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WATER QUALITY OF THE POONTHURA ESTUARY, THIRUVANANTHAPURAM

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ABSTRACT

The Poonthura estuary was monitored for its water quality from February 1991 to September 1991. Light penetration was minimum during the monsoon period and the lowest values were observed at stations receiving large quantities of sewage wastes. pH was maximum during the pre-monsoon period and showed a distinct stratification. Salinity distribution was mostly influenced by the sea-estuary interaction consequent to the opening of the sand bar and the concentration of dissolved oxygen was very low at the polluted stations. High sulphide content was observed at the polluted stations especially during the pre-monsoon period. The general distribution of nutrients maintained an increasing trend from the pre-monsoon to the monsoon period and comparatively high values were observed at the polluted stations.

Key-words : Sewage pollution, water quality, Poonthura estuary.

INTRODUCTION

The sewage disposal facility in the cities of Kerala is inadequate. The poor state of sewage disposal system in Thiruvananthapuram city causes large scale pollution of the Poonthura estuary comprising the downstream tract of the Karamana River. The city sewage treatment farm is located at Muttathara on the banks of the Parvathy-Puthanar canal and reaches the Poonthura estuary which is about 2.4 km away from the sewage treatment farm.

Hydrobiology of polluted water bodies have been the subject of several investigations. Reports are available on the hydrobiology of the Cochin backwaters (Sankaranarayanan and Qasim, 1969; Vijayan, Remani and Unnithan, 1976), the estuarine and inshore waters of Goa (Sankaranarayanan, Rao and Antony, 1978), the retting zones of the backwaters of Kerala (Abdul Azis, and Nair, 1978), the River Par (Zingde, Sarma and Desai, 1979), the River Kolak (Zingde, Sabnis, Mandalia and Desai, 1980) and the Auranga River estuary (Zingde, Sarma and Sabnis, 1985). The present paper discusses the effect of sewage pollution on various hydrographic features of the Poonthura estuary.

Corrigendum

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Larval development of the edible oyster *C. madrasensis* – by M. Kalyansundaram listed in contents of Vol. 24(2) was not included but has now appeared in this issue.

Manglicolous fungi from India – by S. Chinnaraj and A.G. Untawale (page 27 of this issue). The magnification values of Figs. 1 & 2 are to be reworked to 65% of the present values indicated.

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d 76°55'-77°00' East longitude

on the south west coast of India. Five stations were selected for regular observations (Fig. 1). Water samples were collected from February 1991 to September 1991 from the surface with a clean plastic bucket and from the bottom using Mayer's type bottom water sampler. Temperature was measured using an accurate mercury thermometer, transparency using a Secchi disc and pH using an Elico digital pH meter. Salinity, dissolved oxygen, hydrogen sulphide, nitrate, phosphate and silicate were estimated using standard methods (Strickland and Parsons, 1972; Grasshoff, Ehrhardt and Kremling, 1983, APHA, 1978).

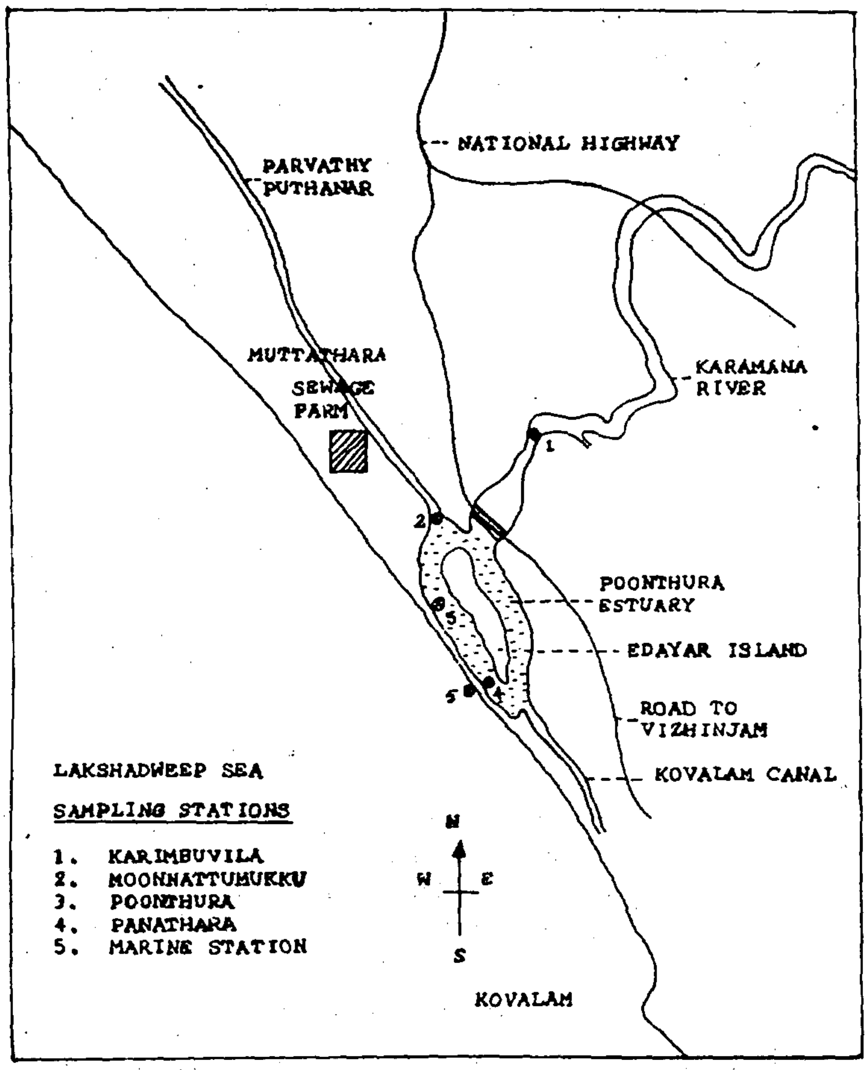

Fig. 1. Map showing sampling stations

RESULTS AND DISCUSSION

Data on the variations in temperature, transparency, pH, salinity dissolved oxygen, hydrogen sulphide, nitrate-nitrogen, nitrite- nitrogen, phosphate-phosphorus and silicate-silicon are given in Tables I and II.

Temperature : The atmospheric temperature fluctuated from 24.5°C in August to 33.5°C in April. The maximum water temperatures recorded were 33°C and 32.5°C for the surface and bottom waters during the summer. The surface water temperature was generally found to be higher than or equal to the temperature at the bottom water except on certain occasions. Analysis of variance for the air temperature showed that the variations between months within stations were significant at 1% level. ANOVA for the water temperature revealed that the variations between stations and between months within stations were significant at 5% level. Thus, it was observed that the variation in temperature was an important water quality change in the present study.

Transparency: The light penetration depth varied from 15 cm to 101 cm at station 1, from 37 cm to 80 cm at station 2, from 36 cm to 101 cm at station 3 and from 37 cm to 195 cm at station 4. Mean seasonal values showed that light penetration was minimum during the monsoon season. This may be due to the silt laden water brought into the estuary by the monsoon rains, river discharge and land drainage. The very low values encountered at station 2 receiving large quantities of sewage wastes may be on account of suspended mater and higher concentration of dissolved organic matter present in the water (Zingde, Sabnis, Mandalia and Desai, 1980; Balakrishnan Nair, Abdul Azis, Krishnakumar, Dharmaraj and Arunachalam, 1984). ANOVA showed that the variation between months were significant at 5% level whereas variations between stations were not significant.

pH: The general distribution of pH for all the stations ranged from 5.7 at station 1 to 8.5 at station 4 for the surface water and from 5.9 at station 1 to 8.5 at station 4 for the bottom water. High pH of the marine station was on account of intrusion of highly saline sea water and the low pH of the river zone could be due to the influence of fresh water and the presence of sewage wastes. The bottom water pH was generally higher than the surface water pH and water column at five stations has been found to be stratified on the basis of hydrogen ion concentration. ANOVA showed that the variations between stations and between months within stations were significant at 5% level. Thus pH values were found quite erratic during the period of observation. The pH variations remained within the acceptable limits as per IS : 24900 - 1974.

Salinity: Salinity distribution was influenced by the sea- estuary interaction consequent to the opening of the sand bar at station 4. Salinity values were found to be comparatively high during the pre-monsoon period at all stations except in March and April when the sand bar remained closed for longer durations. A marked gradient of decreasing salinity was evident from the mouth to the interior of the estuary. Station 4 which is in close proximity with the sea, had salinity values higher than that of all other stations. A distinct stratification between the surface and bottom waters was noticed at all the stations and the higher bottom water

Table I – Monthly variation in hydrographic parameters and hydrogen sulphide during Feb. - Sept. 1991.

Month	Stn.	Temparature (°C)			Trans-parency (cm)	pH		Salinity (‰)		Dissolved oxygen (mg/l)		Hydrogen sulphide (mg/l)	
		AIR	SW	BW		SW	BW	SW	BW	SW	BW	SW	BW
PRE-MONSOON													
Feb	1	29.50	28.50	30.00		7.3	7.5	2.28	7.10	6.31	5.13	0.26	0.31
	2	30.50	29.00	29.00		7.2	7.1	1.16	1.29	0	0	2.37	4.56
	3	32.00	31.50	31.00	-	7.4	7.2	3.39	9.69	4.73	3.55	0.47	1.03
	4	33.00	31.00	31.00		7.6	8.5	7.10	17.94	7.10	6.70	0	0
Mar	1	29.00	30.50	31.30	92	6.9	7.1	1.01	4.26	3.95	2.76	0	0
	2	30.00	31.50	31.30	58	7.2	7.7	1.54	2.28	3.95	3.55	0	0
	3	32.00	33.00	32.30	82	8.2	7.3	2.60	3.03	7.41	4.73	0	0.19
	4	32.00	32.50	32.50	94	8.5	7.8	2.90	2.90	7.10	6.70	0	0
	5	32.50	31.00	31.80	-	8.2	8.3	32.59	32.71	7.89	7.10	0	0
Apr	1	29.50	31.00	31.50	97	7.1	7.3	1.54	2.90	3.52	2.76	0	0
	2	30.00	31.50	32.00	80	7.1	7.5	1.41	3.15	3.55	3.16	0.38	0.47
	3	32.50	32.00	31.50	101	8.0	7.9	2.60	2.78	4.73	3.95	0.26	0.26
	4	33.50	32.80	31.50	195	8.2	8.1	2.90	5.26	7.10	5.52	0	0
	5	28.00	31.50	31.80	-	8.2	8.2	32.99	32.99	5.52	5.52	0	0
May	1	29.00	30.50	31.50	75	7.7	7.9	3.68	11.27	4.73	7.1	0	0
	2	29.50	31.00	30.50	43	7.7	8.2	2.28	2.90	1.58	1.58	1.03	2.37
	3	32.00	32.50	31.50	55	7.9	7.4	6.36	8.46	5.52	3.55	0.30	1.15
	4	32.50	32.50	32.50	68	7.6	8.0	7.47	14.49	3.55	3.55	0	0
	5	33.00	30.50	31.00	-	7.6	7.6	32.81	32.81	4.73	3.95	0	0
MONSOON													
Jun	1	25.50	26.00	26.00		6.7	6.9	0.66	0.66	6.31	6.31	0	0
	2	26.00	27.50	27.50		7.0	6.9	0.97	0.97	3.95	2.37	0.31	0.79
	3	30.00	27.00	27.00	-	7.2	7.1	0.66	0.97	4.73	4.73	0	0
	4	-	-	-		-	-	-	-	-	-	-	-
	5	30.00	28.00	28.00		7.9	7.8	33.51	33.84	7.10	7.10	0	0
Jul	1	26.00	27.00	27.00	42	5.7	5.9	0.34	0.34	7.89	7.1	0	0
	2	26.00	28.00	28.00	57	6.9	6.6	0.34	0.34	3.14	2.37	0.42	0.42
	3	26.50	27.50	27.50	36	7.1	6.9	0.34	0.66	4.73	4.73	0	0
	4	26.50	28.30	28.00	37	6.9	6.9	0.66	0.66	6.31	6.31	0	0
	5	26.50	27.00	27.50	-	7.7	7.8	31.06	31.06	7.10	7.10	0	0
Aug	1	24.50	26.00	26.00	15	6.5	6.9	0.66	0.66	6.31	6.31	00	
	2	24.80	26.50	26.50	37	7.0	7.0	0.66	0.66	2.37	2.37	0.38	0.38
	3	25.50	27.00	27.00	65	7.2	7.3	1.92	2.85	3.95	3.95	0	0
	4	26.00	28.00	28.00	94	7.5	8.2	2.85	3.46	6.31	6.31	0	0
	5	26.00	26.00	26.00	-	8.0	7.8	31.06	31.06	5.40	5.40	0	0
Sept	1	25.00	29.00	29.00	101	6.6	6.6	0.66	0.66	6.70	6.70	0	0
	2	26.50	29.50	29.50	73	6.8	7.0	0.66	0.97	3.53	3.14	0	0
	3	26.50	29.50	29.00	79	6.8	7.2	2.85	3.78	3.14	3.14	0	0.26
	4	26.50	29.50	29.00	66	7.2	7.9	3.78	6.27	5.40	5.40	0	0
	5	26.50	24.00	24.00	-	7.9	7.9	31.36	31.36	6.31	6.31	0	0

SW - Surface Water BW - Bottom Water

Table II – Monthly variation of Nitrate-nitrogen, nitrite-nitrogen, phosphate-phosphorus and silicate-silicon during Feb. - Sept. 1991.

Month	Stn.	Nitrate-nitrogen (μ mol/l)		Nitrite-nitrogen (μ mol/l)		Phosphate-phosphorous (μ mol/l)		Silicate-silicon (μ mol/l)	
		SW	BW	SW	BW	SW	BW	SW	BW
				PRE-MONSOON					
Feb	1	2.25	3.40	1.50	2.83	0.27	0.12	19.81	12.94
	2	11.00	7.00	9.00	6.33	7.87	7.57	26.40	31.09
	3	4.55	4.25	4.16	3.72	5.45	3.45	12.59	3.30
	4	2.11	1.49	2.00	1.67	0.61	0.59	17.16	7.00
Mar	1	0.15	0.25	0.15	0.13	0.15	0.18	17.07	12.48
	2	1.25	1.25	1.17	1.17	0.61	0.61	27.58	28.38
	3	2.01	2.11	2.00	2.17	0.24	0.18	17.16	13.86
	4	1.70	1.65	1.50	1.50	0.21	0.42	16.54	16.50
	5	0.33	0.33	0.30	0.30	0.52	0.52	16.18	16.18
Apr	1	0.15	0.12	0.20	0.20	0.30	1.06	11.22	7.79
	2	1.55	1.50	1.33	1.33	0.53	0.60	9.91	6.47
	3	2.05	1.40	1.67	1.33	4.57	0.53	4.88	3.69
	4	0.98	0.45	0.67	0.30	7.73	2.23	5.54	4.23
	5	0.50	0.50	0.33	0.37	0.45	0.61	5.28	5.54
May	1	1.49	2.50	1.33	2.33	0.30	0.61	19.17	11.04
	2	21.07	30.50	20.00	29.96	12.42	13.03	26.28	32.86
	3	17.00	27.49	13.33	23.33	8.18	5.15	32.07	19.72
	4	11.00	5.50	9.33	5.17	1.51	1.82	18.40	15.77
	5	0.45	0.48	0.50	0.33	0.30	0.30	4.49	3.95
				MONSOON					
Jun	1	3.25	2.90	3.00	2.83	0.45	0.61	10.57	9.92
	2	10.00	10.00	9.00	9.00	7.27	7.27	14.54	12.16
	3	4.78	4.90	5.17	5.17	2.42	3.64	12.55	14.54
	4	-	-	-	-	-	-	-	-
	5	0.75	0.80	0.67	0.67	0.67	0.61	2.25	2.43
Jul	1	1.65	1.70	0.50	0.33	0.15	0.15	10.70	10.40
	2	17.00	20.07	23.33	33.33	10.60	9.39	16.51	14.54
	3	9.52	10.00	5.83	9.49	4.55	2.12	15.99	12.95
	4	14.00	9.52	12.50	9.33	2.27	2.12	8.32	7.66
	5	1.15	1.15	0.67	0.83	0.61	0.61	4.09	4.29
Aug	1	1.70	1.65	1.83	1.58	0.42	0.36	11.89	11.22
	2	13.00	13.00	10.84	10.84	6.66	5.91	21.14	19.14
	3	7.00	4.86	6.32	6.00	2.88	2.43	16.51	12.95
	4	4.50	4.40	4.00	3.67	1.15	0.76	11.23	11.23
	5	0.55	0.55	0.50	0.50	0.45	0.45	5.42	5.42
Sept	1	1.50	1.30	2.17	3.17	0.24	0.23	12.40	11.49
	2	13.01	14.04	10.16	11.50	7.57	6.66	18.24	15.72
	3	4.40	4.50	4.50	5.00	3.33	2.73	14.27	13.48
	4	2.50	1.55	3.33	3.33	1.36	1.24	9.25	9.25
	5	0.98	1.05	0.83	0.83	0.51	0.51	4.49	4.56

SW - Surface Water, BW - Bottom Water

salinity may be due to the penetration of high saline sea water along the bottom. ANOVA revealed that the variations of salinity between stations and between months within stations were significant at 5% level.

Dissolved oxygen: Mean dissolved oxygen concentration of the surface water ranged from 2.37 mg/l at station 2 to 6.29 mg/l at station 4. The mean bottom water values were lower than those of the surface water and ranged from 2.07 mg/l at station 2 to 6.07 mg/l at station 5. The higher concentration at the surface water could be mainly due to the photosynthesis of the phytoplankton and inputs from the atmosphere. In general, the dissolved oxygen values were high during the monsoon season which agree with the observations of Sankaranarayanan and Qasim (1969), Damodaran (1973) and Zingde and Desai (1980). The low oxygen values were probably due to heavy pollution resulting from the sewage disposal. The worst situation was experienced during the pre- monsoon period, when the combined effect of high temperature and rapid decomposition of organic material was very clear (Vijayan, Remani and Unnithan, 1976; Zingde, Trivedi and Desai, 1979). A fluctuation in dissolved oxygen content was experienced at the sewage receiving areas during the study. ANOVA showed that the variations in the concentration of dissolved oxygen between stations were significant at 5% level.

Hydrogen sulphide: Measurable amounts of hydrogen sulphide was observed at stations 1,2 and 3 while at stations 4 and 5, it was absent during the entire period of study. The concentration of hydrogen sulphide was particularly very high at station 2 leading to the depletion of oxygen resulting in an anoxic condition covering the entire water column. The relationship of hydrogen sulphide with dissolved oxygen was an inverse one in the estuary. Such a relationship was reported by Vijayan, Remani and Unnithan (1976) from the sewage polluted areas of the Cochin backwaters, Abdul Azis and Nair (1978) from the retting zones of the Edava-Nadayara backwaters and Bijoy Nandan, Abdul Azis and Natarajan (1989) from the Kadinamkulam lake. Unlike in those estuarine tracts, the anoxic condition in the Poonthura estuary was only a short-lived phenomenon which lasted hardly for a month. The odour and colour of mud samples of the sewage receiving areas in the present study also indicated the presence of high sulphide content. ANOVA showed that the variations between stations and between months within stations were significant at 5% level. Thus it was observed that high hydrogen sulphide concentration is an important feature associated with the sewage pollution.

As per IS : 2490 - 1874, the tolerance limit fixed for sulphides in the industrial effluents discharged into inland surface waters is 2 mg/l. In the present study, the concentration of hydrogen sulphide exceeded this limit on certain occasions at station 2, where the sewage enters the estuary through the Parvathy-Puthanar canal. The formation of high concentration of hydrogen sulphide in the water body is dangerous since sulphides are highly toxic and capable of annihilating all organisms except anaerobic bacteria from the ecosystem.

Nitrate-nitrogen: The concentration of nitrate-nitrogen ranged from 0.15 μ mol/l to 21.07 μ mol/l in the surface water and from 0.12 μ mol/l to 30.50 μ mol/l in the bottom water. The general distribution of nitrate-nitrogen at all the stations maintained an increasing trend several areas (Sankaranarayanan and Qasim, 1969; Suresh and Reddy, 1978; Balakrishnan

Nair, Dharmaraj, Abdul Azis, Arunachalam, Krishnakumar and Balasubramanian, 1984; Chandran and Ramamoorthi, 1984; Sarala Devi, Sankaranarayanan and Venugopal, 1991). Comparatively high values at stations 2 and 3 could be attributed to the sewage contamination of the estuary at these stations. Statistical analysis showed that the variations between stations were significant at 5% level.

Nitrite-nitrogen: The highest concentration of nitrate-nitrogen (23.33 μ mol/l in the surface water and 33.33 μ mol/l in the bottom water) was at station 2 and the lowest concentration was observed at the marine station. All stations except 3 had maximum nitrite content during the monsoon period. Very high values of nitrite observed at stations 2, 3 and 4 could be attributed to the sewage contamination of the estuary at these stations. Degradation process such as ammonification, nitrosification etc. of organic materials in the sewage might also have resulted in the formation of nitrites. ANOVA revealed that variation between stations and between months within stations were highly significant at 5% level. Thus the variation in the concentration of nitrite-nitrogen is an important water quality change during the present study.

Phosphate-phosphorus: The general distribution of phosphate- phosphorus varied between 0.15 μ mol/l and 12.42 μ mol/l for the surface water and between 0.12 μ mol/l and 13.03 μ mol/l for the bottom water with a wide range of fluctuations between the stations. Mean seasonal values of surface water phosphate was maximum during the monsoon season at stations 1, 2 and 5 while at stations 3 and 4, the mean seasonal values were maximum during the pre-monsoon season. The mean seasonal values of phosphate in the bottom water at all the stations except station 1 was maximum during the monsoon season. High concentration of phosphate during the monsoon floods were reported earlier by Sankaranarayanan and Qasim (1969) from the Cochin backwaters. ANOVA showed that the variations between stations and between months within stations were significant at 5% level. The data showed that high phosphate-phosphorus concentration is an important feature associated with sewage pollution in the estuary.

Silicate-silicon: The silicate concentration showed an inverse relationship with salinity. The lowest mean concentration of silicate was recorded at station 5 which is the marine station and the highest at station 2 which recorded the lowest mean salinity value. This type of silicate-salinity relationship was noticed earlier along the Indian coasts (Suresh and Reddy, 1978; Chandran and Ramamoorthi, 1984; Panda, Tripathy, Patnaik, Choudhury, Gouda and Panigrahy, 1989). In general the concentration of silicate was high during the pre-monsoon period and declined during the monsoon season. On an average, the concentration of silicate in the surface water was always higher than that in the bottom water, though there was no distinct stratification. This may probably be due to the high saline nature of the bottom water and the negative relationship between salinity and silicate. ANOVA revealed that the variations between stations and between months within stations were highly significant at 5% level.

When the data collected during the present study were compared with the standards of Indian standard Institution prescribing definite concentration limits for various characteristics in different types of water it was found that the estuary is considerably polluted. The very high organic load carried by the estuary in the form of sewage wastes leads to depletion of dissolved oxygen and very high sulphide content in the water. The values of pH and the concentration of nutrients were also high. High concentration of nutrients may lead to situations of eutrophication. Most adverse conditions of pollution occur during the summer moths when the temperature was high. Organic pollution has significant effect on dissolved oxygen, pH and nutrient content of the estuarine waters while the temperature and salinity are not significantly affected.

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