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Research Article

Studies on the Phosphate Solubilizing Bacteria from Mangroves of Bhatye Estuary, Ratnagiri, Maharashtra

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Abstract

Mangroves are salt-tolerant plants of tropical and subtropical intertidal regions of the world. The specific regions where these plants occur are termed as 'mangrove ecosystem'. These are highly productive but extremely sensitive and fragile. Besides mangroves, the ecosystem also harbours other plant and animal species. the soil is perpetually waterlogged, there is little free oxygen. Anaerobic bacteria liberate nitrogen gas, soluble iron, inorganic phosphates, sulfides, and methane. Mangroves (the rhizhosphere and the pneumatophores) also harbor a variety microorganisms. These microorganisms include phosphate solubilizing, nitrifying and other bacteria which act as symbionts and add to their growth. Less is known about the diversity of these bacteria. The present study focuses on the microbial flora and their quantitative estimation which may act as a guideline for exploring microorganisms and their role in mangrove growth and conservation.

Keywords: Phosphate Solubilizers; Mangroves; Bhatye; Ratnagiri

Introduction

The zone of the western coast of Maharashtra is traditionally known as Konkan Region. It is a narrow terrain with a width of upto 60kms between the western coast and the ridge of the Sahayadri Mountains. The length of the region is 720Kms between the states of Gujarat in the North and Goa in South. The coast along the konkan region is interspersed by estuaries like Anjarle Creek, Adi Creek, Dabhol Creek, Guhagar Creek, Jaigad Creek, Bhatye Creek and Rajapur Creek. Ratnagiri has a total mangrove cover of 0.36km^2 and the length of the coast is 1.20 km. Luxuriant mangrove thickets are found near the mouth of Kajli River, which is also called as Bhatye Estuary, where the river opens into the Arabian Sea. Phosphorus is one of the major components of seat water and present in bound form and adsorbed to slit and clay especially in the mangrove areas. Phosphate uptake has been observed in bacteria present in the soil. The principal mechanism for mineral phosphate solubilization is the production of organic acids, and acid phosphatases play a major role in the mineralization of organic phosphorus in soil. It is generally accepted that the major mechanism of mineral phosphate solubilization is the action of organic acids synthesized by soil microorganisms. Production of organic acids results in acidification of the microbial cell and its surroundings. The production of organic acids by phosphate solubilizing bacteria has been well documented.

In the present studies, microbial assessment of mangrove soils of few selected mangrove species and mangrove associates in Bhatye Estuary was carried out. The study gives an overview of microbial flora associated with the soils of mangrove areas of Bhatye Estuary, Ratnagiri.

Material and Methods

The study area

Bhatye Estuary is situated at $73^0$15' East and $16^0$51'N near Ratnagiri (Figure 1) and known for mangroves on the mud flats and clam fauna like *Meretrix meretrix, Katelysia opima* and *Geliona proxima*. Ten different species of mangroves like *Avicenia alba, Avicenia marina, Avicenia officinalis, Aegeceras corniculatum, Bruigera cylindrica, Bruigera gymnorhiza, kandeli candel, Rhizhophora mucronata, Rhizophora apiculata* and *Sonneratia alba* inhabit the saline backwaters supporting the fisheries along the coast and harbouring a wide range of mangrove associates and fauna [4].

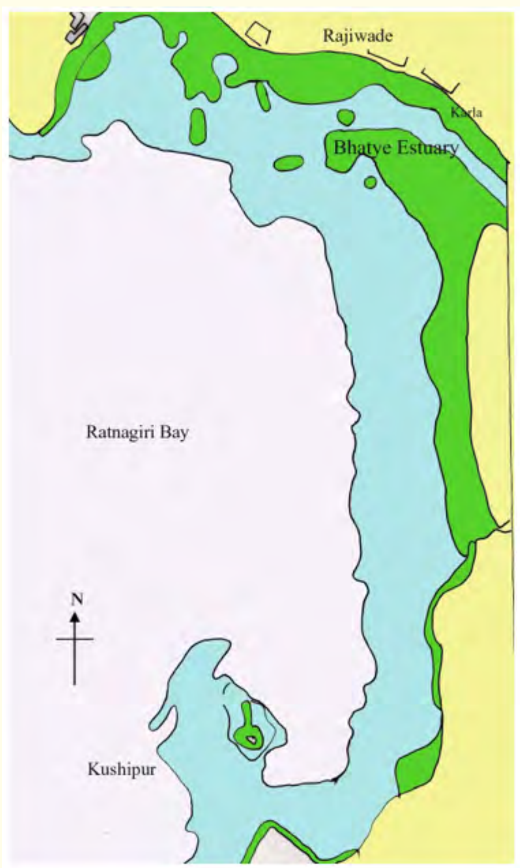

Figure 1: Bhatye Estaury, Ratnagiri, Maharashtra.

The mangrove associates occurring along the mangrove species are- *Erytrina indica, Zizypus jujube, Sisuvium portulactrum, Vitex Negundo, Ipomea biloba, Derris ulginosa*, *Derris trifoliate, Pongamia pinnata, caesalpinia crista, Cordia myxa, Plectranthus volubilis, Acanthus ilicifolius, Salvadora persica, Thespesia populnea, Calophyllum inophyllum and Clerendendron inerme* [1,3].

Collection of soil and analysis: The soil samples were collected in sterilized bags from rhizhosphere and pneumatophores of the mangrove species (*Rhizhophora mucronata, Rhizhophora apiculata, Avicenia* species, *Sonneratia* species,) and their dominant associates (*Acanthus ilicifolius* and *Garcinia* species). The rhizhosphere soil samples were diluted in physiological saline and three dilutions were plated out to determine Standard Plate Count in triplicate and incubated at room temperature. Phosphate solubilizing bacteria were isolated on Pikovasky's medium containing g/l; glucose 10.0, tri-calcium phosphate 5.0, NaCl 0.2, magnesium sulfate 0.1, KCl 0.2, yeast extract 0.5, manganese sulfate 0.01, ferrous sulfate 0.01, agar powder 15.0 and pH 6.5. The plates were incubated at 37°C for 7 days and phosphate solubilizing ability was monitored by observing the zone of clearance around the colonies. Detection and estimation of the phosphate solublization ability of microorganism have been possible using plate screening methods. Phosphate solubilizers produce clearing zones around the microbial colonies in media.

Results

The results for viable, total count and phosphate solubilizers for microorganisms are shown in Table 1 and 2, present on the pneumatophores and the rhizhosphere. The total count/ viable count varied from 1.55 X 10^4 (for *Acanthus ilicifolius*) to 4.8X10^5 cfu/ml/0.1gm of rhizhosphere soil (for *Rhizhophora mucronata*) (Table 1). The pneumatophore soil samples the count ranged from 1X10^{10} cfu/ml/0.1gm of pneumatophore soil (for *Garcinia* species) to 6.8 X10^9 cfu/ml/0.1gm of pneumatophore soil (for *Rhizhophora mucronata*). The count for phosphate solubilizers ranged from 1.04X10^5 cfu/ml/0.1gm of rhizhosphere soil (for *Sonneratia* species) to 6.92X10^8 cfu/ml/0.1gm of rhizhosphere soil (for *Rhizhophora mucronata*). While the count of phosphate solubilizers for pneumatophores varied form 1.58X10^{11} cfu/ml/0.1gm of soil (for *Sonneratia* species) to 7.3X10^8 cfu/ml/0.1gm of soil (for *Acanthus ilicifolius*) (Table 2).

Sr. No.	Species	Rhizopsphere Soil (cfu/ml/0.1gm of soil)	Pneumatophore Soil (cfu/ml/0.1gm of soil)
1	*Rhizhophora mucronata*	$4.8X10^{5}$	$6.8\ X10^{9}$
2	*Rhizhophora apiculata*	$2.98\ X10^{8}$	$7X10^{9}$
3	*Avicennia* species	$1.9X10^{9}$	$1.6X10^{9}$
4	*Sonneratia* species	$3.5X10^{8}$	$1.02X10^{10}$
5	*Acanthus ilicifolius*	$1.55X10^{4}$	$3.1X10^{9}$
6	*Garcinia* species	$4.6X10^{7}$	$1.0X10^{10}$

Table 1: Viable Count for rhizhospehere and pneumatophore in soil samples.

Sr. No.	Species	Rhizopsphere Soil (cfu/ml/0.1gm of soil)	Pneumatophore Soil (cfu/ml/0.1gm of soil)
1	*Rhizhophora mucronata*	$3.04X10^{9}$	$2.53X10^{9}$
2	*Rhizhophora apiculata*	$4.3\ X10^{6}$	$2.16X10^{8}$
3	*Avicennia* species	$6.92X10^{8}$	$6.8X10^{4}$
4	*Sonneratia* species	$1.04X10^{5}$	$1.58X10^{11}$
5	*Acanthus ilicifolius*	$2.8X10^{9}$	$7.3X10^{8}$
6	*Garcinia* species	-	$5.76X10^{4}$

Table 2: Count for Phosphate Solubilizers for rhizhospehere and pneumatophore in soil samples.

Discussion

Mangroves provide a unique ecological niche to a variety of microorganisms [2]. About 125 species of microorganisms (bacteria, fungi and algae) have been identified [6]. The fertility of mangrove waters results from the microbial decomposition of organic matter and recycling of the nutrients. Bacteria exist as symbionts along with plant and animal species, saprophytes on dead organic matter and as parasites on living organisms. They perform variety of activities in mangrove ecosystems.

Next to nitrogen, phosphorus is a vital nutrient for plant and microorganisms and essential for their growth and propagation. The phosphate in the form of elemental phosphorus are immobilized in the living organisms and locked in the sediments as insoluble inorganic and organic phosphorus compounds. This form of phosphorus is held in the sediments for a long time and it remains excluded from recycling [5]. Based on this fact, it can be said that the phosphate solubilizing activity seems to be on the higher in the study area and seen in mangroves as well mangrove associates, indicating retention of phosphates in higher quantity in the sediments. On the other hand, one would expect the abundance of phosphobacteria in the mangrove sediment, as the tannin rich conditions in that sediment are unfavourable for the growth of bacteria. But here the conditions seems to be reverse, that is, the sediments may not be rich in tannins. Therefore a thorough study is necessary on the occurrence, distribution and activity of halophillic phosphobacteria from the mangrove environments.

Isolation of phosphate solubilizing bacteria has been reported by many researchers. Different strains of phosphate solubilizers like Azomonas (A15), and Enterobacter (A31 and A32) have been reported. These bacteria were found in the rhizosphere of mangrove forests which consist of *Avicennia* and *Rhizophora* mangroves. These bacteria are known to have the ability to increase the availability of phosphate in the soil. This ability is one of the capabilities of the potential growth of promoting bacteria (PGPR or Plant Growth Promoting Rhizobacteria) [6]. Though the mangrove systems are rich in microbial diversity, very less number of phosphate solubilizing species have been identified and reported. Research on these microorganisms with more emphasis on their molecular aspects will help in conservation of mangroves and act as potential biofertilizers [7].

Conclusion

The mangroves of Bhatye Estuary, Ratnagiri happen to be rich in biodiversity and also have potential for different phosphate solubilizing bacteria. However, further studies at molecular level are necessary to understand their role as biofertilizers which could also be beneficial in conservation of other plant species.

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