

Benthic fauna of Kakinada bay and backwaters, east coast of India

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Quantitative distribution of macro and meiofauna from Kakinada bay and backwaters was studied. Total macrofauna abundance (no. m^{-2}) ranged from 67 to 116 and 94 to 186 in the backwaters and near-shore environment respectively. Polychaetes and crustaceans constituted the bulk of macrofauna in the backwaters while polychaetes and molluscs in the near-shore bottom deposits. Meiofaunal density (no. 10 cm^{-2}) ranged from 346 to 603 and 674 to 1099 in the backwaters and near-shore region respectively. Nematodes, polychaetes, foraminiferans and turbellarians were the major groups constituting the bulk of meiofauna, both in the backwaters and near-shore region. Macrofaunal diversity was higher in the near-shore region. Impoverishment of fauna in the backwaters was related to lowering in salinity and poor oxygenation.

Kakinada bay is a shallow water marginal environment with the main land on the west, mangrove swamps on the south and a narrow sand bar running northward from the mangrove, roughly parallel to the coastline at a distance of about 11 km, on the east. In addition to numerous creeks of mangrove swamps and coringas branch of Gautami Godavari, it receives farm drainage mixed with town sewage through the Kakinada canal (Fig. 1). The fishery of Kakinada bay is very well known. Even though it supports a good fishery round the year, information on its benthic community is meagre¹. Since benthos supports a rich crop of demersal fishes², the present paper is an attempt to describe the macro and meiobenthos of the area.

Materials and Methods

Sediment samples were collected twice, during December 1984 and January 1985 (post flood period) from 10 stations, 6 in the backwaters and 4 in open sea (Fig. 1). While samples for macrofauna were collected using a van Veen grab (0.04 m^2 area), meiofauna was sampled with a plexiglass core tube (10 cm^2 area) thrust into relatively undisturbed grab sample. Five replicate samples were collected on each sampling. Animals were separated from sediment and counted under microscope as reported earlier³. Macrofaunal density is expressed as no. m^{-2} and meiofauna as no. 10 cm^{-2} . The biomass was calculated by weighing different taxa after blotting excess water and expressed as wet weight.

A part of sediment was analysed for grain size and percentage of organic matter. Bottom water samples were collected to determine temperature, salinity and

dissolved oxygen. Faunal dominance⁴, similarity⁵ and indices of species diversity⁶ (H'), equitability⁷ (E) and species richness⁸ (SR) were calculated.

Results and Discussion

Environmental parameters—Salinity showed wide fluctuations (Table 1) ranging from 0.5 to

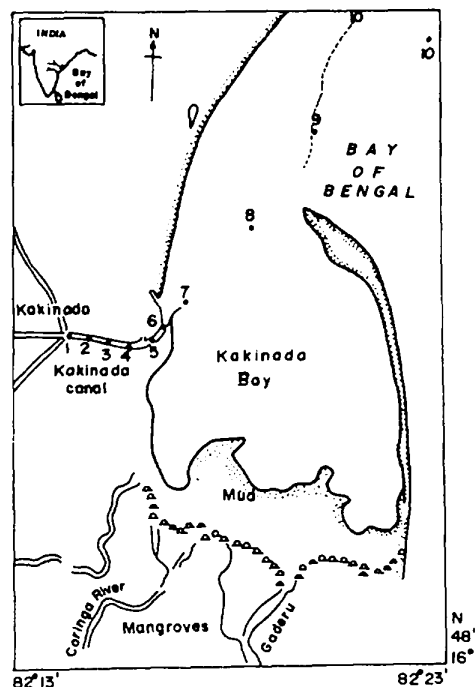


Fig. 1—Map showing location of sampling stations

23.3×10^{-3} in the backwaters while in the near-shore region it ranged between 25.1 and 33.2×10^{-3} . Bottom water temperature ranged from 24.1° to 27°C in the backwaters and from 25.5° to 27.2°C in the near-shore region. The dissolved oxygen (DO) varied from 1.4 to 2.5 ml.l^{-1} and 2.6 to 4.5 ml.l^{-1} in the backwaters and near-shore region, respectively. The median grain size varied from 0.03 to 0.16 mm and the bottom deposits were predominantly muddy (silt clay) in the backwaters and sandy silt in the bay. The organic matter in the sediment varied from 1.8 to 4.2% with relatively high values in the backwaters (*t*-test, $P < 0.05$).

Macrofauna

Density and biomass—The macrofaunal component was mainly composed of polychaetes, molluscs and crustaceans (Table 2), contributing, on an average, 94% of the total macrofauna. Others recorded as stray individuals include echiurid worms,

sipunculids, ophiuroids and hydrozoans. Population count and biomass varied considerably between backwaters and near-shore region (Table 2). Total average macrofaunal density ranged between 67 and 116 m^{-2} and 94 to 186 m^{-2} and average biomass varied from 0.28 to 0.68 g.m^{-2} and 0.82 to 1.9 g.m^{-2} in the backwaters and near-shore regions, respectively, of the bay. Polychaetes were numerically most abundant group and constituted, on an average, 44.3% in the backwaters and 33.7% in the near shore-region. Similarly bivalves contributed 10.5 and 15.15% and gastropods 11.7 and 7.8% in the backwaters and near-shore region respectively. The crustaceans together formed 35.7 and 18.8% of the total macrofauna in the backwaters and near-shore region, respectively.

Faunal composition—About 39 macrofaunal taxa were recorded. Maximum species were recorded at st 7 (Table 2). There was a progressive decrease in the number of species towards the head of the

Table 1—Physico-chemical properties and sediment characteristics at the study stations

St. no.	Salinity ($\times 10^{-3}$)	Temperature ($^\circ\text{C}$)	Dissolved oxygen (ml.l^{-1})	Median grain size (mm)	Organic matter (%)
Backwaters					
1	0.5	27.05	2.12	0.03	4.22
2	1.3	24.20	2.44	0.06	3.68
3	2.1	26.20	2.50	0.04	3.06
4	6.5	24.60	1.42	0.03	2.94
5	10.2	25.10	1.86	0.07	3.13
6	23.3	24.10	2.02	0.09	3.62
Open sea					
7	25.1	25.55	2.64	0.12	2.17
8	31.5	26.00	3.84	0.16	2.06
9	33.2	27.25	4.28	0.13	1.87
10	32.2	26.68	4.54	0.06	1.92

Table 2—Density (no. m^{-2}), wet weight biomass (g. m^{-2}) and species number of macrofauna Stations

Taxa	Stations									
	Backwaters						Open sea			
	1	2	3	4	5	6	7	8	9	10
Polychaeta	43	38	35	24	22	67	69	38	48	23
Bivalvia	—	5	—	9	8	17	17	24	15	18
Gastropoda	—	—	—	11	9	12	13	8	8	15
Euphausiids	3	1	1	6	—	4	4	3	—	2
Amphipoda	5	14	9	27	11	—	11	8	8	6
Cumacea	—	6	3	—	6	6	8	6	2	8
Isopoda	12	20	22	8	6	6	22	—	6	6
Others	9	5	5	4	5	4	42	40	23	16
Total density	72	89	75	89	67	116	186	127	110	94
Total biomass	0.45	0.28	0.52	0.68	0.49	0.38	0.82	1.90	1.71	0.95
Total species	11	11	12	13	14	16	23	20	21	20

backwaters. Variation in the occurrence of number of species in the backwaters and near-shore region was significant ($P=0.05$).

Among polychaetes the dominant species were *Dendronereis aestuarina*, *D. zululandica*, *Prionospio polybranchiata* and *Heteromastus filiformis* in the backwaters while *Nereis heirissonesis*, *N. glandicincta*, *Onuphis holobranchiata*, *Glycera alba*, *Prionospio pinnata* and *Diopatra neapolitana* were common in the near-shore region. Among molluscs, *Littorina undulata*, *Nerita chamleon*, *N. albicella*, *Crassostrea madrasensis* and *Pholas orientalis* were common in the backwaters while *Tellina iridiscens*, *T. pristin*, *Murex* sp., *Umbonium vestiarum*, *Modiolus metcalfe*, *M. undulatus* and *Turritella* sp. were recorded from the near-shore waters. The crustaceans were mainly represented by *Eriopisa chilkinsis*, *Grandidierella* sp., *Mysis* sp. and *Diogenes* sp. The macrofaunal species diversity was higher in the inshore region than in the backwaters.

Faunal dominance-- The mean total biological index and frequency of occurrence of 9 dominant species that topped the list are given in Table 3. *D. aestuarina* had the highest biological index and maximum occurrence making it the most dominant species in the 2 environments. Six of the 9 species

occurred in over half of the samples. *E. chilkinsis* and *T. iridiscens* had low frequency of occurrence compared to other species. *E. chilkinsis* is an estuarine species and thrives well in the brackish water. It was not recorded in the open near-shore region.

Faunal similarity-- The percent similarity indices presented in the Trellis diagram (Fig. 2) shows that the macrofaunal assemblage of the 2 study environments was distinct. While the affinity values were very high between similar backwater stations or between near-shore stations, the index of similarity was low between the stations of the 2 study environment. This is indicative of varying degree of homogeneity and stability of the macrofauna of the 2 environments.

Faunal diversity-- Indices of species diversity (H') varying between 2.02 and 3.55 bits/individual and species richness increasing from 1.95 to 3.76 (Table 4) showed that they increased from backwaters towards near-shore region. The high equitability values (0.73-0.96) account for the increase in informational diversity and lack of patchiness. One of the possible reasons for maximum diversity recorded at st 7 may be due to enrichment of sewage.

Table 3--Rank analysis for dominant macrobenthic species based on 2 sampling

Species	Mean total biological index per sample	Frequency of occurrence in total samples
<i>Dendronereis aestuarina</i>	2.56	92
<i>D. zululandica</i>	1.82	86
<i>Prionospio polybranchiata</i>	1.32	81
<i>Glycera alba</i>	1.02	76
<i>Littorina undulata</i>	0.86	73
<i>Nerita albicella</i>	0.62	64
<i>Grandidierella</i> sp.	0.56	45
<i>Eriopisa chilkinsis</i>	0.45	32
<i>Tellina iridiscens</i>	0.43	27

Table 4--Indices of species diversity (H'), equitability (E) and species richness (SR)

St. no.	H'	E	SR
1	2.02	0.73	1.95
2	2.10	0.89	1.61
3	2.05	0.91	1.44
4	2.17	0.93	2.56
5	2.19	0.92	2.94
6	2.74	0.90	3.01
7	3.55	0.96	3.76
8	3.13	0.89	3.49
9	3.29	0.89	3.25
10	3.28	0.90	2.98

Meiofauna

Density and biomass--The meiofaunal component was composed of nematodes, polychaetes, foraminiferans and turbellarians as dominant taxa. Other groups such as gastrotrichs, kinorhynch, halacarids, harpacticoids and tardigrades were

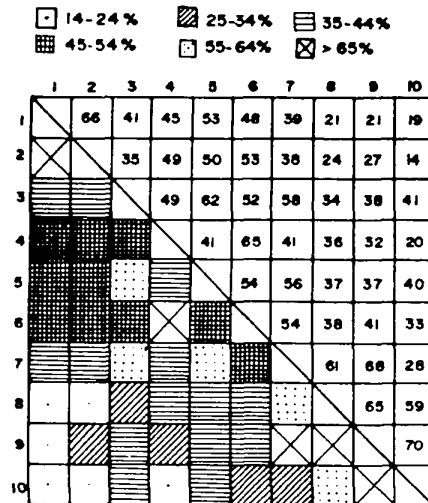


Fig. 2-- Trellis diagram for the 10 stations showing the degree of macrofaunal affinity

present in small number (Table 5). Nematodes were numerically the most dominant taxa both in the near-shore environment and backwaters. Polychaetes and foraminiferans were relatively abundant in the backwaters while nematodes were more in the near-shore region.

Vertical distribution—Meiofauna decreased significantly with increasing depth in the sediment (Fig. 3). The reduction was more pronounced in the backwaters, where the 0-2 cm layer recorded maximum (80%) fauna. A black sulphide layer (presence of H₂S) was visibly observed in the upper 5 cm layer sediment of backwaters. This layer was not found in the top 10 cm layer of the near-shore stations. The vertical decline in meiofaunal density is attributable to anoxic conditions in the sediment, indicated by the presence of H₂S.

Dispersion pattern of the major meiofaunal groups was studied by Morisita's index (Iδ)⁹. The mean Iδ values of nematodes (2.1), polychaetes (1.25), foraminifera (1.09) and turbellarians (1.32) indicate a clumped distribution (χ^2 , $P < 0.05$, $n - 1$ degree of freedom).

Analysis of variance (ANOVA) revealed significant differences between the 2 habitats with faunal density significantly higher in the near-shore regions than in the backwaters. Distribution of benthic fauna in the backwaters and the near-shore region of the Kakinada bay is comparable to the fauna of similar habitats of Cochin backwaters and near-shore region^{10,11}. The fauna in the backwater was dominated by typical estuarine forms while the near-shore region was dominated by marine forms, as expected and as recorded in Cochin backwaters system¹¹. The impoverishment of fauna in the backwaters is due to lowering of salinity and low oxygenation resulting from organic load and poor flushing.

The present study indicates the dominance of bottom community by polychaetes along with crustaceans in the backwaters and bivalves and gastropods in the near-shore regions. This is in contrast with earlier observations of distinct zones of benthic species with an overall dominance of molluscs^{11,12}. The change may be attributed to changes in water quality due to sewage and of the nature of the sediment over the year. It reemphasizes that load of organic sewage may adversely affect the benthic community on one hand while its moderate enrichment may act as biostimulating factor for these organisms¹³.

Benthic animals show characteristic response gradients with distance from the source of organic input¹⁴. Rich crop of benthos at st 7 is attributable to the effect of sewage brought into the area by the Kakinada canal. Presence of *P. polybranchiata* and *D. aestuarina* in the backwaters with low DO indicates the incidence of organic pollution, as in the case with Cochin backwaters¹⁰.

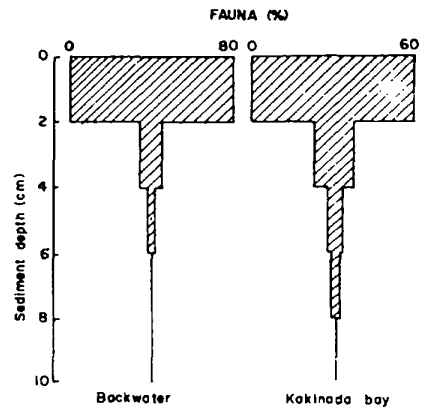


Fig. 3—Vertical distribution of meiofauna

Table 5—Density (no. 10 cm⁻²) and wet weight biomass (mg. 10 cm⁻²) of meiofauna Stations

Taxa	Backwaters						Open sea			
	1	2	3	4	5	6	7	8	9	10
Nematoda	205	213	147	133	85	141	367	432	577	572
Polychaeta	206	128	93	116	25	70	68	101	41	54
Foraminifera	39	24	287	34	361	63	128	98	119	67
Turbellaria	32	35	80	41	110	40	83	101	280	380
Harpacticoida	7	7	4	2	3	14	4	5	9	3
Others	16	15	14	20	19	21	24	19	21	23
Total density	507	424	596	347	605	350	675	757	1048	1101
Total biomass	4.92	2.07	5.72	2.78	6.12	2.87	6.45	5.35	9.10	8.42

The decline in the number of meiofauna with increasing depth in the sediment and their aggregated dispersion reiterates their spatial patchiness which is governed by the patchy distribution of certain food items and the availability of oxygen in the sediment. The increasing dominance of polychaetes in the backwaters suggests that this environment is getting polluted largely through domestic sewage. Such effects of organic load are also reported from other areas¹⁰. This can lead to severe destruction of benthic population, as observed elsewhere¹⁴, and consequent depletion of the living resources of the region.

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