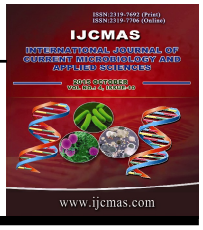
Int.J.Curr.Microbiol.App.Sci (2015) 4(10): 222-237

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 4 Number 10 (2015) pp. 222-237**
http://www.ijcmas.com



Original Research Article

Diversity of Mycoflora in Mangrove Soils of Karankadu, Tamil Nadu, India

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Keywords

Diversity, Mycoflora, Mangrove Soils, Karankadu

A B S T R A C T

The diversity of soil mycoflora of the unique mangrove ecosystem of Karankadu was studied. Physico-chemical characteristics of the soil were also analyzed to find out their impact on fungal population. A total number of 58 fungal species belonging to 21 genera were identified. The maximum number of fungal isolates belonging to the class Deuteromycetes (19 genera and 56 species), followed by Phycomycetes (2 genera and 2 species) were recorded. The genus *Aspergillus* (25 species) was dominant followed by *Penicillium* (8 species), *Curvularia* (4 species) and *Trichoderma* (3 species). The relationship between various physico-chemical parameters of soil and total fungal colonies were statistically analyzed. Findings of this study revealed that Karankadu mangrove soils are the potential source for fungal diversity.

Introduction

Mangroves are coastal wetland forests established at the intertidal zones of estuaries, backwaters, deltas, creeks, lagoons, marshes and mudflats of tropical and subtropical latitudes. Approximately one fourth of the world's coastline is dominated by mangroves that are distributed in 112 countries and territories comprising a total area of about 1,81,000 km^2 (Spalding *et al.*, 1997; Alongi, 2002). According to Forest Survey of India, out of 4,87,100 ha of mangrove wetlands in India, nearly 56.7% (2, 75, 800 ha) is present along the east coast, and 23.5% (1,14,700 ha) along the west coast and the remaining 19.8% (96, 600 ha) is found in the Andaman and Nicobar islands (FSI, 1999).

Fungi in mangrove environment play an important ecological role in decomposition of organic matter by production of variety of extracellular degradative enzymes such as cellulase, xylanase, pectinase, amylase and so on. Such enzymes can be isolated from the mangrove fungi and harnessed for several biotechnological applications. Several bioactive metabolites are derived from mangrove fungi which are used in

pharmaceutical and nutraceutical industries to produce antimicrobial, anticancer, antioxidant, antidiabetic and other therapeutic agents (Pointing *et al.,* 1999; Zhang *et al.,* 2010; Chen *et al.,* 2011; Radhakrishnan *et al.,* 2011; Silva *et al.,* 2011; Song *et al.,* 2012).

The first account of marine fungi occurring on mangroves was made by Cribb and Cribb (1955, 1956) in Australia. They were the pioneers to observe marine fungi *in situ* on mangroves. Literature revealed that a few studies have been undertaken to assess the fungal diversity from different Indian mangroves like Pichavaram in Tamil Nadu (Sivakumar and Kathiresan, 1990) and Maharashtra coast (Borse, 1988) as well as southwest coast of India (Ananda and Sridhar, 2004). But the information of the fungi of mangroves of East Coast of Tamil Nadu remained largely unexplored. Hence, the present investigation was designed to assess the diversity of mangrove fungi from Karankadu, Ramanathapuram District, Tamil Nadu, India.

Materials and Methods

Description of sampling sites

Karankadu is a small village in Ramanathapuram District, Tamil Nadu, India. This village is situated in the Palk Bay, 300 Km south of Chennai. It is located between latitude 9°38'58"N and longitude 78°57'38"E (Fig. 1).

Collection of soil samples

The soil samples were collected from mangrove field at Karankadu for a period of one year from January 2013 to December 2013.The soil samples were collected at a depth within 10 cm using a metal spatula and 5 to 7 samples were collected randomly and were pooled together. The samples were kept in new polythene bags, sealed and transported to the laboratory for the mycological examination. For the analysis of soil nutrients, ½ kg of soil was separately collected in polythene bags (Fig. 2).

Isolation of soil fungi

The soil fungi were isolated by dilution plating technique (Warcup, 1950). One gram of soil weighed and diluted in 10 ml of distilled water. One ml of the diluted sample (10^{-2} and 10^{-3}) was poured and spreaded on the petri plates containing sterilized PDA medium (Potato - 200 gms, dextrose -20 gms, agar - 15 gms, distilled water - 500 ml, sea water - 500 ml, pH -6.5) in replicates. One percent Streptomycin sulphate solution was added to the medium before pouring into petriplates for preventing bacterial growth. The inoculated plates were incubated at the room temperature for 3–5 days. The colonies growing on PDA plates with different morphology were counted separately. The fungal cultures were then transferred, subcultured and the pure cultures were maintained on PDA medium.

Identification

Fungal morphology were studied microscopically by Lacto phenol cotton blue staining technique and observed under a compound microscope. Colony colour and morphology were observed besides hyphal structure, spore size, shapes and spore bearing structures. They were compared with the standard works of Manual of Penicillia (Raper and Thom, 1949), Manual of Soil fungi (Gillman, 1957), Manual of *Aspergillus* (Raper and Fennell, 1965), Hyphomycetes (Subramanian, 1971), Marine Mycology, The higher fungi (Kohlmeyer and Kohlmeyer, 1979) and Compendium of soil fungi (Domsch *et al.*, 1980).

Presentation of data

$$\% \text{ contribution} = \frac{\text{No. of colonies of fungus in a sample}}{\text{Total number all colonies of all the species in a sample}} \times 100$$

$$\% \text{ frequency} = \frac{\text{Number of samples in which a particular fungus occurred}}{\text{Total number of samples examined}} \times 100$$

Based on the frequency occurrences the fungi were grouped as rare (0–25% frequency), Occasional (26–50% frequency), Frequent (51–75% frequency) and common (76-100% frequency) species.

Analysis of physico-chemical characteristics of the soil

pH, Electrical conductivity, cation exchange capacity, organic carbon, organic matter, available nitrogen, phosphorus, potassium, zinc, copper, iron, manganese, calcium, magnesium, sodium and potassium content of mangrove soils were analyzed by APHA method (1989).

Statistical analysis

Pearson's correlation analysis was used to assess the relationship between physico-chemical parameters and total fungal colonies. The data were computed and analyzed using Statistical Package for Social Sciences (SPSS) software.

Results and Discussion

In the present investigation, a dilution plating method was used for isolating fungi from mangrove soils. The list of isolated soil mycoflora of Karankadu mangrove forest from the period of January 2013 to December 2013 was recorded (Table 1). A total number of 58 fungal species belonging to 21 genera were identified. The maximum number of fungal isolates belonging to the class Deuteromycetes (19 genera and 56 species), followed by Phycomycetes (2 genera and 2 species) were recorded. The abundance of Deuteromycetes on mangrove environment has also been reported by Gilna and Khaleel (2011), Madavasamy and Panneerselvam (2013) and this might be due to their spores show adaptation to the marine ecosystem by way of production of appendages, which provide buoyancy in water, entrapment and adherence to the substrates.

In the present study, the genus *Aspergillus* (25 species) was dominant followed by *Penicillium* (8 species), *Curvularia* (4 species) and *Trichoderma* (3 species). The results of the present investigation were harmony with the earlier published reports that the constant presence of *Aspergillus* and *Penicillium* from different mangrove environment of the world (Gilna and Khaleel, 2011; Radhakrishnan *et al.,* 2011; Khalil *et al.,* 2013; Madavasamy and Panneerselvam, 2014).

In the same way Sivakumar *et al.* (2006) reported *Aspergillus* was the common genus in Muthupettai mangrove along the East coast in Tamil Nadu. Recently, Priya and Sivakumar (2014) also reported the biodiversity of fungi in marine and mangrove ecosystem of East Coast of Tamil Nadu, India. Totally, 85 species of fungi were enumerated and the genus *Aspergillus* was dominant member followed by *Penicillium* is in agreement with the present investigation.

Percentage contribution of the individual species to the total fungal population showed variation (Table 2). The maximum percentage contribution of 3.32% was found with *Torula herbarum*. The minimum of 0.81% was found with *Dendryphion nanum*.

Percentage frequency and frequency class of different species of isolated soil fungi from mangrove forest of Karankadu was studied (Table 3). *Aspergillus crystallinus*, *A. luchuensis* and *A. niger* were frequently isolated which showed 75% frequency.

Table.1 List of isolated soil mycoflora from mangrove forest of Karankadu from the period of January 2013 to December 2013

S. No.	Isolated mycoflora
1	*Acrophialophora fusispora*
2	*Aspergillus aculeatus*
3	*A. alliaceus*
4	*A. candidus*
5	*A. carbonarius*
6	*A. cervinus*
7	*A. conicus*
8	*A. crystallinus*
9	*A. flavipes*
10	*A. flavus*
11	*A. foetidus*
12	*A. fumigatus*
13	*A. glaucus*
14	*A. humicola*
15	*A. itaconicus*
16	*A. luchuensis*
17	*A. luteus*
18	*A. niger*
19	*A. ochraceus*
20	*A. phoenicis*
21	*A. sparsus*
22	*A. sulphureus*
23	*A. terreus*
24	*A. terricola*
25	*A. unguis*
26	*A. versicolor*
27	*Botrytis cinerea*
28	*Cephalosporium humicola*
29	*Cladosporium* sp.
30	*Curvularia geniculata*
31	*C. lunata*
32	*C. subulata*
33	*C. pallescens*
34	*Fimetaria sylvatica*
35	*Dendryphion nanum*
36	*Drechslera oryzae*
37	*Fusarium equiseti*
38	*F. moniliforme*
39	*Gliocladiopsis sagariensis*
40	*Helminthosporium oryzae*
41	*Mortierella decipiens*
42	*Penicillium cyaneum*
43	*P. janthinellum*
44	*P. javanicum*
45	*P. nigricans*
46	*P. purpurogenum*
47	*P. purpurrescens*
48	*P. terrestre*
49	*P. raistrickii*
50	*Scopulariopsis acremonium*
51	*Stachybotrys chartarum*
52	*Syncephalastrum racemosum*
53	*Torula herbarum*
54	*Trichoderma harzianum*
55	*T. lignorum*
56	*T. polysporum*
57	*Ulocladium consortiale*
58	*Verticillium arboretum*

Table.2 Total number of colonies, mean density (CFU/g) and percentage contribution of soil fungi from mangrove forest of Karankadu (January 2013 to December 2013)

S. NO	NAME OF THE ORGANISMS	January		February		March		April		May		June		July		August		September		October		November		December		ALL NO OF COL CONTRIBUTION	
		TNC	MD	TNC	MD	TNC	MD	TNC	MD	TNC	MD	TNC	MD	TNC	MD	TNC	MD	TNC	MD	TNC	MD	TNC	MD	TNC	MD		
1	*Acrophialophora fusispora*	5	1.67	4	1.33	-	-	-	-	2	0.67	-	-	-	-	2	0.67	-	-	1	0.33	3	1.00	3	1.00	20	1.79
2	*Aspergillus aculeatus*	-	-	-	-	1	0.33	1	0.33	3	1.00	5	1.67	4	1.33	-	-	7	2.33	-	-	2	0.67	-	-	23	2.06
3	*A. alliaceus*	-	-	-	-	2	0.67	4	1.33	-	-	4	1.33	4	1.33	-	-	-	-	-	-	-	-	-	-	14	1.25
4	*A. carbonarius*	4	1.33	5	1.67	-	-	2	0.67	-	-	3	1.00	-	-	2	0.67	-	-	1	0.33	-	-	-	-	17	1.52
5	*A. cervinus*	-	-	3	1.00	1	0.33	-	-	-	-	-	-	2	0.67	4	1.33	-	-	-	-	1	0.33	4	1.33	15	1.34
6	*A. conicus*	-	-	2	0.67	3	1.00	3	1.00	3	1.00	-	-	-	-	-	-	4	1.33	-	-	4	1.33	-	-	19	1.70
7	*A. candidus*	3	1.00	-	-	-	-	-	-	-	-	3	1.00	-	-	2	0.67	2	0.67	-	-	-	-	2	0.67	12	1.08
8	*A. crystallinus*	2	0.67	-	-	5	1.67	4	1.33	-	-	5	1.67	3	1.00	-	-	2	0.67	2	0.67	4	1.33	4	1.33	31	2.78
9	*A. flavipes*	5	1.67	1	0.33	-	-	-	-	-	-	6	2.00	-	-	1	0.33	2	0.67	3	1.00	-	-	2	0.67	20	1.79
10	*A. flavus*	-	-	-	-	5	1.67	2	0.67	2	0.67	-	-	1	0.33	6	2.00	-	-	-	-	4	1.33	1	0.33	21	1.88
11	*A. foetidus*	-	-	2	0.67	3	1.00	4	1.33	-	-	2	0.67	-	-	-	-	2	0.67	-	-	5	1.67	-	-	18	1.61
12	*A. fumigatus*	-	-	-	-	-	-	-	-	4	1.33	3	1.00	-	-	-	-	5	1.67	-	-	-	-	-	-	12	1.08

13	*A. glaucus*	-	-	-	-	2	0.67	-	-	-	-	4	1.33	5	1.67	3	1.00	-	-	-	-	-	-	-	-	14	1.25
14	*A. humicola*	4	1.33	2	0.67	-	-	-	-	6	2.00	1	0.33	-	-	-	-	5	1.67	1	0.33	4	1.33	3	1.00	26	2.33
15	*A. itaconicus*	-	-	4	1.33	5	1.67	2	0.67	1	0.33	-	-	-	-	3	1.00	-	-	2	0.67	-	-	-	-	17	1.52
16	*A. luchensis*	2	0.67	4	1.33	-	-	4	1.33	3	1.00	5	1.67	3	1.00	-	-	3	1.00	3	1.00	-	-	7	2.33	34	3.05
17	*A. luteus*	1	0.33	-	-	2	0.67	-	-	5	1.67	-	-	-	-	4	1.33	2	0.67	3	1.00	1	0.33	-	-	18	1.61
18	*A. niger*	2	0.67	5	1.67	-	-	2	0.67	3	1.00	4	1.33	4	1.33	4	1.33	-	-	-	-	1	0.33	6	2.00	31	2.78
19	*A. ochraceus*	4	1.33	-	-	2	0.67	3	1.00	-	-	5	1.67	-	-	3	1.00	5	1.67	2	0.67	-	-	1	0.33	25	2.24
20	*A. phoenicis*	-	-	-	-	-	-	-	-	-	-	6	2.00	-	-	4	1.33	-	-	-	-	3	1.00	5	1.67	18	1.61
21	*A. sulphureus*	-	-	5	1.67	4	1.33	3	1.00	-	-	2	0.67	1	0.33	-	-	-	-	1	0.33	4	1.33	3	1.00	23	2.06
22	*A. sparsus*	-	-	-	-	6	2.00	2	0.67	7	2.33	-	-	3	1.00	2	0.67	5	1.67	-	-	-	-	-	-	25	2.24
23	*A. terreus*	5	1.67	-	-	2	0.67	-	-	-	-	-	-	-	-	6	2.00	-	-	-	-	-	-	-	-	13	1.16
24	*A. terricola*	-	-	6	2.00	-	-	3	1.00	3	1.00	1	0.33	-	-	3	1.00	-	-	1	0.33	4	1.33	2	0.67	23	2.06
25	*A. unguis*	3	1.00	-	-	5	1.67	-	-	-	-	-	-	6	2.00	3	1.00	4	1.33	-	-	1	0.33	4	1.33	26	2.33
26	*A. versicolor*	4	1.33	2	0.67	-	-	-	-	-	-	6	2.00	-	-	-	-	3	1.00	1	0.33	2	0.67	-	-	18	1.61
27	*Botrytis cinerea*	-	-	3	1.00	-	-	1	0.33	5	1.67	4	1.33	-	-	-	-	3	1.00	-	-	2	0.67	1	0.33	19	1.70
28	*Cephalosporium humicola*	6	2.00	-	-	2	0.67	-	-	-	-	7	2.33	1	0.33	-	-	3	1.00	1	0.33	4	1.33	-	-	24	2.15

29	*Cladosporium sp*	1	0.33	3	1.00	-	-	-	-	-	-	4	1.33	-	-	-	-	7	2.33	3	1.00	2	0.67	5	1.67	25	2.24
30	*Curvularia geniculata*	-	-	-	-	-	-	-	-	3	1.00	-	-	3	1.00	7	2.33	2	0.67	-	-	2	0.67	-	-	17	1.52
31	*C. lunata*	2	0.67	1	0.33	-	-	2	0.67	-	-	5	1.67	-	-	3	1.00	-	-	-	-	-	-	-	-	13	1.16
32	*C. subulata*	5	1.67	2	0.67	-	-	-	-	3	1.00	-	-	-	-	4	1.33	-	-	1	0.33	3	1.00	-	-	18	1.61
33	*C. pallescens*	-	-	2	0.67	-	-	-	-	-	-	3	1.00	-	-	-	-	-	-	5	1.67	-	-	6	2.00	16	1.43
34	*Fimetaria sylvatica*	-	-	2	0.67	4	1.33	2	0.67	-	-	-	-	-	-	3	1.00	-	-	-	-	-	-	2	0.67	13	1.16
35	*Dendryphion nanum*	-	-	-	-	5	1.67	-	-	-	-	3	1.00	-	-	-	-	-	-	1	0.33	-	-	-	-	9	0.81
36	*Drechslera oryzae*	-	-	-	-	1	0.33	1	0.33	-	-	4	1.33	-	-	5	1.67	-	-	6	2.00	-	-	3	1.00	20	1.79
37	*Fusarium equiseti*	1	0.33	2	0.67	-	-	-	-	-	-	-	-	3	1.00	2	0.67	4	1.33	-	-	-	-	4	1.33	16	1.43
38	*F. moniliforme*	-	-	-	-	5	1.67	2	0.67	4	1.33	-	-	2	0.67	3	1.00	-	-	-	-	1	0.33	1	0.33	18	1.61
39	*Gliocladiopsis sagariensis*	5	1.67	-	-	-	-	-	-	-	-	-	-	3	1.00	-	-	-	-	4	1.33	-	-	-	-	12	1.08
40	*Helminthosporium oryzae*	1	0.33	-	-	2	0.67	3	1.00	1	0.33	-	-	2	0.67	-	-	-	-	-	-	-	-	5	1.67	14	1.25
41	*Mortierella decipiens*	-	-	-	-	1	0.33	-	-	-	-	3	1.00	-	-	6	2.00	3	1.00	6	2.00	4	1.33	-	-	23	2.06
42	*Penicillium cyaneum*	5	1.67	-	-	-	-	-	-	4	1.33	4	1.33	-	-	5	1.67	-	-	-	-	-	-	7	2.33	25	2.24
43	*P. janthinellum*	-	-	-	-	5	1.67	-	-	5	1.67	-	-	-	-	6	2.00	-	-	3	1.00	-	-	-	-	19	1.70
44	*P. javanicum*	2	0.67	1	0.33	-	-	-	-	-	-	4	1.33	1	0.33	-	-	-	-	2	0.67	2	0.67	3	1.00	15	1.34

45	*P. nigricans*	2	0.67	-	-	-	-	-	-	-	-	-	-	3	1.00	1	0.33	-	-	-	-	3	1.00	6	2.00	15	1.34
46	*P. purpurogenum*	-	-	3	1.00	7	2.33	-	-	3	1.00	-	-	5	1.67	-	-	-	-	4	1.33	-	-	-	-	22	1.97
47	*P. purpurrescens*	2	0.67	3	1.00	-	-	1	0.33	-	-	-	-	1	0.33	4	1.33	-	-	-	-	2	0.67	4	1.33	17	1.52
48	*P. terrestre*	4	1.33	-	-	2	0.67	-	-	-	-	-	-	-	-	-	-	2	0.67	3	1.00	-	-	7	2.33	18	1.61
49	*P. raistrickii*	-	-	3	1.00	-	-	-	-	-	-	-	-	-	-	-	-	5	1.67	4	1.33	-	-	3	1.00	15	1.34
50	*Scopulariopsis acremonium*	-	-	-	-	6	2.00	1	0.33	6	2.00	-	-	2	0.67	-	-	4	1.33	-	-	-	-	-	-	19	1.70
51	*Stachybotrys chartarum*	4	1.33	1	0.33	-	-	-	-	-	-	5	1.67	-	-	2	0.67	-	-	2	0.67	-	-	2	0.67	16	1.43
52	*Syncephalastrum racemosum*	-	-	2	0.67	2	0.67	3	1.00	3	1.00	-	-	6	2.00	-	-	3	1.00	-	-	3	1.00	3	1.00	25	2.24
53	*Torula herbarum*	4	1.33	7	2.33	-	-	5	1.67	5	1.67	3	1.00	-	-	-	-	6	2.00	-	-	7	2.33	-	-	37	3.32
54	*Trichoderma harzianum*	-	-	-	-	-	-	-	-	5	1.67	3	1.00	-	-	-	-	-	-	4	1.33	-	-	-	-	12	1.08
55	*T. lignorum*	1	0.33	4	1.33	-	-	2	0.67	-	-	2	0.67	2	0.67	-	-	-	-	3	1.00	1	0.33	5	1.67	20	1.79
56	*T. polysporum*	-	-	2	0.67	1	0.33	-	-	4	1.33	-	-	2	0.67	4	1.33	-	-	-	-	1	0.33	-	-	14	1.25
57	*Ulocladium consortiale*	3	1.00	-	-	-	-	2	0.67	2	0.67	-	-	-	-	5	1.67	-	-	6	2.00	-	-	1	0.33	19	1.70
58	*Verticillium arboretum*	4	1.33	-	-	-	-	6	2.00	-	-	3	1.00	-	-	-	-	3	1.00	-	-	2	0.67	-	-	18	1.61
	Total	96	32	86	28.67	91	30.33	70	23.33	95	31.67	122	40.67	72	24	112	37.33	96	32	79	26.33	82	27.33	115	38.33	1116	100

Table.3 Percentage frequency and frequency class of different species of isolated soil fungi from mangrove forest of Karankadu (January 2013 to December 2013)

S. No.	Name of the organisms	No of months in which the fungus occurred	Percentage Frequency	Frequency Class
1	*Acrophialophora fusispora*	7	58	F
2	*Aspergillus aculeatus*	7	58	F
3	*A. alliaceus*	4	33	O
4	*A. candidus*	5	41	O
5	*A. carbonarius*	6	50	O
6	*A. cervinus*	6	50	O
7	*A. conicus*	6	50	O
8	*A. crystallinus*	9	75	F
9	*A. flavipes*	7	58	F
10	*A. flavus*	7	58	F
11	*A. foetidus*	6	50	O
12	*A. fumigatus*	3	25	R
13	*A. glaucus*	4	33	O
14	*A. humicola*	8	66	F
15	*A. itaconicus*	6	50	O
16	*A. luchuensis*	9	75	F
17	*A. luteus*	7	58	F
18	*A. niger*	9	75	F
19	*A. ochraceus*	8	66	F
20	*A. phoenicis*	4	33	O
21	*A. sparsus*	6	50	O
22	*A. sulphureus*	8	66	F
23	*A. terreus*	3	25	R
24	*A. terricola*	8	66	F
25	*A. unguis*	7	58	F
26	*A. versicolor*	6	50	O
27	*Botrytis cinerea*	7	58	F
28	*Cephalosporium humicola*	7	58	F
29	*Cladosporium* sp.	7	58	F
30	*Curvularia geniculata*	5	41	O
31	*C. lunata*	5	41	O
32	*C. subulata*	6	50	O
33	*C. pallescens*	4	33	O
34	*Fimetaria sylvatica*	5	41	O
35	*Dendryphion nanum*	3	25	R
36	*Drechslera oryzae*	6	50	O
37	*Fusarium equiseti*	6	50	O
38	*F. moniliforme*	7	58	F

39	*Gliocladiopsis sagariensis*	3	25	R
40	*Helminthosporium oryzae*	6	50	O
41	*Mortierella decipiens*	6	50	O
42	*Penicillium cyaneum*	5	41	O
43	*P. janthinellum*	4	33	O
44	*P. javanicum*	7	58	F
45	*P. nigricans*	5	41	O
46	*P. purpurogenum*	5	41	O
47	*P. purpurrescens*	7	58	F
48	*P. terrestre*	5	41	O
49	*P. raistrickii*	4	33	O
50	*Scopulariopsis acremonium*	5	41	O
51	*Stachybotrys chartarum*	6	50	O
52	*Syncephalastrum racemosum*	8	66	F
53	*Torula herbarum*	7	58	F
54	*Trichoderma harzianum*	3	25	R
55	*T. lignorum*	8	66	F
56	*T. polysporum*	6	50	O
57	*Ulocladium consortiale*	8	66	F
58	*Verticillium arboretum*	5	41	O

R – Rare (0-25%); O – Occasional (26-50%); F – Frequent (51-75%); C – Common (76-100%)

Table.4 Physico – chemical characteristics of the soil samples collected from mangrove forest of Karankadu from the period January 2013 to December 2013

Sl. No.	Name of the Parameter	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.
1.	pH	8.26	8.38	8.63	8.46	8.26	8.12	8.49	8.16	8.56	8.32	8.29	8.16
2.	EC (dsm^{-1})	1.69	1.58	1.96	1.81	1.58	1.46	1.56	1.45	1.63	1.68	1.58	1.87
3.	Organic Carbon (%)	0.42	0.55	0.39	0.40	0.52	0.43	0.60	0.54	0.48	0.46	0.54	0.59
4.	Available Nitrogen (%)	0.86	0.924	0.813	0.756	0.819	0.954	0.896	0.917	0.826	0.796	0.893	0.925
5.	Available Phosphorus (%)	0.149	0.169	0.185	0.193	0.245	0.196	0.158	0.179	0.196	0.216	0.248	0.215
6.	Available Potassium (%)	0.729	0.749	0.816	0.762	0.845	0.863	0.821	0.856	0.845	0.842	0.896	0.876
7.	Available Zinc (ppm)	0.63	0.69	0.72	0.76	0.79	0.82	0.82	0.87	0.96	0.82	0.89	0.96
8.	Available Copper (ppm)	0.45	0.58	0.39	0.57	0.45	0.59	0.56	0.68	0.49	0.63	0.56	0.62
9.	Available Iron (ppm)	4.59	4.26	4.71	4.20	4.89	5.13	4.69	4.36	4.82	4.63	5.23	5.45
10.	Available Manganese (ppm)	1.58	1.96	1.74	1.85	1.89	1.95	1.69	2.05	1.84	1.96	1.98	2.02
11.	Cat ion Exchange Capacity C. Mole $Proton^{+}$/kg	32.96	35.62	38.64	35.18	35.87	34.87	33.25	31.25	31.45	34.21	32.58	35.69
12.	Calcium C. Mole $Proton^{+}$/kg	14.25	15.68	12.68	13.25	14.98	15.89	15.25	15.26	13.56	14.25	15.48	15.87
13.	Magnesium C. Mole $Proton^{+}$/kg	9.65	10.28	13.59	11.25	11.59	12.36	10.25	10.36	12.35	12.45	12.09	12.78
14.	Sodium C. Mole $Proton^{+}$/kg	5.68	5.78	6.93	5.21	5.69	6.23	6.32	6.24	6.78	6.13	5.82	6.48
15.	Potassium C. Mole $Proton^{+}$/kg	0.16	0.23	0.22	0.25	0.21	0.28	0.12	0.16	0.23	0.15	0.27	0.32

Table.5 Correlation coefficient (r) values for various physico-chemical parameters and total fungal colonies of mangrove soils of Karankadu from the period January 2013 to December 2013

	pH	EC	OC	OM	AN	AP	AK	AZ	AC	AI	AM	CEC	C	M	P	TFC
pH	1															
EC	0.779*	1														
OC	-0.905**	-0.609	1													
OM	-0.648	-0.434	0.569	1												
AN	-0.773*	-0.765*	0.723*	0.841**	1											
AP	-0.641	-0.756*	0.525	0.489	0.558	1										
AK	-0.222	-0.053	0.337	0.068	0.273	-0.459	1									
AZ	-0.136	0.212	-0.076	-0.101	-0.310	-0.340	0.193	1								
AC	0.115	0.280	-0.398	-0.025	-0.384	-0.075	-0.509	0.683	1							
AI	-0.558	-0.687	0.667	0.180	0.517	0.637	-0.062	-0.496	-0.548	1						
AM	-0.318	-0.424	0.157	-0.278	-0.170	0.591	-0.446	0.192	0.239	0.364	1					
CEC	0.834**	0.925**	-0.749*	-0.659	-0.921**	-0.741*	-0.077	0.330	0.334	-0.712*	-0.172	1				
C	0.692	0.666	-0.554	-0.742*	-0.752*	-0.744*	0.339	0.213	-0.126	-0.481	-0.146	0.827*	1			
M	0.489	0.601	-0.287	-0.805*	-0.776*	-0.615	0.255	0.274	-0.110	-0.200	0.097	0.737*	0.881**	1		
P	0.799*	0.803*	-0.800*	-0.488	-0.702	-0.860**	0.069	0.375	0.354	-0.715*	-0.435	0.856**	0.709*	0.520	1	
TFC	-0.695	-0.963**	0.442	0.349	0.625	0.757*	-0.076	-0.075	-0.094	0.580	0.552	-0.813*	-0.602	-0.567	-0.687	1

TFC - Total Fungal Colony, EC - Electrical Conductivity, OC - Organic Carbon, OM - Organic Matter, AN - Available Nitrogen, AP - Available Phosphorus, AK - Available Potassium, AZ - Available Zinc, AC- Available Copper, AI - Available Iron, AM - Available Manganese, CEC - Cation Exchange Capacity, C – Calcium, M – Magnesium, P – Potassium

* Correlation is significant at the 0.05 level, ** Correlation is significant at the 0.01 level.

Fig.1 Map showing the sampling station

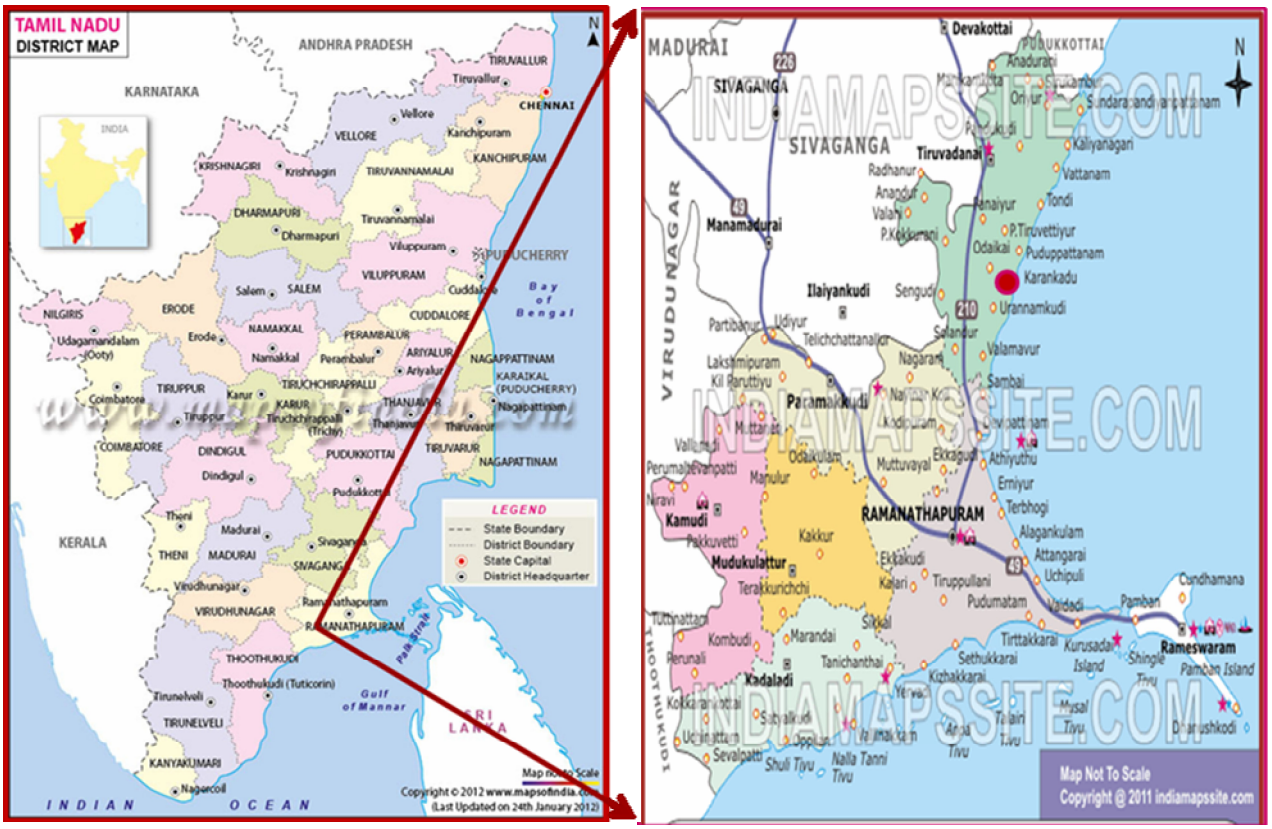

Fig.2 Collection of soil sample and sea water at Karankadu

Mangrove fungal diversity is dependent on the age of mangrove, diversity of mangrove plant species and the physicochemical features of mangrove habitat (temperature, salinity and tidal range) (Hyde and Jones, 1988). The physico–chemical characteristics of soil samples showed variation collected from different months (Table 4). All the soil samples analysed during the entire period of this study from all the stations were alkaline

in nature. The pH of soil was ranged from 8.12 to 8.63. Our findings are accordance with the earlier investigations of mangroves soils (Tam *et al.*, 1995; Tam and Wong, 1998; Saravanakumar *et al.*, 2008; Latiffah *et al.*, 2010) showed alkaline conditions as reported in the present study.

As that of major and minor elements such as nitrogen, phosphorus, potassium, zinc, copper, iron and manganese were showed variations in the study station. The results of the present investigation are agreement with the other mangroves such as Pichavaram mangrove (Periakali *et al.*, 2000), Bangladesh mangrove (Kawser *et al.*, 2002) and Andamans mangrove (Chaudhuri *et al.*, 2005; Chaudhuri *et al.*, 2009).

The relationship between various physico-chemical parameters of soil and total fungal colonies were statistically analyzed (Table 5). Available phosphorus ($r= 0.757$; $P<0.05$) showed positive correlation and electrical conductivity ($r=- 0.963$; $P<0.01$) and cation exchange capacity ($r= -0.813$; $P<0.05$) showed negative correlation. Similar work was done by Sahu *et al.* (2013) who reported pH was significantly correlated with fungal dynamics. The effect of temperature, pH, salinity and salinity- temperature interaction for fungi from Sundarban mangrove swamp has also been investigated by Jaitly (1982) and Jaitly & Rai (1982).

The present study clearly exhibited that the physico – chemical parameters influenced the diversity and distribution of fungi in mangrove environment. Findings of this study revealed that Karankadu mangrove soils are the potential source for fungal diversity.

Acknowledgement

The authors gratefully acknowledge the Secretary and Correspondence of Jamal Mohamed College (Aut.), Trichy - 620 020 for the permission to carry out the research work in the college of excellence.

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