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STUDIES ON SELECTED BIOLOGICAL PARAMETERS OFF MITHAPUR (GUJARAT)

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ABSTRACT

The biological characteristics off Mithapur indicated fairly high productivity in terms of macrobenthos and phytoplankton pigment concentration. The area sustained low standing stock of zooplankton. The overall biological productivity of plankton and macrobenthos indicated 30-90% reduction from the premonsoon to postmonsoon period. This decline in the standing stock of plankton and benthos was coinciding with the peak fishing season of the area.

INTRODUCTION

The discharge of wastes from any industrial establishment into the coastal environment has been reported to have deleterious effect on the ecosystem. Selected biological parameters can serve as indices to substantiate such modifications (Nair and Govindan, 1986). Considering this, a detailed study on the basic biological characteristics of the waters adjoining a chemical factory at Mithapur (Gujarat) was taken up. The parameters considered are phytoplankton pigments, zooplankton and benthos with the first two variables representing living matter in the water column and the last one as life in the benthic realm. Information on the marine life in the Gulf of Kutch area is limited to a few reports on plankton (Dhawan, 1972; Govindan *et al.*, 1982) and on benthos (Kasinathan *et al.*, 1977). However,

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none of the above studies covered the interior and nearshore waters of the Gulf selected for the present investigation.

MATERIAL AND METHODS

Six stations were selected in the Gulf side (G1-G6) (Fig.1).

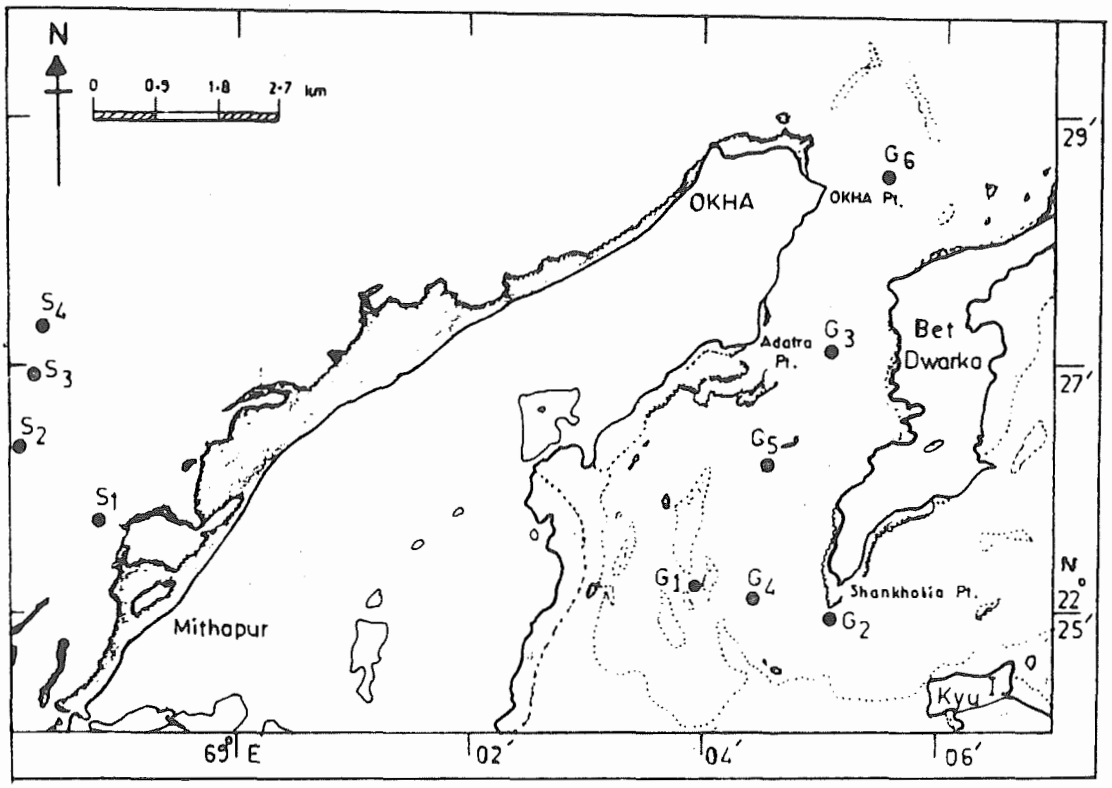

Fig.1 : Location of Stations.

Sampling was done during two season, namely the pre-monsoon (April) and the postmonsoon (December) periods of 1981. During April 4 stations off the open coast of Mithapur (S1-S4) were selected for obtaining additional information on the physico-chemical and plankton characteristics for the premonsoon period. Extreme conditions prevail during the premonsoon period and hence the information for this season is more important for evaluating the extent of pollution. For the estimation of phytoplankton pigments water samples were collected for high and low tides and analysed immediately following the procedure of Strickland and Parsons (1968). For zooplankton oblique hauls were made using an HT net (mesh size 0.3 mm and mouth area 0.25 m^2) with an attached flowmeter. Depth at the gulf stations varied from 3 to 7m while at the open coast depth ranged from 7 to 10 Sediment samples were obtained using a van Veen grab having a sampling area of 0.04 m^2. The abundance of each organism kwas

worked out by analysing the various groups retained on a sieve of 0.5 mm mesh size. Benthic biomass was estimated on wet weight basis. Benthic productivity was evaluated interms of carbon content from the wet weight of benthos (Sanders, 1956). Surface and bottom water samples were collected for the estimation of salinity, DO and nutrients by Niskin samplers. Analyses were carried out as per standard methods (Strickland and Parson, 1968).

RESULTS AND DISCUSSIONS

Environmental conditions : The physico-chemical characteristics of this area had been reported in detail in the NIO Report (1982). the tides in the area are semi-diurnal. The tidal range is more than 3 m during spring and of about 2 m during neap. The general pattern of tidal current is that the flood water enters the area through either side of Dwarka Bet and ebbed out mainly through the channel off the Adatra point. Surface and bottom values of salinity did not vary much either laterally or vertically thereby indicating a well mixed water mass (NIO, Report 1982). IDifference in average salinity values between the Gulf stations and the station at open coast was marginal (Table 1). During the period of observation variation in salinity was also not well marked (Tables 1 & 2). pH value indicated relatively higher values in the Gulf than in the open coast stations while DO values indicated an opposite trend. pH and DO values were relatively higher for the postmonsoon than for the premonsoon period. The levels of nitrite, nitrate and phosphate are those normally expected for coastal waters.

Phytoplankton pigment : The different fractions of chlorophyll and carotenoids inside the Gulf during April showed peak values at St. G6 (Table 3 & 4). Chlorophyll a and b values were generally higher for ebb than for the flood(av. 3.53,2.44 and 4.50, 3.20 mg/m^3 respectively.) In the nearshore waters the value of phytoplankton pigments was relatively high at stations close to the shore. Among the four stations studied in the nearshore waters the interior stations showed relatively high values for phytoplankton pigments (NIO, 1982).

Carotenoid values recorded in April at the Gulf stations were higher (av. 3.4 m SPU/m^3) compared to the outside stations (av. 2.51 m SPU/m^3). Variations in the average values of carotenoid during different tidal condition was negligible for the premonsoon period, whereas it was well marked during the postmonsoon

TABLE 1 : VARIATIONS IN PHYSICO-CHEMICAL PARAMETERS AT STATIONS LOCATED INSIDE THE GULF AND OPEN COAST DURING APRIL, 1981. VALUES GIVEN ARE AVERAGES OF SURFACE AND BOTTOM

	G_1	G_2	G_3	G_4	G_5	G_6	S_1	S_2	S_3	S_4
Depth (m)	4.5	7.5	6.5	4.5	7.0	7.0	7.0	10.0	8.0	7.5
Salinity (‰)	35.83	35.75	35.82	35.79	35.55	35.74	35.80	35.63	35.85	35.71
pH	8.16	8.0	7.78	8.02	7.99	7.78	6.98	8.19	8.20	8.21
Dissolved oxygen (mg/1)	6.00	5.90	6.50	6.33	6.24	5.93	7.28	7.08	7.08	7.48
Phosphate-phosphorus (ug-at/l)	3.14	1.19	0.77	1.24	0.41	.90	0.86	1.02	1.03	1.02
Nitrate-nitrogen (ug-at/l)	0.47	1.26	1.02	1.02	0.80	1.29	1.05	4.11	1.55	0.59
Nitrite-nitrogen (ug-at/l)	0.69	0.27	0.36	0.55	0.29	0.65	0.21	0.63	0.39	0.14

TABLE 2 : VARIATIONS IN PHYSICO-CHEMICAL PARAMETERS AT GULF STATIONS DURING DECEMBER, 1981. VALUES GIVEN ARE AVERAGES FOR SURFACE AND BOTTOM

	G_1	G_2	G_3	G_4	G_5	G_6
Salinity	35.83	36.12	35.89	36.04	35.89	35.66
pH	8.20	8.08	8.73	8.11	8.08	8.09
Dissolved oxygen (mg/1)	7.40	6.80	7.28	6.93	7.38	7.05
Phosphate phosphorus (ug-at/l)	1.34	1.80	1.90	1.90	1.41	0.70
Nitrate-nitrogen (ug-at/l)	-	0.38	0.91	1.18	-	-
Nitrite-nitrogen (ug-at/l)	0.17	0.21	0.36	0.21	0.21	0.27

TABLE 3 : DISTRIBUTION OF PHYTOPLANKTON PIGMENTS AT DIFFERENT STATIONS DURING APRIL, 1981.

Stn.	Tide	Chl. a mg/m^3	Chl. b mg/m^3	Chl. c mg/m^3	Carotenoids $m.SPU/m^3$
G_1	Eb	4.24	4.04	1.25	1.68
G_1	F1	-	-	0.01	1.22
G_2	Eb	2.16	0.76	2.96	3.50
G_2	F1	2.10	0.70	2.70	3.20
G_3	Eb	0.10	0.76	8.92	3.00
G_3	F1	1.67	3.42	42.16	10.96
G_4	Eb	5.92	7.90	35.40	12.82
G_4	F1	2.04	2.38	6.82	4.58
G_5	F1	1.88	3.58	16.18	5.80
G_5	Eb	1.81	4.44	6.82	3.96
G_6	Eb	6.92	8.26	49.80	15.40
G_6	F1	6.94	9.10	38.80	12.20
S_1	Eb	3.18	1.96	6.36	1.83
S_2	Eb	5.15	4.34	19.12	4.56
S_3	Eb	1.11	1.20	3.42	1.52
S_4	Eb	2.18	0.76	3.96	2.13

TABLE 4 : DISTRIBUTION OF PHYTOPLANKTON PIGMENT AT DIFFERENT STATIONS DURING DECEMBER, 1981.

Station	Tide	Chl. a mg/m^3	Chl.b mg/m^3	Chl. c mg/m^3	Carothenoids $m.SPU/m^3$
G_1	Eb	5.36	2.72	9.30	4.42
G_1	F1	1.07	0.54	1.86	3.20
G_2	Eb	2.60	1.23	3.18	3.20
G_2	F1	2.17	0.77	2.94	2.59
G_3	Eb	0.87	0.31	1.18	1.98
G_3	F1	1.08	0.54	1.86	4.42
G_4	Eb	1.72	0.94	3.14	3.96
G_4	F1	2.17	0.76	2.94	7.64
G_5	Eb	1.72	0.94	3.14	1.59
G_5	F1	2.17	0.76	2.94	3.36
G_6	Eb	2.69	0.59	3.86	1.27
G_6	F1	4.26	2.66	6.00	3.66

period.

In December there was a general decrease in the pigment values, Probably correlated with the relatively low values of nitrate during this period. Stations G1 and G4 located towards the interior part of the area of investigation showed higher values. Very often chlorophyll a and b values were higher for the ebb than for the flood period (av.. 2.49, 2.15 and 1.11, 1.01 mg/m^3 respectively).

Correlation has been worked out for the different factors of pigments and environmental parameters (Tables 5 & 6). During

TABLE 5 : CORRELATION BETWEEN PHYTOPLANKTON PIGMENTS AND SELECTED CHEMICAL PARAMETERS FOR THE PREMONSOON PERIOD

	PO_4	NO_3	Carotenoid	Chl.a	Chl.b	Chl.c
pH	0.9696[a]	0.8030[c]	-	-	-	-
DO	-	-	0.8391[b]	-	0.7803[c]	-
NO_3-N	-	-	-	-	-	0.6935[d]
Total Chl.	-	-	0.7703[c]	0.8268[b]	0.9376[A]	0.9733[A]
Carotenoid	-	-	-	-	0.8702[a]	0.7892[c]
Chl.a	-	-	-	-	0.7005[d]	0.6967[d]
Chl. b	-	-	-	-	-	0.9184[a]

Level of significance A - 0.1%; a-1%, b-2%, c-5%; d-10%.

premonsoon period relationship between DO and carotenoid and chlorophyll b was positively significant at 2 and 5% level respectively. Correlation between chlorphyll b and c was significant at 1% level. In December negative correlation significant at 5% level was noticed between pH and chlorophyll. Phosphate was negatively correlated with chlorophyll at 5% level.

Zooplankton : The area is not rich in zooplankton standing stock. In April maximum biomass was recorded at G2 during the ebb period. In general, the enterior station of the Gulf is more productive (Table 7). The biomass of nearshore stations was quite low. Invariably the biomass for the ebb period (av.4.42ml/100m^3) was higher than that recorded for the flood (av.2.57m/m^3). The average biomass in the nearshore waters for the ebb and flood was respectively 2.70 and 1.68ml/100 m^3. During December zooplankton biomass had been considerably reduced with maximum at St. G5. Variations in biomass with tide was not well marked and the respective mean for the flood and ebb periods was 0.6 and 0.53 ml/100^3.

TABLE 6 : CORRELATION BETWEEN PHYTOPLANKTON PIGMENTS AND SELECTED CHEMICAL PARAMETERS FOR THE PREMONSOON PERIOD

	PO_4	NO_3	NO_2	Chlorophyll a	Chlorophyll b	Chlorophyll c	Carotenoid
Salinity	0.8424^{b}	-	-	-	-	0.6736^{d}	-
pH	-	-	0.9074^{a}	0.7522^{c}	0.7400^{d}	-	-
PO_4 - P	-	0.7290^{c}	-	0.8358^{b}	0.8507^{b}	0.8199^{c}	-
NO_3 - N	-	-	-	0.6694^{d}	0.7129^{d}	0.6194	0.7558^{c}
Total chl.	-	-	-	0.9749^{A}	0.9970^{A}	0.9266^{a}	-
Chl. a	-	-	-	-	0.9854^{A}	0.8367^{a}	-
Chl. b	-	-	-	-	-	0.9095^{a}	

A - 0.1%, a - 1%, b - 2%, c - 5%, d - 10%.

TABLE 7 : BIOMASS OF ZOOPLANKTON AT DIFFERENT STATIONS DURING APRIL AND DECEMBER

Station	Tide	Biomass ml/100 m^3 April	December
G_1	Eb	6.01	0.16
G_1	F1	7.88	0.20
G_2	Eb	4.71	0.87
G_2	F1	3.49	0.75
G_3	Eb	2.87	0.07
G_3	F1	0.89	0.09
G_4	Eb	4.20	0.14
G_4	F1	2.60	0.85
G_5	Eb	7.80	1.06
G_5	F_1	0.29	1.20
G_6	Eb	0.91	0.87
G_6	F1	0.27	0.49
S_1	F1	0.45	
S_1	Eb	2.15	
S_2	F1	0.66	
S_2 S_2	F1	2.99	
S_3	F1	2.98	
S_3	Eb	4.48	
S_4	F1	2.64	
S_4	Eb	1.19	

During the two series of observations the different groups of zooplankton encountered in the samples indicated variations In April copepods (85%), decapods (10%), chaetognaths (3%), ctenophores (1%), gastropods (0.4%), fish eggs and larvae (0.5%) and polychaete larvae (1%) constituted the population. In December the total population as well as diversity of groups came down and the constituents of zooplankton community was contributed mostly by copepods (88%) and decapods (11%) with sparse representation of ctenophores and fish larvae.

Benthos : The substantial macrofauna was mainly represented by foraminiferans, polychaetes, crustaceans (amphipods), pelecypods, ophiurans and other miscellaneous groups (Table 8). The numerical abundance of macrobenthos varied from 1975-59600/m^2 (av. 23,271/m^2) and 775-12875/m^2 (av. 5055/m^2) during April and December'81 respectively. The highest population count was recorded at station 1 and 4 during April and December respectively. The lowest numerical count was confined to St.3 (April) and 6 (December).

In terms of biomass (wet) the values varied from 15.00 to 82.5 g/m^2 and 0.4 to 12.0 g/m^2 respectively for the month of April and December. The highest biomass of 82.5 g/m^2 was obtained at St. 1 during April whereas the lowet value. of 0.4 g/m^2 was recorded at St. 2 during December. In general, stations 2 and 3 recorded very poor benthic standing stock interms of both population and biomass than the rest.

The distribution of faunal groups in the order of abundance was formainiferans(92%), crustaceans (4.5%), polychaetes (3.1%), Pelecypods (0.5%), ophiurans (0.2%) and miscellaneous (0.2%). On the other hand, in the order of biomass, these groups were polychaetes (56 .6%), foraminiferans (18.8%), ophiurans (12.5%), crustaceans (10.6%) and pelecypods (1.6%). Thus, it is evident from the results that foraminiferans and polychaetes dominate in terms of numerical count and biomass respectively. Polychaetes and crustaceans were encountered at all the stations whereas foraminiferans, were absent at station 3. Pelecypods and ophiurans showed a pattern of restricted distribution. On an average, the distribution ratio for the major macrofaunal groups was maintained

obtained at St. 1 during April whereas the lowest value of 0.4

TABLE 8 : PERCENTAGE CONTRIBUTION (POPULATION COUNT) OF MACROFAUNAL GROUPS AT DIFFERENT STATIONS DURING APRIL AND DECEMBER

Faunal Groups	Stations					
	G_1	G_2	G_3	G_4	G_5	G_6
			April			
Foraminifera	94.32	98.37	-	90.52	78.24	-
Polychaeta	3.49	0.59	21.52	2.47	2.93	49.07
Crustacea	1.99	1.03	64.55	6.53	16.38	37.03
Pelecypoda	0.13	-	1.27	0.16	0.24	1.85
Ophiuroidea	0.04	-	12.66	-	0.98	8.83
Miscellaneous	0.42	-	-	0.32	1.22	3.70
			December			
Foraminifera	85.00	98.20	-	93.20	99.70	38.70
Polychaeta	5.00	-	-	1.40	-	48.40
Crustacea	10.00	0.80	-	5.40	0.30	9.70
Ophiuroidea	-	-	-	-	-	3.20

betwen the premonsoon and postmonsoon inspite of the drastic decline in the faunal abundance during the post-monsoon. In terms of carbon content polychaetes accounted for the highest mean percentage (53) among the different macrofaunal groups.

The observed average population ($14163/m^2$) and biomass ($23.6g/m^2$) for the region, are comparable to earlier reports (Kasi-nathan *et al.*, 1977) and also indicate a good benthic production (Sanders, 1956) in terms of carbon content (3.4 g c/m^2/year) and fairly good demersal fishery potential of this region. However, a postmonsoon decline in the order of 4.5, 8 and 8 times less benthic standing stock in terms of population, biomass and carbon content respectively, suggests a good feeding ground for demersal fishes in the coastal waters of Saurashtra especially during the postmonsoon period. The observed physicochemical parameters

(Tables 1 and 2) did not indicate any significant correlation with benthic productivity. On the other hand the benthos indicated a positive correlation with phytoplankton pigments especially at Station 1 and 4. IThe total biological production potentiasl in terms of phytoplankton pigment concentrations, zooplankton and benthic standing stock indicated relatively low valued in December. This decline in biomass during postmonsoon period at the lower trophic levels may be compensated by the higher productivity in terms of fishery potential at tertiary level. This has been supported bythe fish landing data for the area (Anon, 1982).

Overall, the biological productivity in terms of phytoplankton pigment concentrations and benthic standing stock is quite good especially, during April as compared to December (Table 9). The region also sustanins a good fishery potential as per the available data from April to December, a considerable reduction in the biomass in the order of 90% was observed in the case of zooplankton and benthos as compared to chlorophyll a where the reduction was only 30% (Table 8). The above decline in the biomass in general, can be correlated to an active use of these marine organisms at the lower trophic levels as a source of food for the rich pelagic and demersal fishes associated with post monsoon periods.

Toxicity bioassay studies were carried out with the raw effluent from the chemical factory and the results indicate that the waste water is very toxic. Even at 20% concentration the fishes did not survive for more than 15 minutes. LC_{50} for 96 hr was obtained at a concentration of 5.5% (Nair *et al.*, 1987), suggesting the possibility of waste release affecting the water quality and biological productivity at and near the vicinity of disposal site.

However, from the biological and chemical data it appears that the waste water released from the factory does not reach the Gulf of Kutch in the quantities released. It gets stagnated in the low lying area above the high water mark and partly trickles to the Gulf waters. Because of this the high suspended load associated with the effluent does not seem to influence appreciably the naturally occuring load in the Gulf waters and also maintains the excellent water quality with good oxidising conditions and low BOD (NIO, 1982).

TABLE 9 : COMPARISON OF SELECTED BIOLOGICAL PARAMETERS AT DIFFERENT STATIONS

Biomass (mean)	Stations G_1	G_2	G_3	G_4	G_5	G_6	Seasonal mean	Regional mean
1. Chlorophyll a (mg/m^3)								
April	4.24	2.13	0.88	3.98	1.85	6.93	3.34	2.83
December	3.21	2.38	0.97	1.94	1.94	3.47	2.32	
2. Zooplankton								
a. Biomass ($ml/100\ m^3$)?								
April	6.95	4.10	1.88	3.34	4.10	.54	3.49	2.03
December	0.18	0.81	0.08	0.50	1.13	0.68	0.56	
3. Benthos								
a. Population (no/m^2)								
April	59600	33750	1975	31375	10225	2700	23271	14163
December	1000	1400	-	12875	9225	775	5055	
b. Biomass (g/m^2)								
April	82.50	15.00	37.90	35.50	25.60	60.40	42.80	23.60
December	1.60	0.40	-	10.20	2.40	12.00	4.40	

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