—	—	1	—	—	1	—	—	—	—

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During the diurnal studies invariably juvenile population was quite high during 1900-2200 hrs. An unusual peak of juveniles was observed at 1400 hrs during the collection of February (12/13) probably due to the prevailing tide. Representation of mature individuals was usually observed during night collection.

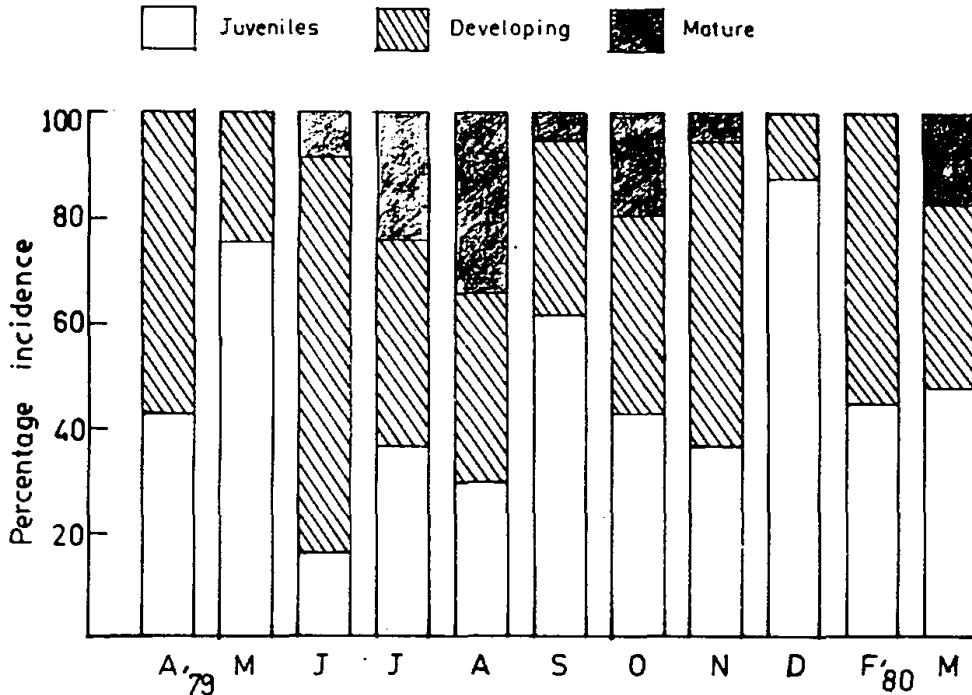


FIGURE 7 – Variation in the percentage incidence of different maturity stages of *S. tenuis*.

## DISCUSSION

In general, the estuarine fauna includes relatively few species but their numerical representation will be large (Emery & Stevenson, 1957; Montú, 1980). This is true pertaining to the chaetognaths of the Potengi estuary with limited diversity and fairly high representation in many of the collections. *S. tenuis* alone can be considered as the permanent inhabitant of this estuary. It is reported to be a neritic species of tropico-equatorial Atlantic (Alvariño, 1965, 1968, 1969, 1980) and has been recorded from the region of Ubatuba, Brazil (Almeida Prado, 1961). *S. enflata* is a cosmopolitan epiplanktonic species of temperate and warm oceanic

waters (Alvariño, 1965; Nair, 1977; Montú, 1980). *S. helenae* is an epiplanktonic tropico-equatorial Atlantic species (Alvariño, 1965, 1968, 1969, 1980). *S. enflata* and *S. helenae* being oceanic species were usually found during high tide conditions, probably indicating the incoming waters from the open sea.

An estuary being a dynamic ecosystem is controlled by a variety of physico-chemical parameters which govern the existence of organisms. In many of the tropical estuaries salinity is the major limiting factor controlling the distribution of zooplankton (Rao, 1977; Montú, 1980). Since the area of study is located near the mouth of the Potengi river salinity variations are not drastic. Parameters like temperature and pH varied marginally whereas dissolved oxygen level was low during the low tide of February to March. However, oxygen value rose during high tide. It appears that the moderate conditions prevailing from July to October were more congenial for *S. tenuis* as evidenced by population peak in July/August.

Breeding cycles of chaetognaths appear to vary with geographical location (Alvariño, 1965, 1983; Ghirardelli, 1968) and the number of generations produced each year generally increased with distance from poles (Dunbar, 1941; Owre, 1960; Alvariño, 1965, 1983; Nair, 1973). Many of the tropical species breed throughout the year (Owre, 1960; Alvariño, 1965, 1983; Nair & Selva Kumar, 1979) and occurrence of juveniles in all the collections suggests that breeding is continuous in the Potengi estuary. Recognising separate broods and follow them through maturity is difficult as the periods of heavy spawning are superimposed in what appears to be continuous spawning (Owre, 1960; Nair, 1973). There were three such well defined peaks of intense breeding for *S. tenuis* in Potengi estuary. Young populations of *S. tenuis* were steady having distinct periodicity in their peak. *S. helenae* and *S. enflata* were represented only by a few developing specimens and it is doubtful whether they breed within the estuary or not.

Being passive drifters zooplankton are bound to be influenced by the high and low tide conditions. However, there is conflicting reports on the effect of tide on the distribution of zooplankton. In the Cochin backwaters, the variations in zooplankton biomass appear to be partly influenced by the diel rhythm of plankters and the incoming tides contribute to their increase during day time (Pillai & Pillai, 1973). But Madhupratap and Rao (1979) could not find any significant effect of tides on zooplankton components in the Cochin backwaters. Tidal flow is reported to influence the larval ingress of decapods into Mandovi-Zuari estuarine complex with peak during high tide (Goswami & George, 1979). In general, one can expect shoreward increase in zooplankton during the flood period and a reverse trend during ebb tide. This naturally should influence the distribution of zooplankton in an estuarine habitat depending on the extend of tidal influence. In the nearshore waters off Thal chaetognaths and molluscs showed better representation during flood period. (Gajbhiye et al., 1983). In the Potengi estuary tide plays an important role in the incidence of different chaetognath populations and high tide population was very often larger than that observed during low tide. The day/night difference in the abundance of chaetognaths was also well defined with larger population during the night or evening. It would appear that tide as well as day/night variation in illumination have significant influence on the composition of zooplankton. Since other physico-chemical parameters showed modest variations, they appear to have

limited effect on zooplankton composition. Day/night variation in zooplankton composition is also attributed to the ability of the organisms to perceive and avoid approaching net during the day (Clutter & Anraku, 1968). From the observations conducted here (Sankarankutty et al., 1985; Sankarankutty & Medeiros, 1985) there is no clear indication of such avoidance.

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