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Seasonal Distribution of Halophilic Bacterial Population in Water and Sediment at Muthupet Mangrove, Tamilnadu

C. Govindasamy[1,*], P.Ruban[1] and S. Sekar[2]

[1]Department of Oceanography and Coastal Area Studies, School of Marine Sciences, Alagappa University, Thondi Campus- 623 409, Tamilnadu, India.

[2]Department of Zoology, University of Madras, Maraimalai Campus Guidy, Chennai- 600 025, Tamilnadu, India.

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ABSTRACT

Muthupet mangrove ecosystem (Lat.10°15'N; Long.79°30'E) is located at the southern end of the Cauvery delta on the eastcoast of India. Halophilic bacteria play an important role in mangrove ecosystem due to their role in decomposition of mangrove litter. In the mangrove swamp at Muthupet, a total of 32 isolates of bacteria were identified. Of these 32 species of bacteria, characterized by presence of 5 genus namely *Bacillus, Carnybacterium, Vibrio, Micrococcus and Pseudomonas.* The above five are dominant bacterial groups and were found to be present lagoon of Muthupet mangrove forest. Fluctuation values in bacterial density ($39x10^3$ spc.ml^{-1} to $99x10^4$ spc.ml^{-1}) and ($144x10^3$ spc.gm^{-1} to $175x10^4$ spc.gm^{-1}) in water and sediment at two stations was noticed respectively. Higher values were recorded during the premonsoon season and sudden decrease during the summer season. The bacterial population was found to be higher than that of the water, which may be due to the biodegradation processes of sediment mangrove leaves and vegetation, as well as due to high nutrient accumulation, precipitation of organic compounds and settlement of the dead organic matter in sediment. The paper identifies the seasonal distribution of Halophilic bacteria in few selected species in mangrove area of Muthupet.

Introduction

In this largest marine habitat mangroves are the most productive ecosystem. Mangrove ecosystems are dominant ecosystems along tropical coastlines (Govindasamy et al. 2011). Mangrove ecosystem are open ecosystem (Kathiresan, 2000), which exchange matter and energy which the adjacent marine terrestrial ecosystem. However, they are found to differ in their "energy signature" or the sum of all forces which dictates the type of organisms that will survive and speed of ecological process (Cintron and Novelli, 1984). In recent years there has been a rediscovery of many values of mangrove ecosystem namely biological, ecological, functional, medical and economic values (Odum, 1972; Azariah, 1992). At the ecological level, mangrove serve as nursery feeding and spawning grounds for commercial fish and wind damage and prevent soil erosion. It also serves as nesting and feeding ground for a variety of wildlife and as a coastal sink or trap for pollutants. The allochthonous detritus produced by mangroves is more important source than phytoplankton in the estuarine area. Mangroves are important in the detritus based food chain and food web (Govindasamy et al. 2011 ; Chendur Palpandi, 2011; Paramasivam et al. 2011).The bacteria have also been recognized as a large and active component of marine and mangrove ecosystem (Pomeroy, 1979; Mastaller, 1996; Gina Holguin et al. 2001) and that the halophilic bacteria are acting as large and acting as major consumer of dissolved organic matter in the mangrove ecosystem and are of considerable importance in nutrient regeneration and decomposing activity. Such as an important mangrove halophilic bacterium is now being decreasing stage and exploited in various marine sources due to pollution increasing. From this view point, the paper examines the sensational variation of halophilic bacteria and its distribution in the Muthupet mangrove forest, which is located on one of the deltaic branches of the southern part of the Cauvery delta. The paper also provides baseline information on halophilic bacteria of dynamic mangrove ecosystem, Bay of Bengal.

Materials and Methods

Area Distribution

Muthupet is a coastal village of Thanjavur district, where an extensive mangrove swamp is located at the southern end of the Cauvery delta (Lat.10°15'N; Long.79°30'E) (Fig. 1). A total number of two station were located in the muddy area and at low tide region station 1(Manakkathu lagoon) was located 1 km upstream from station 2 (Sethuguda). It is situated near the place where the Korayar River joins the lagoon and it's surrounded by pure stands of *Avicennia marina*. At the time of high tide the depth is about 1 meter and during the low tide time, the width of the river is about 40 meters from highest high tides to lowest low tide mark and the substratum is muddy in nature.

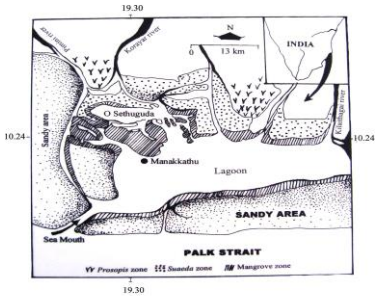

Figure 1: Map showing the Study Area

Tele: +91-9444256247
E-mail addresses: govindasamyocas@gmail.com

Sample Collection

Monthly water and sediment sample were collected at fortnightly intervals during the full moon and new moon day at the time of high tide period from September 2007 to August 2008 for the enumeration of halophilic bacteria. Water sample were collected in pre sterilized BOD bottles. Similarly sediment samples were collected in fresh polytene bags using Paterson grab. The samples were transported to the microbiological laboratory in an ice box without any contamination.

The sediment sample were serially diluted and plated in Zobell 2216 marine agar medium prepared with 50% aged seawater (Rheinheimer, 1972) Serial dilution method was used and pour plate technique was employed. A calendar year was divided into four seasons based on the northeast monsoon which along brings bulk rainfall to the southeast coast of India where the present study area is situated. The seasons are: Monsoon (October- December), Post monsoon (January-March), summer (April-June) and Pre monsoon (July-September).

Result and Discussion

One of the major impediments in the mangroves of water and sediment quality of mangrove community is the absence of quantitative understanding of the structure and dynamics of mangrove ecosystem (Mastaller, 1995). The results, embodied in the present paper on the bacterial ecology of Muthupet mangrove swamps, are a step towards an understanding of the seasonal distribution and abundance of the halophilic bacteria at mangrove ecosystem. As in other ecological system the role of bacteria in substrate transformation cannot be over emphasized. It is known that about 15% to 30% of organic matter in water and sediment in the mangrove environment are mineralized by microorganisms, especially by the facultative bacteria (Daengshuba, 1979; Holguin *et al*. 2001). At both the stations a total number of 32 species were identified. Of these 32 species of bacteria, characterized by the presence of 5 genus namely *Bacillus, Carnybacterium, Vibrio, Micrococcus* and *Pseudomonas*. The above five are dominant bacterial groups were found to be present in lagoon of the Muthupet mangrove forest.

Seasonal variations halophilic bacterial population was studied at two station 1 (lagoon) and station 2 (Sethuguda). At station 1, the fluctuating average values from $39x10^2$ to 195x 10^6spc.ml^{-1} in water and from $120x10^2$ to $663x10^6$ spc.gm^{-1} in sediment. During the late pre monsoon to late monsoon period a decreasing trend was noticed in water and sediment samples. The values decreased from $99x10^4$ spc.ml^{-1} to $131x10^3$ spc.ml^{-1} in water and 175x 10^4 spc.gm^{-1} to $144x10^3$ spc.gm^{-1} in sediment and sudden increasing trend was noticed during post monsoon season, in April 2007, the value of $195x10^6$ spc.ml^{-1} and $663x10^6$ spc.gm^{-1} in water and sediment respectively (Tab. I). At station 2, the fluctuating average values from $130x10^2$ to $205x10^6$ spc.ml^{-1} and $180x10^2$ to $600x10^6$ spc.gm^{-1} were recorded in water and sediment respectively. Highest average values of $205x10^6$ spc.ml^{-1} (water) and of $600x10^6$ spc.gm^{-1} (sediment) and lowest values of $130x10^2$ spc.ml^{-1} (water) and of $180x10^2$ spc.gm^{-1} sediment were recorded in summer (April 2008) and monsoon (November 2007) seasons respectively (Tab. I and II). Salinity is an important environmental factor in the study of halophilic bacterial fauna of different mangrove ecosystem (Takahashi and Norton, 1977; Capone, 2002, Govindasamy et al. 2011). Salinity was found to be one of the important environmental factors responsible for the seasonal variation in the abundance of bacteria. During summer, when salinity was high population density was also high in water and sediment at both the station. This lowest average value of $39x10^2$ spc.ml^{-1} in water and $120x10^2$ spc.gm^{-1} in sediment were recorded during the monsoon season in November (sediment) and December (water) 2007. The results indicated that the decreasing bacterial population, found during the monsoon season may be due to high inflow of fresh water in the river Korayar and intense dilution of estuarine water, which is supported by the low salinity (0.5%o) values (Takahashi and Norton, 1977). Predation may also be one of the reasons for the decrease n bacterial density and the bottom of feeding macro fauna could remove substantial fraction of bacterial production. Further, the low values of halophilic bacteria during the initial stages may be due to the low saline condition which may not be suitable for the growth of these organisms at both the stations in water and as well as in sediment.

At the both the stations, the results indicated that the sediment bacterial population was found to be higher than that of the water (Tab. II). The observed higher bacterial density in sediment may be due to the association of the halophilic bacteria with biodegradation processes of senescent mangrove leaves and vegetation (Paliniappan and Krishnamurthy, 1985; Rajendran and Kathiresan, 2006). In general, sediment has more bacterial population than the water because of this might be due to high nutrient accumulation, precipitation of organic compounds and settlement of dead organic matter in sediment (Natarajan and Venkateswaran, 1980; Geneviève Carr and James Neary, 2006; Technical Report, 2010; Govindasamy et al. 2012) and the ability of the bacteria to adhere themselves to the sediment particles as well as to decomposing particles that settle down (Hope, 1984). Where in water, as they exist as free floating organisms there is the possibility of being washed away during the ebb and flow of the tides. This might be one of the reasons for the occurrence of low values of bacterial population in water than in sediment. At station 1, during the month of January 2008 in both water and sediment low bacterial value was noticed, but the average values of water were slightly higher than that the sediment (Tab. II). Such an increase in bacterial density in water may be due to the liberation of microorganisms from soil (Azaiah and Jayakumar, 1988; Pramila and Vijaya Ramesh, 2011).

Present study indicates that the differences between the bacterial population of water and sediment at the end of the experiment and the variation in the density between these two populations during the first collection were found to be closer. The seasonal variation in the number of singe colonies at station 1 (Lagoon) varied between 4 and 8 isolates and at station 2 (Sethuguda) the variation was recorded between minimum 5 and maximum 8 isolates respectively. The overall variation in the occurrence of the number of single colonies in all the samples together, showed a minimum of 8 and a maximum of 12 isolates in year long period of study. The above conclusion is further evidenced by statistical analysis of variation (ANOVA) used to test the significance of halophilic bacterial population in water and sediment at both station (Tab. III).

Conclusion

In the present investigation may be noted that, at both the station there are marked seasonal fluctuation in the density of bacterial population and the pattern was increase and decrease at both the stations. Further, the results clearly indicated that the sediment bacterial population was found to be higher than that of the water because the huge amounts of humus substances were present in the mangrove region.

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Result of F test

1. Seasons (S)-Highly significant ;
2. Stations (V)-Not significant
3. Composition (T) (water and sediment – significant at 0.01% level)
4. Season and station (SV)- Not significant
5. Station and Component (VT)- Not significant
6. Season and Component (ST) – significant at 0.1% level

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Table I. Seasonal variation of halophilic bacterial population in water and sediment at station 1 (Lagoon) for a period of one year from September 2007 to August 2008

Lagoon-Water ml^{-1}				Lagoon- Sediment gm^{-1}		
Months	Full Moon	New Moon	Average	Full Moon	New Moon	Average
September 2007	$170x10^4$	$280x10^3$	$99x10^4$	$230x10^4$	$120x10^4$	$175x10^4$
October	$250x10^3$	$120x10^2$	$131x10^3$	$260x10^3$	$290x10^2$	$144x10^3$
November	$65x10^2$	-	$65x10^2$	$120x10^2$	-	$120x10^2$
December	$140x10^1$	$54x10^2$	$39x10^2$	$280x10^1$	$110x10^3$	$564x10^2$
January 2008	$110x10^2$	$39x10^3$	$250x10^2$	$49x10^2$	$290x10^6$	$169x10^2$
February	$59x10^4$	$52x10^2$	$297x10^2$	$210x10^6$	$45x10^6$	$127x10^6$
March	$130x10^5$	$250x10^5$	$190x10^5$	$200x10^6$	$45x10^6$	$122x10^6$
April	$130X10^5$	$250X10^6$	$195x10^6$	$130x10^6$	$270x10^6$	$78x10^6$
May	$59x10^4$	$93x10^3$	$341x10^3$	$210x10^4$	$180x10^5$	$100x10^5$
June	$250x10^3$	$40x10^3$	$325x10^3$	$180x10^5$	$120x10^4$	$960x10^4$
July	$100x10^4$	$56x10^3$	$528x10^3$	$140x10^5$	$140x10^5$	$140x10^5$
August	$130x10^4$	$100x10^4$	$115x10^4$	$130x10^5$	$170x10^5$	$150x10^5$

- No Collection

Table II. Seasonal variation of halophilic bacterial population in water and sediment at station 2 (Sethuguda) for a period of one year from September 2007-2008

	Water (ml l^{-1})			Sediment gm^{-1}		
Months	Full Moon	New Moon	Average	Full Moon	New Moon	Average
September 2007	$130x10^3$	$100x10^2$	$70x10^3$	$210x10^4$	$280x10^2$	$106x10^4$
October	$180x10^3$	$200x10^2$	$150x10^3$	$240x10^3$	$220x10^2$	$131x10^3$
November	$130x10^2$	-	$130x10^2$	$180x10^2$	-	$180x10^2$
December	$120x10^2$	$210x10^2$	$11x10^2$	$220x10^1$	$44x10^3$	$231x10^2$
January 2008	$93x10^3$	$150x10^3$	$121x10^2$	$160x10^3$	$51x10^4$	$335x10^3$
February	$180x10^3$	$100x10^4$	$590x10^3$	$180x10^6$	$130x10^4$	$906x10^5$
March	$41x10^6$	$280x10^5$	$345x10^5$	$100x10^7$	$110x10^6$	$555x10^6$
April	$230X10^6$	$190X10^6$	$200x10^6$	$100x10^6$	$200x10^6$	$600x10^6$
May	$170x10^4$	$120x10^4$	$145x10^4$	$280x10^5$	$180x10^6$	$104x10^6$
June	$52x10^4$	$100x10^4$	$76x10^4$	$280x10^5$	$52x10^6$	$400x10^5$
July	$120x10^4$	$57x10^3$	$628x10^3$	$150x10^5$	$43x10^4$	$771x10^4$
August	$230x10^4$	$120x10^4$	$175x10^4$	$1500x10^5$	$270x10^5$	$210x10^5$

- No Collection

Table III. Analysis of variation (ANOVA) to test the halophilic bacteria population in water and sediment

Source of Variation	Degrees of freedom	Sum of Square	Mean Square	F
Seasons (S)	11	$0.6729x10^{18}$	$61x10^{15}$	15.56
Stations (V)	01	$0.5345x10^{16}$	$5.3x10^{15}$	1.35
Composition (T) (water and sediment)	01	$0.7502x10^{17}$	$75x10^{15}$	19.13
Season and station (SV)	11	$0.4821x10^{17}$	$4.4x10^{15}$	1.12
Station and Component (VT)	01	$0.4256x10^{16}$	$4.3x10^{15}$	1.10
Season and Component (ST)	11	$0.220x10^{18}$	$20x10^{15}$	5.10
Residual	11	$0.4310x10^{17}$	$3.92x10^{15}$	1.01
Total	47	$0.11x10^{19}$		