Indian Journal of Marine Sciences
Vol. 10, March 1981, pp. 66-69

Distribution of Chaetognaths in the Polluted & Unpolluted Waters around Bombay

VIJAYALAKSHMI R NAIR, S N GAJBHIYE & B N DESAI
National Institute of Oceanography, Regional Centre, Versova, Bombay 400061

Received 1 *December* 1980

Chaetognath fauna inhabiting the nearshore waters of Bombay was studied during Oct. 1977 - Sept. 1978. Among the 4 stations investigated Thana and Mahim represent polluted regions while Harbour and Versova are relatively unpolluted. Maximum density of chaetognaths at all stations was obtained during postmonsoon period. Fluctuation in the population of chaetognaths was greater in the polluted than in the unpolluted water. *Sagitta bedoti* was the most common species in the collections. Juveniles of *S. bedoti* were in appreciable numbers throughout the period of collection. Breeding of *S. bedoti* was continuous in the nearshore waters with a few intense spawning periods. The other species present were *S. bombayensis*, *S. enflata*, *S. oceania*, *S. pulchra* and *S. robusta*. Species diversity was more in the unpolluted waters. It would appear that the disappearance of sensitive species and the consequent decrease in diversity may be the first indication of impending deterioration of the environment.

Variability and patchiness are unique features in plankton distribution. The basic factors responsible for such patterns are many, of which the effect of additional environmental stress imposed on the ecosystem by pollution or any other man-made modification is a major one. Eventhough chaetognaths are extremely abundant in coastal and oceanic waters most of them are very sensitive to physico-chemical variations. Hence a study of the chaetognath fauna abounding the nearshore waters of Bombay has been undertaken for assessing the effect of pollution on the distribution of these organisms.

The pioneer work on the chaetognaths of the Bombay waters was done by Lele and Gae[1]. Later Silas and Srinivasan[2] reported on chaetognaths from the Bombay Harbour. Observations on the plankton of the Bombay region[3-5] included some information on the seasonal abundance of chaetognaths. The physico-chemical characteristics of the Bombay water were fairly well investigated[6-11]. The present communication forms the first detailed study on the yearly variations on the abundance and diversity of chaetognaths inhabiting the nearshore waters of Bombay.

Materials and Methods

The area of study is shown in Fig.1. The stations selected are representative of the prevailing conditions around Bombay.

St 1, located off Versova at a depth range of 10-13 m represents more or less clean water where no known discharge takes place. St 2 was located towards the mouth of the Mahim creek at a depth 10-14 m. Large amount of domestic sewage and some industrial effluents are discharged into this area and is representative of a typically polluted area. St 3 was fixed near the Harbour mouth and the depth varied from 10-14 m. The collective effluents from the Thana

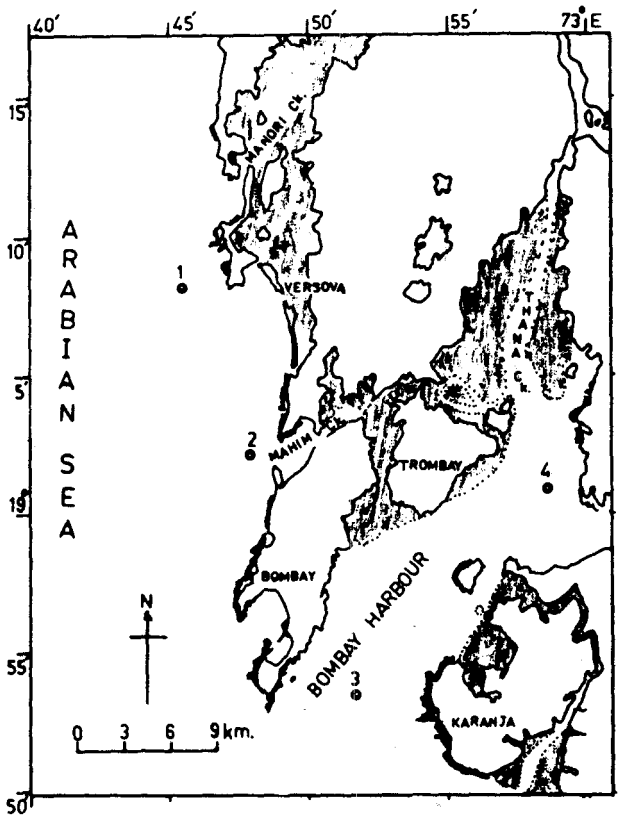

Fig. 1—Location of stations off Versova, off Mahim, mouth of Bombay Harbour and Thana creek

creek, domestic sewage and large amounts of oil and grease are being brought to the harbour. However, the strong tidal current and circulation of water keeps the area relatively clean[10]. St 4 was in the Thana creek about 1 km to the interior of the mouth. The depth at this station varied from 8 to 11 m. Many industries around Thana discharge large quantities of effluent into the creek.

Zooplankton samples covering the ebb and flood periods were collected during the period Oct. 1977 to Sept. 1978. Samples were taken from the surface using a HT net (mouth area 0.25 m^2; mesh size 0.3 mm) with a flow meter attached. An aliquot of 25% of each sample was taken for the analyses of common chaetognath species and the entire sample was examined for the representation of rare species. The density was calculated in terms of Nos/100 m^3 of water filtered. The common chaetognaths were grouped into 3 maturity stages namely juveniles, developing and mature following the features suggested earlier[12]. Percentage incidence of juveniles or mature individuals was considered as a measure of the reproductive phase of the population.

Water samples were collected from all the stations for estimating salinity, dissolved oxygen (DO), biological oxygen demand (BOD) and nutrients.

Results

Physico-chemical conditions—The coastal circulation is influenced by the tide. In general, the direction of the current is northeast during the flood tide and southwest during the ebb tide. Temperature variation during the period of study was comparable at all the stations with minimum in February (24.2-25.1°C) and maximum in May (31.6-32.6°C).

At sts 1 to 3 salinity variations were respectively 28.45-36.54, 27.23-36.42 and 26.58-36.35°/$_{oo}$. At st 4 the fluctuation in salinity was relatively more (18.53-38.01°/$_{oo}$). The relatively low salinity at all the stations was associated with the southwest monsoon in July-August. Very high values of salinity observed at Thana during premonsoon (April-May) was due to the influence of salt pans. Relatively higher range of DO was recorded at Versova (3.2-5.8 mg/litre) and Harbour (2.0-6.3 mg/litre) and lower values at Mahim (0.8-5.6 mg/litre) and Thana (0.8-6.5 mg/litre). Abnormally low DO and high BOD were noted at Mahim and Thana due to the discharge of waste water. Estimated values of phosphate-phosphorus were relatively high during December-January and July (4.67-7.45 μg at/litre) and low values were confined to October-November (0.95-1.77 μg at/litre). Recorded nitrate values were high in November-February (11.07-32.4 μg at/litre) and low in October (1.32-2.4 μg at/litre).

Distribution of total chaetognaths—Quantitative variations in the chaetognath population during ebb and flood conditions are shown in Fig.2. During October-May an almost steady population was observed at Versova and these started increasing appreciably with maximum in September. The flood and ebb periods did not show much variation. The mean population range irrespective of the tidal condition was 623-7391/100 m^3 (av. 2323/100 m^3). At Mahim from July to October high density of chaetognaths was observed with maximum in October. During the remaining period chaetognaths were relatively low particularly from February to May. Influence of tides on the incidence of chaetognaths was insignificant. Numerical representation of chaetognaths showed a variation of 6-4541/100 m^3 (av. 963/100 m^3). The harbour region sustained a more or less steady population density of chaetognaths with maximum in October. There was not much difference in the quantitative representation of chaetognaths during the ebb and flood periods. Yearly range in the

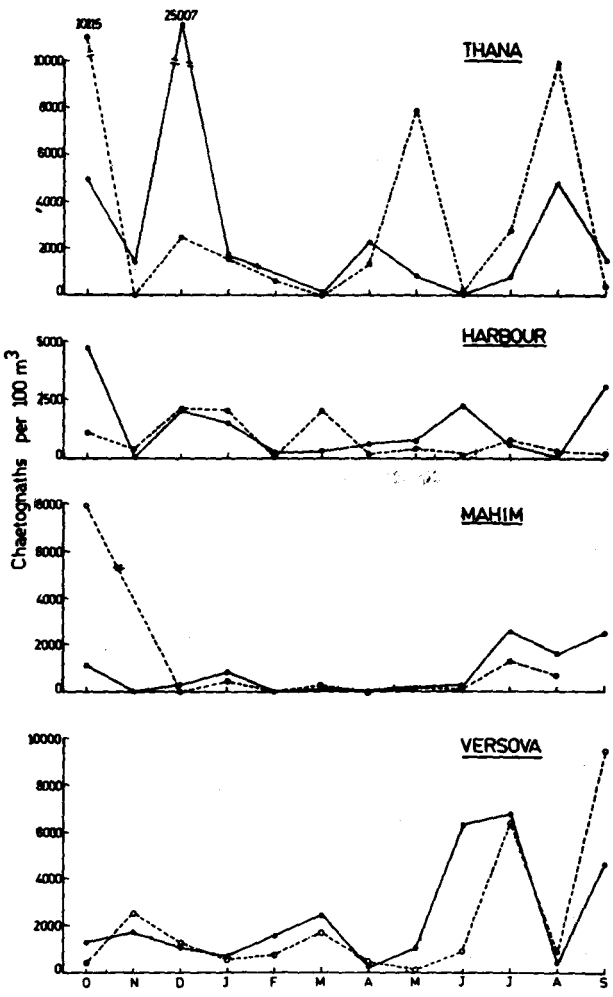

Fig. 2—Quantitative distribution of chaetognaths during ebb and flood periods at 4 stations [–●–, high tide; -○--, low tide]

total number of chaetognaths was 180-2888/100 m^3 (av. 1088/100 m^3). At Thana the yearly variations in the total chaetognath population showed many prominent peaks with highest in December. Often such high abundance was observed during the ebb period. However, higher abundance of chaetognath during the ebb period was only in 42% of the samples. Relatively poor representation of chaetognaths was during January-April. Total population showed a fluctuation of 47-13742/100 m^3 (av. 3891/100 m^3).

Species composition—*Sagitta bedoti*, *S. bombayensis*, *S. enflata*, *S. oceania*, *S. pulchra* and *S. robusta* were identified from the collections. Incidence of different species at the 4 stations are shown in Fig.3. Since there was no appreciable difference during the ebb and flood periods the percentage incidence of different species was represented irrespective of the tidal conditions.

Versova: Among the 4 species represented in the area *S. bedoti* was the dominat species throughout the year. *S. enflata* was encountered mostly during the postmonsoon and premonsoon periods. *S. pulchra* and *S. robusta* were the occasional inhabitants of the area.

Mahim: Three species were recorded from this station. *S. bedoti* was the most abundant species in the area. Percentage incidence of *S. enflata* was very low and the incidence of this species was restricted to October and December. Appearance of *S. pulchra* was also irregular with low representation.

Harbour: Maximum diversity of 5 species was encountered at this station. *S. bedoti* dominated in most of the collections except in May and June when *S. enflata* outnumbered the *S. bedoti* population. *S. enflata* was a common species in the area. *S. bombayensis* and *S. robusta* were obtained during the premonsoon period. *S. pulchra* was occasionally present in the collections.

Thana: Three species were found in the collections and *S bedoti* was the predominant species. *S. oceania* was a very common species while *S. pulchra* was fairly represented.

Breeding of S. bedoti—Representation of mature individuals was rare in the collections and hence percentage incidence of juveniles alone was considered for evaluating the intensity of spawning. Since *S. bedoti* was the only species found throughout the year the breeding intensity of this species alone was worked out (Table 1). Juveniles of *S. bedoti* were encountered in appreciable numbers throughout the year indicating the continuity of breeding. The percentage values above the mean value could be considered as peak spawning periods[12]. At Versova such intense spawning periods were obtained in November, February, May and July. At Mahim breeding was more intense in November, January, February and August-September. In the Harbour maximum

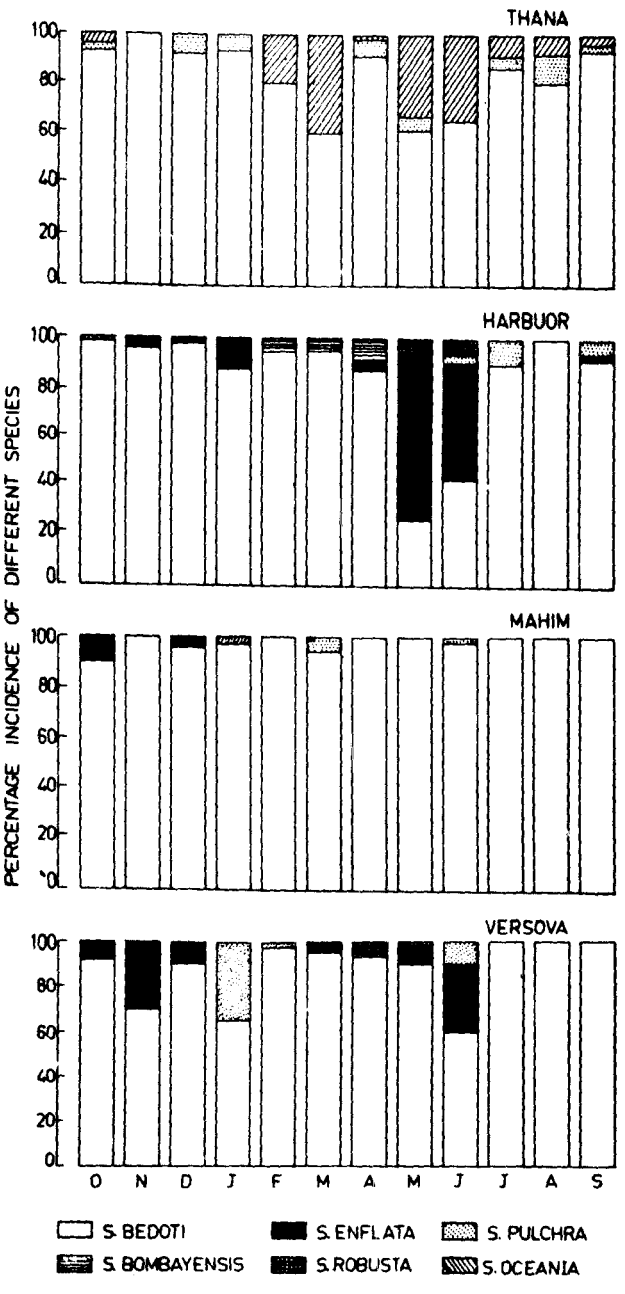

Fig. 3—Variability in percentage incidence of different species found at 4 stations

spawning was in January-March, May and August. At Thana the percentage incidence of juveniles was relatively low and November, January-February and June-July could be considered as intense breeding periods.

Discussion

Chaetognaths abound the marine environment around Bombay in appreciable numbers. Eventhough the pattern of distribution at different stations indicated variation, the maximum population density was noticed soon after monsoon (September-December). A secondary peak was observed during premonsoon (March-May) except at Mahim. The

Table 1 — Fluctuations in Juvenile Population of *S. bedoti* at Different Stations

[Values given are percentages]

Month	Versova	Mahim	Harbour	Thana
		1977		
Oct.	72.5	88	80.5	20
Nov.	75	95	72.5	77.5
Dec.	70	67.5	71.5	10
		1978		
Jan.	60	95	97	45
Feb.	90	92.5	92	50
March	72.5	80.5	98.1	20
April	67.5	80.0	46	35
May	80	75	90	31
June	70	72.5	74	65
July	84	68	78	70
Aug.	65	91	99.5	12.5
Sept.	65	99	64	37.5

results of the previous investigations on chaetognaths from the Bombay harbour are not identical. Pillai[4] found total absence of chaetognaths during November-December when the standing crop of plankton was fairly high. Belsare *et al.*[5] reported them to be abundant throughout the year similar to the present observation.

Eventhough 6 species were identified from the collections *S. bedoti*, a typical neritic species of the estuarine and coastal waters of India[13,14] was the most abundant chaetognath at all the stations. *S. enflata*, the dominant oceanic species of the Indian Ocean[13] was common at Harbour and Versova while at Mahim they were rarely found. *S. oceania* seemed to be typical of Thana. Lele and Gae[1] recorded *S. gardineri Doncaster*, *S. bedoti* and *S. bombayensis* of which the first species is a synonymn of *S. enflata* Grassi. In addition to the above 3 species Silas and Srinivasan[2] obtained *Krohnitta pacifica*, *S. regularis* and *S. pulchra* from the Harbour area of which the former 2 were not encountered in the present samples. *S. tenuis* reported later[4] might be a synonymn of *S. robusta*.

Most of the species belonging to the phylum Chaetognatha are oceanic and hence representation of species will be relatively low in nearshore waters. However, quantitatively they will be present in adequate numbers in the coastal waters[14]. In the surveyed region salinity never lowered beyond 18.53‰ and hence it never acted as a limiting factor[15]. The water quality at different stations indicated the prevailing pollution load at Mahim and Thana. Versova and harbour were relatively clean areas. Concomitantly, the distribution of chaetognaths also showed significant variation. The unpolluted regions were characterised by an almost steady population and the fluctuations were within a relatively narrow limit except during the peak periods. At the polluted areas the total population of chaetognaths indicated great amount of fluctuations, the lowest values being confined to premonsoon. Species diversity was higher at Harbour and Versova probably suggesting a healthier condition - the lesser the stress the greater will be the diversity. *S. enflata* seems to be a sensitive species and was well represented only at Harbour and Versova. The disappearance of sensitive species and the consequent decrease in diversity may be the first indication of impending deterioration of the environment at Thana and Mahim.

Acknowledgement

The authors are thankful to Dr S.Z. Qasim, Director for his encouragement and comments on the manuscript.

References

1 Lele S H & Gae P B, *J Bombay Univ*, **4** (1936) 105.
2 Silas E G & Srinivasan M, *J mar Biol Ass India*, **9** (1968) 84.
3 Bal D V & Pradhan L B, *Curr Sci*, **14** (1945) 211.
4 Pillai V K, *J mar Biol Ass India*, **10** (1968) 237.
5 Belsare S G, Mhasawade D H & Gore P S, *J Biol Sci*, **18** (1975) 11.
6 Jayaraman R & Gogate S S, *Proc Indian Acad Sci*, **45B** (1957) 151.
7 Jayaraman R, Viswanathan R & Gogate S S, *J mar Biol Ass India*, **3**.
8 Carruthers J N, Gogate S S, Naidu J R & Laevastu T, *Nature Lond*, **183** (1959) 1084.
9 Gupta R S & Sankaranarayanan V N, *Mahasagar - Bull natn Inst Oceanogr*, **7** (1974) 73.
10 NIO Report, *Waste water disposal and submarine outfall studies around Bombay*, with Metcalf & Eddy and EEC Joint Venture for BMC, Regional Centre, Bombay 1978.
11 Zingde M D, Trivedi S K & Desai B N, *Indian J mar Sci*, **8** (1979) 271.
12 Nair V R & Selvakumar R A, *Mahasagar, Bull natn Inst Oceanogr*, **12** (1979) 17.
13 Nair V R, in *Proceedings of the symposium on warm water zooplankton* (special Publication UNESCO NIO) 1977, 168.
14 Nair V R, *Indian J mar Sci*, **6** (1977) 142.
15 Nair V R, *J mar Biol Ass India*, **13** (1971) 226.