*Indian Journal of Marine Sciences*
*Vol. 31(1), March 2002, pp. 65-68*

***Short Communication***

# Abundance of indicator and general heterotrophic bacteria in Port Blair bay, Andamans

T. Nallathambi, M. Eashwar[†] & K. Kuberaraj

CECRI Field Station, Central Laboratory, APWD Building, DIG Road, Port Blair 744 101, Andamans, India

and

G. Govindarajan

CECRI Madras Centre, CSIR Complex, Taramani, Chennai 600 113, India

*Received 26 March 2001, revised 7 September 2001*

Viable counts of indicator and general heterotrophic bacterial populations were enumerated from 6 stations in Port Blair bay during different seasons. High counts of coliforms and indicator bacteria were generally recorded in the Aberdeen zone of Port Blair bay. Other zones in the bay showed few, if any, coliforms or indicator species during non-monsoon periods. During periods of intensive rainfall, the entire bay waters showed positive results for *Vibrio cholerae*, *Vibrio parahaemolyticus*, *Streptococcus faecalis* and *Escherichia coli* like organisms. *Pseudomonas aeruginosa* was mostly absent, except during a dinoflagellate bloom when counts as high as $10^2$ CFU $ml^{-1}$ were recorded. Viable heterotrophic bacteria showed a specific pattern of variation in which the numbers decreased progressively from the entry channel to inner portions of the bay. On the whole, results point to the large probability of coastal water contamination from rainwater runoff effects.

[ **Key words:** Coastal water contamination, indicator bacteria, rainfall, heterotrophic bacteria, Port Blair bay, Andamans, land run off ]

Port Blair bay in Andamans is easily one of the least explored areas with reference to physicochemical and microbiological studies. Upsurge in human settlements, urbanization, tourism and marine transportation are matters that add significance to coastal water quality monitoring in Port Blair bay. Recently, there have been reports on coral bleaching in Port Blair region[1] and elsewhere[2] in Andamans. The bleaching event is generally accepted to be due to abrupt changes in physicochemical as well as specific biological events[3]. However, basic information on physico-chemical and bacteriological aspects of these waters is still lacking. Water quality surveillance programmes are important for evolving regulations on coastal environmental protection. Thus, the objective of the present work was to provide basic insights into the abundance and variations of bacterial populations in Port Blair bay region.

Spread in a northeast to southwest course (Fig. 1), the Port Blair bay extends to a length of roughly 6 km. Six station locations encompassing the entire bay, as indicated, were considered in this work. Samples were taken from onboard a fishing vessel *MV Ramkali* during non-monsoon (August and September 1999), northeast monsoon (October 1999) and southwest monsoon (June 2000). Water samples for physicochemical tests[4] were taken using a clean plastic bucket or a water sampler (Hydrobios, Kiel). For bacteriological analyses, surface water samples were taken using clean, pre-sterilized, glass containers. These samples were stored on ice and transported to the shore lab within 30 minutes to accomplish the enumeration course in the shortest time possible.

Agar pour plate technique was routinely followed in this work, employing seven different media. These media allow presumptive identification of a wide range of organisms, including pollution indicator species[5]. The media used (HiMedia, Mumbai) and the specific bacterial growths they support are as follows: nutrient agar (aerobic, heterotrophic bacteria), MacConkey agar and M-FC agar (*Escherichia coli* or faecal coliforms), XLD agar (*Salmonella* and *Shigella* like organisms), cetrimide agar (*Pseudomonas aeruginosa* like organisms), TCBS agar (*Vibrio cholerae* and *Vibrio parahaemolyticus* like organisms)

[†]For correspondence. E-mail: meashwar@rediffmail.com

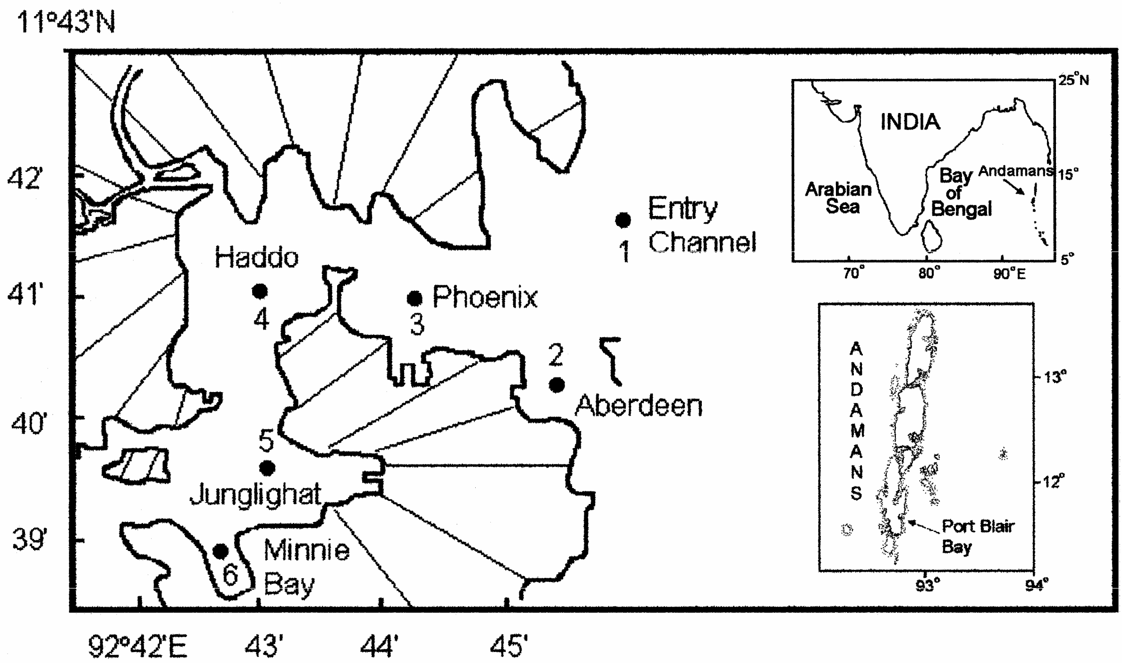


Fig. 1—Location of Port Blair bay and the sampling stations

and M-Enterococcus agar (*Streptococcus faecalis* like organisms). Heterotrophic bacteria were enumerated from 0.01, 0.1 and 1 ml aliquots of water samples. For enumeration of indicator bacteria, aliquots of 0.5 and 1.0 ml were used in addition to 10 ml aliquots filtered on 0.22 $\mu$m membranes (Millipore). This scheme provided an ideally wide range of inocula for reasonable precision in bacterial enumeration. Nutrient agar plates were incubated in room temperature (28 ± 2° C) for 72 h while others were incubated at 37° C for 24 to 36 h. Two replicate samples were used throughout this work, and the colony-forming units (CFUs) enumerated at the end of the incubation period were averaged.

Physicochemical characteristics of surface water samples from Port Blair bay are presented in Table 1. The results are the average values for all 6 station locations covered in each sampling period. The rainfall data (Table 1) account for some of the variations in water characteristics between the different sampling periods. Notably, the levels of nitrate, silicates and suspended solids were the highest during monsoon months.

Counts on nutrient agar were generally higher than on other media, as expected, indicating the prevalence of general heterotrophic bacteria in the waters. Data in Table 2 illustrate two types of variations in the numerical abundance of heterotrophic bacteria in the bay waters. Firstly, the numbers of heterotrophic bacteria are higher for the non-monsoon months, as compared to the monsoon periods. Secondly, there is a distinct gradient in the numerical abundance of heterotrophic bacteria during non-monsoon. This gradient is relative to the distance from the entry channel of Port Blair bay, the numbers of heterotrophic bacteria becoming progressively lower in the inner zones of the bay. During periods of

Table 1 — Physicochemical characteristics of Port Blair bay surface waters during the study period (average data for the 6 sampling stations)

| Parameter | Sampling seasons | | | |
|---|---|---|---|---|
| | Non-monsoon | | Monsoon | |
| | Aug 1999 | Sept 1999 | Oct 1999 | June 2000 |
| Water temp. (°C) | 27.0 | 28.5 | 27.1 | 29.2 |
| Salinity ($\times 10^{-3}$) | 33.46 | 32.8 | 32.27 | 32.61 |
| *p*H | 8.01 | 8.16 | 8.08 | 8.16 |
| Diss. $O_2$ (mg $l^{-1}$) | 5.57 | 5.75 | 5.22 | 5.07 |
| Susp. solids (mg $l^{-1}$) | 23.63 | 19.63 | 29.62 | 32.13 |
| BOD (mg $l^{-1}$) | 2.05 | 1.84 | 1.58 | 2.18 |
| Nitrite ($\mu$mol $l^{-1}$) | 0.10 | 0.20 | 0.13 | 0.52 |
| Nitrate ($\mu$mol $l^{-1}$) | 0.57 | 0.36 | 2.32 | 2.02 |
| Phosphate ($\mu$mol $l^{-1}$) | 0.25 | 0.31 | 0.23 | 0.39 |
| Silicate ($\mu$mol $l^{-1}$) | 7.21 | 6.48 | 26.36 | 9.89 |
| *Rainfall, mm | 1.6 | 0.8 | 46.0 | 27.4 |

*In the 24 hours prior to sampling (Source: Meteorological Data Centre, Port Blair).

Table 2—Counts (CFU $ml^{-1}$) of different groups of bacteria in samples taken from various stations in Port Blair Bay during different sampling periods

| | Non-monsoon | | | | | | | | | | | | Northeast monsoon | | | | | | Southwest monsoon | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Aug-99 | | | | | | Sep-99 | | | | | | Oct-99 | | | | | | June-00 | | | | | |
| Group* | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 | 1 | 2 | 3 | 4 | 5 | 6 |
| GAHB | 450 | 3750 | 2400 | 670 | 170 | 80 | 330 | 1800 | 2500 | 900 | 260 | 330 | 102 | 130 | 80 | 110 | 120 | 109 | 153 | 100 | 60 | 105 | 100 | 145 |
| ECLO | ND | ND | ND | ND | ND | ND | NC | 4 | 7 | 1 | 2 | 4 | 27 | 2 | 24 | 77 | 14 | 8 | 2 | 4 | 49 | 7 | 65 | 186 |
| SHLO | NC | 9 | 2 | 1 | NC | NC | NC | 5 | 2 | 2 | NC | NC | 4 | 17 | 12 | ND | 6 | NC | NC | NC | 2 | 2 | 2 | 29 |
| SALO | NC | 10 | 1 | 2 | NC | NC | NC | 6 | 3 | 2 | NC | NC | 4 | 6 | 2 | ND | 10 | 3 | NC | NC | 1 | NC | NC | 4 |
| PKLO | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | ND | NC | NC | NC | NC | NC | NC | NC | NC |
| VPLO | 3 | 76 | 5 | 1 | NC | NC | 4 | 54 | 12 | 4 | 2 | 3 | 26 | 12 | 10 | 33 | 7 | 17 | NC | NC | NC | NC | NC | 6 |
| VCLO | 4 | 150 | 2 | 1 | NC | NC | 2 | 20 | 7 | 1 | NC | NC | 69 | 388 | 3 | 17 | 11 | 31 | NC | NC | NC | NC | NC | NC |
| SFLO | NC | 4 | 3 | 3 | 2 | 2 | NC | 6 | 3 | 5 | 2 | 4 | 49 | 93 | 12 | 44 | 25 | 6 | NC | NC | NC | NC | NC | NC |
| PALO | NC | 1 | 1 | NC | NC | NC | NC | NC | NC | NC | NC | NC | NC | 7 | NC | NC | 5 | NC | NC | NC | NC | NC | 6 | 108 |

*GABH = General aerobic heterotrophic bacteria, ECLO = *Escherichia coli* like organisms, SHLO = *Shigella* like organisms, SALO = *Salmonella* like organisms, PKLO = *Proteus* and *Klebsiella* like organisms, VPLO = *Vibrio parahaemolyticus* like organisms, VCLO = *Vibrio cholerae* like organisms, SFLO = *Streptococcus faecalis* like organims, NC = No colony, ND = Not determined.

rainfall, there was not only a general reduction in the numerical abundance, but a more uniform distribution of heterotrophic bacteria in the bay waters.

Data for indicator bacteria are also summarized in Table 2. Faecal coliforms, pathogenic vibrios and *Streptococcus faecalis* like organisms more regularly encountered than others. Faecal coliform (*Escherichia coli*) counts were enumerated on MF-C agar, which yielded higher counts than MacConkey agar. *Proteus* and *Klebsiella* like organisms and *Pseudomonas aeruginosa* like organisms were generally absent even though large aliquots of samples from all locations were plated both by filtration technique and pour plate method. Indicator bacteria were generally high in the Aberdeen zone of Port Blair bay. Pathogenic vibrios were particularly high at this location, and *Vibrio cholerae* like bacteria showed counts of the order of $10^2$ CFU $ml^{-1}$ on two instances. The data also show a general increase in the numbers of indicator bacteria during northeast monsoon (October 1999) throughout the bay, possibly as a result of land runoff inputs associated with rainfall. This observation is consistent with reports[6,7] that land runoff can bring in allochthonous microflora, including disease-causing bacteria, to the coastal waters. Studies in Ventura County beaches (California), for instance, have shown that a 10 mm rainfall may be enough to increase the numbers of coliforms and pathogens by 1 to 2 orders of magnitude[7].

Conversely, there was a substantial reduction in bacterial numbers during southwest monsoon (June 2000). This particular period was characterized by intense blooms of the dinoflagelate, *Noctiluca scintillans*. Changes in coastal water characteristics associated with this event are addressed in detail elsewhere[8]. For reasons unknown, *Pseudomonas aeruginosa*, which showed a general absence on other sampling dates, was high in the inner regions of the bay where the bloom was most intense. Also high in this zone of the bay during the bloom event were faecal coliforms. The general absence of other bacteria through the entire bay waters at this point of time probably points to an influence of the dinoflagellate, which is known to ingest bacteria at remarkably high rates[9].

The numerical abundance of viable heterotrophic bacteria in the present work ($0.6 \times 10^2$ to $3.75 \times 10^3$ $ml^{-1}$) is within the ranges reported earlier from southeast coast of India[10,11]. It is generally accepted that variations in numbers of heterotrophic bacteria are common within a location and even within a single sample[12] and, further, that plate counts considerably underestimate the total bacterial numbers[13]. From this judgment, spatial rather than temporal variations would appear more reliable sets of data, assuming a uniform discrepancy resulting from such concerns as media variations and handling techniques. Spatial variations were indeed marked in this work, and the data allude to the existence of gradients in the distribution of heterotrophic bacteria.

As for indicator bacteria, the results suggest that the Aberdeen zone of Port Blair bay apparently receives maximal contamination from anthropogenic activities. In this work, the categorization of sampling periods as non-monsoon and monsoon months is only tentative. Given the hilly topography of Port Blair town and the generally high amounts of rainfall, the risk of coastal water contamination from runoff effects looks probable, regardless of the season prevailing. Again, the Aberdeen zone seems to be the most affected due to such runoffs.

The authors are thankful to the Director, CECRI for encouragement and the Department of Ocean Development, New Delhi for funding.

## References

1 Ravindran J, Raghukumar C & Raghukumar S, Disease and stress-induced mortality of corals in Indian reefs and observations on bleaching of corals in the Andamans, *Curr Sci*, 76 (1999) 233-237.

2 Dorairaj K, Soundararajan R & Jagadis I, Studies on the marine fauna of the Mahatma Gandhi marine national park, Wandoor, south Andaman, part 1: corals. *J Andaman Sci Assoc*, 13 (1997) 10-31.

3 Glynn P, Coral reef bleaching: ecological perspectives, *Coral Reefs* 12 (1993) 1-12.

4 Strickland J D H & Parsons T R, *A practical handbook of seawater analysis* (Fisheries Research Board of Canada, Ottawa) 1978, pp. 310.

5 Chandramohan D, Microbiological methods, in *Manual on methodology for biological parameters*, (Department of Ocean Development, ICMAM Project Directorate, Chennai) 1998, pp. 1-30.

6 Coelho M P P, Marques E M & Roseiro C J, Dynamics of microbiological contamination at a marine recreational site, *Mar Poll Bull*, 39 (1999) 1242-1246.

7 Anon, *EPA National water quality report 305b*, (Office of Water, Washington DC) 1998.

8 Eashwar M, Nallathambi T, Kuberaraj K & Govindarajan G, *Noctiluca* blooms in Port Blair bay, Andamans, *Curr Sci*, 81 (2001) 203-206.

9 Kirchner M, Sahling G, Uhlig G, Gunkel W & Klings K-W, Does the red tide forming dinoflagellate *Noctiluca scintillans* feed on bacteria? *Sarsia*, 81 (1996) 45-55.

10 Prabhu S K, Subramanian B & Mahadevan A, Occurrence and distribution of heterotrophic bacteria of Madras coast (Bay of Bengal), *Indian J Mar Sci*, 20 (1991) 130-133.

11 Ramaiah N, Raghukumar C, Sheelu G & Chandramohan D, Bacterial abundance, communities and heterotrophic activities in the coastal waters off Tamil Nadu, *Indian J Mar Sci*, 25 (1996) 234-239.

12 Ramaiah N & Chandramohan D, Distribution and species composition of planktonic luminous bacteria in the Arabian Sea, *Indian J Mar Sci*, 16 (1987) 139-142.

13 Hoch M P & Kirchman D L, Seasonal and inter-annual variability in bacterial production and biomass in a temperate estuary, *Mar Ecol Prog Ser*, 98 (1993) 283-288.