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Research Article

Biodiversity of Fungi in Marine and Mangrove Ecosystem of East Coast of Tamil Nadu, India

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Abstract

The study area comprises a stretch of 16 kilometers in the coastal region of Thiruvarur, Pudukkottai and Ramanathapuram districts which were selected for present study. Totally 11 sampling stations were selected based on the richness of natural substrates availability. Water and Sediment samples were collected from the surface layer in each sampling stations Isolation of fungi from water and sediment samples by plating technique using selective media. The semi permanent slides for the fungi isolated were prepared using Lactophenol Cotton Blue Staining method. Totally, 85 species of fungi were isolated by plating and baiting techniques, identified, enumerated and arranged according to the classification of Hendrick, B (1992) of which out of 85 species, 65 terrestrial species and 20 marine fungi were identified. Among the all the 11 sampling stations, Maximum 49 species were represented in S7. In this study, totally 60 species of fungi were isolated and enumerated from the sediment samples, 44 species, of fungi were isolated from the water samples. Among the fungal isolates, species of *Aspergillus* were seem to be dominant members of this marine and mangrove eco-system followed by *Penicillium*, *Rhizopus* and *Curvularia.*

Keywords: Marine fungi; Isolation of fungi; Physico-chemical parameters; Species Diversity.

Introduction

Biological diversity refers the variability among living organisms from all sources including terrestrial, marine and other aquatic ecosystem and ecological complexes of which they are part. Biodiversity encompasses all life forms, ecosystems and ecological processes and acknowledges the hierarchy at genetic, taxon and ecosystem level. The essential ingredients of biodiversity are phenotypic flexibility genetic variation within populations and ecotypic variations (Ananthakrishnan, 1997).

Microbial biodiversity can be viewed from a variety of perspectives, including physiological diversity, interaspecific genetic diversity and phylogenetic diversity of species and higher taxa (Delong, 1997). Microbial diversity represents the largest untapped reservoir of biodiversity for potential discovery of new biotechnological products, including new pharmaceuticals, new enzymes, new special chemicals or new organisms that carryout novel process (Jensen and Fenical, 1994). Quantitative

data on the occurrence of tropical marine fungi have been published by Koch (1986); Kohlmeyer (1984); Zainal and Jones (1984, 1986). However all of these reports were on driftwood in the sea, along with driftwood on the mangrove floor or panels belonging to various timbers submerged near jetties.

Marine fungi have the ability to grow at certain seawater concentrations (Johnson and Sparrow, 1961; Tubaki, 1969). It has been shown that marine fungi cannot be defined strictly on a physiological basis whereas, a broad ecological definition names that the marine fungi of obligate types are those that grow and sporulate exclusively in a marine and estuarine habitat. Facultative forms are those from fresh water or terrestrial milieus able to grow in the marine environment (Kohlmeyer, 1974).

While viewing into the role of fungi in the marine ecosystem marine fungi are the important intermediaries of energy flow from detritus to higher tropic levels in the marine ecosystem. They require seawater for the completion of their life cycle. About 50,000 fungal species are known from terrestrial habitats (Ainsworth, 1968), but in contrast, less than 500 species have been described from oceans and estuaries, which cover a much larger area, namely 3 quarters of the world. The higher filamentous marine fungi include, 209 species, the marine occurring yeasts comprise 177 species and the cover marine fungi comprise probably less than 100 species. The oceans, compared to the landmasses, provide stable environments with little change in temperatures and salinities, organic substrates concentrated mostly along the shores, where they provide nutrients for the occurrence of fungi. The open sea is a fungal desert where only yeasts or lower fungi may be found attached to planktonic organisms or pelagic animals. The higher marine fungi occur as parasites on plants and animals or as symbionts in marine lichens and algae.

The higher marine mycota or manglicolous fungi which occur on submerged parts of mangroves include 42 species, and are the fourth largest ecological group after the wood, salt-marsh, and algae – inhabiting species. These mangrove fungi are almost exclusively saprobes and belong to the family Ascomycetes, Deuteromycetes, and Basidiomycetes. The majority of manglicolous marine fungi are omnivorous and occur mostly on dead cellulosic substrates all around the tropics (Kohlmeyer and Kohlmeyer, 1979). According to Chowdhery (1975) the mangrove isolates or the marine fungi have higher osmotic optima as compared to their fertile soil counter parts. In mangrove swamps, the microbial life has to withstand high salinity and fungi found in this habitat show a high degree of osmotic tolerance and increased salinity optima.

Based on the necessary basic information obtained on marine fungi ecosystem, the present study has been undertaken in the proposed study area in Thiruvarur, Pudukkottai and Ramanathapuram districts, a coastal deltaic habitat along the East coast of Palk Strait, in Bay of Bengal in Tamil Nadu, India.

Materials and Methods

Study area

The study area comprises a stretch of 16 kilometers in the coastal region of Thiruvarur, Pudukkottai and Ramanathapuram districts which were selected for present study. Totally 11 sampling stations were selected based on the richness of natural substrates availability. The 11 sampling stations are as follows;Muthupettai (S1), Iyampattinam (S2), Kumarapattinam (S3), Gopalapattinam (S4), R.Pudupattinam (S5), Arasangaripattinam (S6), Muthukuda (S7), Sethadimunai (S8), Sundrapandiapattinam (S9), Pasipattinam (S10) and Therthandathanam (S11).

Collection Water and sediment

Water and Sediment samples were collected from the surface layer in each sampling stations. The sediment samples were collected manually wearing hand gloves then transferred to sterile polythene bags and sealed properly.

Isolation of fungi from water and sediment samples by plating technique

Water samples

After sampling, within 24 hrs the water samples from each station were subjected to appropriate dilutions (10^{-2} to10^{-5}) and 0.1 ml of sample was aseptically transferred into the plates containing Potato dextrose agar/ Czapek dox agar/Corn meal agar/Rose Bengal agar with addition of mixture antibiotics, Tetracycline and Penicillin (Spread plate method) The plates were incubated at room temperature (28°C) for 4-5 days (Plate. 2a). Control plates were also maintained. Sterilization of glasswares and preparations of media were carried out as per the method described by Booth (1971).

Sediment sample

One gram of the sediment weighed and then dissolved with 99 ml of sterile seawater and then subjected to dilution series as done for water samples. 0.1 ml of the samples was directly inoculated onto medium containing plates and incubated in the incubation chamber at 28ºC for further observation. In this technique, 10^{-2} to 10^{-5} dilutions were prepared and taken into account for plating .

Isolation of mycoflora by membrane filtration techniqe

Through nitrocellulose membrane filter disc of 0.45 μm pore size (Sartorius) 100 ml of the sediment mixed sterile sea water samples were filtered using membrane filtration unit. Then the discs were transferred aseptically into agar plates (Corn meal agar and Czapek dox agar) and incubated in room temperature at 28°C with appropriate control plates for further observation (Vrijmoed, 2000).

Isolation for fungi from natural substrates employing plating technique

Wood substrates

The naturally occurring different wood substrates such as, Driftwood, and intertidal woods found in the sandy beach were collected in sterile polythene bags and brought to the laboratory for further processing. In the laboratory the surface fouling organisms were gently scraped off and washed off by exposing under running tap water and the samples were again washed with sterile seawater. Then wood samples were cut into small pieces with different sizes and again washed with sterile seawater and allowed to drain for 1 hour to remove excess surface waters. (Vrijmoed, 2000). The samples were kept at 4˚C for further use (Kohlmeyer and Kohlmeyer, 1979). The wood samples were placed aseptically on surface of the agar media in the petriplates such as, sabourard's dextrose agar, corn meal agar and czapek dox agar. The plates were as usually incubated at 28-30^{o}C for 4-5 days and observed the occurrence of fungal colonies

Mangrove plant root samples

The normal negatively geotropic respiratory roots (pneumatophores) of *Avicennia marina* (Forsk.) Vireh. and prop roots of *Rhizophora mucronata* L., were also collected in polythene bags and washed with sterile seawater in the laboratory to remove the sediment and adhering particles. The washed root samples were cut into small pieces and placed on the surface of sterile agar medium in the petriplates with Sabouraud's dextrose agar and Corn meal agar. All plates were incubated at 28°C to observe the development of fungal colonies.

Mangrove plant leaves

In addition to root samples, fresh and decomposed leaves of mangrove plant species *Avicennia marina*, *Excoecaria agallocha* and *Rhizophora mucronata* were also collected, washed thoroughly twice with sterile sea water to remove the debris and cut into small pieces, preferably the infected portion of the leaves (up to 1 cm) was then transferred to agar containing plates incorporated with antibiotics. The plates were incubated at 28˚C (room temperature) and observed for the development of fungal colonies.

Isolation of fungi from natural substrates by Baiting technique

The collected specimens of the wood samples were used for the isolation of mycoflora using sterile polythene bags. All these individual specimens were kept in sterile polythene bags and aerosal was created inside the bags by spraying with sterile seawater. The bags were tightly covered and kept under illumination and subsequent transferred to dark conditions during the entire study periods to observe the colonization of fungi on these different natural substrates.

All the plant baits were regularly observed under aseptic condition using stereoscopic Dissection Microscope under 2X and 4X magnification. The fungal spores observed on the natural substrates (baits) along with hyphae were picked up using sterile fine forces or sharp Nichrome wire mounted on needle holder then these were transferred to agar containing plates to ensure with the germination of the spores and development on the agar media employed.

Isolation of fungi

The incubated plates were observed for the development of fungi from 3rd day onwards. The number of colonies in each plates was counted and compared with control. The data obtained were used for calculating the frequency of occurrence. In addition to this, cultural characters of the colonies [color and structure] were also observed and fungi were enumerated. The natural baits kept in the plates were observed directly under the Stereoscopic Binocular dissection Microscope from 5th day onwards. All the isolated fungal cultures were sub cultured in test tubes containing agar medium and fungal culture collection being maintained in the department.

Presentation of data

The semi permanent slides of the isolated fungi were prepared using Lactophenol Cotton Blue Staining method (Dring, 1976**)** and sealed with DPX mountant. The fungal species were photographed using photo micrographic instrument (Nikon AFX II Microscope fitted with Nikon FX-35 camera, Tokyo, Japan).

Identification of fungi

The identification of fungal taxa was based on Hyphomycetes **(**Subramanian, 1971), Dematiaceous Hyphomycetes and More Dematiaceous Hyphomycetes (Ellis, 1971, 1976), Marine Mycology (Kohlmeyer and Kohlmeyer, 1979), Micro fungi on land plants (Ellis and Ellis, 1985) Micro fungi on Miscellaneous substrate (Ellis and Ellis, 1988), Illustrated key to the filamentous higher marine fungi (Kohlmeyer and Volkman - Kohlmeyer, 1991) and Manual of soil fungi (Gilman, 1957, 1998).

Enumeration of fungi

The distribution of fungal taxa was listed out and the nomenclature followed is based on the fungi: Fifth kingdom: (**Kendrick,** 1992). Each taxon is briefly described by its bionomical followed by morphology (diagnostic features).

Physico – chemical analyses of water and sediment samples

The water and sediment sample were collected separately and analysed for temperature, pH, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), salinity, alkalinity, on water (Venugopalan and Paulpandian,1989; Aneja, 2001; APHA, 1998; and pH, Alkalinity, Total carbon, Total organic matter, salt concentration, were also analyzed on sediment samples.

Quantitative analysis

At the end of one year, the percentage of frequency of occurrence of fungi, density, abundance were determined based on the number of stations from which the particular fungi was isolated and the total number of fungal isolation.

$$\text{Frequency of occurrence} = \frac{\text{Number of sampling stations where the species occurred}}{\text{Total number of sampling stations studied}} \times 100$$

$$\text{Density} = \frac{\text{Total number of individuals of the species}}{\text{Total number of sampling stations studied}} \times 100$$

$$\text{Abundance} = \frac{\text{Total number of individuals of the species}}{\text{Number of sampling stations in which the species occurred}} \times 100$$

Species richness, diversity, evenness and Similarity indices of fungi

The diversity of fungi in the mangrove samples of 11 sampling stations were assessed on the basis of diversity indices,

$$\text{Simpson index } D' = \frac{1}{\sum (pi)^2},$$

and

$$\text{Shannon index, } H' = -\sum (p_i \ln p_i),$$

Where *pi* is the proportion of individuals of that species; *i* contribute to the total (Magurran, 1988).

The Shannon Evenness, J′, was expressed by:

$$J' = \frac{H'}{H'_{max}}$$

Where *H′* mark is the maximum value of diversity for the number of species present (Pielou, 1975).

Results and Discussion

The results of study in marine ecosystem comprising of Thiruvarur, Pudukkottai and Ramanathapuram are presented and discussed under three sections, *viz*., Enumeration of taxa, Ecology of fungi.

Enumeration of taxa

The fungi belonging to different genera which were isolated by plating and baiting techniques were enumerated with morphological and ecological descriptions. The system of classification was based on **"The Fifth Kingdom – Mycota (ed.) Kendrick (1992)** for the arrangement of genera under their respective orders and families. The genera and species within each family are arranged in alphabetical order.

Ecology of fungi

This section deals with the ecology of fungi include Physico-chemical status of water and sediment samples with respect to fungal distribution, Species diversity fungi in the mangrove ecosystem, The ecology of fungi in a marine system depends on the various physical, chemical and biological factors of the water and sediment samples. In the present investigation, a study has been made on the distribution of fungi in relation to sampling stations, marine vegetation, frequency, and physico-chemical nature of the marine system.

Physico-chemical status of water and sediment samples with respect to fungal distribution

Physico-chemical status of water and sediment samples analysed for temperature, pH, biological oxygen demand (BOD), salinity, and total dissolved solids (TDS) of water and Salt Concentration (Kg/ach), Alkalinity (mg/l), Total Carbon (%), Total organic Matter (%) on Sediment samples were observed and recorded in all the four seasons. (Tables.1- 4).

Ecology of fungi

This section deals with the ecology of fungi under the following headings.

1. Species diversity fungi in the marine system.
2. Frequency of occurrence of fungi
3. Distribution of fungi in relation to woody substrates
4. Diversity indices of fungi

Species diversity of fungi in the marine system

During the study period, a total of 85 fungal species were enumerated from 11 sampling stations by plating and baiting techniques and also direct

Table 1. Details of physico-chemical parameters of water and sediment in 11 stations in post-monsoon.

Parameters	Mean (n=11)
Water samples	
Temperature (° C)	32.4±1.46
pH	7.73±0.16
Dissolved oxygen (mg/l)	12.32±0.51
Biological oxygen demand (mg/l)	4.44±0.44
Chemical oxygen demand (mg/l)	15.2±4.63
Alkalinity (mg/l)	35.96±4.86
Salinity (%)	53.25±4.06
Total dissolved solids (mg/l)	229±109.9
Sediment samples	
pH	7.72±0.37
Salt Concentration (Kg/ach)	5.53±3.81
Alkalinity (mg/l)	26±6.82
Total Carbon (%)	9.186±3.25
Total organic Matter (%)	15.83±5.61

Table 2. Details of physico-chemical parameters of water and sediment in 11stations in summer.

Parameters	Mean (n=11)
Water samples	
Temperature (°C)	33.2±1.12
pH	7.86±0.19
Dissolved oxygen (mg/l)	7.88±1.54
Biological oxygen demand (mg/l)	2.88±0.61
Chemical oxygen demand (mg/l)	28.32±4.62
Alkalinity (mg/l)	36.4±4.99
Salinity (%)	53.81±2.10
Total dissolved solids (mg/l)	303±55.64
Sediment samples	
pH	7.80±0.36
Salt concentration (Kg/ach)	7.6±5.62
Alkalinity (mg/l)	65.5±28.8
Total carbon (%)	10.48±3.05
Total organic matter (%)	16.48±5.83

Table 3. Details of physico-chemical parameters of water and sediment in 11 stations in pre monsoon.

Parameters	Mean (n=11)
Water samples	
Temperature (° C)	31.79±0.75
pH	7.65±0.24
Dissolved oxygen (mg/l)	11.70±1.08
Biological oxygen demand (mg/l)	4.22±1.36
Chemical oxygen demand (mg/l)	29.11±2.91
Alkalinity (mg/l)	40.63±5.90
Salinity (%)	52.53±2.06
Total dissolved solids (mg/l)	13.70±1.04
Sediment samples	
pH	7.88±0.03
Salt Concentration (Kg/ach)	3.306±1.81
Alkalinity (mg/l)	45±15.6
Total Carbon (%)	9.38±2.39
Total organic Matter (%)	16.18±4.13

Table 4. Details of physico-chemical parameters of water and sediment in 11 stations in monsoon.

Parameters	Mean (n=11)
Water samples	
Temperature (° C)	31.06±0.64
pH	7.57±0.25
Dissolved oxygen (mg/l)	15.94±1.15
Biological oxygen demand (mg/l)	4.93±0.86
Chemical oxygen demand (mg/l)	33.48±9.95
Alkalinity (mg/l)	38.71±7.93
Salinity (%)	45.66±4.62
Total dissolved solids (mg/l)	556.66±71.43
Sediment samples	
pH	7.45±0.65
Salt Concentration (Kg/ach)	4.45±4.72
Alkalinity (mg/l)	38.5±11.7
Total Carbon (%)	7.85±1.14
Total organic Matter (%)	13.58±1.97

observation techniques. Among these, 30 species were represented inS1, 31 in S2, 39 in S3, 33 in S4 and 24 in S5, 30 in S6, 40 in S7, 35 in S8, 20 in S9, 28 in S10,and 26 in S11.

Even though, the some of sediment samples in all sampling stations, the number of fungi common to all the sampling stations was 11 out of the total 85 fungal species recorded..Maximum fungal diversity was observed in S7 (40 species) and S3 (39 species).

Among the Hyphomycetes, *Aspergillus* was the common genus followed by *Penicillium* and *Curvularia*. In addition to this C*ladosporium*, *Neurospora crassa*, *Fusarium semitectum* were the common genera found in this marine system.
Out of the total 85 species isolated only, 20 were of typical marine lignicolous fungi isolated from wood samples while remaining 65 species were of from marine derived fungi migrated from terrestrial sources. It is to be noted that the marine fungi enumerated in this study were isolated exclusively from the wood samples by direct microscopic examination.

Occurrence of fungi in the marine water and sediment

Employing all the above said techniques, from the marine water samples, totally 44 fungi were isolated. In sediments samples also the genus *Aspergillus* was found to be dominant followed by *Penicillium* and *Curvularia*. From the marine sediment samples, totally 60fungi were isolated. In sediments samples also the genus *Aspergillus* was found to be dominant species, followed by *Penicillium* (Table 5).

With the above-presented results, while assessing the species diversity of fungi in the marine and sediments .The fungal genera, *Aspergillus, Penicillium, Curvularia,* were found to be dominant members and represented with the more species of this system. This is well agreed with the findings of Garg (1982), Rai and Choudhery (1978); Raper and Fennell (1965) and Roth *et al*.,(1964).According to their findings *Aspergilli* dominated over Mucorales and *Penicillia* in the mud of mangrove swamps of Sunderbans. Nicot (1958) recorded the dominate of *Aspergilli* and *Penicillia* in the coastal soils of France. Furthermore, Raper and Fennell (1965) have also suggested that certain non-osmophilic species of *Aspergillus* may grow luxuriantly under halophytic conditions. Although terrestrial fungi are found in coastal environments frequently as part of the spore population, only species adapted to saline environments appear to be able complete their life cycles fully in coastal and marine environments (Jennings, 1986). Sparrow (1934 and 1936) reported that the presence of *Aspergillus* and *Penicillium* species in the marine sediments.

Table 5. List of Fungi isolated from various samples collected in the study area.

S.No	Name of the fungi	Water	Sediment	Natural Substrate
1.	*Absidia sp.*	+	+	-
2.	*Mucor sp.*	+	+	-
3	*Rhizopus nigricans*	+	+	-
4.	*Rhizopus oryzaye*	+	+	+
5.	*Rhizopus stolinifer*	-	+	-
6.	*Neurospora crassa*	+	+	-
7.	*E. nidulans*	-	+	-
8.	*Dectyolopora sp.*	-	-	+
9.	*Massarina sp.1*	-	-	+
10.	*Massarina sp.2*	-	-	+
11.	*Leptosphaeria sp1*	-	-	+
12.	*Leptosphaeria sp 2*	-	-	+
13.	*Lulworthia sp*	-	-	+
14.	*Trimmatostroma sp.*	-	-	+
15.	*T.lineolastroma*	-	-	+
16.	*Veruclina enalina*	-	-	+
17.	*Aspergillus clavatus*	+	+	-
18.	*Aspergillus fumigatus*	+	+	-
19.	*A.funiculoss*	+	+	-
20.	*A. luchuensis*	+	+	-
21.	*A.nidulans*	+	+	-
22.	*Pleospora trichinicola*	-	-	+
23.	*A. flavus*	+	+	-
24.	*A.niger*	+	+	-
25.	*A.ochraceous*	+	+	+
26.	*A.oryzae*	+	+	-
27.	*A.quercinus*	+	+	+
28.	*A.sulphureus*	+	+	-
29.	*A.terrus*	+	+	-
30.	*A.ustus*	-	+	+
31.	*A.versicolor*	+	+	-
32.	*Penicillum citricum*	-	+	-
33.	*P.frequentans*	+	+	-
34.	*P.funiculosum*	+	+	-
35.	*P.rubrum*	+	+	-
36.	*P.jamthnellam*	+	+	-
37.	*Verticillium sp*	-	+	-
38.	*Citrenalia tropicali*	-	-	+
39.	*Alternaria brasicola*	+	+	-
40.	*A.cinereriae*	+	+	-
41.	*Cladosporium tennssimum*	+	+	+
42.	*C.uredinicola*	-	+	-
43.	*C.andripopogonsis*	+	+	-
44.	*Curvularia catnulata*	+	+	-
45.	*C.palmarrum*	+	+	-
46.	*C.lunata*	+	+	+
47.	*C.richardiae*	+	+	-
48.	*C.subulata*	-	+	-
49.	*Drecaslera sp.*	+	+	-
50.	*Fusarium semitectetum*	-	+	-
51.	*Ascochyta vulgaris*	-	+	-
52	*Ampullifernia fagi*	+	+	-

53	*Bidenticula cannae*	-	+	-
54	*Bipolaris tetramera*	+	+	-
55	*B. turcica*	-	+	-
56	*Cercospora beticola*	-	+	+
57	*Cercosporella gossypii*	-	+	+
58	*Cercosporidium heningsii*	-	+	-
59	*Cirrenalia tropicalis*	-	-	+
60	*Varicosporium ramulosa*	-	-	+
61	*Pleospora triglochinicola*	-	-	+
62	*Lignincola tropica*	-	-	+
63	*Drechslera. ellissi*	+	+	-
64	*D. indica*	+	+	-
65	*D. japonica*	+	+	-
66	*D. stenospila*	+	+	-
67	*D. teres*	+	+	-
68	*D. tripogonis*	-	+	-
69	*Drechslera avenacea*	+	+	-
70	*Corollospora maritima*	-	-	+
71	*Lulworthia grandispora*	-	-	+
72	*Exosporium* sp.	+	+	-
73	*Haplariopsis fagicola*	+	+	-
74	*Helminthosporium oryzae.*	+	+	+
75	*H. velutinum*	+	+	-
76	*Didymosphaeria lignomaris*	-	-	+
77	*Sporiodesmium salinum*	-	-	+
78	*Quintaria lignatilis*	-	-	+
79	*Melanomma fuscidulum*	-	+	+
80	*Monosporium flavum*	-	+	-
81	*Monotospora brevis*	-	+	-
82	*Nigrospora sphaerica*	+	+	+
83	*Periconia laminella*	-	+	-
84	*P. prolifica*	-	+	-
85.	*Bipolaris tetramera*	-	+	+

Table 6. Frequency of occurrence, Density, Abundances of Fungi isolated from various samples collected in the study area.

S.No	Name of the fungi	Frequency of occurrence (%)	Density	Abundances
1.	*Absidia sp.*	63.6	20	4.0
2.	*Mucor sp.*	36.3	10.9	2.5
3	*Rhizopus nigricans*	45.4	17.7	7.0
4.	*Rhizopus oryzaye*	63.6	19.9	5.5
5.	*Rhizopus stolinifer*	72.7	18.8	12.0
6.	*Neurospora crassa*	54.5	14.4	2.5
7.	*E. nidulans*	36.3	12.2	6.0
8.	*Dectyolopora sp.*	9.09	36.3	14.2
9.	*Massarina sp.1*	9.09	27.2	5.6
10.	*Massarina sp.2*	18.1	27.2	3.0
11.	*Leptosphaeriasp1*	9.09	45.45	19.2
12.	*Leptosphaeriasp 2*	9.09	45.4	6.0
13.	*Lulworthia sp*	9.09	45.4	20.6
14.	*Trimmatostroma*	9.09	27.2	26.8
15.	*T.lineolastroma*	9.09	18.18	7.75
16.	*Veruclina enalina*	18.18	18.18	21.8

17.	*Aspergillus clavatus*	72.7	26.6	17.4
18.	*Aspergillus fumigatus*	81.8	21.1	5.33
19.	*A.funiculoss*	36.3	100	9.0
20.	*A. luchuensis*	63.6	24.4	9.0
21.	*A.nidulans*	45.4	45.4	4.0
22.	*Pleospora trichinicola*	18.18	81.8	16.8
23.	*A. flavus*	90.9	27.7	17.0
24.	*A.niger*	54.5	24.5	32.2
25.	*A.ochraceous*	45.4	27.2	29.4
26.	*A.oryzae*	63.6	14.4	27.2
27.	*A.quercinus*	54.5	15.5	2.0
28.	*A.sulphureus*	45.4	100	15.0
29.	*A.terrus*	81.8	15.5	9.25
30.	*A.ustus*	72.7	36.3	5.0
31.	*A.versicolor*	81.8	90.9	16.0
32.	*Penicillum citricum*	72.7	28.8	2.0
33.	*P.frequentans*	54.5	25.5	19.2
34.	*P.funiculosum*	63.6	14.4	14.0
35.	*P.rubrum*	54.5	22.7	4.0
36.	*P.jamthnellam*	27.2	54.5	29.8
37.	*Verticillium sp*	36.3	54.5	11.8
38.	*Citrenalia tropicali*	18.1	90.9	13.0
39.	*Alternaria brasicola*	45.4	81.8	6.6
40.	*A.cinereriae*	72.7	20	10.8
41.	*Cladosporium tennssimum*	45.4	100	13.6
42.	*C.uredinicola*	45.4	18.1	3.4
43.	*C.andripopogonsis*	36.3	109	10.75
44.	*Curvularia catnulata*	36.3	17.7	14.0
45.	*C.palmarrum*	81.8	18.8	2.0
46.	*C.lunata*	9.09	45.4	3.0
47.	*C.richardiae*	9.09	45.4	4.0
48.	*C.subulata*	18.1	27.2	2.0
49.	*Drecaslera sp*	27.2	54.5	9.4
50.	*Fusarium semitectetum*	27.2	72.7	7.75
51.	*Ascochyta vulgaris*	27.2	45.4	4.0
52	*Ampullifernia* fagi.	9.09	54.54	9.75
53	*Bidenticula cannae*	36.36	12.27	9.33
54	*Bipolaris tetramera*	18.18	81.81	11.0
55	*B. turcica*	9.09	45.45	7.0
56	*Cercospora beticola*	9.09	45.45	6.6.
57	*Cercosporella gossypii*	9.09	36.36	3.0
58	*cercosporidium heningsii*	18.18	81.81	3.5
59	*Cirrenalia tropicalis*	54.54	16.36	6.0
60	*Varicosporium ramulosa*	18.18	45.45	4.0
61	*Pleospora triglochinicola*	63.63	17.72	10.4
62	*Lignincola tropica*	18.18	63.63	6.25
63	*D. ellissi*	36.36	19.09	4.0
64	*D. indica*	27.2	81.8	5.0
65	*D. japonica*	45.4	17.7	5.0
66	*D. stenospila*	27.2	81.8	3. 0
67	*D. teres*	18.1	81.8	3.0
68	*D. tripogonis*	27.2	81.8	2.5
69	*Drechslera avenacea*	18.1	63.6	2.5
70	*Corollospora maritime*	27.2	27.2	4.0
71	*Lulworthia grandispora*	18.1	54.5	3.0
72	*Exosporium* sp	9.09	54.5	9.33

73	*Haplariopsis fagicola*	9.09	27.2	5. 0
74	*Helminthosporium oryzae.*	18.1	54.5	5. 0
75	*H. velutinum*	18.1	63.6	5.0
76	*Didymosphaeria lignomaris*	9.09	36.3	9.33
77	*Sporiodesmium salinum*	9.09	27.2	3. 0
78	*Quintaria lignatilis*	18.1	54.5	9.33
79	*Melanomma fuscidulum*	18.1	72.7	3.0
80	*Monosporium flavum*	18.1	63.6	5.0
81	*Monotospora brevis*	9.09	18.1	6.25
82	*Nigrospora sphaerica*	18.1	72.7	9.33
83	*Periconia laminella*	9.09	54.5	3.0
84	*P. prolifica*	9.09	27.2	5.0
85.	*Bipolaris tetramera .*	27.2	63.6	6.0

Table 7. Species richness, diversity and evenness of fungi Recovered from 11 sampling stations

Sampling stations	Species richness special recovered	Simpson (D)	Shannon (H1)	Shannon Evenness(J)
S1	30	0.9997	0.4335	0.1035
S2	31	0.9889	0.8161	0.1902
S3	39	0.9995	6.6204	0.4713
S4	33	0.9800	4.1010	0.9427
S5	24	0.9889	0.9404	0.2213
S6	30	0.9998	0.3756	0.0867
S7	40	0.9989	0.7612	0.1772
S8	35	0.9995	0.6139	0.1369
S9	20	0.9800	0.0019	0.0003
S10	28	0.9989	0.8459	0.1991
S11	26	0.9990	0.5890	0.1355.

Satio (1952) investigated the mycoflora of a salt marsh and observed that the species of *Penicillium* and *Trichoderma vignorum* were the common forms encounted in the surface mud.

Distribution of fungi in relation to woody substrates

The fungi in the marine system was studied by plating and baiting techniques. Totally, 32 species of fungi belong to different groups were enumerated from the natural decaying wood substrates attempted with direct plating technique. In this, *Aspergillus* was found to be more predominant fungi, *A.flavus, A.fumigatus, A.luchuensis, A.terreus, A.nidulans*, followed by *Penicillium* sp (Table 5).

The fact that the mangrove vegetation play on important role in the distribution of fungi in the aquatic system, since they contribute to the leaf litter which harbor mycoflora was pointed out by Cunnell (1956). The fungal diversity of proproots, seedlings and wood of *Rhizophora apicualta* and wood and pneumatophores of *Avicennia* sp. were investigated by Sarma and Vittal (2000). Fungi occur on drift wood, intertidal wood, manalia rope and other lignocellolic substrates in marine and estuarine environments were reported by Johnson and Sparrow,(1961),Hughes (1974), Kohlmeyer and Kohlmeyer(1979).

Isolation of fungi from sediment mixed with water attempted with membrane filtration technique

As similar to dilution-plating technique fungi were also isolated by membrane filtration technique. Totally, 18 species of fungal flora were isolated and enumerated .Of which, Zygomycotina, Ascomycotina and Deuteromycotina.

Among the isolated fungi, *Aspergillus* was occurred predominant species followed by *Penicillium*.

Frequency of occurrence of fungi

The fungal frequency of occurrence in the five sampling stations was calculated (in percentage) and it was represented in the following frequency groupings per sample. The fungus *Aspergillus niger* occurred frequently and C*ladosporium*, *Neurospora crassa*, *Fusarium semitectum* were rarely occurred in the system. In Deuteromycotina, *Aspergillus*, *Penicillium*, most frequently occurred in this system. (Table 6).

Species richness, diversity and evenness of fungi

The species richness and diversity of fungi at 11 sampling stations were determined by Simpson and Shannon indices. Simpson and Shannon indices were highest at S5 represented by 0.9889 (Simpson), and Shannon was 6.6204 at S3. The Shannon evenness was highest at S4 (0.9427) while it was least at S6 with 0.0867 (Table 7).

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