

Microbiological Studies in the Mandovi-Zuari River System

ANURAGINI ROW

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Total heterotrophic and coliform bacteria were surveyed during Oct. 1977 to Sept. 1978 from 9 stations each along the rivers Mandovi and Zuari and 3 along the coast of Goa. Total heterotrophic population showed wide temporal and spatial variations and ranged from 1×10^4 to 5×10^8 . The ratio of coliforms to aerobic heterotrophs indicated that the extent of pollution was very low.

Mandovi and Zuari estuaries are tidal stream estuaries being predominantly influenced by sea water inflow. Annual contribution of sewage to Zuari and Mandovi river systems is 4.67×10^6 and 5.21×10^6 m³ respectively. Industrial discharge amounts to 4.4×10^6 m³/year for Zuari and 0.8×10^6 m³/year for Mandovi¹.

Variation of heterotrophic bacterial population and the presence of coliforms in the estuaries are reported²⁻⁶. Matondkar *et al.*⁷ have studied the seasonal variation of heterotrophic bacteria in the mangrove swamps along the Mandovi-Zuari river systems. However, no information on the monthly variation of total heterotrophic bacteria or presence of coliforms in these rivers is available. Hence, the present investigation on distribution and monthly variation of total heterotrophic bacteria and coliforms in Mandovi and Zuari estuaries has been made.

Nine stations were fixed in each of the 2 rivers and 3 stations along the coast (Fig. 1). These stations were considered on the basis of probable penetration of salt water front and consequent tidal influence and their nearness to the areas of mining, industrial and domestic activities. The total distance covered by the 9 stations was 67 km in Zuari and 65 km in Mandovi. Of these, 2 stations were worked in the 17 km long Cumbarjua Canal, connecting the 2 rivers at distances of 14 and 11 km respectively from their openings into the sea. The 3 coastal stations covered a distance of 32 km between Baga on the north and Colva on the south. Samples could not be collected from the coastal stations during monsoon as this area was inaccessible. Between Oct. 1977 and Sept. 1978, samples of water were collected by boat once every month over a period of 12 hr at a mid-depth of each station along the 2 rivers as well as along the coast. Samples were collected in sterile glass bottles with screw caps and stored in an ice-box until they were analysed in the laboratory. Counts of aerobic heterotrophic bacteria were carried out by the pour plate method using marine agar (Zobell's 2216E, peptone 5 g; yeast extract 1 g; FePO₄

0.1 g; agar 14 g in 1000 ml of filtered sea water, pH adjusted to 7.8)⁸. Counts were made after 24 to 48 hr incubation at room temperature. These counts indicate the level of readily available organic matter in the water. Counts of coliform bacteria (which indicate recent sewage pollution) were carried out by the most probable number method⁹ using multiple tubes of MacConkey Broth and reading the results from McCrady's Tables, after 24-hr incubation at 37°C.

Monthly variations in the total heterotrophic bacteria in Mandovi River, are shown in Fig. 2. Counts varied between 8×10^4 and 250×10^6 /ml. Counts of coliforms (Table 1) varied between 0 and 1100/100 ml. In the Zuari River, the total heterotrophic counts (Fig. 2) varied between 3×10^4 /ml and 241×10^6 /ml. Coliforms (Table 1) varied from 0 to 1100/100 ml. Yearly mean values of aerobic heterotrophs do not show any significant variation in the density of population from the mouth to the source of the rivers. This indicated that the heterotrophs were highly tolerant to changes in salinity (Table 2). Ratio of coliforms to aerobic heterotrophs was very low, indicating the absence of pollution in both the rivers.

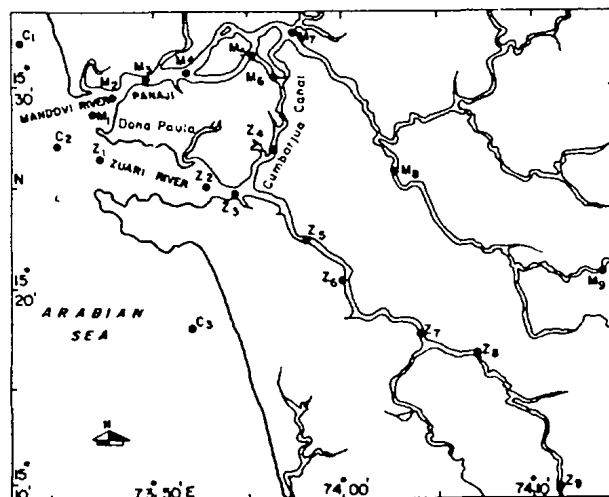


Fig. 1—Station locations

Table 1—Monthly Variations of Coliforms (organisms/100 ml) at Different Stations in Rivers Mandovi (M) and Zuari (Z)

	M ₁	M ₂	M ₃	M ₄	M ₅	M ₆	M ₇	M ₈	M ₉
1977									
Oct.	1100*	1100	1100	1100	1100	—	1100	1100	1100
Nov.	1100	1100	1100	1100	1100	1100	—	1100	1100
Dec.	—	7	4	—	460	39	20	210	1100
1978									
Jan.	0*	15	7	9	150	150	150	1100	1100
Feb.	240	1100	1100	1100	75	1100	240	15	1100
March	0	0	9	—	0	0	0	1100	93
April	—	—	—	—	—	—	—	—	—
May	—	—	—	—	—	—	—	—	—
June	—	1100	150	210	150	23	1100	240	75
July	—	93	150	1100	1100	150	9	0	150
Aug.	—	1100	1100	1100	1100	1100	1100	1100	1100
Sept.	0	0	15	15	0	150	28	28	210
	Z ₁	Z ₂	Z ₃	Z ₄	Z ₅	Z ₆	Z ₇	Z ₈	Z ₉
1977									
Oct.	1100	1100	1100	1100	—	—	—	—	1100
Nov.	1100	1100	1100	1100	1100	1100	1100	1100	1100
Dec.	0	0	0	0	0	0	93	1100	23
1978									
Jan.	1100	1100	4	75	1100	—	0	1100	1100
Feb.	0	0	0	0	0	0	1100	93	0
March	0	0	4	0	4	0	0	460	75
April	—	—	—	—	—	—	—	—	—
May	—	—	—	—	—	—	—	—	—
June	—	15	23	43	7	43	43	1100	1100
July	1100	1100	1100	1100	1100	1100	1100	1100	1100
Aug.	—	93	460	75	1100	1100	210	1100	240
Sept.	43	150	75	15	9	150	210	1100	1100

*Readings taken from McCrady's table where the maximum number of coliforms for 3 positive McConkey broth tubes showing acid and gas production is 1100/100 ml and minimum where all 3 tubes read negative is zero.

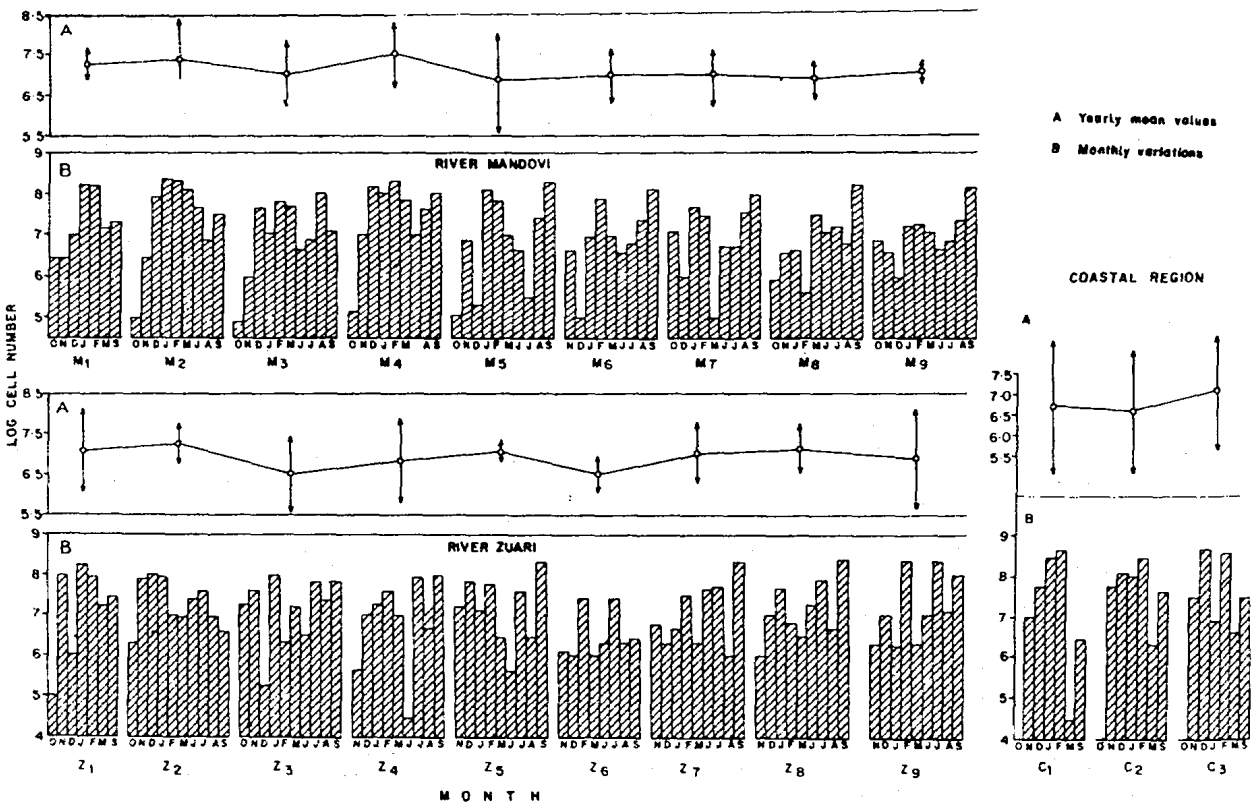


Fig. 2 Variations in aerobic heterotrophs

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Table 2—Annual Mean Heterotrophic Bacteria and Salinity in Mandovi and Zuari

St No.	Mandovi		Zuari	
	Bacteria No. ($\times 10^6$)/ 100 ml	Salinity ‰	Bacterial No. ($\times 10^6$)/ 100 ml	Salinity ‰
1	75.1	34.1	75.4	34.3
2	145.5	26.3	50.7	29.28
3	149	24.5	36.8	25
4	86.4	21.05	53.2	21.81
5	150	15.3	59.7	18.85
6	60	14.8	12.6	14.4
7	29.1	10.12	46.7	8.9
8	49.5	0.38	52.3	2.9
9	61.4	0.036	41.5	0.04

Higher values of coliforms observed at some stations may be due to localized contamination⁶.

Density of microbial number in all coastal stations was high compared to the rivers (Fig. 1). The counts varied between 1×10^4 /ml and 500×10^6 /ml (Fig. 2). The density of coliforms was relatively low, but were present during September (150, 1100 and 9/100 ml respectively at sts C₁, C₂ and C₃), October and November (1100/100 ml at all stations). This may be due to the very recent flushing of water from the estuaries into the sea, at the time of sampling. Samples collected during the rest of the months did not show the presence of coliforms, since coliforms die rapidly in sea water¹⁰.

These studies indicated that the rivers Mandovi and Zuari, along with a stretch of coastal area of Goa, are relatively free from human influence on their water quality.

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