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POLLUTION IMPACT ON CHAETOGNATHS OF THE VISAKHAPATNAM HARBOUR AND NERITIC WATERS, EAST COAST OF INDIA

R. VIJAYAKUMAR, K. L. BHAT, U. SUDHAKAR*, V. V. SARMA* AND A. H. PARULEKAR

National Institute of Oceanography, Dona Paula, Goa-403 004

ABSTRACT

An attempt has been made to elucidate the effects of pollution on the distribution, abundance and diversity of chaetognaths inhabiting the harbour and neritic waters of Visakhapatnam (East Coast of India). Nine species were recorded, out of which three species were common both in harbour and neritic waters. *Sagitta bedoti* was found to be the most dominant and was present throughout the year. High percentage of *S. hipsida* and *S. robosta* and to some extent *S. bombayensis* are the organisms sustain the adverse conditions of water quality. *S. oceanica* and *Krohnitta pacifica* are present only in the clean environment.

INTRODUCTION

INDISCRIMINATE disposal of domestic sewage and industrial effluents through inlets, coupled with inadequate flushing and stagnant conditions have created a polluted environment in the Visakhapatnam Harbour (Sarma *et al.,* 1982, Subramanyam, 1990). Deleterious effects of pollutants on the aquatic biota and ecosystems need no over emphasis. Effect of pollution stress is greatly manifested in the biotic rather than the abiotic component of the ecosystem. Even though zooplankton forms a less effective parameter to evaluate the intensity of pollution, systematic studies on standing stock diversity will serve as reliable indices for biological monitoring (Nair and Govindan, 1986). Chaetognaths, being a common constituent of zooplankton community and also because of their sensitive nature should be useful in such investigation. Even though the distribution of chaetognaths around Visakhapatnam coastal waters was carried out by Ganapathi and Rao (1954) for a prolonged period of 3 years, the effect of pollution from the industrial effluents and domestic sewage on the distribution of chaetognaths in the waters of Visakhapatnam Harbour and coastal region is not reported so far. Considering the deleterious effect of pollution, the present study has been taken up for a period of one year from June 1981 to May 1982 on the distribution, abundance and diversity of chaetognaths inhabiting the harbour and neritic waters of Visakhapatnam (17°40′ N; 83°16′ – 83° 19′ E) and the results are presented in this paper.

*National Institute of Oceanography, Regional Centre, 52, Kirlampudi layout, Visakhapatnam-530 023.

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MATERIALS AND METHODS

Zooplankton sample and chemical parameters were collected from six stations in

and around Visakhapatnam Harbour (Fig. 1) between June 1981 to May 1982 at monthly intervals covering the ebb and flood period. Four stations in different channels of harbour, one in the outer harbour and one in the coastal waters of Visakhapatnam are selected to represent different environmental conditions.

amplitude in Visakhapatnam Harbour is 1 to 1.8 m. Stn. VI is the neritic zone at a depth of 18-20 m and represents a clean coastal environment.

Zooplankton collections were made by oblique hauls using HT net (mouth area 0.25 m^2; mesh size 0.3 mm) with an attached

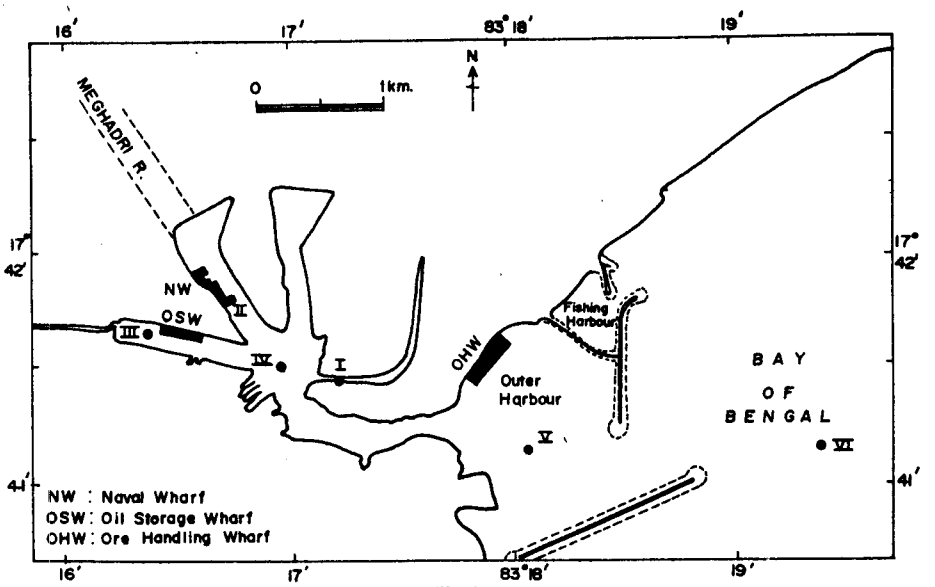

FIG. 1. Location of sampling stations.

Station I located in the channel 1 at a depth of 1-2 m receives a large amount of domestic sewage from the major city. Stn. II in channel 2 at a depth of 4-6 m receiving large discharges of industrial effluents represents the polluted zone and is the base channel for the Naval wharf. Stn. III in channel 3 at a depth of 4-6 m where zinc smelter effluent discharge takes place and is also the base for oil storage wharf. Stn. IV at a depth of 10 - 12 m is centrally located in the area of harbour, turning basin, where all the these channels join. Stn. V in the outer harbour at a depth 14-17 m represents more or less clean water even though a variety of cargoes are handled annually through this ore handling wharf. The tidal

TSK flowmeter. Zooplankton samples were collected twice in flood and ebb periods in monthly interval and at selected stations (I and II) in the premonsoon season, the diurnal observations were made to know the adverse effects of pollution. The biomass was determined by displacement method and the density was calculated in terms of numbers of water filtered. The average values of chaetognaths in flood and ebb tides during each sample collection are presented in the interpretation of results. An aliquot of 25% of each sample was taken for the enumeration of common chaetognaths and the representation of uncommon species. Water samples from surface and bottom from all stations were

analysed for salinity, dissolved oxygen, Phosphate, nitrate and silicate as per the procedures given in 'Manual of Methods in Aquatic Environment' (Anon., 1975).

Results and Discussion

Variations in different chemical parameters (Table 1) indicated the status of water quality at different stations. At stn. I, abnormally low oxygen values (0.2 - 0.8 ml. l^{-1}) occasionally reaching a value of 1.5 $ml.l^{-1}$ clearly indicate anoxic conditions and also the impact of domestic sewage and stagnation of the water. Abnormally high concentrations of phosphate, nitrate and silicate at stns. I-IV also indicate the discharge of domestic and industrial effluents and least flushing from the harbour into coastal waters. Even though large amounts of industrial effluents and domestic sewage entering into the harbour through Naval Jetty (stn. II) and channel (stn. I), the flow of pollutants into the coastal waters is restricted, because of construction of the outer harbour. Thus the stagnant conditions in the harbour channels and large amount of nutrients present appear to be the cause for making this environment highly eutrophied. However, at stn. V (outer harbour) the concentrations are lower compared to the channels (stns. I-IV) making this zone as less polluted and the ambient levels of chemical characteristics of stn. VI depict the clean coastal environment. Hence from these characteristics, the study area was divided into three zones; polluted (stns. I-IV); less polluted (stn. V) and a clean or neritic zone (stn. VI) and the distributions of chaetognaths and effect of pollution studied according to this division.

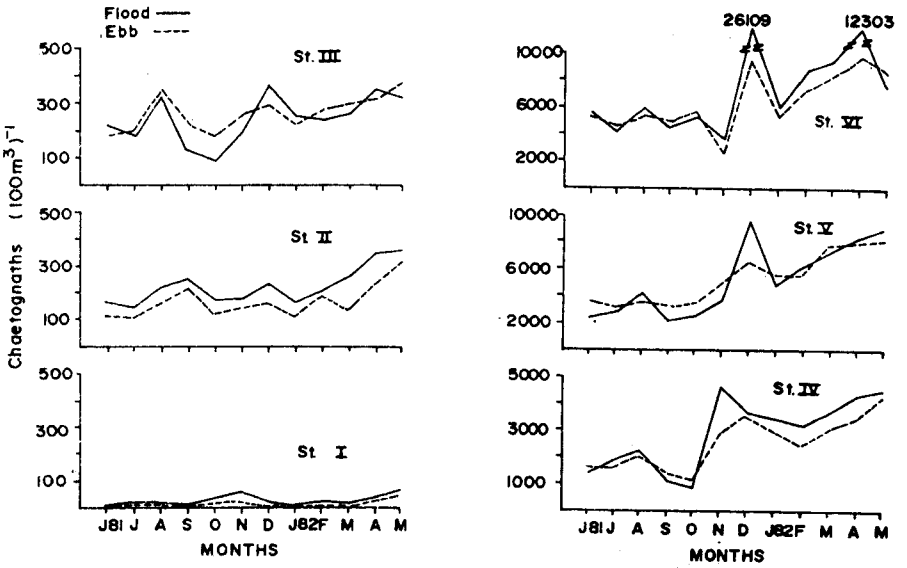

FIG. 2. Quantitative distribution of chaetognaths during flood and ebb periods.

Distribution and species diversity

The population density gradually increased from the inner channels (I-III) towards the open sea (V, VI) and the variations in chaetognaths both during flood and ebb tides are shown in Fig. 2. In general, the two peak periods, *viz.*, March-April and December were observed in the less polluted and neritic zones, but an

interesting features of this study was an observation of an intermediate peak during August. Earlier studies on distribution of chaetognaths (Ganapati and Rao, 1954; Rao, 1956; Rao and Ganapati, 1956) at Lawson's Bay and off Visakhapatnam Coast also revealed the existence of distinct periodicity in the occurrence and density of different chaetognath species. Tidal variations in the incidence of chaetognaths showed that higher density of chaetognaths sustained in the flood tide rather than low tide at stn. I, stn. II, stn. IV and stn. VI. However, at stn. III & stn. V, during monsoon season higher density of chaetognaths were noticed during ebb tide.

TABLE 1. *Range of different chemical parameters at sampling stations during the study period*

Station		Salinity X 10^{-3}	Do mlL^{-1}	Phosphate mg L^{-1}	Nitrate mg L^{-1}	Silicate mg L^{-1}
I	S	11.4–31.0	0.5–1.5	3.5–21.0	0.8–21.0	2.0–10.4
	B	19.0–31.5	0.2–0.8	1.2–17.2	0.4–17.0	0.8– 4.0
II	S	22.7–34.4	5.3–6.6	2.9–11.2	—	3.4–10.2
	B	29.5–34.9	0.8–4.7	0.6– 4.2	—	0.4– 4.2
III	S	11.8–31.5	3.4–6.8	2.0–14.0	2.6–20.0	1.2– 4.8
	B	21.4–31.5	0.8–4.8	0.9– 4.4	0.8–14.0	0.3– 2.6
IV	S	16.9–33.4	2.1–7.5	3.2–11.5	0.1– 5.9	2.2–10.6
	B	18.6–34.3	1.9–4.4	0.7– 3.3	0.3– 5.6	0.5– 4.2
V	S	17.5–34.3	3.5–5.0	0.2– 2.2	0.5–19.6	0.2– 2.4
	B	23.1–34.6	1.3–4.7	0.2– 1.0	0.5– 2.3	0.5– 3.1
VI	S	23.4–35.0	3.3–6.3	0.0– 0.1	0.0– 0.1	0.1– 0.6
	B	28.2–35.4	1.8–5.3	0.0– 0.1	0.0– 0.2	0.0– 2.1

Nine species were identified out of which three species were common in both harbour and neritic waters. The species identified were *Sagitta bedoti, S. enflata, S. regularis, S. hipsida* and *Krohnitta pacifica* and the respective percentage contribution of chaetognaths at each station to the total crop was shown in Fig. 3. *Sagitta bedoti* was the dominant species in the study area. At stn. I, *S. pulchra* and *S. hipsida* were present in low densities while at stn. II, *S. enflata, S. pulchra* and *S. hipsida* are present. At stn. III, besides *S. bedoti* and *S. enflata, S. bombayensis* and *S. robusta* were also present. The species encountered at stn. IV were *S. bedoti, S. enflata, S. pulchra, S. robusta* and *S. bombayensis* in which *S. pulchra* and *S. bombayensis* were represented in good numbers during February - May. Among the five species recorded at stn. V (Fig. 3), *S. regularis* and *S. oceanic* are the new to this semi healthier area. The latter were remarkably higher during February to May and especially in November. In the neritic zone at stn. VI, among the six species, *K. pacifica* was the new species to this habitat.

In general stn. I sustained very low population of chaetognaths (4 - 121/100 m^3) even during the flood period and totally absent during December to March. In the polluted stations (I-III) the chaetognaths population was invariably low irrespective of the tidal

conditions. High range of salinity during premonsoon season also did not encourage thriving of rich population of chaetognaths showing the adverse effects of pollution on the

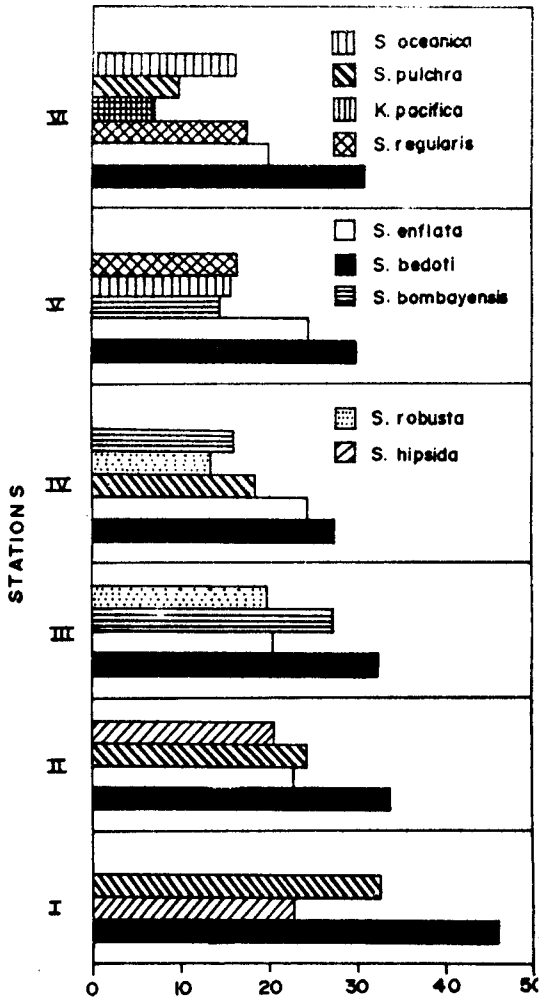

FIG. 3. Percentage composition.

distribution of chaetognaths. Further *S. hipsida* is the species commonly abundant (22% and 19%) at these two polluted stations I and II respectively, wherein domestic sewage and industrial effluents are reaching the harbour area. Salinity acts as an important environmental variable affecting the distribution of chaetognaths. Williams and Collins (1980) reported the same for Bristol channel ecosystem. However, no correlation (r -0.0126) is noticed between the abundance of chaetognaths and salinity in the polluted zone in the present study area. *S. enflata* showed its absence at stn. I because of its sensitive characteristic to anoxic conditions coupled with high BOD (Sarma *et al.*, 1982).

S. pulchra, S. regularis, S. bombayensis and *S. robusta* were found to inhabit in less polluted environment (II-V). Silas and Srinivasan (1968) reported the occurrence of *S. pulchra* and *S. regularis* species in Bombay Harbour. Nair *et al.*, (1991) also noticed the species *S. bombayensis* and *S. robusta* in the nearshore waters of Bombay as observed in the present study.

S. oceanica and *K. pacifica* were the most abundant in neritic waters coinciding with maximum salinity. These oceanic species namely *S. oceanica* and *S. regularis* are also noticed in stn. V, less polluted zone of the outer harbour suggest the incursion of high saline water into the Visakhapatnam Harbour. The man-made barriage between neritic and harbour area restrict the flushing and incursion of sea water and subsequently restrict the distribution of chaetognaths. Thus the major oceanic species *S. oceanica, K. pacifica* and *S. regularis* are not found in any of the polluted environments. Further with the exception of *S. bedoti,* the tolerance of each species to different pollutants is variable.

Quantitative distribution of chaetognaths along the different channels of Visakhapatnam Harbour suggests some of the species are prone to adverse effects of pollution depending on water quality. The high percentage contribution of *S. hipsida* and *S. robusta* and to some extent

S. bombayensis in the polluted environment (IV) suggest these organisms can sustain in adverse conditions of water quality while non existence of oceanic species like *S. oceanica, K. pacifica* and *S. regularis* in the polluted environment, indicates the sensitive nature of these organisms to pollutants. The effect of industrial effluents and domestic sewage, in terms of bioconcentration may also lead to the decline of such chaetognaths in the polluted environment *i.e.* load stress affecting the eco-physiological conditions of chaetognaths. Detailed studies are essential in order to understand the selection pattern of habitat with reference to ecobiology of the key species in estuarine and estuarine marine groups.

References

ANON. 1975. Manual of methods in aquatic environment research. *Fisheries Technical paper,* **137**, FAO, Rome.

GANAPATI, P. N. AND T. S. S. RAO 1954. Part I. Distribution of chaetognatha in the waters of Visakhapatnam Coast. *Mem. Oceanogr. Andhra Univ.* Ser., **49** : 143-150.

NAIR, V. R. AND K. GOVINDAN 1986. Biological characteristics as part of pollution monitoring studies. *Proc. National Seminar on Mussel Watch, Cochin.* pp. 86-92.

————, S. N. GAJBHIYE AND B. N. DESAI 1991. Effect of pollution on the distribution of chaetognaths in the near shore waters of Bombay. *Indian J. Mar. Sci.,* **20** : 43-48.

RAO, T. S. S. 1956. The chaetognaths of the Lawson's Bay, Waltair. *Mem. Oceanogr. Andhra Univ. Ser.,* **62** : 137-142.

———— AND P. N. GANAPATI 1956. Part III. Systematics and distribution of chaetognaths on the waters off Visakhapatnam. *Ibid.,* **62** : 147-163.

SILAS, E. G. AND M. SRINIVASAN 1968. On the little known chaetognatha *Sagitta bombayensis* Lele and Gae (1936) from Indian waters. *J. mar. biol. Ass. India,* **9** : 84-95.

SARMA, V. V., G. R. K. RAJU AND T. BOSE BABU 1982. Pollution characteristics and water quality in the Visakhapatnam Harbour. *Mahasagar, Bull. Natn. Inst. Oceanogr.,* **15** (1) : 15-22.

SUBRAMANYAM, M. N. V. 1990. Concentration of Mn, Cu, Cd and Co and toxicity of Mn and Ni in zooplankton from Visakhapatnam Harbour (Bay of Bengal). *Indian J. Mar. Sci.,* **20** : 43-48.

WILLAMS, R. AND N. R. COLLINS 1980. The implication to the benthic and planktonic fauna of presumed alterations to salinity regimes in relation to the proposed seven Barrage. Part 2. *Department of Energy Report, Contract No. E/5A/CON/4012/51/072. pp. 14 (meimeo).*