

राष्ट्रीय समुद्र-विज्ञान संस्थान  
(वैज्ञानिक तथा औद्योगिक अनुसंधान परिषद)  
दोना पॉल, गोवा-403 004, भारत

# NATIONAL INSTITUTE OF OCEANOGRAPHY

( Council of Scientific & Industrial Research )

DONA PAULA, GOA-403 004, INDIA



REPORT ON

## Ecological Studies near MCF Effluent Outfall at Thanneerbhavi, Mangalore

*SPONSORED BY*

**MANGALORE CHEMICALS & FERTILIZER LIMITED, MANGALORE**

APRIL 1988

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### Genesis:

The Mangalore Chemicals and Fertilizers Pvt. Ltd. (MCF) - a fertilizer production unit, discharges the treated effluents, through a marine outfall, in the nearshore waters of Thanneerbhavi, near Mangalore in the state of Karnataka. As per the recommendations of the Karnataka State Board for Prevention of Water Pollution, the management of MCF approached the Director, National Institute of Oceanography, with a request to assess the present status of environment and biota in the marine environs of MCF effluent discharge in the sea off Thanneerbhavi near Mangalore.

### Plan of work:

As the field observations to be undertaken were short term in nature, it was scientifically valid to carry out a diurnal observation, of the changes in bio-physico-chemical characteristics over a period of varying tidal phases and photoperiodicity. Accordingly, a diurnal study extending over a continuous period of 24 hrs was planned and executed from 1200 hrs of 29th December 1987 to 1200 hrs of 30th December 1987, off Thanneerbhavi near Mangalore. Three transects, almost perpendicular to the coast were fixed for the diurnal study (Fig. 1). Transect II was in line with the MCF marine outfall, transect I and III were to the south and north of the reference transect II, respectively. The observations were spread over an area of about 25 km<sup>2</sup>.

Along each of the transect, three observation points or stations at 5, 10 and 15 meter depth contour were fixed (Fig. 1) for recording the bio-physico-chemical parameters. Station 2 situated near the point of effluent discharge was selected for diurnal observations at 4 hour interval extending between 1200 hrs of 29th December 1987 and 1200 hrs of 30th December 1987.

#### PARAMETERS STUDIED

Following characteristics or parameters were observed and recorded:

1. Water temperature ... Surface, 5 m & 10 m
2. Salinity ... Surface, 5 m & 10 m
3. Dissolved oxygen ... Surface
4. Hydrogen Ion Concentration (pH) ... Surface
5. Suspended load ... Surface, 5 m & 10 m
6. Phosphate ... Surface, 5 m & 10 m
7. Nitrate ... Surface, 5 m & 10 m
8. Nitrite ... Surface, 5 m & 10 m
9. Urea ... Surface, 5 m & 10 m
10. Ammonia ... Surface, 5 m & 10 m
11. Bacterial flora ... Water & sediment
12. Chlorophyll a ... Water
13. Phytoplankton ... Surface
14. Zooplankton ... Sub-surface
15. Benthic macrofauna ... Sea floor

## MATERIALS AND METHODS

### a) Abiotic parameters

Water temperature, salinity and dissolved oxygen were monitored by using Hydrolab digital 4041 equipment AUSTIN, Texas (USA). Water samples were collected at surface, 5 m & 10 m using a 5 litre Niskin water sampler for the analysis of phosphate-P, Nitrate-N, Nitrite-N and Urea-N. The samples were analysed by standard methods and absorbance was measured on a Baush and Lomb Spectrophotometer (Model 710) using a 5 cm cell. Suspended load was estimated by filtering 1 litre water sample through pre-combusted (450°C for 30 minutes) and preweighed GF/C filter pad. The filter was subsequently dried in a hot air oven at 60°C for 5 days and weighed. The difference in weight is the suspended load.

### b) Biotic parameters

#### Bacteriological analyses:

Water and sediment samples were collected aseptically and stored in iced condition until the analysis was carried out. The estimation of aerobic heterotrophic bacteria from these samples was done by using pour plate technique. Media used was sea water nutrient agar - suitable dilution of the samples was done by using sterile sea water blanks.



### Estimation of chlorophyll a:

Particulate matter from each water sample was separated on MgCO<sub>3</sub> treated GF/C filters. Chlorophyll a on the filter was extracted overnight in 90% acetone under cold conditions and measured on a Turner Design Fluorometer.

### Phytoplankton

Phytoplankton samples were collected from surface and near bottom by using a Niskin water sampler. Samples were transferred in 500 ml plastic bottles, fixed with 1% Lugol's iodine and preserved in 3% formaldehyde, and allowed to settle down for 3 days. The supernatant liquid was removed. The sedimented phytoplankton samples were sub-sampled and counted under a stereoscopic microscope.

### Zooplankton

Zooplankton samples were collected by surface tow using a Heron-Tranter net (0.25 m<sup>2</sup> mouth area) of 300 micron mesh size. The volume of water filtered through the net was calibrated from flow meter which was attached at the mouth of the net. Samples preserved in 5% formaldehyde, were sorted and counted for different groups under stereoscopic microscope, after estimating the biomass.

### Macrobenthos

Macrobenthic samples were collected with van Veen grab covering an area of 0.04 m<sup>2</sup>. The sediments were washed through a 0.5 mesh size stainless steel sieve and the retained samples were preserved in 10% sea water formalin containing rose bengal stain. The samples were again washed through 0.5 mm mesh sieve in running fresh water in the laboratory to clear adhering mud. All stained animals were picked and preserved in 5% formaldehyde. Later, organisms were sorted and counted groupwise under a stereoscope zoom binocular microscope. Wet weight of each group was taken after removing the hard parts.

### RESULTS

#### Abiotic parameters:

##### Temperature:

Temperature varied from 28.3 to 29.4°C at all the stations and at different depths. (Table 1a & 1b). Relatively higher surface water temperature values were due to penetration of solar radiation and interaction with the atmospheric temperature.

##### Salinity:

Salinity values varied from 30.0 to 32.5‰. (Table 1a & 1b).

No significant variations were observed. However, during diurnal observations, slightly lower values (Table 1b) were recorded at 2000 hrs. This may be due to tidal, riverine and effluent influence.

Dissolved oxygen:

The water column was well oxygenated as observed from the values varying from 4.9 to 6.4 ml/l.

Hydrogen ion concentraion (pH):

The pH values varied between 8.1 to 8.5 and were befitting to the alkaline nature of the sea water.

Suspended load:

The values varied from 0.0159 to 0.1324 g l<sup>-1</sup> at all the stations (Table 2a). Diurnal changes ranged between 0.0163 and 0.0545 g l<sup>-1</sup> (Table 2b). All these values fall within the range of values normally encountered in coastal inshore waters.

Phosphate-P:

Phosphate concentrations varied from 0.08 to 0.51  $\mu$  mol. l<sup>-1</sup> at all the stations along the three transects. These values are within the range of the coastal and estuarine waters of tropical region (Table 3a & 3b).

Urea-N:

The urea-N varied between 0.40 to 3.05  $\mu$  mol. l<sup>-1</sup>, with maximum concentration to be 4.58  $\mu$  mol. l<sup>-1</sup> (Table 3a & 3b). The values were lower than the concentrations observed around the outfall.

Ammonia-N:

The concentration varied from 1.9 to 18.0  $\mu$  mol. l<sup>-1</sup> at all the stations (Table 3a), as against 2112.3  $\mu$  mol. l<sup>-1</sup> in the effluents. From the comparison of ammonia values in the effluents and in the coastal waters, it appears that once the effluents are discharged on beach they are quickly mixed in the coastal waters. Diurnal variation studies showed that the maximum ammonia concentration of 11.16  $\mu$  mol. l<sup>-1</sup> was at station 2 at 0000 hrs (Table 3b).

Ammonia is known to be the major toxic component of the fertilizer effluent and when present in excess can produce fish mortality due to asphyxiation. However, low levels of ammonia observed during the present studies do not appear to be directly harmful for the fish life since ammonia values were below the standard tolerance limit for fish.

Nitrate-N and Nitrite-N:

The nitrate concentration ranged from 0.9 to 2.0  $\mu$  mol. l<sup>-1</sup>

and nitrite ranged from 0.65 to 1.37  $\mu$  mol. l<sup>-1</sup> (Table 3a & 3b). The concentration of nitrate and nitrite were found to be much lower, compared to the ammonia. These values are within the reported ranges for the coastal waters.

Biotic data:

Bacteriological analysis:

The colony forming units (CFU) value ranged between 2.35 to 7.60 x 10<sup>2</sup> per ml of sea water and 2.58 to 8.34 x 10<sup>4</sup> /g/dry wt. sediment at all the stations (Table 4). There was not much variation of CFU value in water sample unlike sediment samples. Low count of bacterial population was observed in sediment at station 2.

Chlorophyll a:

Chlorophyll a, a measure of standing crop of organic production varied from 2.98 to 7.30 mg m<sup>-3</sup> at all the stations and along the 3 transects. These values favourably compare with the values already reported for the coastal and estuarine regions along the west coast of India. The highest value of 7.30 mg m<sup>-3</sup> was recorded at station 8 at a depth of 5 m (Table 5a).

Diurnal variations measured at station 2 were 3.22 to 8.82 mg m<sup>-3</sup> (Table 5b), the highest value being recorded at 0800 hrs at both the surface and 5 m depth.

### Phytoplankton cell counts:

Phytoplankton cell counts varied from  $93.0 \times 10^3$  to  $652.70 \times 10^3$  cells per litre. The largest phytoplankton population was recorded at station 5 at 10 m depth which was followed by surface value at station 3. High phytoplankton counts were also recorded at all the depths at station 8. The observed phytoplankton counts are rather higher than normally encountered in a comparable ecosystem along the west coast of India.

On diurnal cycle at station 2, the highest counts were recorded at 0800 hrs which coincide with high chlorophyll a value (Table 5b & 6b).

Diatoms dominated the standing crop of phytoplankton population. At station 3, 5 and 8, which supported high phytoplankton populations, Chaetoceros sp., Chaetoceros curvisetus and Rhizosolenia stolterforthii were the dominant species. Other organisms, which contributed significantly to the standing crop were Nitzschia seriata, Leptocylindrus sp., Leptocylindrus danicus and Skeletonema costatum. Ceratium furca was the most frequently occurring dinoflagellate.

### Zooplankton:

Table 7a shows the biomass and group of zooplankton observed at all stations. The biomass was relatively high and it

ranged from 0.13 to 0.32 ml/m<sup>3</sup> ( $\bar{x}$  = 0.22, SD =  $\pm$  0.07). Similarly total zooplankton abundance varied from 115 to 950 ( $\bar{x}$  = 424, SD =  $\pm$  254) at stations 1 and 9, respectively. Copepods (85 - 447/m<sup>3</sup>) and Lucifer spp. (18 - 307/m<sup>3</sup>) were numerically most abundant.

Table 7b depicts the abundance of zooplankton during the course of diurnal investigation. The biomass ranged between 0.17 and 0.71 ml/m<sup>3</sup> ( $\bar{x}$  = 0.39, SD =  $\pm$  0.18). High biomass was observed between 2000 hrs and 0400 hrs (Table 7b). This clearly illustrates the diurnal migration of zooplankton even in shallow waters. Bivalve larval forms were observed in large numbers between 0000 and 0800 hrs. High biomass was largely due to over abundance of Acetes spp.

#### Macrobenthos:

Benthic fauna (Table 8) mainly comprised of polychaeta (74.96%), mollusc (11.63%), crustaceans (5.56%), ophiuroidea (4.55%), echiurida (2.78%) and sipunculoidea (0.50%).

The population density varied between 100 at station 8 to 1785/m<sup>2</sup> at station 1 ( $\bar{x}$  = 1095, SD =  $\pm$  1295). Similarly biomass values ranged from 0.01 to 104.5 g/m<sup>2</sup> ( $\bar{x}$  = 17.23, SD =  $\pm$  32.70) at stations 8 and 7 respectively.

There was no direct relationship in biomass and population abundance due to difference in body size. High biomass was mainly contributed by Echiurida and Polychaeta. Nearshore stations had rich fauna than the offshore stations. The population was high at station 1 (Table 8). It is interes-

ting to note that station 2 was dominated by a single species of polychaete worm Nerine, probably an indication of effect of effluent discharge.

Summary and Recommendations:

Observations on the ecological and biotic characteristics of the environs of marine outfall of MCF off Thanneerbhavi near Mangalore revealed that

- i) No significant effect of effluent discharge on the ecology of marine biota off Thanneerbhavi was discernible.
- ii) Bio-physico-chemical characteristics as observed are normal and comparable with post-monsoon (October-January) seasonal features of coastal and estuarine ecosystems along the Goa-Karnataka coast.
- iii) Overall dominance of a single species (Nerine sp.) of benthic polychaeta in the close proximity of the effluent discharge point, clearly manifests the local impact of fertilizer effluents on marine biota.
- iv) The present set of data can only be considered valid for assessing the short term changes in the ecology and biota as induced by the tidal cycle. However, commensurate with the wide seasonal variations, the magnitude of effect of fertilizer effluents on the marine environs off Thanneerbhavi can not be predicted, unless a long term monitoring programme is implemented.



Table 1a: Distribution of temperature (°C) and Salinity (‰) in the study area

Stations	Temperature			Salinity		
	Surface	5 m	10 m	Surface	5 m	10 m
1	28.5	28.4	-	32.0	32.0	-
2	28.5	28.4	-	32.0	32.0	-
3	28.8	28.2	-	31.9	31.6	-
4	29.3	28.5	28.5	32.0	32.0	32.0
5	29.3	28.3	28.5	32.3	32.3	32.3
6	28.3	28.3	28.3	32.3	32.3	32.3
7	28.5	28.4	28.4	32.0	32.0	32.0
8	28.5	28.4	28.4	32.0	32.0	32.0
9	29.4	28.6	28.5	31.8	32.5	32.5
$\bar{x}$	28.8	28.38	28.43	32.03	32.07	32.18
SD $\pm$	0.40	0.11	0.04	0.16	0.24	0.19

Table 1b : Diurnal variation of temperature (°C) and salinity (‰) at station 2

Time	Temperature		Salinity	
	Surface	5 m	Surface	5 m
1200	28.5	28.4	32.0	32.0
1600	28.9	28.8	31.5	31.5
2000	28.8	29.0	30.0	31.8
0000	28.6	28.4	31.4	32.5
0400	28.0	28.3	32.4	32.6
0800	27.8	28.2	32.2	32.2
1200	28.7	28.4	32.4	32.1
$\bar{x}$	28.47	28.5	31.7	32.1
SD $\pm$	0.38	0.27	0.79	0.35

Table 2a: Distribution of suspended load  $g l^{-1}$

Stations	Surface	5 m	10 m
1	0.0318	0.0322	-
2	0.0386	0.0214	-
3	0.0386	0.0541	-
4	0.0159	0.0161	0.0176
5	0.0384	0.0348	-
6	0.0200	0.0166	0.0832
7	0.0380	0.0278	0.0404
8	0.0370	0.0350	0.0300
9	0.0191	0.0183	0.1324
$\bar{x}$	0.0388	0.0284	0.0606
SD $\pm$	0.0201	0.0115	0.0421

Table 2b: Variation in quantum of suspended load g l <sup>-1</sup>

Time (hrs)	Surface	Bottom
1200	0.0386	0.0214
1600	0.0163	0.0176
2000	0.0163	0.0314
0000	0.0386	0.0408
0400	0.0212	0.0545
0800	0.0400	0.0416
1200	0.0410	0.0396
$\bar{x}$	0.0302	0.0352
SD $\pm$	0.0108	0.0118

Table 3a: Distribution of nutrients (  $\mu\text{mol.l}^{-1}$  ) in the study area

Stn. No.	PO <sub>4</sub> -P		Urea-N		NH <sub>4</sub> -N		NO <sub>3</sub> -N		NO <sub>2</sub> -N						
	Surf.	5m	10m	Surf.	5m	10m	Surf.	5m	10m	Surf.	5m	10m			
1	0.24	0.08	-	0.65	2.29	-	4.54	3.78	-	1.53	0.75	-	0.86	0.65	-
2	0.34	0.29	-	0.40	0.76	-	3.66	4.04	-	1.23	1.32	-	0.81	0.95	-
3	0.13	0.16	-	2.73	2.29	-	2.46	4.45	-	1.14	1.38	-	0.65	0.76	-
4	0.29	0.51	0.18	1.31	0.98	0.65	2.65	6.37	3.66	1.20	1.08	1.08	0.77	0.89	0.79
5	0.39	0.21	0.16	1.09	0.33	0.65	15.20	8.26	5.36	1.14	1.05	1.80	0.70	0.68	0.70
6	0.13	0.16	0.26	1.31	1.31	0.87	3.53	7.06	4.60	1.14	1.05	0.84	0.63	0.77	0.86
7	0.46	0.24	0.37	0.87	3.16	4.58	2.52	3.28	4.22	1.47	1.95	1.11	1.37	1.22	1.19
8	0.24	0.50	0.37	3.05	2.94	1.31	2.96	18.03	3.03	1.71	1.98	1.92	0.99	1.24	1.37
9	0.13	0.16	0.20	3.05	1.09	1.64	1.89	2.02	7.50	1.49	0.90	1.05	1.28	0.92	0.74
Beach sample	0.08	-	-	25.5	-	-	605.28	-	-	20.07	-	-	14.96	-	-
Outfall sample	0.42	-	-	21.2	-	-	2112.25	-	-	57.71	-	-	45.00	-	-
$\bar{x}$	0.26	0.25	0.26	1.61	1.68	1.63	4.37	6.36	4.72	1.33	1.27	1.30	0.89	0.89	0.94
SD $\pm$	0.11	0.14	0.09	0.99	0.95	1.37	3.89	4.53	0.44	0.20	0.40	0.40	0.25	0.20	0.25

-1  
 Table 3b: Diurnal variations of nutrients ( $\mu\text{mol.l}^{-1}$ ) at station 2

Time (hrs)	PO -P 4		Urea-N		NH -N 4		NO -N 3		NO -N 2	
	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom	Surface	Bottom
1200	0.08	0.16	1.09	0.30	3.85	2.08	4.53	1.98	0.76	0.68
1600	0.18	0.92	1.31	0.32	2.33	2.52	1.41	0.96	0.63	0.79
2000	0.34	0.29	1.42	1.74	3.34	2.33	0.72	1.11	0.54	0.61
0000	0.16	0.39	0.76	2.40	7.50	11.16	0.48	1.70	0.47	0.56
0400	0.50	0.29	0.76	1.31	7.69	3.72	1.53	1.47	0.81	0.97
0800	0.52	0.49	1.31	0.98	5.74	2.33	1.71	1.47	0.81	0.97
1200	0.34	0.29	0.40	0.76	3.66	4.04	1.23	1.32	0.81	0.95
$\bar{x}$	0.30	0.40	1.01	1.12	4.87	4.02	1.65	1.43	0.69	10.79
SD $\pm$	0.16	0.23	0.35	0.70	1.96	2.99	1.24	0.32	0.13	0.16

Table 4: Total number of colony forming units of aerobic heterotropic bacteria in water ( $\text{CFU} \times 10^2 \text{ ml}^{-1}$ ) and dry sediment ( $\text{CFU} \times 10^4 \text{ g}^{-1}$ ).

Stations	Water samples		Sediment
	Surface	Bottom	
1	6.32	-	6.38
2	6.96	-	0.43
3	5.84	-	3.91
4	3.30	2.35	2.58
5	ND	6.28	ND
6	6.66	5.46	ND
7	5.59	6.80	8.34
8	7.42	6.80	3.40
9	7.60	6.60	ND
$\bar{x}$	6.21	5.72	4.17
SD $\pm$	1.28	1.57	2.56

ND = not determined

Table 5a: Distribution of chlorophyll a ( $\text{mg m}^{-3}$ ) in the study area

Station	Surface	5m	10m
1	5.26	5.60	-
2	4.92	4.24	-
3	6.80	5.94	-
4	5.44	5.26	3.74
5	5.78	2.90	7.48
6	4.92	4.42	4.08
7	4.76	6.28	3.82
8	6.28	7.30	6.12
9	5.94	2.94	5.28
$\bar{x}$	5.57	4.92	5.09
SD $\pm$	6.65	1.52	1.37



Table 5b: Diurnal changes in chlorophyll a (mg m<sup>-3</sup>) at station 2

Time	Surface	Bottom
1200	4.92	4.24
1600	4.24	4.42
2000	3.74	3.22
0000	3.90	4.42
0400	3.40	4.92
0800	8.82	8.16
1200	6.46	4.76
$\bar{x}$	5.06	4.87
SD $\pm$	1.79	1.43

Table 6a: Phytoplankton cell numbers ( $\times 10^3$  /litre) in the study area

Station	Surface	5m	10m
1	390.25	236.30	-
2	353.50	157.50	-
3	521.15	149.10	-
4	93.00	192.50	140.00
5	496.65	276.50	652.70
6	373.75	271.43	148.50
7	342.00	365.50	315.50
8	380.63	496.65	460.55
9	271.20	91.20	309.50
$\bar{x}$	358.01	248.52	337.79
SD $\pm$	118.17	116.79	178.18

Table 6b: Diurnal variation in phytoplankton cell numbers ( $\times 10^3$  / litre)

Time (hrs)	Surface	Bottom
1200	101.18	172.20
1600	162.75	57.40
2000	391.00	151.25
0000	214.20	309.93
0400	194.25	255.18
0800	630.00	831.30
1200	312.70	158.70
$\bar{x}$	286.58	276.56
SD $\pm$	166.04	238.30

Table 7a: Biomass ( $\text{ml/m}^3$ ) and groups of zooplankton abundance ( $\text{n/m}^2$ ) in the study area

Groups	Stations								
	1	2	3	4	5	6	7	8	9
Copepoda	85	161	182	359	280	171	117	252	447
Lucifer spp.	18	56	18	135	188	52	36	307	99
Other decapoda	3	3	1	8	20	2	3	20	13
Cladocera	3	18	6	6	14	83	24	55	365
Cirriped nauplii	1	-	-	-	-	1	-	-	-
Amphipoda	-	-	-	-	7	-	-	-	-
Chaetognatha	1	3	2	4	65	8	48	17	20
Siphonophora	1	1	-	-	-	-	-	-	-
Ctenophora	-	-	1	1	-	-	-	-	-
Medusae	1	-	-	-	3	-	2	-	-
Young bivalve	-	-	-	-	-	-	-	-	-
Appendicularia	-	1	2	-	-	1	-	-	3
Fish eggs	1	-	-	-	7	1	-	-	-
Fish larvae	1	-	-	1	3	1	2	-	3
<b>Total</b>	<b>115</b>	<b>243</b>	<b>212</b>	<b>514</b>	<b>587</b>	<b>320</b>	<b>232</b>	<b>651</b>	<b>950</b>
<b>Biomass</b>	<b>0.16</b>	<b>0.21</b>	<b>0.13</b>	<b>0.16</b>	<b>0.32</b>	<b>0.16</b>	<b>0.22</b>	<b>0.25</b>	<b>0.32</b>

Table 7b: Diurnal variations in zooplankton biomass (ml/m<sup>3</sup>) and groupwise abundance (n/m<sup>2</sup>) - at station 2

Groups	Time (hrs)						
	1200	1600	2000	0000	0400	0800	1200
Copepoda	196	213	208	344	433	921	161
Lucifer spp.	43	130	51	85	95	140	56
Acetes spp	-	-	7	7	7	-	-
Other decapoda	3	6	-	14	34	14	3
Cladocera	-	38	7	14	143	41	18
Chaetognatha	20	3	14	51	20	41	3
Siphonophora	1	-	-	-	-	-	1
Ctenophora	1	1	7	3	-	-	-
Medusae	1	-	3	-	-	-	-
Young bivalve	-	-	-	85	68	34	-
Appendicularia	-	-	7	7	-	-	1
Fish eggs	-	-	-	3	-	-	-
Fish larvae	1	1	-	-	14	3	-
<b>Total</b>	<b>266</b>	<b>392</b>	<b>304</b>	<b>613</b>	<b>814</b>	<b>1153</b>	<b>243</b>
<b>Biomass</b>	<b>0.17</b>	<b>0.25</b>	<b>0.52</b>	<b>0.71</b>	<b>0.52</b>	<b>0.39</b>	<b>0.21</b>

Table 8: Benthic macrofauna biomass ( $\text{g/m}^{-2}$ ) and population ( $\text{n/m}^{-2}$ ) -  
at all sampling sites

Benthic fauna	Stations								
	1	2	3	4	5	6	7	8	9
<u>Nerine</u> sp.	450	4000	-	-	50	-	750	-	475
<u>Prionospio</u> spp.	135	-	-	-	-	-	-	-	25
<u>Scoelelepsis</u> sp.	-	-	-	-	-	-	-	-	-
<u>Nereis</u> spp.	125	-	200	-	50	-	25	75	25
<u>Scoloplos</u> sp.	75	-	-	-	-	-	-	-	-
<u>Onupis</u> spp.	100	-	-	-	-	-	-	-	-
<u>Glycera</u> spp.	100	-	-	-	-	-	-	-	-
<u>Lumbrinereis</u> spp.	-	200	150	-	-	325	50	25	-
<u>Polydora</u> spp.	-	-	-	-	-	-	-	-	-
Amphipoda A.	100	275	-	-	25	-	-	-	-
Amphipoda B.	75	-	-	-	-	-	-	-	-
Cumacea	75	-	-	-	-	-	-	-	-
<u>Tellina</u> sp.	-	-	-	725	-	-	125	-	-
<u>Gafrarium</u> spp.	-	-	-	-	25	-	-	-	-
<u>Donax incarnatus</u>	-	-	50	-	-	-	-	-	-
Gastropoda	-	-	-	25	-	-	-	-	-
<u>Bullia</u> sp.	-	-	50	-	25	-	25	-	-
<u>Umbonium</u> sp.	-	-	50	-	-	-	-	-	-
Echiurida A.	100	-	75	-	-	-	50	-	-
Echiurida B.	100	-	-	-	-	-	-	-	-
Ophiuroidea	350	25	-	25	-	25	25	-	-
Sipunculoidea	-	-	-	-	25	-	-	-	-
Total	1785	4500	575	775	200	350	1050	100	525
Biomass	1.29	10.92	1.32	0.07	36.73	0.05	104.05	0.01	0.65

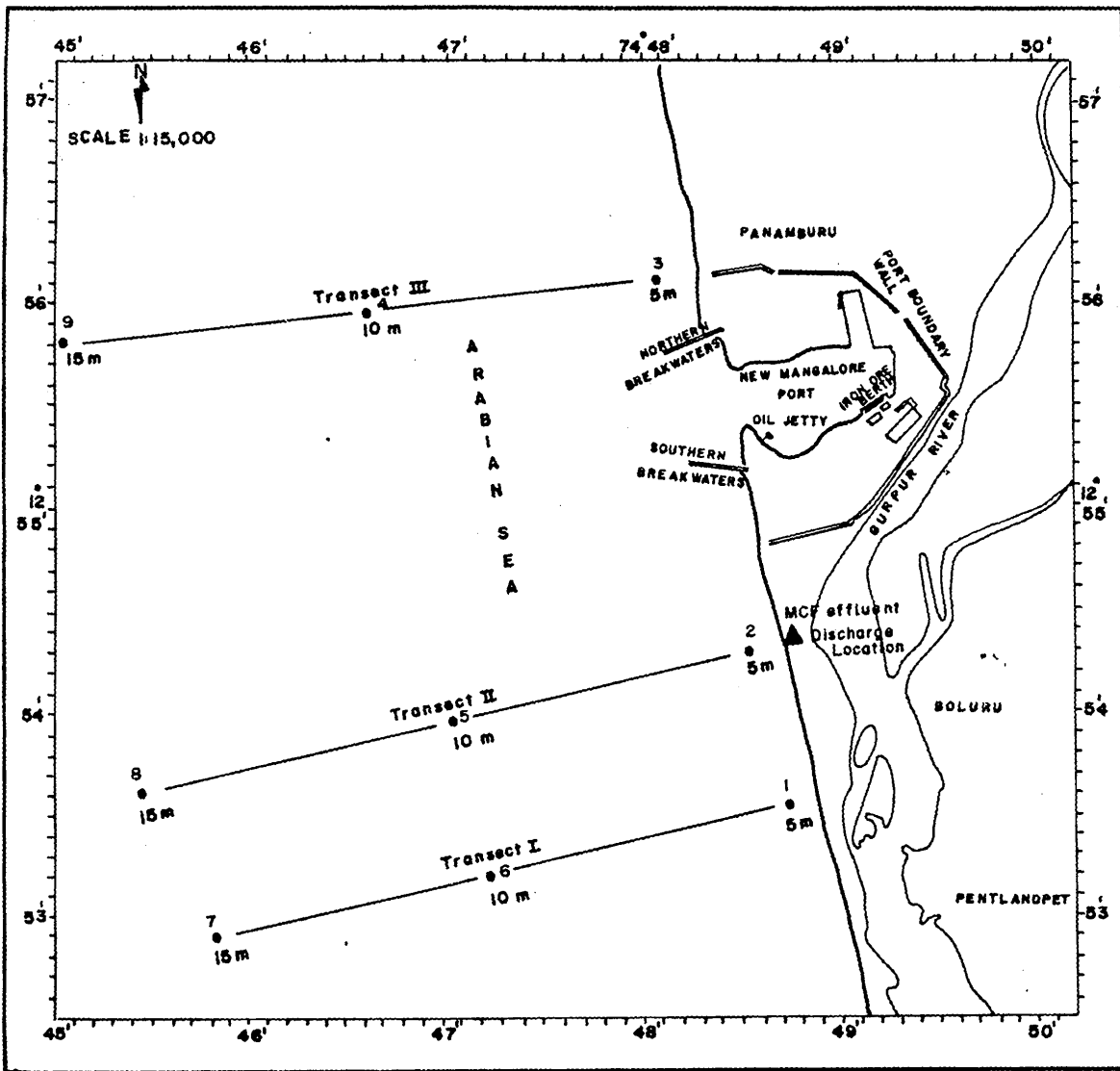


Fig. 1