



Effect of oil spillage on ecological diversity of pneumatophore associated fauna and flora in central west coast of India

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Abstract: *Pneumatophores of Avicennia alba* is rich in flora (diatoms) and faunal (meiofauna) diversity from the sedimentary environment. Flora and faunal composition from two sites: one polluted (Dighodi) and other non-polluted (Goa) was also compared. The pneumatophores of Dighodi and Goa harboured 21 and 15 diatom genera respectively. In Goa, the Shannon Wiener's Diversity index (H') was 2.6 and 2.3 for sediment diatom community and pneumatophore diatom community respectively while in Dighodi, it was less i.e. 2.4 and 1.7 respectively. Centrale diatoms dominated in case of sediment while pennales dominated on the pneumatophore surface. In Goa, the diatom community was dominated by *Nitzschia* (1203 cells/ 1 cm^2) and *Coscinodiscus* (1876 cells/ 1 cm^2) for pneumatophore and sediment substratum respectively; but in Dighodi, the dominant diatom was *Navicula* (2951 cells/ 1 cm^2) and *Bacillaria* (1671 cells/ 1 cm^2) respectively. In contrast to pneumatophores, sediment diatom community showed some variations. The effect of oil pollution was clearly seen on both meiofauna and flora. In both cases reduction in number and diversity due to oil pollution were noticed. This preliminary investigation not only generated baseline data but also highlights the hidden biodiversity associated with pneumatophores.

Key words: Mangroves, Pneumatophores, Diatom, Meiofauna, Polluted, Non-polluted.

Introduction

In tropics, Mangrove ecosystem is the second most productive ecosystem after the coral reefs¹ (Ansari *et al.*, 1977). These forests are valuable ecosystems providing a variety of environmental goods and services and have high ecological, economical and cultural values. This ecosystem also plays an important role in the nutrient enrichment of coastal water and sustains coastal fisheries. However, global climate change integrated with anthropogenic activities pose a serious threat for the disappearance of mangrove forests and associated biota.

Mangrove ecosystem of India harbours 77% faunal and 23% floral species, being richest in the world (Sandilyan *et al.*, 2010). Microalgae and meiofauna both being important components of benthic food chain, transfer

energy to higher trophic levels sustaining mangrove food web. However, research on these two components is traditionally based on sedimentary environment. But studies suggested that mangrove roots or pneumatophores are a suitable substratum for the attachment of diatoms and meiofauna (Proches *et al.*, 2001).

Pneumatophores are the pencil like roots meant for aerial respiration through tiny pores called lenticels. Being an island in a matrix of soft sediment, it also supports rich flora and fauna. So the current investigation was intended to evaluate the diatom and meiofaunal community structure growing epibiotically on the surface of pneumatophores of *Avicennia alba* (Family: Acanthaceae) from a polluted and a non-polluted environment and to compare with that of sedimentary biotope.

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Materials and Methods

The current investigation was undertaken in a regular monitoring programme of Dighodi, Maharashtra (18°47'56.3" N/72° 52' 03.1" E) site which was severely affected by an oil spill (due to collision of MV Chitra with MV Khalija on 7.08.2010). Ten pneumatophores of *Avicennia alba* were cut from the base by a sharp knife. Simultaneously the upper 1 cm of sediment was collected by a plastic syringe of area 7.065 cm². For comparison purpose, pneumatophores (of the same plant) and sediment were collected from Chorao island, Goa (15°36'46.9"N/73°52'14.1"E) which is a protected environment. The meiofauna was separated by placing each pneumatophore in measuring cylinder, shaken vigorously with filtered water followed by decanting as described by Gwyther and Fairweather 2002. For area calculation, diameters were measured by vernier calipers on three regions per individual unit- one is the base diameter followed by middle diameter and then tip diameter and average value is taken. For separation of epiphytes from pneumatophores, the 5 cm² of surface area was scraped by a fine nylon brush into 0.2 µm membrane filtered seawater and fixed with Lugol's iodine. This a mixture of sediments, organic matter and epiphytes obtained. All the samples were cleaned by oxidizing organic matter using conc. sulphuric acid and potassium dichromate. One ml of sample was taken in a Sedgewick Rafter counting chamber and cells were counted under an inverted binocular microscope (Olympus BX 40) and identified up to genus level using available taxonomic keys (Heurck, 1896; Subrahmanyam, 1946; Desikachary *et al.* 1987; Tomas, 1997; Horner, 2002). The density of diatoms and meiofauna was expressed per 1 cm² and 10 cm² respectively. The univariate indices such as Shannon Wiener's Diversity Index (H'), species richness (d) and evenness (J) were calculated by using PRIMER 6 software.

Results and Discussion

The data suggests that mangrove

pneumatophores are a unique niche capable of harbouring a number of flora and fauna. Some time the pneumatophore associated diversity is significantly higher than its sediment counterpart. The details of diatom community are given in Table 1. The diatom community of Goa pneumatophores were represented by centricales, pennales, cyanophyceans and chlorophyceans. Pennale and central dominated (57%) the population. The dominant species at Goa was *Nitzschia sp.* (1203 cells/ 1 cm²) while at Dighodi, *Navicula sp.* was dominant (2951 cells/1 cm²) followed by *Pleurosigma sp.* (1521 cells/1 cm²). In contrast to pneumatophores, sediment diatom community showed some variations. At Goa, it was dominated by *Coscinodiscus sp.* (1876 cells/ 1 cm²), *Cyclotella sp.* (1628 cells/ 1 cm²) followed by pinnate *Nitzschia* (1257 cells/1 cm²), while at Dighodi, *Bacillaria* (1671 cells/1 cm²) was dominant. In case of Goa and Dighodi, centrics dominated in case of sediment contributing 54% and 13% respectively whereas in case of pneumatophores, pennates dominated contributing 69% and 95% respectively. For sediment diatoms, the H' was highest for Goa (2.6) and lowest for Dighodi (2.4). For pneumatophore diatoms, the highest and lowest value is 2.3 and 1.7 for Goa and Dighodi respectively. Chen *et al.*, (2010) reported 101 species under 40 genera of epiphytic diatoms from the roots of a Chinese mangrove *Kandelia candel.* Beltrones and fuerte, (2006) found 34 genera of diatoms from the roots of a Mexican mangrove *Rhizophora mangle.* The present study 21 and 15 genera of diatoms were recorded from the pneumatophores of *Avicennia alba* from Goa and Dighodi respectively. This low diversity of diatoms may be attributed to salinity or nutrients or anthropogenic stress. The role of host specificity also can not be ruled out. So to confirm the host-specificity hypothesis, future studies should focus on the exploration of epiphytic diatom flora from the roots of different mangrove plants in a fine grained taxonomy

approach. Indeed, this preliminary investigation not only will be a baseline data, but also highlights our lack of understanding of these assemblages.

Table 1. Relative abundance of diatoms from the sediment and pneumatophores of Goa and Dighodi

Taxa	Goa		Dighodi	
	Sediment	Pneumatophore	Sediment	Pneumatophore
<i>Centric diatoms</i>				
Actinoptychus	+	-	-	-
Asteromphalus	+	-	-	-
Bidduphia	++	+	+	-
Chaetoceros	+	-	-	-
Coscinodiscus	++++	++	+	-
Cyclotella	++++	++	+	-
Melosira	+++	++	++	++
Odontella	++	+	+	-
Paralia	++	-	-	-
Thalassiosira	++	++	+	+
<i>Pennate diatoms</i>				
Achnanthes	+	+	+	+++
Adoneis	++	-	-	-
Amphiprora	++	+	++	-
Amphora	++	+	++	+
Asterionellopsis	+	-	-	-
Bacillaria	+	++	++++	++
Colonies	+	+	-	+
Cocconeis	+	+	++	+
Cylindrotheca	-	-	+	-
Cymbella	+	-	-	-
Diatoma	++	-	+	-
Diplonies	+	+	++	+
Eunotia	+	-	-	-
Flagilaria	+	-	-	-

Flagilariopsis	++	-	+	++
Grammatophora	-	-	++	-
Gyrosigma	++	++	+	+
Haslea	+	+	+	-
Navicula	++	++	+++	+++++
Nitzschia	++++	++++	+++	+++
Pleurosigma	++	++	+	++++
Pseudo-nitzschia	+	-	++	-
Surirella	++	+	+	++
Synedropsis	++	+	+	-
Thalassionema	+	-	-	-
H'	2.6	2.3	2.4	1.7
d	3.5	2.2	2.7	1.4
J'	0.7	0.7	0.7	0.7

(-)Absent, (1-100) +, (100-500) ++, (500-1000) +++, (1000-2000) +++++, (>2000) ++++++

Table 2. Relative abundance of meiofauna from sediment and pneumatophores of Goa and Dighodi

Taxa	Goa		Dighodi	
	Sediment	Pneumatophore	Sediment	Pneumatophore
Nematoda	+++	+++	+++	++
Harpacticoida	+++	++	++++	+++
Rotifers	-	++	-	-
Tanaidacea	-	+	-	-
Halacarida	-	+	-	-
Oribatida	-	+	-	-
Uropodina	-	+	-	-
Amphipoda	-	+	-	-
Turbellaria	-	+	++	+
Diptera	-	+	-	-
Oligochaeta	++	++	+	-
Polychaeta	-	-	-	+
Unidentified sp.	-	-	-	+
H'	1.1	1.9	0.7	0.7
d	0.8	2.6	0.6	1.2
J'	0.8	0.8	0.5	0.4

(-)Absent, (0.1-3.0) +, (3.0-10.0) ++, (10.0-20.0) +++, (> 20.0) +++++

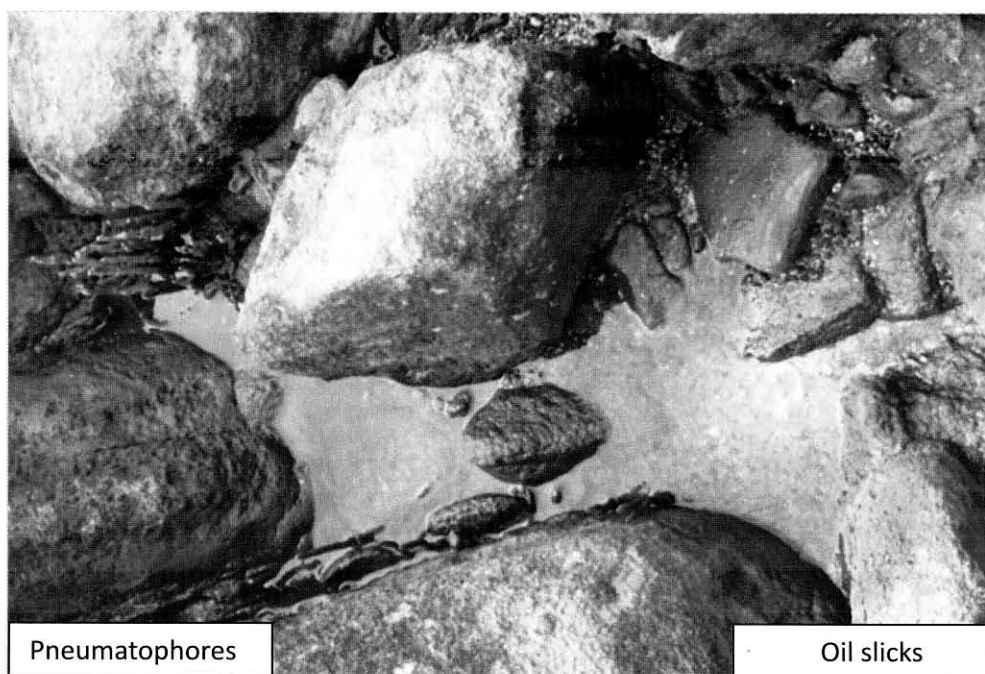


Fig. 1. Oil slicks detected near to mangrove pneumatophores during low tide at Dighodi, Maharashtra

The details of Meiofaunal community are given in Table 2. Meiofaunal community of Goa pneumatophores was dominated by nematodes (17 cells/ 10 cm²) followed by harpacticoids (8 / 10 cm²) while in case of Dighodi, the reverse trend was seen, i.e. harpacticoids (73 ind./10 cm²) dominated over nematodes (15 ind./10 cm²). For meiofauna H' was highest at Goa (1.9) and lowest at Mumbai (0.7). At Goa, pneumatophores were found to harbor 11 taxa out of which 7 taxa were not found in the sediments. But at Dighodi, five taxa were found on the pneumatophores and four on the sediments. This indicates their rich diversity over sediment. Meiofauna results were quite interesting. As there is no previous report on meiofauna, it is very difficult to compare our data.

In Goa, nematodes dominated in both sediments and pneumatophores contributing 45% and 39% respectively while in Dighodi, nematodes were replaced by harpacticoids contributing 77% and 73% respectively. The meiofauna of the polluted sediment had more

harpacticoid than nematodes. This study contradicts the earlier reports which showed that harpacticoids are generally more sensitive to oil pollution (Ansari and Ingole, 2002; Ingole *et al.*, 2006). Due to lack of PHC data on both sites and environmental factors, it is very difficult to conclude about their pollution tolerant nature. However future may should utilize a fine grained taxonomy and both field studies and laboratory experiments are needed to confirm that harpacticoids are also tolerant of oil pollution. Several authors through field studies and laboratory experiments confirmed that both diversity and abundance and growth of microalgae gets decreased due to oil pollution (Ansari *et al.*, 1997; Essien *et al.*, 2008) our study corroborated the same. This study unraveled the rich biodiversity existing on the surface of pneumatophores which are generally neglected. As these are cryptic species, so exploration of this biotope in a wider scale will bring to light new names of species and genera to the existing marine biodiversity. The oil pollution along the west coast of India has threatened many sensitive ecosystem, it is

imperative that mangrove ecosystem of India are saved from such oil spillage for its sustainable future and associated biodiversity.

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