



## Original Research Article

# Abundance and Diversity of fungi in salt pan and marine ecosystem of the east coast of Tamil Nadu, India

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## A B S T R A C T

### KEYWORDS

Marine fungi;  
Physico-Chemical  
parameters;  
Species diversity;  
Frequency of  
occurrence.

Abundance and Diversity of fungi in salt pan and marine of the East coast of Tamil Nadu, India was studied in terms of species diversity, frequency of occurrence in Marakkanam (S1), Pillaichavadi (S2), T.R.Pattanam (S3), Muthukuda (S4) and Kanyakumari (S5, S6, S7) of the marine and salt pane ecosystem. Among the 46 species of fungi isolated, totally 35 species were isolated from sediment samples followed by water with 31 species. Among the fungal members *Aspergillus* was common genus represented with 10 species followed by *Penicillium* with 5 species

## Introduction

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 where as, 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).

Marine fungi have been classified into three geographical groups by Kohlmeyer and

Kohlmeyer (1979): i) cosmopolitan species; ii) temperate – water species and iii) species from tropical and subtropical waters. Mangrove fungi have been incorporated in biogeographical maps by Jones (1993), Kohlmeyer (1981, 1984), Kohlmeyer and Volkmann-Kohlmeyer (1987); and Volkmann - Kohlmeyer and Kohlmeyer (1993); Thamizhmani and Senthilkumaran, 2012. Based on the distribution in Atlantic Ocean, Indian Ocean, South – East Asia and Pacific Ocean this study was carried out. Hyde and Lee (1995) revised geographical distribution of representative mangrove fungi (*Halosarphaeria fibrosa*, *H. marina*, *Lignincola laevis* and *Lulworthia*

*grandispora*). Geographical and seasonal distribution of *Asteromyces cruciatus*, *Stigmoidea marina* and *Varicosporina ramulosa* correlated with their growth patterns under different temperature regimes (Boyd and Kohlmeier, 1982).

There are umpteen literatures on the ecology and taxonomy of soil fungi. Most of the reports relate to the study of fungal flora from cultivated agricultural soils, uncultivated soil, pasturelands and forest soils. However, little is known about the microbial ecology of mangrove swamps. During the past several years, considerable work has been done on the taxonomy and ecology of mangrove swamp fungi in India (Padhye *et al.*, 1967; Pawar, *et al.*, 1963; 1965 and Rai and Tewari, 1963). Owing to the lack of studies on different location along the Indian coast, the present study was carried out to understand the ecology and diversity, seasonal variations, frequency of occurrence and distribution fungi in relation to physico - chemical status of marine ecosystem in east coast of India.

## Materials and Methods

### Study area

Totally, five sampling stations were selected depends on the richness of the mangrove vegetation. The stations are Marakkanam (S1), Pillaichavadi (S2), T.R.Pattanam (S3), Muthukuda (S4) and Kanyakumari (S5, S6 S7) in India.

### Samples collection and processing

Random sampling of water was carried out at various depths in each sampling station. Besides this, sediment was also collected to isolate and enumerate the fungi. The naturally occurring different wood substrates

such as drift wood and intertidal wood found in the crevices of rock along the banks of the estuary were collected (randomly in the study area) 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 of different sizes and were again washed with sterile and allowed to drain for 1 hour to remove excess surface waters (Vrijmoed, 2000). The samples were kept at 4°C for further use (Kohlmeier and Kohlmeier, 1979).

### Isolation and identification of fungi

By employing plating technique, all the collected samples were plated on Potato Dextrose agar, Corn Meal agar, Rose Bengal agar, Low Nutrient Growth Medium, Sabouraud's Dextrose Agar with addition of mixture antibiotics (Tetracycline + Penicillin). After incubation at room temperature (28°C), the fungal colonies were identified (Kohlmeier and Kohlmeier, 1979; Subramanian, 1791; Ellis, 1971 and 1976; Ellis and Ellis, 1985; Gilman, 1959 and 1998).

### Analysis of physico - chemical parameters

The water and sediment samples were collected separately to analyse the physico - chemical parameters along with the collection of water and sediment samples for fungal studies. The parameters such as temperature, pH, Dissolved oxygen (DO), Chemical oxygen demand (COD), Salinity, Alkalinity and Total dissolved solids (TDS) of water samples and Nature of soil, pH, Salt concentration, Nitrogen, Alkalinity, Total organic matter of sediment samples were

also studied. The methodology of water and sediment samples analysis was followed as per the manual by Venugopalan and Paulpandian (1981) and Plummer (2003).

**Frequency of occurrence and diversity indices of fungi**

The physico-chemical data obtained were correlated with the fungal diversity and distribution of fungi. The frequency of occurrence of fungi in the four sampling stations was calculated and represented in the following frequency grouping per sample.

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

The diversity of fungi in all samples from seven sampling stations was assessed on the basis of diversity indices.

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

and

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

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

The Shannon Evenness, *J'*, was expressed by:

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

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

**Results and Discussion**

The physico-chemical parameters of water and sediment samples in salt pane system, salinity, alkalinity, total dissolved solids were 53.09%, 24.0 mg, 0.18mg respectively (Table.1). The physico-chemical parameters of water and sediment samples in marine eco system, salinity, alkalinity, total dissolved solids were 54.84%, 27.2 mg, 0.41mg respectively (Table.1).

Table.1. Physico-chemical parameters of water and sediment samples.

Parameters	Salt pane	Marine system
<b>Water samples</b>		
Temperature (°C)	31.5	30.8
pH	7.8	7.7
Dissolved oxygen (mg/L)	12.0	24.96
Chemical oxygen demand (mg/L)	10.4	10.88
Salinity (%)	53.09	54.84
Alkalinity (mg/L)	24.0	27.2
Total dissolved solids(mg/L)	0.18	0.41
<b>Sediment samples</b>		
pH	7.7	8.2
Salt (NaCl) mg/100g	58.09	54.97
Alkalinity (mg/g)	2.09	1.53
Total organic matter (mg/g)	6.67	8.77

During the study period, a total of 46 fungal species were enumerated from 7 sampling stations by plating and baiting techniques. 35 species of fungi were recovered from sediment samples whereas water samples yielded 31 species and 15 species were isolated from natural substrates (Table 3). When the fungal species diversity was analyzed in relation to different classes, it has been observed that maximum number of species recorded belonged to Hyphomycetes. This was followed by Ascomycetes and Zygomycetes. Among the Hyphomycetes, *Aspergillus* was the common genus represented by 11 species

**Table.2** Isolation of fungi from all the sampling stations in east coast of India

Name of the Fungi	S1	S2	S3	S4	S5	S6	S7
<i>Mucor sp</i>	-	-	-	+	-	-	-
<i>R. oryzae</i> Went and Gerlings	+	-	-	-	-	-	+
<i>Actinomucor sp</i>	-	+	-	-	-	-	-
<i>Saccharomyces sp</i>	+	-	+	+	+	+	+
<i>Emericella nidulans</i> (Eidam)Vuill	+	-	-	-	-	-	-
<i>Neurospora crassa</i> Shear and Dodge	+	-	-	+	-	-	-
<i>A. flavipes</i> (Bain & Sart.) Thom & Church	-	-	-	-	-	-	-
<i>A. flavus</i> Link	+	+	+	+	-	-	+
<i>A. fumigatus</i> Fresenius	+	-	+	+	-	-	-
<i>A. glaucus</i> Link	-	-	+	+	+	+	-
<i>A. luchuensis</i> Inui	+	-	-	-	-	-	-
<i>A. niger</i> Van Tieghem	+	+	+	+	+	-	-
<i>A. ochraceus</i> Wilhelm	+	-	-	+	-	+	-
<i>A. oryzae</i> (Ahlburg in Korschelt.) Cohn	+	-	+	-	-	-	-
<i>A. sacchari</i>	-	-	+	-	-	-	-
<i>A. sulphreus</i>	+	-	-	+	-	+	+
<i>A. terreus</i> Thom	+	-	-	-	+	+	-
<i>Gliocladium sp.</i>	-	-	-	-	-	-	+
<i>P. citrinum</i> Thom	+	+	+	+	+	+	+
<i>P. digitatum</i>	-	-	-	-	-	+	-
<i>P. frequentans</i>	-	-	-	+	-	-	-
<i>P. janthinellum</i> Biourge	-	-	+	+	+	+	+
<i>P. martensii</i>	-	-	-	-	-	-	+
<i>Spicaria divertica</i>	-	-	+	-	-	-	-
<i>T. viride</i>	-	-	+	-	-	-	+
<i>Verticillium sp.</i>	+	-	-	+	+	-	+
<i>Alternaria sp.</i>	-	+	+	+	+	-	-
<i>Ampullifernia sp.</i>	+	-	-	-	-	-	-
<i>Cladosporium britannicum</i> M.B.Ellis	+	+	-	+	+	+	+
<i>C. gallicola</i>	-	+	+	+	-	-	-
<i>C. tenuissimum</i> Cooke	+	+	+	+	+	-	-
<i>C. uredinicola</i>	-	-	+	+	-	-	-
<i>C. psoraleae</i>	-	-	+	-	-	-	-
<i>Cladosporium sp.</i>	+	-	-	-	-	-	-
<i>Curvularia lunata</i> (Wakkar.) Boedijn	+	-	-	-	-	-	-
<i>C. pallescens</i>	-	-	-	+	-	-	-
<i>C. richardiae</i> Alcorn	+	-	-	-	-	+	-
<i>Drechslera indica</i> (Rai, Wadhvani & Tewari)	-	-	-	-	+	-	-
<i>Mouchacca</i>							
<i>D. tripogonis</i>	-	-	-	-	-	+	+
<i>Drechslera sp</i>	-	-	-	-	-	+	-
<i>Helminthosporium sp</i>	-	-	-	-	-	-	+
<i>Heteroconium tetracolum</i>	-	-	-	-	-	+	-
<i>Pterulopsis dummeri</i>	-	-	-	-	+	-	-
<i>Fusarium oxysporum</i> Schlechtendahl	+	+	-	+	-	-	-
<i>F. semitectum</i> Berkeley & Ravenel	+	+	-	+	-	+	-
<i>Ascochyta vulgaris</i>	-	+	-	-	-	-	-

+ indicate Present; - indicate Absent

**Table.3** Isolation of fungi from Sediment, Water, Natural substrates of marine ecosystem and their frequency of occurrence

Name of the Fungi	Water	Sediment	Natural substrates	FO
<i>Mucor sp</i>	-	+	-	27.27
<i>R. oryzae</i> Went and Gerlings	-	+	-	9.09
<i>Actinomucor sp</i>	-	+	-	9.09
<i>Saccharomyces sp</i>	+	+	-	81.81
<i>Emericella nidulans</i> (Eidam)Vuill	+	-	-	9.09
<i>Neurospora crassa</i> Shear and Dodge	+	+	+	27.27
<i>A. flavipes</i> (Bain & Sart.) Thom & Church	+	-	-	9.09
<i>A.flavus</i> Link	+	+	+	81.81
<i>A. fumigatus</i> Fresenius	+	+	-	45.45
<i>A. glaucus</i> Link	+	+	-	45.45
<i>A. luchuensis</i> Inui	-	+	-	27.27
<i>A. niger</i> Van Tieghem	+	+	+	45.45
<i>A. ochraceus</i> Wilhelm	+	+	+	45.45
<i>A. oryzae</i> (Ahlburg in Korschelt.) Cohn	+	+	+	36.36
<i>A.sacchari</i>	-	+	-	9.09
<i>A.sulphreus</i>	+	+	-	54.54
<i>A. terreus</i> Thom	-	+	+	45.45
<i>Gliocladium sp.</i>	-	+	-	9.09
<i>P. citrinum</i> Thom	+	+	+	90.90
<i>P. digitatum</i>	+	-	+	9.09
<i>P.frequentans</i>	+	+	-	18.18
<i>P. janthinellum</i> Biourge	+	+	+	72.72
<i>P.martensii</i>	-	+	-	9.09
<i>Spicaria divertica</i>	+	-	-	9.09
<i>T.viride</i>	+	-	-	27.27
<i>Verticillium sp.</i>	+	+	-	54.54
<i>Alternaria sp.</i>	+	+	-	54.54
<i>Ampullifernia sp.</i>	-	+	-	18.18
<i>Cladosporium britannicum</i> M.B.Ellis	+	+	+	72.72
<i>C.gallicola</i>	+	+	-	54.54
<i>C. tenuissimum</i> Cooke	+	+	+	81.81
<i>C.uredinicola</i>	+	+	-	36.36
<i>C.psoraleae</i>	+	-	-	9.09
<i>Cladosporium sp.</i>	-	+	-	18.18
<i>Curvularia lunata</i> (Wakkar.) Boedijn	+	-	-	9.09
<i>C.pallescens</i>		+	-	9.09
<i>C. richardiae</i> Alcorn	+	+	-	36.36
<i>Drechslera indica</i> (Rai, Wadhvani & Tewari)	+	-	-	9.09
Mouchacca				
<i>D.tripogonis</i>	+	+	+	27.27
<i>Drechslera sp</i>	-	+	-	9.09
<i>Helminthosporium sp</i>	+	-	-	9.09
<i>Heteroconium tetracolum</i>	-	-	+	9.09
<i>Pterulopsis dummeri</i>	+	+	-	9.09
<i>Fusarium oxysporum</i> Schlechtendahl	+	+	+	45.45
<i>F. semitectum</i> Berkeley & Ravenel	+	+	+	54.54
<i>Ascochyta vulgaris</i>	+	+	-	9.09

+ indicate Present; - indicate Absent

**Table. 4** Isolation of fungi from salt pane and marine ecosystem in east coast on India

Name of the Fungi	Salt pan	Marine ecosyatem
<i>Mucor sp</i>	-	+
<i>R. oryzae</i> Went and Gerlings	+	-
<i>Actinomucor sp</i>	-	+
<i>Saccharomyces sp</i>	+	-
<i>Emericella nidulans</i> (Eidam)Vuill	+	-
<i>Neurospora crassa</i> Shear and Dodge	+	+
<i>A. flavipes</i> (Bain & Sart.) Thom & Church	+	-
<i>A.flavus</i> Link	+	+
<i>A. fumigatus</i> Fresenius	+	+
<i>A. glaucus</i> Link	+	+
<i>A. luchuensis</i> Inui	+	-
<i>A. niger</i> Van Tieghem	+	+
<i>A. ochraceus</i> Wilhelm	+	+
<i>A. oryzae</i> (Ahlburg in Korschelt.) Cohn	+	+
<i>A.sacchari</i>	+	-
<i>A.sulphreus</i>	+	+
<i>A. terreus</i> Thom	+	+
<i>Gliocladium sp.</i>	-	+
<i>P. citrinum</i> Thom	+	+
<i>P.digitatum</i>	-	+
<i>P.frequentans</i>	-	+
<i>P. janthinellum</i> Biourge	+	+
<i>P.martensii</i>	-	+
<i>Spicaria divertica</i>	+	-
<i>T.viride</i>	+	+
<i>Verticillium sp.</i>	+	+
<i>Alternaria sp.</i>	+	+
<i>Ampulliferia sp.</i>	-	+
<i>Cladosporium britannicum</i> M.B.Ellis	+	+
<i>C.gallicola</i>	+	+
<i>C. tenuissimum</i> Cooke	+	+
<i>C.uredinicola</i>	+	+
<i>C.pSORaleae</i>	+	-
<i>Cladosporium sp.</i>	+	+
<i>Curvularia lunata</i> (Wakkar.) Boedijn	+	-
<i>C.pallesCens</i>	+	-
<i>C. richardiae</i> Alcorn	+	+
<i>Drechslera indica</i> (Rai, Wadhvani & Tewari) Mouchacca	-	+
<i>D.tripogonis</i>	-	+
<i>Drechslera sp</i>	-	+
<i>Helminthosporium sp</i>	-	+
<i>Heteroconium tetracolum</i>	-	+
<i>Pterulopsis dummeri</i>	-	+
<i>Fusarium oxysporum</i> Schlechtendahl	+	+
<i>F. semitectum</i> Berkeley & Ravenel	+	+
<i>Ascochyta vulgaris</i>	-	+

+ indicate Present; - indicate Absent

followed by 5 species with *Penicillium* and *Curvularia* with 3 species. In addition of this *Cladosporium*, *Mucor*, *Rhizopus*, *Fusarium*, *Dreschlera* and *Helminthosporium* were the common genera found in this system.

During the four month study period, a total of 46 fungal species were enumerated from seven sampling stations S1, S2, S3, S4, S5, S6 and S7 by plating and baiting techniques. Among these, 22 species were represented in S1, 11 in S2, 16 in S3, 21 in S4, 13 in S5, 14 in S6 and 13 in S7 (Table 2). Maximum fungal diversity was observed in S1 with represented by 22 species and minimum of 13 species was isolated in S5 and S7 stations.

In water samples totally, 31 species of fungi were isolated and enumerated from the water samples by dilution – plating technique (Table 3). The above result was discussed with previous reports of Chandralata (1999) and Raghukumar and Raghukumar (1998) also reported adaptation and activity of mangrove ecosystem as facultatives of indwellers or residents. Terrestrial fungi are common in mangrove water and mud (Chowdhery *et al.*, 1982; Garg, 1983).

In this study, 35 fungi were isolated from the marine sediment samples. As like in the water samples, in sediment samples also the genus *Aspergillus* (10 sp) was also found to be dominant followed by

*Cladosporium*, *Penicillium*, *Drechslera*, *Alternaria* and *Curvularia*. totally, 15 species of fungi were isolated from natural substrates of marine plants by baiting technique (Table 3). A detailed investigation of fungi on marine and mangroves of west coast was made by Patil and Borse (1985), Chinnaraj and Untawale (1992); Chinnaraj (1993). However, vast tracts of mangroves on the east coast remain vitually - unexplored except for the studies of Ravikumar and Vital (1996) and Sarma and Vittal (2001). In this study, 36 species of fungi were recovered from marine ecosysyem whereas salt pane samples 32 species fungi were recorded (Table 4).

The fungal frequency of occurrence in all sampling stations was calculated (in percentage). Accordingly *P. citrinum* showed 90.90% frequency of occurrence followed by *C. tenussimum* and *A. flavus* (81.81%), *C. britannicum* (72.72) and *P. janthnellium* showed lowest occurrence with 9.09% observed in the mangrove ecosystems. The species richness and diversity of fungi at mangrove stations were determined using Simpson and Shannon indices. Both Simpson and Shannon indices were highest at Marakkanam (0.9360 and 2.7852) (Table.5). Species richness and diversity of fungi in all the sampling stations during the study period was in conformity with the diversity studies of Maria and Sridhar (2002).

**Table. 5** Species richness, diversity and evenness of fungi recovered from all stations of Marines system

Sampling stations	Species Recovered	Species richness impson (D')	Diversity indices Shannon (H')	Shannon Evenness (J')
Marakkanam (S1)	22	0.9360	2.7852	0.6889
Pillaichavadi(S2)	14	0.8965	2.2846	0.5651
T.R. Pattinam(S3)	16	0.9028	2.4216	0.5558
Muthukuda (S4)	26	0.9233	2.6548	0.6566
Kanyakumari(S5)	21	0.8678	2.0952	0.5182
Kanyakumari(S6)	14	0.8724	2.1211	0.5246
Kanyakumari(S7)	13	0.8903	2.2956	0.5269

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