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Heterotrophic bacteria in the coastal waters of Cochin

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Aerobic heterotrophic bacterial flora in the coastal waters of Cochin was studied for 1 y at monthly intervals. Bacterial counts (no. ml^{-1}) ranged from 0.5 to 24.5×10^5. Their counts were high during summer and the station, 3 sea miles off Cochin had maximum bacterial load throughout the year. The macromolecule hydrolysing bacterial population varied from 0.2 to 6.8×10^5. Among the isolates, gram negative bacteria accounted for 88% and pigmented forms for 23.4%. Most frequently encountered genera were *Pseudomonas* (13%), *Aeromonas* (13%), *Moraxella* (8%) *Flexibacter* (10.4%) and *Micrococcus* (8%).

There is considerable amount of data[1,2] available on the physical, chemical and biological oceanographic features of the brackish and seawater off Cochin, while the information on the bacteriological aspects is scanty. Occurrence of faecal indicator bacteria[3], *Vibrio parahaemolyticus*[4], and drug resistant coliforms[5] have been reported from these waters. The present study was conducted with the objective to have baseline information on the heterotrophic bacteria occurring in a coastal water body. In this paper, population of culturable heterotrophic bacteria, zymogenous bacteria and the bacterial flora occurring in the coastal waters of Cochin are presented.

Materials and Methods

The sampling stations are shown in Fig. 1. Sampling was done at monthly intervals (May 1987 through April 1988). Surface water samples were collected with Nansen bottles operated manually on board *R V Cadalmin* and transferred to 250 ml sterile glass bottles and stored in refrigerator till further processing. Within 4 h of collection, the water samples were inoculated on Zobell's marine agar 2216 (Himedia) by serial dilution and spread plate method and incubated at room temperature (30°C) for 5 d. The colonies formed on the plates were counted and recorded as total viable count (TVC). Morphologically different colonies were isolated and identified up to genus based on the scheme of Oliver[6]. The macromolecules, protein, starch and lipid hydrolysing bacterial counts were obtained by recommended methods[7].

Results and Discussion

The culturable aerobic heterotrophic bacterial population (no. ml^{-1}) at 4 stations ranged from 0.5 to 24.5×10^5 during the period of study (Fig. 2). The average bacterial population of the 4 stations showed a major peak during January and February, and a secondary peak during August and September (Fig. 3). The reasons for a major peak during the early summer may be evaporation of surface water, suitable temperature for bacterial growth and low variations in the salinity[1]. Low counts of bacteria during the rainy season (June-August) could be attributed to discharge of flood waters from the Vembanad lake[1], which reduces the culturable number of halophilic bacteria. The secondary peak which was mainly due to high counts of bacteria at the sts 2 and 3 during September and August respectively could be attributed to bloom of micro alga *Noctiluca*[8]. It is

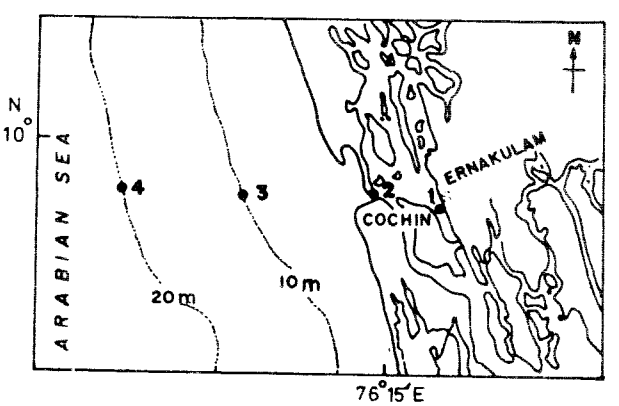

Fig. 1 – Location of sampling stations

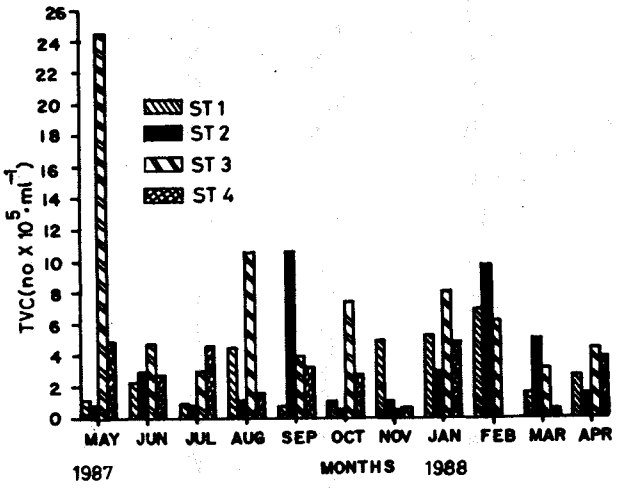

Fig. 2 – Total heterotrophic bacterial population at 4 stations from May 1987 through April 1988

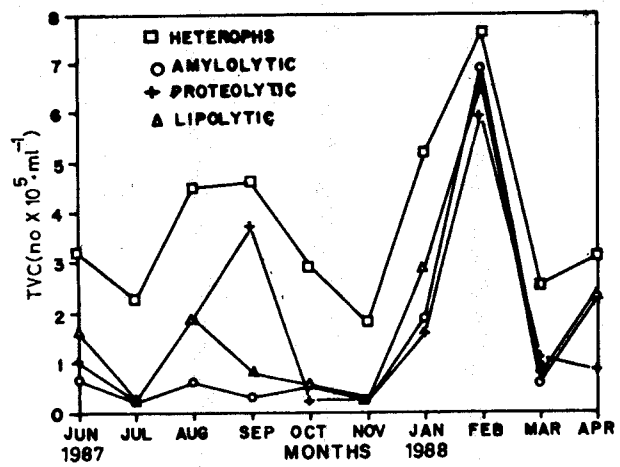

Fig. 3 – Total heterotrophic bacterial population *vs* zymogenous bacterial population (*av* of 4 stations) from June 1987 through April 1988

established that algae release exudates containing dissolved organic carbon and the bacteria are capable of utilising it for their growth and metabolism[9]. On the whole, the bacterial density is apparently higher than that reported for the Vellar estuary[10]. This may be due to availability of more organic substrates suitable for bacteria of allochthonous origin because of harbour activities. The average bacterial count for the year at third station situated at 10 m depth off Cochin was comparatively higher than at the other stations.

Zymogenous bacteria – The monthwise population distribution of zymogenous bacteria in the coastal waters off Cochin is given in Fig. 3 along with the total aerobic heterotrophs. The proteolytic and lipolytic forms follow the same pattern of seasonal occurrence as that of total heterotrophs, with a major peak during early summer (January-February) and a secondary peak during the rainy season (August-September). Amylolytic bacterial population did not show secondary peak during the rainy season. The average proteolytic bacterial population was high at st 2 while the lipolytic bacterial counts were more at st 3 (Fig. 4). The average population of amylolytic forms was comparatively lower than the other two zymogenous forms. With the exception of lypolytic forms at st 3, zymogenous bacterial populations appear to decrease from shore to the open ocean. Bacteria in the marine environment are known to be more proteolytic than saccharolytic and lipolytic[11], whereas in the present study the lypolytic forms occurred in higher numbers than the proteolytic forms which should be related to the high amounts of fatty substrates available for bacterial action.

Generic composition – During this study more than 160 bacterial isolates were obtained and identified up to generic level. Among them, 88% were gram negative and majority of them belonged to Pseudomonadales (Table 1). The bacterial genera and their counts during the year are given in Fig. 5. It has been recorded that among the culturable bacterial community of the marine environment, *Pseudomonas* is the most predominant genus[12] and the present findings (Fig. 5a) also conform to the same with the isolation of *Pseudomonas* (13%) and *Aeromonas* (13%). Neisseriaceae (25%) and Enterobacteriaceae (25%) were reported from the waters off Cochin[13], whereas in the present study 14.5% of the isolates belonged to Neisseriaceae (*Moraxella, Acinetobacter*) and only two isolates of Enterobacteriaceae were obtained during April 1987.

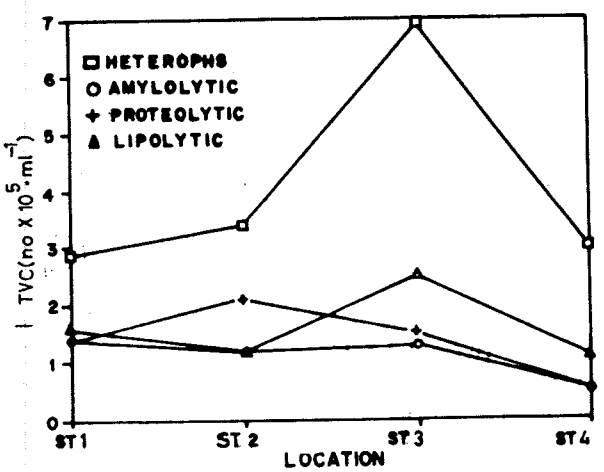

Fig. 4 – Heterotrophic and zymogenous bacterial population (Total *av* for the year) at 4 stations

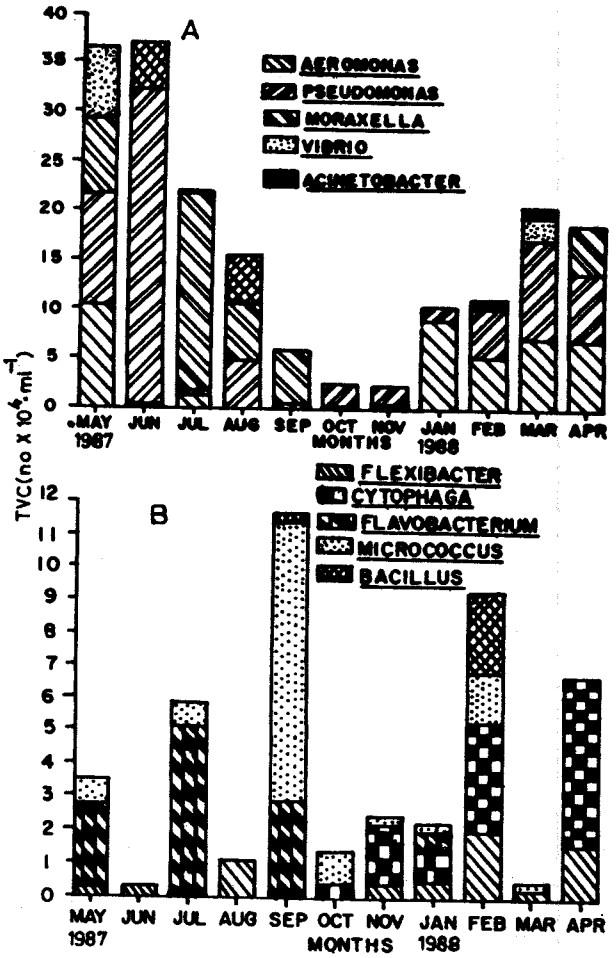

Fig. 5 – Non-pigmented gram negative (A) and pigmented gram negative and gram positive bacterial genera (B) and their counts from May 1987 through April 1988

The pigmented gram negative forms (Fig. 5b) accounted for 23.4%, of which *Flexibacter* occurred more frequently than *Cytophaga* and *Flavobacterium*.

From these findings it is evident that the halophilic heterotrophic bacterial load decreases during the rainy season in the coastal waters. It is also clear that the populations of zymogenous bacteria are high and hence their activity is more in the neretic waters compared to the offshore waters.

Table 1 – Bacterial genera and their percentage occurrence in the coastal waters of Cochin

Genus	Percent
I Gram negative bacteria (GNB)	
Pseudomonas	13.0
Aeromonas	13.0
Moraxella	8.0
Vibrio	5.0
Alcaligens	6.5
Acinetobacter	6.5
Flexibacter	10.4
Cytophaga	6.5
Flavobacterium	6.5
Unidentified G N B	12.6
II Gram positive bacteria	
Micrococcus	8.0
Bacillus	4.0

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