

Distribution of Heterotrophic Bacteria in Vellar Estuary, East Coast of India

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Density ($\times 10^3 \text{ ml}^{-1}$) of heterotrophic bacterial population was highest (10.9) in marine zone followed by gradient (3.75), freshwater (3.4) and tidal (1.9) zones of the estuary. *Vibrio*, *Pseudomonas*, *Micrococcus*, *Bacillus* and *Alcaligenes* were the most commonly encountered genera. Particulate organic carbon values (mgC.l^{-1}) were high in marine zone (0.665) followed by the gradient, freshwater and tidal zones. Higher values of POC coincided with the higher densities of both phytoplankton and bacteria. Chl. *a* varied from 0.005 to 0.018 mg.m^{-3} , registering higher value in the gradient zone and lower value in the freshwater zone. Higher density of phytoplankton population was encountered from the marine zone (2,480 cells. l^{-1}) followed by gradient, tidal and freshwater zones and the phytoplankton density decreased with fall in salinity.

The principal input of organic carbon to oceans is by the marine phytoplankton^{1,2}. However, to the estuaries and coastal waters, rivers contribute substantial amounts of terrestrial particulate and dissolved organic carbon together with riverine phytoplankton³. In these marine environs, heterotrophic bacteria play an important role in the decomposition of particulate organic matter and regeneration of nutrients.

In the present investigation, an attempt has been made to study the heterotrophic bacterial population in relation to the distribution of particulate organic carbon (POC), phytoplankton and chlorophyll *a* in Vellar estuary.

Four stations were selected one each from the marine, gradient, tidal and freshwater zones of the Vellar estuary, Porto Novo (lat. 11°29' N; long. 79°46'E). Samples were collected at fortnightly intervals during monsoon season in Oct. 1985 at one excursion from all stations.

Temperature of the surface water was measured using an ordinary Celsius mercury thermometer. Light penetration was measured using a Secchi disc and the extinction coefficient (K) calculated using the formula of Poole and Atkins⁴. Salinity was estimated by argentimetric titration⁵.

Water samples for POC analysis⁶ were collected in 1 l polythene bottles and filtered using 4.5 cm Whatman GF/C glassfibre filter paper coated with NaSO_4 .

For bacteriological examination, surface water samples at 30 cm depth were collected in sterile McCartney bottles and brought to the laboratory within 2-4 h of sampling. The bacterial density was estimated by serial dilution technique and plated using ZoBell's 2216 e agar medium, in duplicates. Plates were incubated at room temperature ($29^\circ\text{C} \pm 1^\circ\text{C}$) for

2-4 d and bacterial density expressed as CFU. ml^{-1} . Bacterial strains were randomly isolated, purified and identified by different schemes⁷⁻⁹.

For the determination of chl. *a*, 250 ml of water sample was filtered through 4.5 cm Whatman GF/C glass-fibre filter paper coated with MgCO_3 . Acetone (90%) was used to extract chlorophyll and concentration of chl. *a* was measured by the method of Parsons *et al.*⁶. Phytoplankton population density was assessed by the sedimentation technique, using the Utermöhl's inverted microscope for counting the cells.

Various parameters estimated are given in Table 1. Bacterial population (Table 2) showed highest value in the marine zone and lowest in the tidal zone. *Bacillus*, *Corynebacterium*, *Micrococcus*, *Vibrio*, *Pseudomonas*, *Alcaligenes* and *Flavobacterium-Cytophaga* group occurred in the 4 zones with different percentage compositions. The bacterial isolates from the freshwater zone were same as those encountered from the marine zone. However, the low saline condition coupled with low light extinction (Table 1) at the freshwater zone seem to promote the occurrence of gram-positive bacteria here as compared to the marine zone.

Heterotrophic bacteria play an important role as decomposers of particulate organic matter^{10,11} and regenerate the primary nutrients¹² by utilizing various organic compounds produced by the phytoplankton. In the present study, in general, high densities of total heterotrophic bacterial population coincided with the high values of POC which in turn coincided with high counts of phytoplankton. High values of POC recorded from the marine zone could be attributed to high density of phytoplankton at that zone whereas the higher POC value recorded from the freshwater zone

Table 1 — Physico-Chemical and Biological Parameters in Different Zones of Vellar Estuary

	Water temp. (°C)	Light extinc. (K)	Sal. ($\times 10^{-3}$)	POC (mgC.l^{-1})	Chl.a (mg.m^{-3})	Phyto-plankton (cells.l^{-1})	Viable count of heterotrophic bacteria (CFU.ml^{-1})
Marine zone	29.0	1.55	33.2	0.665	0.012	2,480	10.9×10^3
Gradient zone	28.5	2.20	33.0	0.126	0.018	2,200	3.75×10^3
Tidal zone	29.1	1.61	30.3	0.058	0.014	1,500	1.9×10^3
Freshwater zone	29.4	1.16	26.7	0.114	0.005	800	3.4×10^3

Table 2— Composition of Bacterial Isolates and Their Percent Occurrence (in parenthesis) in Different Zones of Vellar Estuary

	Zone			
	Marine	Gradient	Tidal	Fresh water
No. of isolates	68	67	57	64
Gram-positive	23.53%	20.89%	19.30%	39.06%
Gram-negative	76.47%	79.11%	80.69%	60.94%
<i>Bacillus</i>	4 (5.89)	9 (13.43)	4 (7.02)	12 (18.75)
<i>Corynebacterium</i>	9 (13.24)	—	7 (12.28)	11 (17.19)
<i>Micrococcus</i>	3 (4.41)	5 (7.46)	—	2 (3.13)
<i>Vibrio</i>	26 (38.24)	28 (41.79)	28 (49.12)	9 (14.06)
<i>Pseudomonas</i>	15 (22.06)	18 (26.87)	7 (12.28)	10 (15.63)
<i>Alcaligssnes</i>	7 (10.29)	5 (7.46)	5 (8.77)	8 (12.50)
<i>Flavobacterium - Cytophaga group</i>	4 (5.89)	—	5 (8.77)	11 (17.19)
Unidentified		2 (2.99)	1 (1.75)	1 (1.56)

than the tidal zone could be attributed to the terrigenous organic matter. Murchelano and Brown¹³ also reported that the annual bacterial cycle coincided with that of the phytoplankton in Long Island Sound. Likewise, Fukami *et al.*¹⁴ opined that the heterotrophic bacterial population was more during the bloom of phytoplankton in Japanese waters. Kannan¹⁵ reported that the standing crop of phytoplankton, dominated by diatoms, was high during summer during which season, dissolved organic matter values were also high in the Vellar estuary¹⁶. This is because of the fact that bacterial heterotrophy is directly related to the availability of organic substrates¹⁷ susceptible to degradation. The phytoplankton tends to be the most important group for the production of particulate organic matter, and its exudates serve as a source of carbon substrate to heterotrophic bacterial populations for deriving energy.

The incidence of high bacterial and phytoplankton counts alongwith high POC values, observed in the present study, suggests that the bacterial degradation of particulate organic matter leads to mineralization, whereby the nutrients are made available to the primary producers.

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References

- 1 Duge R A & Duursma E K, *Mar Chem*, **5** (1977) 319.
- 2 Mopper K & Degens E T, in *The global carbon cycle*, edited by B Bolin, E T Degens, S Kempe & P Ketner (Wiley, New York) 1979, 293.
- 3 Cadée G C, *Netherland J Sea Res*, **17** (1984) 426.
- 4 Poole H H & Atkins W R G, *J Mar Biol Assoc UK*, **16** (1929) 297.
- 5 Strickland J D H & Parsons T R, *A practical hand book of sea water analysis*, 2nd edition (*Fish Res Bd Canada, Ottawa, Bull*, **125**) 1972, 311.
- 6 Parsons T R, Marita Y & Lalli C M, in *A manual of chemical and biological methods for seawater analysis* (Pergamon Press) 1984.
- 7 Shewan J M, Hobbs G & Hodgkiss W, *J Appl Bacteriol*, **23** (1960) 379.
- 8 Simidu U & Aiso K, *Bull Japanese Soc Fish*, **28** (1962) 1133.
- 9 Buchanan R E & Gibbons N E, in *Bergey's manual of determinative bacteriology*, edited by Williams & Wilkins (Baltimore) 1974.
- 10 Newell R, *Proc Zool Soc Lond*, **144** (1965) 25.
- 11 Harrison P G & Mannn K H, *Limnol Oceanogr*, **20** (1975) 924.
- 12 Kogure K, Simidu U & Taga N, *J Exp Mar Biol Ecol*, **30** (1979) 201.
- 13 Murchelano R A & Brown C, *Mar Biol*, **7** (1970) 1.
- 14 Fukami K, Simidu U & Taga N, *J Exp Mar Biol Ecol*, **55** (1981) 171.
- 15 Kannan L, *Hydrobiological studies in nearshore and estuarine waters of Portonovo (India) with special reference to diatoms*, Ph.D. thesis, Annamalai University, 1981.
- 16 Balasubramanian T, *Dissolved organic matter in the coastal waters of Portonovo*, Ph.D. thesis, Annamalai University, 1981.
- 17 Palaniappan R & Krishnamurthy K, *Indian J mar Sci*, **14** (1985) 113.