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STUDIES ON THE BIOLOGICAL CONTAMINATION OF THE COASTAL ENVIRONMENT OF KARACHI

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Microbiological investigations undertaken to assess the degree of pollution caused by the discharge of industrial and municipal effluents through Lyari river into the coastal areas of Karachi indicate that a high FC Count (918/dl) is found on the beaches. The pattern of variation of FC Counts (MPN) among the samples collected from the contaminated area during 1980 and 1982 has been discussed.

INTRODUCTION

Enormous quantities of untreated municipal and industrial wastes are being drained into the sea. This is resulting into a serious degradation of marine environment and adjoining coastal areas. Mixing of untreated municipal and industrial effluents not only adversely affects marine life but also causes serious health hazard for the people visiting such areas. The health hazard is directly related to the extent of exposure. In close proximity with the site where Lyari is drained into the sea, large number of salt works are located which cater to both domestic and industrial needs of salt. Additionally, the much popular beach of Sandsp.* also lies in the vicinity of the Lyari discharge point. As is evident from the map the beach is bifurcated by a triangular dry strip of land which leads right upto Himalya Base. The triangular dry belt separates the picnickers beach and the discharge point of Lyari. This site of the beach is muddy with thick growth of mangroves and is criss-crossed by channels which are navigable.

From the health point of view the major cause of concern is the contamination of water with faecal wastes of warm blooded animals especially man (Craun) [4]. In the world literature there have been very few reports regarding the outbreak of water borne diseases assocaited with the exposure to recreational waters. Diseases caused by *Salmonella, Shigella, Pseudomonas, Vibro, Aeromonas, Entamoeba, Leptospira* and infections of Tularemia, Hepatitis and Swimmers itch are on record to have been caused after the contact of contaminated recreational waters.[3,5,8,9].

It is well established that occurrence of diseases caused by contact with contaminated recreational water is much more than those recorded. Sporadic and self limiting ailments caused by such manner generally go unnoticed. Cabelli and Co-workers[2] found correlation between the densities of faecal coliforms and the occurrence of gastrointistinal disorders among the persons coming in contact with such waters. Regarding indicator organism there is a general agreement that with presently available data, *E. coli* remains to be the best indicator organism (WHO,[10]). The United States Federal Water Pollution Control Administration (1968) has set the limit of *Coliform* organisms to 200/dl and the Total Count to 1,000. Earlier studies [1] showed that the faecal coliforms, with the methods applied in general practice, could only be detected in the samples with low concentration of salts. Work was therefore, initiated in January 1980 at PCSIR to study the extent of pollution caused by Lyari with the view to assessing the seasonal variation.

METHODOLOGY

The Sandspit beach area has a peculiar location. A dry strip of land bifurcates the beach. The northern side is covered with mud and mangroves while the southern side is the coastal side and is generally used by picnickers. Lyari is drained on the northern side where a number of salt works are located. This side also accommadates a few channels used by boatmen. Sampling was performed from 9 points covering a major portion of beach area:

- Sampling points 1 and 2 are closest to the drainage point of Lyari and signify pre-pumping and post-pumping sites of salt works,
- Sampling point 3 signifies the site a little beyond the Laxmi salt works,

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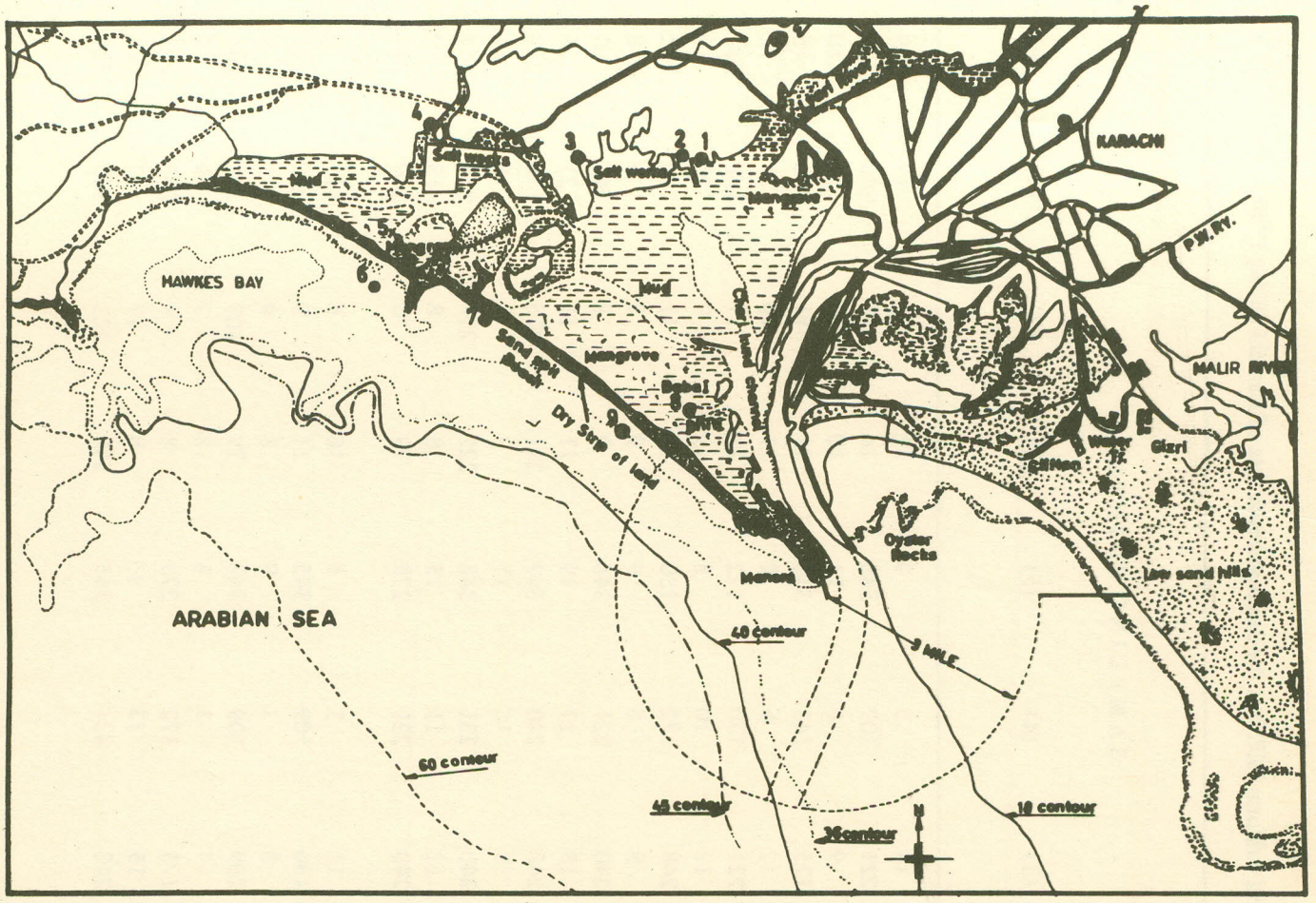

Area Map

- Sampling point 4 indicates the site beyond Grax salt works,
- Sampling point 5 lies adjacent to dry strip of land on the northern side,
- Sampling point 6 is located on the coastal area on the southern dry strip.
- Sampling point 7 is also on the coastal side but a little beyond point 6,
- Sampling point 8 covers the site close to Naval Establishment Himalya,
- Sampling point 9 denotes the site opposite point 8 which is the coastal side and is beyond point 7.

Samples were collected in glass stopperd bottles which were returned to Laboratories within one hour of collection and put to test immediately. For presumptive test, samples were processed according to method of Olson [7] and were seeded in 10, 1 and 0.1 ml quantities in MacConkey broth (Difco). The samples were inoculated in quintuplicate and were incubated at 35.5 ± 0.5°C. Observations were recorded after 24 and 48 hours of incubation. Tubes showing positive tests as per "Standard Methods for the Examination of Water and Waste Water (1973)" were re-inoculated in Brilliant Green Bile broth and incubated at 44.5 ± 0.2°C. The observations were made after 24 and 48 hours. MacConkey broth tubes showing turbidity without gas were re-seeded in MacConkey broth and re-incubated at 35°C. If acid and gas were formed after the incubation period (24 or 48 hours) the original tube was taken to be positive and the results were noted accordingly. Faecal Coliform (FC) Counts were made from the observations of the tubes showing positive tests at 44.5°C in Brilliant Green Bile broth. For total count serial dilutions were made in 0.85% saline and inoculations were made on Isoplate Count Agar (E. Merck). The plates were incubated at 35.5°C and the results were noted after 48 hours.

RESULTS

Table 1 shows the results of observations made from January to December 1980. Highest FC Counts at sampling point 1, were observed in the months of March, June, September, October and December. They were low in the months of January, February, May and November. At

Table 1. Variation in the total bacterial load and the faecal coliform (MPN) at the Sandspit beach area of Karachi during 1980.

Month	Total bacterial load per ml x 10^{-3} and FC count (MPN) per dl	SAMPLING POINTS (1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
January	Total Bacterial Load	12	11	13	5	9	12	11	17	9
	FC Count (MPN)	345	240	221	109	348	14	13	240	221
February	Total Bacterial Load	10	9	9	6	11	10	10	12	10
	FC Count (MPN)	348	278	175	141	345	11	11	240	46
March	Total Bacterial Load	13	14	12	6	9	11	10	15	11
	FC Counts (MPN)	918	278	221	130	172	21	17	348	221
April	Total Bacterial Load	10	11	12	10	8	9	9	10	10
	FC Count (MPN)	542	221	248	172	130	79	11	240	240
May	Total Bacterial Load	5	5	9	8	9	9	8	9	8
	FC Count MPN)	348	240	240	221	348	9	8	240	63
June	Total Bacterial Load	18	21	19	17	19	11	11	21	14
	FC Count (MPN)	918	348	240	240	542	221	278	348	278
July	Total Bacterial Load	15	18	15	15	17	3	9	18	11
	FC Count (MPN)	542	542	240	221	348	221	221	345	348
August	Total Bacterial Load	14	15	12	11	13	8	8	13	9
	FC Count (MPN)	542	348	240	221	278	79	70	240	278
September	Total Bacterial Load	12	10	11	3	8	10	5	15	8
	FC Count (MPN)	918	345	130	109	345	11	9	240	31
October	Total Bacterial Load	9	6	8	3	9	8	9	11	8
	FC Count (MPN)	918	542	109	109	348	79	109	221	240
November	Total Bacterial Load	9	5	7	3	8	8	7	9	7
	FC Count (MPN)	345	348	175	172	278	8	9	278	221
December	Total Bacterial Load	14	17	15	13	15	8	17	17	10
	FC Count (MPN)	918	542	240	221	345	240	221	348	345

sampling point 2, high FC counts were observed in the months of July, October and December whereas they were low in the months of January, February, March, April and May. Increased FC Counts at point 3, were noted in the months of April, May, June, July, August and December, Beyond point 4, comparable counts were observed in the months of May, June, July, August and December. Sampling point 5, showed appreciable increase in FC Counts as compared with sampling point 4 and throughout the year the higher trend of FC Counts was maintained. Concurrently total count also remained high except in the months of April, September and November. Precipitous fall in the FC Count was observed at sampling point 6 but a similar trend, in the total count, was not seen. However, in the months of June, July and December they remained above 200/dl. The overall picture, at point 7, was quite comparable, throughout the year as seen in the case of point 6. The FC Counts increased again at point 8 and remained above 200/dl throughout the year. Concurrently the total count also showed increase during the whole year of study. At sampling point 9, the FC counts were observed above 200/dl level throughout the year except in the months of February, May and September 1980.

In 1982 sampling was carried out for a casual monitoring at points 1,2,5,6 and 7 in the month of November. All the sampling point showed marked increase in total as well as FC Counts.

Table 2. Degree of pollution of the beach during November 1982

Sampling points	Total Count ($x10^{-2}$/ml)	FC Counts (MPN/dl)
1	140	1,609
2	120	1,609
5	90	1,609
6	70	918
7	70	918

DISCUSSION

If we try to trace the route of contamination some clue can be found from the quantum of discharge from Lyari. The rainfall during the year was: January and February – dry, March- 10.9 mm, April and May -dry, June -43.0 mm, July- 45.0 mm, August- 1.0mm, September - dry, October- 24.0 mm, November - 7.0 mm, December - 53.6 mm and therefore peak discharges were witnessed in the months of June, July, October and December. These were the months in which maximum contaminations (above 500 /dl) were observed at point 1 which is nearest to the discharge point of Lyari. Other months in which comparable counts were observed are March, April, August and September. It seems that the low rainfall in the month of March caused high FC Counts. There was some rain in August which may be the reason for the high counts in this month but the high count in the month of September remains unaccounted for and perhaps some other factor which could not be traced may be responsible for the high FC Counts. It seems that during the rainy days the quantity of discharge from Lyari is increased, the storm water containing the municipal waste crosses the apex of the triangular dry strip of land and comes to the beach used by the picnickers. The tides of the sea rebound the wastes back to the beach. In each month the general pattern of the contamination (in decreasing order) was sample Nos. 1, 2, 3, 4, 5, 8, 9, 7, 6. It seems that the contamination, after the rainfall, spreads over the entire area covered with the sampling points 1, 2, 3, 4, 5, 8. When the discharage is high the contamination crosses over to point 9 then spreads to 7 and 6. This hypothesis is supported by the fact that highest FC Counts at point 6 and 7 were seen in the months of June, July and December which incidentally are also the months in which maximum rainfall were witnessed. The few samples collected and analysed in November 1982 showed increase in contamination although there were no rains in this month.

A peculiar feature of the study was that no correlation was found between the FC Count and Total Counts. It seems that the methodology used for the Total Counts was inadequate for the halophils. This observation was previously reported by Beg *et al.* [1].

The studies are also indicative that singularly Total Counts can not be used as indicators of contamination. FC Counts are definitely better indicators. In our studies during the entire period of investigation FC Count did not show any correlation with the Total Counts. Additionally it will be of interest to check as to how much the *Faecal coliforms,* detected by this method, conform to the typical *E. coli* type 1 tests. It has been reported that even in cases where no *Faecal coliforms* are seen other members of *Enterobacteriaceae* may be present (Ahmed *et al* 1964). The studies, therefore, need to be extended to see whether some correlation with the discharge of municipal wastes into the sea is found with the number of *Salmonella* present in the waters.

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