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Marine-derived fungi of *Avicennia marina* var. *marina* of a mangrove stand

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ABSTRACT

Marine derived fungi were retrieved from living leaves (phyllosphere, phylloplane and endophytic niches), senescent and dead leaves of *Avicennia marina* var. *marina* from a mangrove stand near Marakkanam, Villupuram district, Tamil Nadu, East coast of India. In total 240 leaf bits each for phyllosphere, phylloplane and endophytic niches and 360 leaf bits each for senescent and dead leaves totaling 1440 leaf bits were processed. Totally, 64 morphologically identifiable fungal species belonging to 31 genera were encountered, while many non-sporulating morphotypes and producing only chlamydospores were also recorded. *Aspergillus* was the most speciose genus with 13 species followed by *Penicillium* and *Drechslera* (5), *Curvularia* (4), *Cladosporium* and *Alternaria* with 3 species were recorded. Of the 64 fungi only one fungus viz., *Nigrospora sphaerica* was recorded from all the niches i.e., phyllosphere, phylloplane, endophytic, senescent, dead leaves or soil samples. *A. flavus, A. niger, Curvularia* sp., *Alternaria* sp., were recorded in any 5 of the 6 niches. *A. fumigatus, A. glaucus, A. niger* 1, *Aspergillus* sp., *Curvularia lunata, Drechslera australiensis, Penicillium* sp. 1, *Trichoderma* sp. were recorded in any 4 out of the 6 niches. Seven fungi were common to any 3 niches. Twelve fungal species were common to any 2 niches. Thirty-two fungi were recorded only from any one of the 6 niches

Keywords: Diversity, Ecology, Marine fungi, Phyllosphere, Phylloplane, Leaf litter, Endophytes

INTRODUCTION

The importance of mangrove forest ecosystems and their relevance to humanity as against the human disturbances (such as reclamation for aquaculture, farming, residential and industrial development) have been raised through various publications (Ong, 1982, 1995; Untawale, 1987). The mangrove ecosystems continue to disappear due to shrimp culture, wood chip and pulp industry, urban development and human settlements and domestic uses for timber, firewood and fodder (Kathiresan and Rajendran, 2005). In addition to this destruction of mangroves due to tsunami (Roy and Krishnan, 2005) or regular cyclones in Bay of Bengal, an aspect that is getting aggravated due to human interference (Kathiresan and Rajendran, 2005). Hence it is necessary to enumerate microbial diversity in addition to floral and faunal diversity to be undertaken with high priority. The role of detritus organisms and the microbes depending on the mangroves have been highlighted (Jones and Alias, 1997) as any damage to this ecosystem also reflects on the loss of microbes. Among various organisms' fungi more than bacteria are known to play an important role in nutrient regeneration cycles maintaining C: N ratios (Fell and Master, 1980) and in the production of organic detritus that could feed large animal communities (Kohlmeyer and Kohlmeyer, 1979) including commercial fisheries where they act as breeding and nursery grounds (Jones and Alias, 1997). Maintenance of detrital-based food webs in the coastal environment depends on the availability of mangrove leaf litter (Odum and Heald, 1975; Ong *et al.,* 1984; Ashton *et al.,* 1999). Being productive ecosystems mangroves support a high abundance and rich diversity (Ong, 1995), which is suggestive of high leaf production, leaf fall and rapid breakdown of the detritus (Aksornkoae, 1986; Ashton *et al.,* 1999). In order to conserve and sustainably manage the mangrove ecosystem, it is necessary to understand the key processes or production and breakdown of mangrove litter (Ashton *et al.,* 1999).

Heald and Oldum (1969) and Odum and Heald (1972) determined the detritus production to be 3 metric tons (dry weight) per acre per year from mangrove leaf-fall alone in a South Florida estuary. According to these authors leaves are greater contributors to the food web than mangrove twigs, bark, and leaf scales and hence mangrove leaves as a source of detritus is of great interest to investigate the role of microorganisms in the breakdown of leaves (vide Kohlmeyer and Kohlmeyer, 1979). Exploitation of environmental resources is more efficient in diverse communities, which possess greater structural and functional versatility than individual species (Jolliffe, 1997; Ashton *et al.,* 1999). Further, a rich biodiversity would sustain the productivity and stabilize community performance under different environmental conditions (McNaughton, 1993). As leaf breakdown has been suggested to play a key role in ecosystem function, species richness of leaf litter may be important in determining the interrelationships between biodiversity and ecosystem properties (Wardle *et al.,* 1997; Ashton *et al.,* 1999). Considering the above facts, it is very important to understand the significance of the biodiversity of mangrove ecosystems for their function and stability (Ashton *et al.,* 1999). This is more so in the case of detrital organisms of which fungi have been considered to play a greater role in nutrient recycling than bacteria (Fell and Master, 1980).

Aerobiological studies in mangroves are negligible. The phyllosphere and phylloplane fungi have been enumerated in some studies (Newell, 1976; Kohlmeyer and Kohlmeyer, 1979). Similarly, the endophytic fungi have been studied considerably (Kumaresan and Suryanarayanan, 1998; Suryanarayanan and Kumaresan, 2002). The earliest studies in mangroves were on the soil fungal diversity (Kohlmeyer and Kohlmeyer, 1979). Similarly, some studies have been conducted on the litter degrading fungi in mangroves along with fungi colonizing the senescent leaves as part of the succession studies (Newell, 1976). However, all these niches i.e., phyllosphere, phylloplane, endophytic, senescent, dead leaves degrading and the soil fungi in one particular stand of a particular plant have not been attempted so far. Among different mangrove plants *Avicennia* is most diverse. Of the different species belonging to *Avicennia* the *Avicennia marina* has a small plant variety known as *Avicennia marina* var. *marina* which occurs in brackish waters or back waters. One such stand dominated only by the *Avicennia marina* var.

marina could be found near Marakkanam, Villupuram district of Tamil Nadu, along east coast of India. This particular stand has been taken up for the present study and all the niches mentioned above were sampled for fungal diversity. The results of this study are presented in this paper and discussed.

MATERIALS AND METHODS

Collection site and materials

A mangrove stand near Marakkanam, Villupuram district, Tamil Nadu, East coast of India (12.1869°N, 79.9279°E) that has only *Avicennia marina* var. *marina* has been chosen for the present study (Fig. 1). Fresh, senescent and decomposing leaves of *A. marina* var. *marina* and the soil samples surrounding this plant were collected during December 2012 and transported immediately to the laboratory and processed after reaching the laboratory (Fig.2).

Processing of plant leaf samples

Leaf bits of the size of 5 mm round discs were cut with the help of ethyl alcohol swap-sterilized punching machine and incubated on Potato Dextrose Agar (PDA) and Czapek-Dox Agar (CDA) media, amended either with sea water (SW) or distilled water (DW) added with appropriate antibiotics, either exposing the upper surface or lower surface of the leaf bits. The antibiotics consisted of 250 µg amoxicillin and 100 µg ciprofloxacin per ml of the medium. In each plate 5 leaf bits were placed and incubated. For each of living leaf niches (phyllosphere, phylloplane and endophytic) 240 leaf bits and 360 leaf bits each of senescent and dead leaves, totaling 1440, were processed. Similarly, the soil samples collected beneath the tree at three vertical levels by digging the soil near pneumatophores, rhizosphere and other surrounding areas were collected. The soil samples were collected from three different depths, namely, (i) 2cm, (ii) 10 cm, (iii) 30 cm and pooled up.

Inoculation

The living and senescent leaf bits were processed as follows: (i) Direct placement of the bits (phyllosphere type), (ii) after washing in the distilled water (phylloplane type), (iii) after treating with ethyl alcohol for 1 minute and then washing with distilled water (endophyte type). The dead leaves (leaf litter) were processed as follows: (i) after washing in the distilled water, (ii) after washing in ethyl alcohol for 1 minute and then washing with distilled water. Fungal strains growing on the agar media from 4th day onwards were retrieved and were examined after preparation of microslides followed by observation under light microscope for identification. 10g soil was mixed in 100 ml of sterile distilled water and stirred well. Serial dilutions followed by pour plate method was followed for isolation of fungi from soils. All the soil samples were diluted up to 10^3. Then 1ml of the diluted samples was transferred to sterile Petri dishes and then the appropriate agar media (PDA and CDA) were poured after adding antibiotics in a still molten condition of the agar media. Approximately 500 µg/ml of amoxicillin and 200 µg/ml of ciprofloxacin were added to the respective media used for isolation of the fungal cultures. The data of individual niches i.e. phyllosphere, phylloplane, endophytic, senescent and leaf litter and soil fungal samples were pooled up and presented in a master table.

Microscopy and identification

The colonies propping up with fungal propagules were picked up with a needle and transferred on to a microslide containing lactophenol or lactophenol + cotton blue and covered with a cover slip and sealed with DPX mountant. Then the slides were observed under a compound microscope for identification. Standard manuals and books were referred for identification including Ellis (1971, 1976) and Barnett and Hunter (1998) and Onions *et al.* (1981).

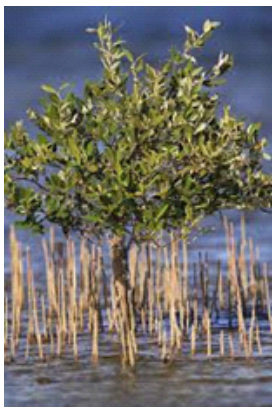

Fig. 1: A plant of *Avicennia marina*

Fig. 2: Leaf of *Avicennia marina*

RESULTS

A total of 219 fungal colonies from phyllosphere samples, 174 from phylloplane, 131 from endophytic, 390 from senescent, 344 from dead leaf and 148 from soil niches were isolated (Tables 1 & 2). A total of 64 identifiable fungal species belonging to 31 genera were encountered in addition to a large number of non-sporulating fungi only recognizable as morphotypes and others only producing chlamydospores thus making the colonies difficult to identify morphologically, were recorded. *Aspergillus* was the most speciose genus recorded with 13 species followed by *Penicillium* and *Drechslera* each with 5 species, *Curvularia* with 4 species, *Cladosporium* and *Alternaria* with 3 species were recorded with a greater number of species. In all, 20 identified fungal species belonging to 8 genera from phyllosphere, 19 species in 11 genera from phylloplane, 3 species in 2 genera from endophytic, 34 species in 15 genera from senescent and 25 species in 16 genera from dead leaf niches were recorded in addition to 36 species from 22 genera from soil samples (Table 1).

Phyllosphere fungi

Twenty identified fungal species belonging to 8 genera were recorded. Several of the other fungi recorded were sterile forms (14) and/or unidentified fungi (8) (Table 1). Most of the recorded species belonged to *Aspergillus* (6) followed by

Drechslera (4) and *Curvularia* (3). The percentage occurrence showed that *Aspergillus niger* was predominating. The other species of *Aspergillus* were rare in their occurrence. *Drechslera hawaiensis, Nigrospora sphaerica* and *Alternaria* sp. which are typical leaf litter degrading fungi have also been recorded in more numbers.

Phylloplane fungi

Totally 20 identified fungal species belonging to 12 genera were recorded. Several of the other fungi recorded were sterile forms (8) and/or unidentified fungi (8). Most of the recorded species belonged to *Aspergillus* (6) followed by *Drechslera* (3) and *Curvularia* (2). The percentage occurrence showed that *Aspergillus niger* was predominating (Table 1).

Endophytic fungi

Totally 20 endophytic fungi were isolated of which 3 were identified fungal species belonging to 2 genera. Several of the fungi recorded were sterile forms (10) and/or unidentified fungi (7) were also recorded. *Nigrospora sphaerica* was the most dominant species recorded in the present study followed far behind by *Aspergillus niger. N. sphaerica, A. niger* and a non-sporulating one (VVST18) were the most dominant among the endophytic isolates (Table 1).

Fungi on senescent leaves of *A. marina* var. *marina*

The processing of leaf bits of senescent leaves of *A. marina* var. *marina* yielded 34 identified fungal species (belonging to 15 fungal genera) and 27 non-sporulating fungi (morphotypes) from 360 leaf bits. Almost all non-sporulating fungi were recorded from leaf bits that were washed with alcohol (representing senescent endophytic fungi). In this experiment almost a fungus per leaf bit has been recorded on an average. Though a large number of species (62) have been recorded, it is interesting to note that almost half of them are non-sporulating. This could be due to the alcohol washing step, which promoted endophytic fungi from within the senescent leaves. The genus *Aspergillus* has been recorded with the highest number of species which is 10. This is followed by *Penicillium* (4), *Alternaria, Curvularia, Drechslera* (each with 3 species) and *Cladosporium* (2) (Table 1).

Fungi on dead and decomposing leaves of *A. marina* var. *marina*

In total 344 fungal colonies were recorded when dead and decomposing leaves of *A. marina* separated into 3 types based on stages of decomposition were processed for fungal isolation. These included 25 identified fungal species in 15 genera, 25 non-sporulating fungi and 2 unidentified fungi. This result is unusual because almost half of the fungi isolated were non-sporulating and the reason could be once again the usage of alcohol wash, which would have killed or washed the spores on the surface of dead leaves. Usually either direct examination method or particle filtration method are followed to retrieve the typical leaf litter degrading fungi; however, only leaf bits either washed with distilled water or alcohol were used. This may be the reason why a greater number of *Aspergillus* and *Penicillium* were recorded (Table 1).

Frequency of occurrence

Percentage of occurrence of each fungus was calculated based on the occurrence of individual fungus and the occurrence of all fungal species put to together divided by 100. Based on the percentage occurrence of different fungi the very frequent fungi were entered into the table 3. Among the phyllosphere fungi *Aspergillus niger* sp.2 (38.3%), *Aspergillus niger* sp.1 (7.3%), *Alternaria* sp. (7%), *Nigrospora sphaerica* (6.4%) were recorded with high percentage occurrence while non-sporulating morphotypes (10%) and Unidentified chlamydospores (6.4%) were also recorded. Similarly among phylloplane *Aspergillus niger* sp. 2 (51%), *Nigrospora sphaerica* (9.2%); among endophytic *Nigrospora sphaerica* (26.7%), *Aspergillus niger* sp.2 (23.7%); among senescent niche occupying fungi *Aspergillus niger* sp. 2 (19.4%), *Nigrospora sphaerica* (7.6%), *Alternaria* sp. (6.6%), *Drechslera australiensis* (3.7%) and finally from among leaf litter colonizing fungi *A. niger* sp.2 (28.4%), *Alternaria* sp. (12.7%), *Curvularia* sp. (4.6%), *Nigrospora sphaerica* (2.9%) were recorded with more percentage occurrence (Table 3).

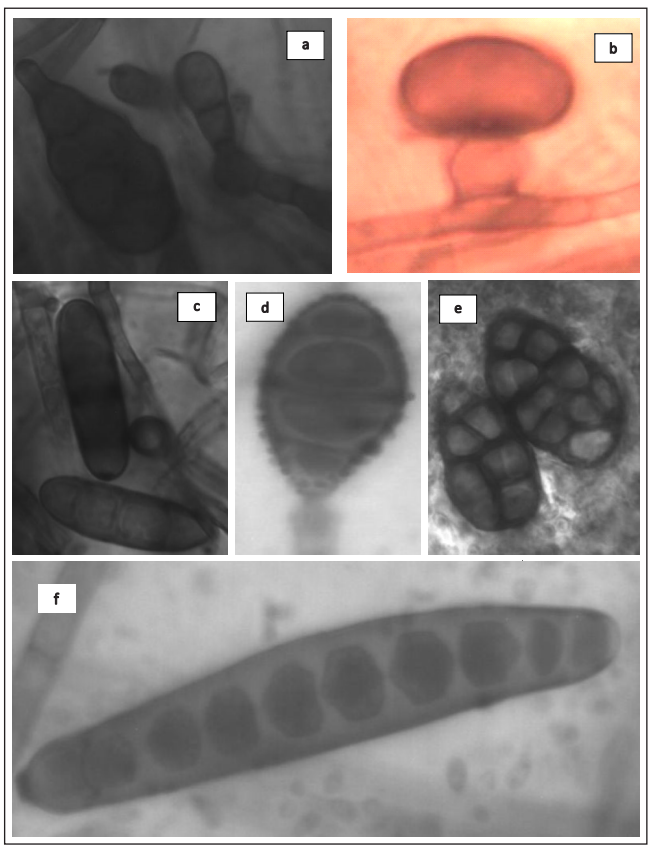

Fig. 3: a. *Alternaria alternata,* b. *Nigrospora sphaerica*, c. *Drechslera* sp., d. *Curvularia tuberculata,* d. *Alternaria* sp., e. *Drechslera australiensis*

In this study totally six niches were studied for fungal diversity including phyllosphere, phylloplane, endophytic, senescent, leaf litter and soil samples. Very few fungi occurred in most of the niches. Of the 64 fungi, only

Nigrospora sphaerica was recorded from all the niches i.e., phyllosphere, phylloplane, endophytic, senescent, dead leaves or soil samples. *A. flavus, A. niger, Curvularia* sp., *Alternaria* sp., were recorded in any 5 of the 6 niches. *A. fumigatus, A. glaucus, A. niger* 1, *Aspergillus* sp., *Curvularia lunata, Drechslera australiensis, Penicillium* sp. 1,

Table 1: List of fungi isolated from different niches of *Avicennia marina* var. *marina* mangrove stand at Marakkanam, Villupuram district Tamil Nadu, India

S.No.	Name of the species	Phyllosphere	Phylloplane	Endophytic	Senescent	Leaf Litter	Soils*	No. of Niches
1	*Acremonium* sp.1	-	1 (0.6%)	-	-	-	2 (1.4%)	2
2	*Acremonium* sp.1	-	-	-	-	-	1 (0.7%)	1
3	*Alternaria alternata*	-	-	-	1 (0.3%)	3 (0.9%)	-	2
4	*Alternaria verruciformis*	-	-	-	1 (0.3%)	-	-	1
5	*Alternaria* sp.	15 (7.0%)	4 (2.3%)	-	26 (6.6%)	44 (12.7%)	3 (2.1%)	5
6	*Arthrinium* sp.	-	-	-	-	-	1 (0.7%)	1
7	*Aspergillus candidus*	1 (0.5%)	-	-	-	-	-	1
8	*A. clavatus*	-	-	-	-	-	1 (0.7%)	1
9	*A. flavipes*	-	-	-	4 (1.0%)	3 (0.9%)	4 (2.8%)	3
10	*A. flavus*	10 (4.5%)	2 (1.1%)	-	7 (1.7%)	4 (1.2%)	7 (4.9%)	5
11	*A. fumigatus*	1 (0.5%)	3 (1.7%)	-	1 (0.3%)	-	5 (3.5%)	4
12	*A. glaucus*	1 (0.5%)	1 (0.6%)	-	1 (0.3%)	-	2 (1.4%)	4
13	*A. japonicus*	-	-	-	1 (0.3%)	8 (2.3%)	-	2
14	*A. nidulans*	-	-	-	1 (0.3%)	-	1 (0.7%)	2
15	*A. niger* 1	16 (7.3%)	3 (1.7%)	4 (3.0%)	-	-	9 (6.3%)	4
16	*A. niger* 2	84 (38.3%)	89 (51%)	31 (23.7%)	76 (19.4%)	98 (28.4%)	-	5
17	*A. restrictus*	-	-	-	1 (0.3%)	-	-	1
19	*A. terreus*	-	-	-	2 (0.5%)	-	7 (4.9%)	2
20	*A. versicolor*	1 (0.5%)						1
21	*Aspergillus* sp.	-	1 (0.6%)	-	3 (0.8%)	2 (0.6%)	11 (7.7%)	4
22	*Aureobasidium pullulans*	1 (0.5%)	-	-	-	-	-	1
23	*Bispora* sp.-like				1 (0.3%)	1 (0.3%)	1 (0.7%)	3
24	*Botryodiplodia theobromae*	-	-	-	2 (0.5%)	-	-	1
25	*Botrytis cinerea*	-	-	-	1 (0.3%)	1 (0.3%)	1 (0.7%)	3
26	*Cladosporium cladosporioides*	-	-	-	4 (1.0%)	-	-	1
27	*Cladosporium herbarum*	-	-	-	-	1 (0.3%)	-	1
28	*Cladosporium* sp.	-	-	-	4 (1.0%)	4 (1.2%)	13 (9.1%)	3
29	*Cladophora* sp.	-	-	-	-	1 (0.3%)	-	1
30	*Cunninghamella elegans*	-	-	-	1 (0.3%)	-	-	1
31	*Curvularia eragostridis*	-	-	-	1 (0.3%)	-	-	1
32	*Curvurlaria lunata*	4 (1.8%)	1 (0.6%)	-	3 (0.8%)	2 (0.6%)	-	4
33	*Curvularia tuberculata*	4 (1.8%)		-	1 (0.3%)	-	-	2
34	*Curvularia* sp.	4 (1.8%)	3 (1.7%)	-	13 (3.4%)	16 (4.6%)	1 (0.7%)	5
35	*Deightoniella* sp.			-	-	-	1 (0.7%)	1

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36	*Drechslera australiensis*	11 (5.0%)	5 (2.9%)	-	14 (3.7%)	8 (2.3%)		4
37	*Drechslera erythrospila*	1 (0.5%)		-	-	-	-	1
38	*Drechslera hawaiensis*	8 (3.7%)	2 (1.1%)	-	2 (0.5%)	-	-	3
39	*Drechslera papendorfii*			-		1 (0.3%)	1 (0.7%)	2
40	*Drechslera* sp.	2 (0.9%)	3 (1.7%)	-	2.5%	7 (2.0%)	1 (0.7%)	5
41	*Erythrospora* sp.	-	-	-		1 (0.3%)		1
42	*Fusarium* sp.	-	-	-	5 (1.3%)	5 (1.5%)	11 (7.7%)	3
43	*Monascus* sp.-like	-	-	-	-	-	1 (0.7%)	1
44	*Memnoniella echinata*	-	1 (0.6%)	-	-	-		1
45	*Monilia* sp.	-	-	-	-	-	2 (1.4%)	1
46	*Mucor* sp.1	-	-	-	6 (1.5%)	5 (1.5%)	3 (2.1%)	3
47	*Mucor* sp.2	-	-	-		5 (1.5%)	1 (0.7%)	2
48	*Nigrospora spaherica*	14 (6.4%)	16 (9.2%)	35 (26.7%)	30 (7.6%)	10 (2.9%)	2 (1.4%)	6
49	*Penicillium candidus*	1 (0.5%)	-	-	-	-		1
50	*Penicillium citrinum*	-	-	-	1 (0.3%)	-	2 (1.4%)	2
51	*Penicillium oxalicum*	3 (1.4%)	-	-	5 (1.3%)	-		2
52	*Penicillium thomii*	-	-	-	1 (0.3%)	-	2 (1.4%)	2
53	*Penicillium* sp.1	-	1 (0.6%)	-	6 (1.5%)	5 (1.5%)	2 (1.4%)	4
54	*Penicillium* sp.2	-	-	-	-	-	3 (2.1%)	1
55	*Periconia* sp.	-	1 (0.6%)	-	-	-	-	1
56	*Pithomyces quadratus*	-	-	-	1 (0.3%)	-	-	1
57	*Pithomyces* sp.	-	2 (1.1%)	-	-	4 (1.2%)	-	2
58	*Scolecobasidium* sp.	-	-	-	-	1 (0.3%)	-	1
59	*Sporotrichum* sp.	-	-	-	-	-	3 (2.1%)	1
60	*Sporothrix* sp.	-	-	-	-	-	1 (0.7%)	1
61	*Trichoderma* sp.	1 (0.5%)	2 (1.1%)	-	13 (3.4%)	-	1 (0.7%)	4
62	*Trimmatostroma* sp.	-	-	-	-	-	2 (1.4%)	1
63	*Zalerion varium*	-	-	-	-	-	1 (0.7%)	1
64	*Zygosporium* sp.	-	-	-	-	-	2 (1.4%)	1
	Non-sporulating colonies (morphotyes)	22 (10%)	5 (2.9%)	52 (40.0%)	151 (38.7%)	82 (23.8%)	11 (7.7%)	
	Total number of identified fungi	20	19	3	34	25	36	

Numbers in parenthesis indicate the percentage occurrence of each fungus in a particular niche.

*The data is pooled up for fungi isolated from (i) soil samples in the vicinity, (ii) surrounding pneumatophore and (iii) roots (rhisozosphere).

**Totally 108 were plated on to agar media including 36 for Normal soil, 36 for pneumatophore attached soil and; 36 for rhizosphere soil samples after making serial dilutions to 10-3.

Trichoderma sp. were recorded in any 4 out of the 6 niches. Seven fungi were common to any 3 niches. Twelve fungal species were common to any 2 niches. Thirty-two fungi were recorded only from any one of the 6 niches (Table 1)

Table 3: Very frequent fungi in each of the niches

	Niche	Total no. of identified fungi(Genera/ species)	Very frequent fungi
1	Phyllosphere	8/20	*Aspergillus niger* 2 (38.3%) Non-sporulating morphotypes (10%) *Aspergillus niger* 1 (7.3%) *Alternaria* sp. (7%) *Nigrospora sphaerica* (6.4%) Unidentified chlamydospores (6.4%)
2	Phylloplane	11/19	*Aspergillus niger* 2 (51%) Non-sporlating Morphotypes (17.8%) *Nigrospora sphaerica* (9.2%) Unidentified chlamydospores (4.6%) *Drechslera australiensis* (2.9%) *Alternaria* sp. (2.3%)
3	Endophytic	2/3	Non-sporulating (40%) *Nigrospora sphaerica* (26.7%) *Aspergillus niger* 2 (23.7%) Unidentified (6.9%) *Aspergillus niger* 1 (3%)
4	Senescent	15/34	Non-sporulating (38.7%) *Aspergillus niger* 2 (19.4%) *Nigrospora sphaerica* (7.6%) *Alternaria* sp. (6.6%) *Drechslera australiensis* (3.7%) *Curvularia* sp. (3.4%) *Trichoderma* sp. (3.4%)
5	Leaf litter	16/25	*Aspergillus niger* (28.4%) Non-sporulating (23.8%) *Alternaria* sp. (12.7%) *Curvularia* sp. (4.6%) *Nigrospora sphaerica* (2.9%) Unidentified (2.9%)
6	Soils	22/36	*A. flavus* (4.9%) *A. niger* (6.3%) *A. terreus* (6.3%) *Aspergillus* sp. (7.7%) *Cladosporium* sp. (9.1%) *Fusarium* sp. (7.7%) Non sporulating (7.7%)

DISCUSSION

In any study a few species may shape the fungal communities on any particular host or site. In the present study we found that *Nigrospora sphaerica* and *Aspergillus niger* sp.2 were not only recorded in all or almost all the niches studied but also these two were recorded with high percentage occurrence. Hence these two fungi could be inferred as having higher ecological amplitudes.

The fungi recorded in the present study are commonly encountered in terrestrial environments, unlike typical marine fungi which occur only on marine substrata, they can still be called as 'marine derived fungi'. Though the present mangrove stand is also exposed to salt water through the brackish water system none of the true marine fungi could be isolated. It thus shows that direct examination method of the fallen dead and decomposing woody substrata alone would lead to retrieving the typical marine fungi (lignicolous marine fungi). However, the interest and bias on marine fungi often neglects the terrestrial mycota in mangrove. Hence, an attempt has been made here to isolate the marine derived fungi through culture-based studies. However, the examination of decaying samples of leaves and twigs under direct examination method did not yield many fungi including marine fungi (personal observation of the first author). Not many typical marine fungi have been reported from this host i.e. *A. marina* var. *marina* (Figure 1 & 2). While the tree species, *A. marina,* supports a large number of marine fungi (Sarma and Vittal, 2001), the shrub variety *A. marina* var. *marina* does not. Further, many isolates were either non-sporulating ones or produce only chlamydospores and hence difficult to identify at microscopic level.

Culture-based studies of mangrove sediments, muds and soils, leaf litter samples, phyllosphere and phylloplane samples normally yield species belonging to common genera found in terrestrial environments. Their identification up to species level is often difficult. Out of the 64 species recorded only 35 could be identified up to special level while many others were up to generic level.

Out of 64 fungi 25 were recorded from soils. Of these 13 are common to one or two or more of the other niches of the plant. Only 12 fungi exclusively found in the soils beneath the A. marina var. marina stand. This shows that half of the soils have air borne fungi as source while the remaining seem to be run offs from the riverine or back water systems.

Of the 6 niches processed in the present study for the fungal diversity, the senescent leaves showed a higher diversity than other niches including the litter samples.

Among the different niches investigated in the present study, fungi isolated from only the soil and leaf litter samples could be considered as marine while all others could be considered as terrestrial, even though they are normally encountered in the terrestrial environments. One of the criteria that has been given to recognize a fungus as marine is its frequent occurrence (higher percentage occurrence) in the marine environment exposed to sea water (Pang *et al.,* 2016).

In the present study the following taxa were the core group fungi of the soils beneath the *A. marina* var *marina* stand: *A. niger* (6.3%), *A. terreus* (6.3%), *Aspergillus* sp. (7.7%), *Cladosporium* sp. (9.1%), *Fusarium* sp. (7.7%), *A. flavus* (4.9%). Some of these fungi were also found to be the core group fungi in other studies also. For example, at Kothapalem mangroves of Krishna delta mangroves, near Repalle, Guntur district, Andhra Pradesh, *A. terreus, A. niger, Penicillium funiculosum, Trichoderma* sp. and *P. citrinum* were the core group fungi, while *A. niger, A. terreus, A. japonicus* and *Trichoderma* sp. were the core group fungi at Coringa mangroves, Near Kakinada, East Godavary district, Andhra Pradesh, India (Sarma and Vittal, 2007).

CONCLUSION

Since a direct examination method for leaf litter fungi or the particle filtration study of leaf litter fungi were not followed in

this study and hence it could be surmised that this study is not still exhaustive to get a complete picture about the mycota on this plant. But, still, a large number of fungi could be recorded from the different leaf niches of *A. marina* that have been processed and analyzed for fungal diversity in this study.

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