*Indian Journal of Marine Sciences*
*Vol. 31(4), December 2002, pp. 310-314*

# Composition and distribution of epigrowth fauna in Visakhapatnam harbor, east coast of India

C. Jayaprada

Marine Biological Laboratory, Zoology Department, Andhra University, Visakhapatnam-530 003, Andhra Pradesh, India

( E-mail : jsowri@vsnl.com )

*Received 16 October 2001, revised 17 September 2002*

Biological examination of epigrowth fauna on concrete underwater structures and shell settled on made structures was carried out at three selected stations in Visakhapatnam harbor (latitude 17 °14' 34" N and longitude 83 °17′ 45″E) during low tide for a period of three months. The study revealed changes in the composition and distribution of epigrowth fauna at inner harbor (st.1), outer harbor (st.3) and an intermediate location in between these two (st.2). The number of species was high at seaward station (20, st.3) when compared to st.1 (8); whereas the overall population showed gradual decrease seawards (3,890 no / 50 ml at st.1 – 2,267 no / 50 ml at st.3). Based on the Pearson coefficient, two distinct groups were identified among the fauna, such as *Corophium – Polydora* group (seaward stations) and *Capitella-Mytilopsis* group (inner harbor). The strong correlation between organisms and the abiotic factors (salinity, dissolved oxygen and *p*H) was found to be the decisive factor for the spatial distribution of epigrowth fauna.

[ **Key words**: Epigrowth fauna, Pearson coefficient, water quality, epifauna, nematodes ]

Epigrowth fauna is synonymous to foulers, which are sedentary in nature, and often found on boulders, rocks etc., or man-made underwater structures as well as settled organisms like living/dead organisms and vegetation (epifauna). Epigrowth fauna consists of diverse group of organisms ranging from protozoans to fish and inhabit under water structures in harbors, bays and lagoons. They also include several small sized animals such as nematodes, copepods, crustacean larvae, nauplii, polychaete larvae etc. Epigrowth fauna is found at places below the tide mark, and their proportion in number changes with the nature of substratum and water quality[1-5].

Visakhapatnam harbor is situated on the east coast of India (latitude 17 °14′ 34" N and longitude 83 °17′ 45"E). It has gained prominence on account of recent increase in industrial and urban activities. However, this has also resulted in notable polluted conditions. In Visakhapatnam harbor, a number of studies were undertaken on the incidence of sedentary marine species in relation to ambient water quality status[6-8]. The objective of this paper is to characterize the epigrowth faunal community structure at inner and outer harbor locations of Visakhapatnam harbor; to compare the faunal composition and abundance between stations and relate the fauna to measured environmental variables. Presently an attempt is made to identify epigrowth fauna, both qualitatively and quantitatively; and note its preferences for selected stations. The study scope also highlights the species and the abiotic parameters' interaction, as well as, base for future investigations on harbor pollution.

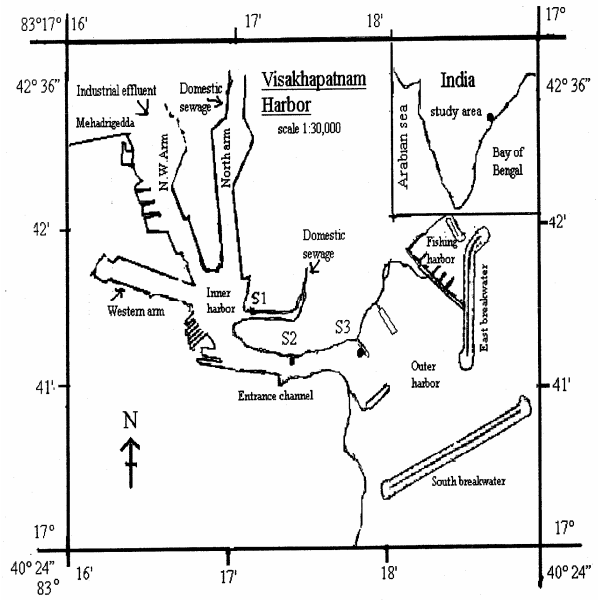


Fig.1 — Station locations

Present address: Plot No.149, Flat No.21, Tolani College of Commerce Campus, Sher-e-Punjab Society, Andheri (E), Mumbai-400 093, India

Both water and faunal samples were collected to study the epifauna as well as physico-chemical characteristics of water from harbor piers of Visakhapatnam harbor at weekly intervals for three months (29th June-29th September, 1991). Three stations were chosen, one each in the inner harbor and outer harbor (st.1 and 3 respectively) and the third (st.2) in the entrance channel, connecting the first two stations (Fig. 1).

Water samples were collected 1-3 m below the surface with the help of a shallow water sampler equipped with one-liter glass bottle. Temperature, *p*H, dissolved oxygen and salinity were estimated following standard methods[9]. A pile scrapper (Hydrobios, Germany) was employed for faunal collection[6] from man made submerged underwater concrete harbor piers. Samples were preserved in 10 % formaldehyde. In the laboratory, the samples were washed with tap water in 50 μ sieves and the volume of the material was estimated by displacement method. The washed material was stained with Rose Bengal and preserved in rectified spirit, until further analysis. Lightweight faunal elements were separated by repeated stirring and decanting; and observed under binocular microscope. The heavy-bodied organisms and fauna attached to shells (epizooic) were counted with the help of a magnifying glass. Faunal abundance was expressed as number of individuals per 50 ml volume of material collected. Since it was difficult to estimate unit area of underwater structure, the volume of sample (as estimated by displacement method) was taken into consideration and standardized to 50 ml volume. Biologically important species were identified and Pearson coefficient was estimated[10].

## Results and Discussion

The overall atmospheric temperature varied from a minimum of 27.2°C to a maximum of 38.6°C; while the total rainfall was 3522 mm during the study period. The tides in the harbor were semi-diurnal (mean range 0.9 m) in nature. Seawater temperature ranged from 22.5°C to 27.5°C. Relatively high temperature was noticed in the inner harbor. Salinity varied markedly from 18.7 to 34.8‰. At st.1 (inner harbor) the mean salinity was 29.7‰ and it gradually increased

Table 1 — Composition and distribution of epigrowth fauna in Visakhapatnam harbor - A summary of findings

| Characteristic | Stations | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Distance from outfall (km) | 0.63 | 1.85 | 2.45 |
| Channel depth (m) | 3.0 | 15.0 | 18.0 |
| Depth from which the sample collected (m) | 1.0 | 1.5 | 2.5 |
| Water quality : | | | |
| a. Temperature (°C) | 23.0-27.5 (25.6±1.49) | 22.7-26.6 (25.1±1.16) | 22.5-26.5 (25.1±1.47) |
| b Salinity (‰) | 18.7-34.0 (29.7±4.58) | 21.3-34.8 (30.96±3.72) | 26.8-34.7 (31.01±2.59) |
| c. Dissolved oxygen (mg/l) | 1.6-8.2 (5.17±1.90) | 5.4-8.8 (7.15±0.92) | 6.2-10.2 (7.8±1.25) |
| d. *p*H (range and mean ± SD) | 7.45-8.50 (7.79±0.35) | 7.55-8.6 (8.07±0.37) | 7.65-8.8 (8.29±0.45) |
| Fauna | | | |
| a. Number of taxa (excluding larval forms) | 9 | 18 | 20 |
| a. Number of Abundance (nos/50ml) range and mean | 396-8,474 (3,894) | 826-9,359 (3,275) | 877-6,498 (2,567) |
| c. Dominant species(%) | Nematodes(76.96)<br>*Capitella capitata* (6.82)<br>Copepods (5.62)<br>*Mytilopsis salleii*(4.54)<br>*Balanus amphitrite* (1.48) | Nematodes(58.08)<br>*Mytilopsis salleii* (5.5)<br>*Balanus amphitrite* (4.0)<br>*Sphaeroma terebrans* (5.5)<br>Copepods (8.94) | Nematodes (38.8)<br>*Polydora ciliata* (12.3)<br>*Balanus amphitrite* (3.85)<br>*Sphaeroma terebrans* (5.54)<br>Nauplii (10.12)<br>Copepods (16.38) |

seawards. Semi-diurnally, the salinity influenced by sewage outfall; changed appreciably at st.1 (23.8-31.8‰) as compared to the other stations (located 1.85 km away from outfall). The *p*H values ranged from 7.45 to 8.8 and the mean values increased gradually seawards. This could be attributed to the proximity of sewage outfall or the sea. Dissolved oxygen in the harbor varied markedly from 1.6 to 10.2 mg/l (Table 1).

Investigations on water quality (Table 1) revealed appreciable differences from station to station. At st.1 (southern lighter channel) comparatively high temperatures, low salinity and low dissolved oxygen characterized the waters. This could be attributed to the constant influx of fresh water from a nearby sewage outfall as well as tidal influence. On the other hand, at the other two stations, the proximity of the sea should be considered as a major controlling factor rather than tides.

Faunistically, six major groups namely, Anthozoa, Polychaeta, Crustacea, Nematoda, Gastropoda, and Pelecypoda constituted the fauna comprising 20 different species and their larval forms (Table 1). Qualitatively, the composition of organisms was remarkably different at three stations (Table 2). Gastropods, anthozoans, pycnogonids, mysis, shrimps and certain polychaetes such as Aphroditid, *Nereis* sp., *Cirratulus* sp., *Sabella* sp., *Serpula* sp., were encountered at seaward stations (in about only 10% of the samples). The seven species of fauna common along with nematodes and harpecticoid copepods at all three stations were *Dorvellia rudolphii* (Delle Chajaja), *Polydora ciliata* (Johnston), *Capitella capitata* (Fabicius), *Balanus amphitrite* (Darwin), *Sphaeroma terebrans* (Bates), *Corophium volutator* (Pallas), and *Mytilopsis salleii* (Recluz). Though the stations at outer harbor (st.3) and entrance channel (st.2) have common species, *Syllis* sp., and crabs were present at the former station.

Qualitatively the percentage composition of fauna showed remarkable differences at three stations (Table 1). For example, at st.1, the epigrowth fauna was represented by 9 species and the major constituent of these were nematodes (76.96 %); followed by *Capitella capitata* (6.82 %), *Mytilopsis salleii* (4.55 %) and copepods (5.62 %). At st.2, 18 species were encountered. Numerically, nematodes (58.08 %), nauplii (9.76 %) and copepods (8.94 %) were prominent. At st.3, which is located close to the sea, 20 species were recorded. Of these species, *Polydora ciliata* (12.3 %), *Sphaeroma terebrans* (5.54 %), *Balanus amphitrite* (3.85 %), copepods (16.38 %) and nauplii (10.12 %) were important; though the nematodes amongst these were dominant (38.8 %). Numerically, the overall faunal abundance varied from low of 396(st.1) to a high of 9359/50ml (st.2). The mean density of epigrowth fauna decreased seawards (3894 to 877 no/50 ml); in contrast the number of species increased.

As suggested by Feder *et al.*[10] based on the numerical abundance, eight species of epigrowth fauna (excluding larval forms) were identified as biologically important species. During this study the major epigrowth fauna was analyzed using Pearson coefficient method. The dendrogram (Fig. 2) showed two distinct clusters. Of these, the major cluster was represented by 5 species namely, *Polydora ciliata, Balanus amphitrite, Sphaeroma terebrans*, *Corophium volutator* and copepods. The similarity was high between *Polydora ciliata* and *Corophium volutator* (r = 0.999)

Table 2 — Epigrowth fauna--species composition at selected stations in Visakhapatnam harbor

| Species | Stations | | |
|---|---|---|---|
| | 1 | 2 | 3 |
| Anthozoa (anemones) | - | + | + |
| Polychaeta | | | |
| Aphroditid | - | + | + |
| *Nereis* sp. | - | + | + |
| *Syllis* sp. | - | - | + |
| *Dorvellia rudolphii* | + | + | + |
| *Polydora ciliata* | + | + | + |
| *Capitella capitata* | + | + | + |
| *Cirratulus sp.* | - | + | + |
| *Sabella sp.* | - | + | + |
| *Serpula* sp. | - | + | + |
| Polychaeta larvae | + | + | + |
| Crustacea | | | |
| *Balanus amphitrite* | + | + | + |
| *Sphaeroma terebrans* | + | + | + |
| *Corophium volutator* | + | + | + |
| Copepoda | + | + | + |
| Decapoda | | | |
| Shrimps | - | + | + |
| Crabs | - | - | + |
| Nauplii | + | + | + |
| Zoea | - | + | + |
| Mysis | - | + | + |
| Pycnogonida | - | + | + |
| Nematoda | + | + | + |
| Gastropoda | - | + | + |
| Pelecypoda | | | |
| *Mytilopsis salleii* | + | + | + |
| Total number of species (excluding larval forms) | 8 | 18 | 20 |

(+= present, - absent)

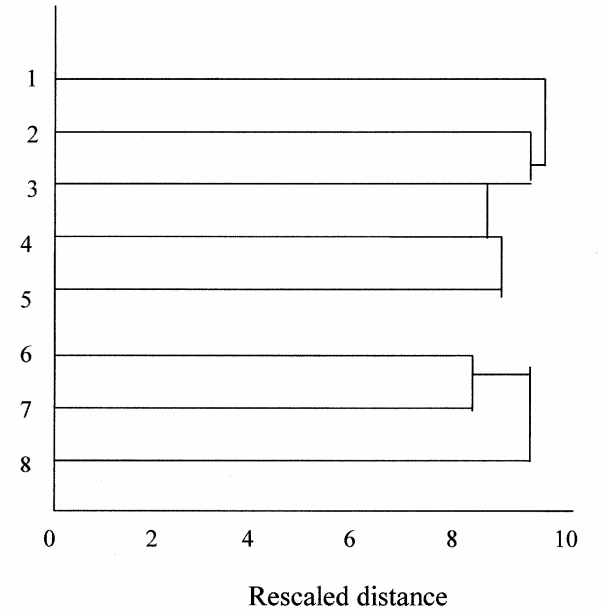


Fig. 2—Epigrowth fauna in Visakhapatnam harbor : Species similarity among biologically important species
(1. *Polydora ciliata* 2. *Corophium volutator* 3. Copepods 4. *Sphaeroma terebrans* 5. *Balanus amphitrite* 6. *Mytilopsis salleii* 7. Nematodes 8. *Capitella capitata*)

followed by *Corophium volutator* and copepods (r = 0.998) and, *Balanus amphitrite* and *Sphaeroma terebrans* (r = 0.854). These species were found to be abundant at seaward stations (st.2 and 3). The second cluster consisted of 3 species and represented by nematodes, *Capitella capitata* and *Mytilopsis salleii*. These species were dominant at inner harbor station (st.1).

An attempt to correlate species distribution and abundance patterns with abiotic variables (temperature, *p*H, salinity and dissolved oxygen) was made with the help of Pearson coefficient equation. The results revealed characteristic responses (Table 3). A strong positive correlation was evident between temperature and the prevalence of nematodes, *Capitella capitata* and *Mytilopsis salleii*(r = > 0.48) and a negative relationship with other abiotic variables (r = > 0.74).

Species belonging to *Corophuim volutator* and *Polydora ciliata* cluster showed a positive correlation with salinity (r = > 0.932), dissolved oxygen (r = > 0.858) and *p*H (r = > 0.921) and negative correlation with temperature (r = > –0.714). In this cluster, copepods, *Corophium volutator* and *Polydora ciliata*, displayed preference to dissolved oxygen and salinity (r = 0.954) than to *p*H (r = 0.90). *Balanus amphitrite* and *Sphaeroma terebrans* showed more preference to *p*H (r=0.97 and 0.71 respectively) than the other abiotic factors (Table 3).

Table 3—Correlation between **b**iologically important species and variants

| Name of the species | Temperature | Salinity | *p*H | Dissolved oxygen |
|---|---|---|---|---|
| Polydora ciliata | –0.714 | 0.954 | 0.904 | **0.991** |
| *Capitella capitata* | **0.988** | –0.950 | –0.984 | –0.885 |
| *Balanus amphitrite* | –0.902 | 0.607 | **0.711** | 0.466 |
| *Sphaeroma terebrans* | –0.995 | 0.932 | **0.973** | 0.858 |
| *Corophium volutator* | –0.742 | 0.966 | 0.921 | **0.995** |
| Copepods | –0.781 | 0.979 | 0.942 | **0.999** |
| Nematodes | **0.892** | –1.000 | –0.991 | –0.986 |
| *Mytilopsis salleii* | **0.479** | –0.826 | –0.740 | –0.908 |

A gradual change in the composition and distribution of epigrowth fauna and the water quality was noticed along with improved conditions from inner harbor to outer harbor stations. The number of species increased (8-20) and the mean abundance of organisms decreased (3894-2567 no/50 ml). A similar trend was noticed earlier in the case of benthic polychaetes[11] and phytoplankton[12] in Visakhapatnam harbor. At st.1 low numerical abundance of organisms was noticed (396 no/50 ml) as compared to its overall high mean numerical abundance (3894 no/50 ml); this could be attributed to environmental conditions such as relatively low temperature (23ºC), high salinity (34‰), dissolved oxygen (6.8 mg/l) and *p*H (8.5). Away from sewage outfall, the numerical abundance of species was evident, possibly due to the pollution effects, which lead to an overwhelming dominance of nematode population at st.1. Nematode population constituted as much as 76% of fauna indicating a high incidence of pollution.

Visakhapatnam harbor had also witnessed significant changes in the composition of fouling communities[13]. The recent spread of dressinid bivalve *Mytilopsis salleii* in the harbor is found to be a tough competitor for the epigropwth organisms in Visakhapatnam harbor[14]. The species was found at st.1 and st.2 in predominant numbers. A sustained presence and growth of *Mytilopsis salleii* can be attributed to its ability to adopt to stressed environmental conditions.

Taking into consideration, the hydrographic conditions, changes in the conditions in relation to stations and previous investigations carried out in the region; it is evident, that overall community structure, composition and association of organisms showed remarkable difference with changing water quality conditions. For instance *Capitella capitata*-nematodes

cluster indicated its preference to organically enriched environment with comparatively high temperature (st.1). In contrast, the other cluster *Corophuim volutator - Polydora ciliata* preferred oxygenated and saline marine waters. However, *Balanus amphitrite* showed preference to moderate saline and *p*H conditions, thus occurring in high numbers (in abundance) at st.2. Considering these studies, measures should be taken to improve the degrading water quality conditions, which will restore the changed ecosystems.

**Acknowledgement**

Author gratefully acknowledges valued guidance of Prof. A.V. Raman and the laboratory facilities provided in the Department of Zoology, Andhra University, Waltair. She also acknowledges technical counseling and encouragement given by Prof.C.Kalavathi.

**References**

1 Becker K, Attachment strength and colonization patterns of two macrofouling communities on substrata with different surface tension (in-situ studies) *Mar Biol*, 117 (1993) 301-309.

2 Dean T A & Bellis V J, Seasonal and spatial distribution of epifauna in the Pamlico river estuary, North Carolina, USA, *J. Elisha Mitchell Sci Soc*, 91/1 (1975) 1-12.

3 Glasby T M, Effects of shading on subtidal epibiotic assemblages. *J Exp Mar Biol Ecol*, 234 (1999) 275-290.

4 Lampadariou N, Austen M C, Robertson N & Vlachonis G, Analysis of meiobenthic community structure in relation to pollution and disturbance in Iraklion harbour, Greece, *Oceanogr Lite Rev*, 44 (1997) 1206.

5 Lowe Sarah & Thompson Bruce, Identifying benthic indicators for San Francisco Bay, In: *Regional monitoring program 1997 Annual report* (San Francisco Estuary Institute, Oakland, CA, USA) 1977.

6 Jayaprada C, *Epigrowth fauna in pollution assessment in Visakhapatnam harbor*, M.Phil. Dissertation, Andhra University, India, 1992.

7 Jayaprada C, *Ecology of benthic microalgae in relation to pollution in Visakhapatnam, east coast of India*. Ph.D.thesis, Andhra University, India, 1998.

8 Satyanarayana D, Sahu S D & Panigrahy P K, Assessment of eutrophication in the marine environment of Visakhapatnam using nutrient index as a tool.,*Indian J Mar Sci*, 21 (1992) 155-157.

9 Anon, *Standard methods for the examination of water and waste water* (13 Th edition), (American Public Health Association, Washington, USA) 1971, pp. 874.

10 Feder H M, Muller G J, Dick M H & Hawkins D B, The living baseline — Preliminary benthos survey, In: *Environmental studies of Port Valdez*, edited by. Hood, D M, Shiels, W E and Kelly, E J, (Univ. Alaska, USA), 1973, pp. 303-386.

11 Raman A V & Ganapati P N, Pollution effects on ecobiology of benthic polychaetes in Visakhapatnam harbor (Bay of Bengal), *Mar Pollut Bull*, 14 (1983) 46-52.

12 Raman A V & Phaniprakash K, Phytoplankton in relation to pollution in Visakhapatnam harbor, east coast of India, *Indian J Mar Sci*, 18 (1989) 33-36.

13 Raman A V. Pollution effects in Visakhapatnam harbor, India- an overview of 23 years of investigations and monitoring, *Helgolander Meeresunters*, 49 (1995) 633-645.

14 Satyanarayana Rao K, Srinivasan V V & Balaji M. Success and spread of the exotic fouling bivalve, *Mytilopsis salleii* (Recluz) in Indian waters, In: *Exotic aquatic species in India*, edited by M.M. Joseph, (Asian Fisheries Society, Manglore, India) 1989, pp. 125-127.