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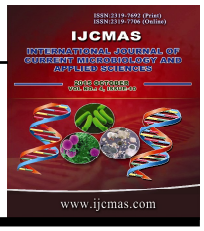

Original Research Article

Diversity and Seasonal Variation of Soil Fungi Isolated from Coastal Area of Tuticorin Dt., Tamil Nadu, India

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A B S T R A C T

In the present investigation totally 42 species of fungi belonging to 16 genera were isolated by plating techniques, identified and enumerated from coastal area of Tuticorin Dt. in the year of 2012–2013. Among them Deuteromycetes were represented by 97.62% and Phycomycetes were 2.38%. The maximum number of fungal species isolated from coastal area of Tuticorin (17 species) followed by Punnakayal (16 species) and Palayakayal (15 species). The seasonal variation of three study stations revealed that there is no uniformity in the diversity of marine fungi and their distribution pattern. The relationship between various physico-chemical parameters of soil and total fungal colonies were statistically analyzed and discussed in this manuscript.

K e y w o r d s

Fungi, Coastal area, Deutero-mycetes, Seasonal variation

Introduction

The coastal area is the place where the land meets the sea. A "coastal ecosystem" includes estuaries and coastal waters and lands located at the lower end of drainage basins, where stream and river systems meet the sea and are mixed by tides. The world's coastline is 312,000 km long and India's coastline is 7,500 km. The total area of Tuticorin Coastal Zone is 1488.62 sq km. The coastal belt comprises of a wide range of ecosystems extending from sandy beaches, mangroves to coral reefs and rocky shores (Gattuso and Smith, 2011).

Fungi being ubiquitous organisms occur in all types of habitats and are the most adaptable organisms. Fungi are one of the important microbial components of the soil. Diversity and distribution of soil fungi have been studied by several mycologists in India. Seasonal variations affect the distribution of fungi of particular area. Number and types of fungal species change with the season, geographical location and the presence of local spore sources.

Marine fungi have proven to be a rich and promising source of novel antibacterial, antioxidant, anticancer, antiplasmodial, anti-inflammatory and antiviral agents (Daferner *et al.,* 2002; Abdel-Lateff *et al.,* 2003; Mathan *et al.,* 2011; Ya-Nan *et al.,* 2011;

Khouloud and Yousry, 2012). Many of these fungi had been proven to be rich source of structurally novel and biologically active secondary metabolites, which are emerging as a significant new chemical resource for drug discovery. The productions of these unique secondary metabolites by marine fungi are possibly because of adaptation to a very distinct set of environmental pressures (Jensen and Fenical, 2002; Blunt *et al.*, 2003; Shang *et al.*, 2012; Swathi *et al.*, 2013).

The diversity of soil fungi in coastal ecosystem has been studied by many workers notably Migahed (2003), Figueira and Barata (2007), Panda (2010), Babu *et al.* (2010) Thennarasu *et al.* (2011), Behera *et al.* (2012) and Anitha and Nayak, (2014). However there are no reports available on soil fungi in Tuticorin coastal area. Hence the present investigation was deliberated to study the diversity of soil fungi in Tuticorin coastal ecosystem.

Materials and Methods

Study site

Tuticorin Coast, the present study area is located in the south eastern part of coastal zone of Tamil Nadu State, India. It lies between 8°41'49" N and 9°22'20" N latitudes and 78°3'56" E and 79°26'6" E longitudes.

Collection of soil samples

The soil samples were collected seasonally from three different coastal areas of Palayakayal, Punnakayal and Tuticorin (Figure 1). In each sampling station, the soil samples were collected at a depth within 10 cm using a metal spatula. The spatula was sterilized every time with 70 per cent alcohol. At each station 5 to 7 samples were collected randomly and were pooled together. The samples were kept in sterilized polythene bags, sealed and transported to the laboratory.

Isolation of soil fungi

The soil mycoflora were isolated by the method of Warcup (1950). Soil sample weighed 1g was diluted in 10 ml of 50% seawater (1:1 v/v seawater (30 ppt): distilled water). One ml of the diluted sample (10^{-2} and 10^{-3}) was poured and spreaded on the petriplates containing sterilized PDA medium (Potato - 200 gms, dextrose-20 gms, agar -15 gms, distilled water -500 ml, sea water - 500ml, pH -6.5) supplemented with one percent streptomycin sulphate solution for preventing bacterial growth in replicates. The inoculated plates were incubated in a dust free cupboard at the room temperature (24±2°C) 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.

Fungal morphology were studied macroscopically by observing colour and texture and microscopically by staining with lactophenol cotton blue and observed under Nikon phase contrast microscope (Nikon, Japan) for the conidia, conidiophores and arrangement of spores (Aneja, 2001).

Identification

The identification of the fungi taxa followed as the standard manuals of fungi such as a manual of Penicillia (Raper and Thom, 1949), manual of soil fungi (Gillman, 1957), manual of *Aspergillus* (Raper and Fennell, 1965), Hyphomycetes (Subramanian, 1971), Dematiaceous hyphomycetes (Ellis, 1971, 1976), The higher fungi (Kohlmeyer and Kohlmeyer, 1979) and Soil fungi (Domsch *et al.*, 1980).

Presentation of data

Percentage of contribution and percentage of frequency of fungal isolates were calculated by using the following formulas.

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

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

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.

Physico-chemical analysis of soil

The physico-chemical parameters of collected soil samples were analyzed by standard methods (APHA, 1989). The analysis of physico-chemical parameters of the soil samples were done at Soil Testing Laboratory, Department of Agriculture, Government of Tamil Nadu, Tiruchirappalli-20.

Statistical analysis

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

Results and Discussion

Study of marine fungal diversity plays a vital importance to the understanding of the different processes of the marine environment, which will help to identify potential fungal organisms with novel bioactive compounds (Swathi *et al.*, 2013).

In the present study, totally 42 species of fungi belonging to 16 genera were isolated by plating techniques, identified and enumerated from coastal area of Tuticorin Dt. in the year of 2012–2013. Among them Deuteromycetes were represented by 97.62% and Phycomycetes were 2.38%. Ascomycetes and Basidiomycetes were entirely absent in the study stations. Our results are agreement with the findings of Anitha and Nayak (2014) who reported that 22 species belong to 10 genera were Deuteromycetes among the 29 fungal species isolated from coastal areas of Puducherry and Karaikal region.

In the present investigation, Aspergilli were seems to be the predominant genera with 19 species. The genus *Fusarium* was represented by four species followed by *Curvularia* and *Penicillium* were represented by three species each (Table 1). Previously, Babu *et al.* (2010) recorded Aspergilli and Penicillia were predominant genera from South East Coast of India. Madhanraj *et al.* (2010) also reported that *Aspergillus* was dominant genera among the 24 fungal species isolated from Tamil Nadu Coast.

The maximum number of fungal species isolated from coastal area of Tuticorin (17 species) followed by Punnakayal (16 species) and Palayakayal (15 species). Figure 2 demonstrated that the seasonal variation of fungal isolates in the study stations. *Aspergillus fumigatus*, *A. glaucus*, *A. ustus* and *Fusarium oxysporum* were commonly isolated from two stations such as Punnakayal and Tuticorin. *Bipolaris* sp. isolated from Palayakayal and Punnakayal stations. The percentage contribution of fungal isolates from three study stations was analyzed (Table 2, 3 & 4).

Table.1 List of isolated mycoflora from coastal soils of Tuticorin Dt. in the year of 2012 -2013

S. No.	Isolated soil mycoflora
1.	*Acrocylindrium oryzae*
2.	*Alternaria fasciculata*
3.	*Aspergillus awamori*
4.	*A. conicus*
5.	*A. citrisporus*
6.	*A. flavipes*
7.	*A. flavus*
8.	*A. fumigatus*
9.	*A. fuscus*
10.	*A. nidulans*
11.	*A. niger*
12.	*A. glaucus*
13.	*Aspergillus* sp.
14.	*A. spinulosum*
15.	*A. sydowii*
16.	*A. terreus*
17.	*A. thomii*
18.	*A. unguis*
19.	*A. ustus*
20.	*A. variegatus*
21.	*A. versicolor*
22.	*Bipolaris* sp.
23.	*Chaetomium globosum*
24.	*Curvularia geniculata*
25.	*C. lunata*
26.	*Curvularia* sp.
27.	*Gliocladium* sp.
28.	*Fusarium moniliforme*
29.	*Fusarium equiseti*
30.	*F. oxysporum*
31.	*Fusarium* sp.
32.	*Helminthosporium oryzae*
33.	*Helminthosporium* sp.
34.	*Humicola* sp.
35.	*Myrothecium verrucaria*
36.	*Penicillium granulatum*
37.	*P. janthinellum*
38.	*Penicillium* sp.
39.	*Rhizopus stolonifer*
40.	*Syncephalastrum* sp.
41.	*Trichoderma polysporum*
42.	*Verticillium* sp.

Table.2 Total number of colonies, mean density (CFU/g) and percentage contribution of fungi from Palayakayal in the year of 2012-2013

S. No.	Name of Organism	Post monsoon (Jan, Feb, Mar)		Summer (Apr, May, June)		Premonsoon (July, Aug, Sep)		Monsoon (Oct, Nov, Dec)		Total no of colonies	% of Contribution
		TNC	MD	TNC	MD	TNC	MD	TNC	MD		
1.	*Acrocylindrium oryzae*	1	0.33	1	0.33	1	0.33	1	0.33	4	5.13
2.	*Aspergillus awamori*	1	0.33	3	1	2	0.66	-	-	6	7.69
3.	*A. conicus*	1	0.33	1	0.33	1	0.33	1	0.33	4	5.13
4.	*A. fuscus*	2	0.66	1	0.33	2	0.66	1	0.33	6	7.69
5.	*A. fumigatus*	3	1	-	-	-	-	3	1	6	7.69
6.	*A. niger*	3	1	3	1	-	-	1	0.33	7	8.97
7.	*A. spinulosum*	-	-	1	0.33	1	0.33	1	0.33	3	3.85
8.	*A. unguis*	-	-	1	0.33	1	0.33	1	0.33	3	3.85
9.	*Bipolaris* sp.	2	0.66	-	-	1	0.33	1	0.33	4	5.13
10.	*Chaetomium globosum*	3	1	-	-	3	1	-	-	6	7.69
11.	*Curvularia geniculata*	2	0.66	-	-	1	0.33	1	0.33	4	5.13
12.	*Helminthosporium oryzae*	3	1	-	-	3	1	1	0.33	7	8.97
13.	*Penicillium granulatum*	1	0.33	1	0.33	1	0.33	1	0.33	4	5.13
14.	*Penicillium* sp.	-	-	3	1	1	0.33	2	0.66	6	7.69
15.	*Rhizopus stolonifer*	2	0.66	2	0.66	2	0.66	2	0.66	8	10.26
		24	**7.96**	**17**	**5.64**	**20**	**6.62**	**17**	**5.62**	**78**	**100**

TNC – Total Number of Colonies; MD – Mean Density

Table.3 Total number of colonies, mean density (CFU/g) and percentage contribution of fungi from Punnakayal in the year of 2012-2013

S. No.	Name of Organism	Post monsoon (Jan, Feb, Mar)		Summer (Apr, May, June)		Premonsoon (July, Aug, Sep)		Monsoon (Oct, Nov, Dec)		Total No. of colonies	% of Contribution
		TNC	MD	TNC	MD	TNC	MD	TNC	MD		
1.	*Alternaria fasciculata*	3	1	3	1	3	1	1	0.33	10	10.87
2.	*Aspergillus flavus*	3	1	-	-	3	1	1	0.33	7	7.61
3.	*A. fumigates*	2	0.66	1	0.33	-	-	3	1	6	6.52
4.	*A. nidulans*	-	-	3	1	2	0.66	1	0.33	6	6.52
5.	*A. glaucus*	1	0.33	1	0.33	1	0.33	1	0.33	4	4.35
6.	*Aspergillus* sp.	1	0.33	1	0.33	1	0.33	-	-	3	3.26
7.	*A. sydowi*	1	0.33	-	-	-	-	1	0.33	2	2.17
8.	*A. thomii*	1	0.33	1	0.33	2	0.66	1	0.33	5	5.43
9.	*A. ustus*	-	-	-	-	2	0.66	2	0.66	4	4.35
10.	*A. variegatus*	1	0.33	1	0.33	1	0.33	1	0.33	4	4.35
11.	*Bipolaris* sp.	-	-	2	0.66	2	0.66	2	0.66	6	6.52
12.	*Curvularia lunata*	2	0.66	2	0.66	2	0.66	2	0.66	8	8.70
13.	*Fusarium moniliforme*	3	1	2	0.66	3	1	2	0.66	10	10.87
14.	*F. oxysporum*	-	-	-	-	3	1	3	1	6	6.52
15.	*Myrothecium verrucaria*	1	0.33	1	0.33	1	0.33	1	0.33	4	4.35
16.	*Syncephalastrum* sp.	2	0.66	1	0.33	2	0.66	2	0.66	7	7.61
		21	**6.96**	**19**	**6.29**	**28**	**9.28**	**24**	**7.94**	**92**	**100**

TNC – Total Number of Colonies; MD – Mean Density

Table.4 Total number of colonies, mean density (CFU/g) and percentage contribution of fungi from Tuticorin in the year of 2012 -2013

S. No.	Name of Organism	Post monsoon		Summer		Premonsoon		Monsoon		Total No of	% of Contribution
		TNC	MD	TNC	MD	TNC	MD	TNC	MD		
1.	*Aspergillus citrisporus*	3	1.00	1	0.33	2	0.67	2	0.67	8	9.76
2.	*A. flavus*	3	1.00	-	-	1	0.33	-	-	4	4.88
3.	*A. flavipes*	2	0.67	-	-	1	0.33	-	-	3	3.66
4.	*A. glaucus*	1	0.33	1	0.33	1	0.33	1	0.33	4	4.88
5.	*A. ustus*	-	-	1	0.33	1	0.33	1	0.33	3	3.66
6.	*A. terreus*	-	-	2	0.67	2	0.67	2	0.67	6	7.32
7.	*A. versicolor*	3	1.00	2	0.67	1	0.33	-	-	6	7.32
8.	*Curvularia* sp.	2	0.67	2	0.67	2	0.67	3	1.00	9	10.98
9.	*Gliocladium* sp.	1	0.33	1	0.33	1	0.33	1	0.33	4	4.88
10.	*Fusarium* sp.	1	0.33	1	0.33	-	-	1	0.33	3	3.66
11.	*Fusarium equiseti*	-	-	2	0.67	2	0.67	-	-	4	4.88
12.	*F. oxysporum*	3	1.00	-	-	2	0.67	1	0.33	6	7.32
13.	*Helminthosporium* sp.	2	0.67	1	0.33	-	-	1	0.33	4	4.88
14.	*Humicola sp*	1	0.33	1	0.33	-	-	1	0.33	3	3.66
15.	*Penicillium janthinellum*	1	0.33	2	0.67	1	0.33	2	0.67	6	7.32
16.	*Trichoderma polysporum*	3	1.00	-	-	-	-	3	1.00	6	7.32
17.	*Verticillium* sp.	1	0.33	-	-	1	0.33	1	0.33	3	3.66
		27	**9**	**17**	**5.67**	**18**	**6**	**20**	**6.67**	**82**	**100**

TNC – Total Number of Colonies; MD – Mean Density

Table.5 Percentage frequency and frequency class of different species of fungi recorded at three stations (n=24) in the year of 2012-2013

S. No.	Name of organisms	Palayakayal			Punnakayal			Tuticorin		
		No. of season in which the fungus occurred	Percentage frequency	Frequency class	No. of season in which the fungus occurred	Percentage frequency	Frequency class	No. of season in which the fungus occurred	Percentage frequency	Frequency class
1.	*Acrocylindrium oryzae*	4	100	C						
2.	*Alternaria fasciculata*				4	100	C			
3.	*Aspergillus awamori*	3	75	F						
4.	*A. conicus*	4	100	C						
5.	*A. citrisporus*							4	100	C
6.	*A. flavipes*							2	50	O
7.	*A. flavus*				3	75	F	2	50	O
8.	*A. fumigatus*	2	50	O	3	75	F			
9.	*A. fuscus*	4	100	C						
10.	*A. nidulans*				3	75	F			
11.	*A. niger*	3	75	F						
12.	*A. glaucus*				4	100	C	4	100	C
13.	*Aspergillus* sp.				3	75	F			
14.	*A. spinulosum*	3	75	F						
15.	*A. sydowii*				2	50	O			
16.	*A. terreus*							3	75	F
17.	*A. thomii*				4	100	C			
18.	*A. unguis*	3	75	F						
19.	*A. ustus*				2	50	O	3	75	F
20.	*A. variegatus*				4	100	C			

21.	*A. versicolor*							3	75	F
22.	*Bipolaris* sp.	3	75	F	3	75	F			
23.	*Chaetomium globosum*	2	50	O						
24.	*Curvularia geniculata*	3	75	F						
25.	*C. lunata*				4	100	C			
26.	*Curvularia* sp.							4	100	C
27.	*Gliocladium* sp.							4	100	C
28.	*Fusarium* sp.							3	75	F
29.	*Fusarium equiseti*							2	50	O
30.	*Fusarium moniliforme*				4	100	C			
31.	*F. oxysporum*				2	50	O	3	75	F
32.	*Helminthosporium oryzae*	3	75	F						
33.	*Helminthosporium* sp.							3	75	F
34.	*Humicola* sp.							3	75	F
35.	*Myrothecium verrucaria*				4	100	C			
36.	*Penicillium granulatum*	4	100	C						
37.	*P. janthinellum*							4	100	C
38.	*Penicillium* sp.	3	75	F						
39.	*Rhizopus stolonifer*	4	100	C						
40.	*Syncephalastrum* sp.				4	100	C			
41.	*Trichoderma polysporum*							2	50	O
42.	*Verticillium* sp.							3	75	F

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

Table.6 Physico – chemical characteristics of the soil samples collected from Palayakayal

S. No.	Name of the Parameters	Palayakayal (2012-2013)			
		Post monsoon	**Summer**	**Pre monsoon**	**Monsoon**
1	pH	8.26	8.45	8.16	8.16
2	Salinity	32	34	31	30
3	EC (dsm^{-1})	2.69	2.95	2.45	2.36
4	Organic Carbon (%)	0.25	0.24	0.26	0.32
5	Organic Matter (%)	0.62	0.45	0.64	0.53
6	Available Nitrogen (%)	0.786	0.723	0.819	0.894
7	Available Phosphorus (%)	0.199	0.194	0.205	0.201
8	Available Potassium (%)	0.827	0.816	0.915	0.889
9	Available Zinc (ppm)	0.89	0.84	1.28	1.12
10	Available Copper (ppm)	0.69	0.62	0.54	0.76
11	Available Iron (ppm)	4.50	4.23	4.56	4.47
12	Available Manganese (ppm)	2.15	2.19	2.54	2.58
13	Cat ion exchange capacity (C. Mole $Proton^{+}$ / kg)	20.10	19.8	20.5	21.6
14	Calcium (C. Mole $Proton^{+}$ / kg)	16.8	16.3	14.5	12.5
15	Magnesium (C. Mole $Proton^{+}$ / kg)	7.6	7.9	7.4	7.2
16	Sodium (C. Mole $Proton^{+}$ / kg)	1.35	1.45	1.03	1.08
17	Potassium (C. Mole $Proton^{+}$ / kg)	0.15	0.19	0.22	0.26

Table.7 Physico – chemical characteristics of the soil samples collected from Punnakayal

S. No.	Name of the Parameters	Punnakayal (2012-2013)			
		Post monsoon	Summer	Pre monsoon	Monsoon
1	pH	8.50	8.59	8.46	8.53
2	Salinity	29	32	30	28
3	EC (dsm^{-1})	1.80	1.96	1.89	1.85
4	Organic Carbon (%)	0.20	0.18	0.21	0.25
5	Organic Matter (%)	0.40	0.35	0.42	0.50
6	Available Nitrogen (%)	0.859	0.813	0.924	0.756
7	Available Phosphorus (%)	0.169	0.149	0.185	0.193
8	Available Potassium (%)	0.749	0.729	0.816	0.762
9	Available Zinc (ppm)	1.20	1.16	1.32	1.89
10	Available Copper (ppm)	0.87	0.82	0.92	0.75
11	Available Iron (ppm)	4.90	4.89	4.96	4.58
12	Available Manganese (ppm)	2.43	2.36	2.48	2.46
13	Cat ion exchange capacity (C. Mole $Proton^{+}$ / kg)	22.7	22.3	24.5	23.5
14	Calcium (C. Mole $Proton^{+}$ / kg)	12.7	15.5	13.9	10.5
15	Magnesium (C. Mole $Proton^{+}$ / kg)	7.8	7.9	7.5	7.1
16	Sodium (C. Mole $Proton^{+}$ / kg)	1.34	1.45	1.09	1.07
17	Potassium (C. Mole $Proton^{+}$ / kg)	0.25	0.28	0.21	0.26

Table.8 Physico – chemical characteristics of the soil samples collected from Tuticorin

S. No.	Name of the Parameters	Tuticorin (2012-2013)			
		Post monsoon	Summer	Pre monsoon	Monsoon
1.	pH	8.56	8.76	8.21	8.16
2.	Salinity	29	35	32	31
3.	EC (dsm^{-1})	2.36	2.59	2.45	2.23
4.	Organic Carbon (%)	0.32	0.23	0.35	0.26
5.	Organic Matter (%)	0.47	0.41	0.48	0.45
6.	Available Nitrogen (%)	0.856	0.659	0.789	0.834
7.	Available Phosphorus (%)	0.206	0.199	0.227	0.232
8.	Available Potassium (%)	0.915	0.816	0.829	0.869
9.	Available Zinc (ppm)	1.08	0.08	1.15	1.06
10.	Available Copper (ppm)	0.95	0.47	0.86	0.68
11.	Available Iron (ppm)	5.69	4.25	4.56	4.36
12.	Available Manganese (ppm)	2.59	1.74	1.96	1.85
13.	Cat ion exchange capacity (C. Mole $Proton^{+}$ / kg)	22.9	24.1	20.6	25.4
14.	Calcium (C. Mole $Proton^{+}$ / kg)	14.2	14.5	14.2	14.0
15.	Magnesium (C. Mole $Proton^{+}$ / kg)	7.5	7.9	7.4	7.3
16.	Sodium (C. Mole $Proton^{+}$ / kg)	1.20	1.45	1.36	1.34
17.	Potassium (C. Mole $Proton^{+}$ / kg)	0.26	0.34	0.31	0.28

Table.9 Correlation of physico – chemical and total number of colony characteristics of the soil samples of Palayakayal in the year of 2012 -2013

	PH	SA	EC	OC	OM	AN	AP	AK	AZ	AC	AI	AM	CEC	CA	MG	NA	K	TFC
PH	1																	
SA	0.967*	1																
EC	0.973*	0.990**	1															
OC	-0.660	-0.828	-0.795	1														
OM	-0.721	-0.535	-0.545	-0.021	1													
AN	-0.886	-0.975*	-0.954*	0.932	0.339	1												
AP	-0.929	-0.822	-0.872	0.401	0.807	0.687	1											
AK	-0.852	-0.812	-0.886	0.561	0.508	0.742	0.917	1										
AZ	-0.833	-0.768	-0.849	0.476	0.553	0.679	0.932	0.995**	1									
AC	-0.147	-0.347	-0.226	0.661	-0.258	0.494	-0.230	-0.212	-0.302	1								
AI	-0.924	-0.808	-0.811	0.346	0.930	0.660	0.920	0.708	0.720	-0.029	1							
AM	-0.778	-0.823	-0.882	0.760	0.234	0.828	0.758	0.943	0.908	0.016	0.521	1						
CEC	-0.752	-0.892	-0.872	0.989*	0.097	0.969*	0.528	0.671	0.594	0.566	0.456	0.832	1					
CA	0.684	0.813	0.833	-0.925	0.062	-0.889	-0.544	-0.773	-0.707	-0.339	-0.354	-0.935	-0.950*	1				
MG	0.949	0.997**	0.990**	-0.862	-0.472	0.986*	-0.799	-0.822	-0.774	-0.358	-0.763	-0.856	-0.921	0.857	1			
NA	0.916	0.895	0.949	-0.659	-0.531	-0.836	-0.925	-0.987*	-0.971*	0.064	-0.760	-0.948	-0.760	0.817	0.903	1		
K	-0.516	-0.650	-0.694	0.827	-0.172	0.742	0.431	0.732	0.672	0.201	0.163	0.914	0.846	-0.967*	-0.707	-0.741	1	
TFC	-0.202	-0.029	0.021	-0.405	0.758	-0.136	0.231	-0.175	-0.125	-0.080	0.541	-0.435	-0.357	0.559	0.050	0.130	-0.734	1

TFC - Total Fungal Colony, SA - Salinity, 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 - Cat ion exchange capacity, CA - Calcium, MG - Magnesium, NA - Sodium, K – Potassium

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

Table.10 Correlation of Physico – chemical and total number of colony characteristics of the soil samples of Punnakayal in the year of 2012 -2013

	PH	SA	EC	OC	OM	AN	AP	AK	AZ	AC	AI	AM	CEC	CA	MG	NA	K	TFC
PH	1																	
SA	0.499	1																
EC	0.567	0.852	1															
OC	-0.310	-0.862	-0.469	1														
OM	-0.361	-0.884	-0.510	0.998**	1													
AN	-0.697	0.255	-0.025	-0.436	-0.393	1												
AP	-0.664	-0.834	-0.523	0.909	0.927	-0.022	1											
AK	-0.865	-0.267	-0.135	0.341	0.372	0.654	0.684	1										
AZ	-0.056	-0.731	-0.275	0.963*	0.946	-0.626	0.782	0.166	1									
AC	-0.646	0.296	-0.034	-0.515	-0.471	0.994**	-0.113	0.566	-0.701	1								
AI	-0.267	0.630	0.232	-0.827	-0.798	0.866	-0.518	0.215	-0.927	0.907	1							
AM	-0.881	-0.734	-0.559	0.711	0.745	0.320	0.938	0.851	0.517	0.236	-0.194	1						
CEC	-0.802	-0.372	-0.137	0.513	0.536	0.479	0.795	0.977*	0.365	0.378	0.009	0.892	1					
CA	0.295	0.968*	0.728	-0.925	-0.932	0.475	-0.803	-0.133	-0.857	0.519	0.804	-0.622	-0.279	1				
MG	0.305	0.747	0.295	-0.977*	-0.970*	0.379	-0.912	-0.441	-0.958*	0.473	0.782	-0.720	-0.616	0.821	1			
NA	0.649	0.684	0.325	-0.851	-0.864	-0.053	-0.973*	-0.779	-0.744	0.051	0.443	-0.923	-0.887	0.664	0.904	1		
K	0.951*	0.265	0.285	-0.192	-0.236	-0.797	-0.583	-0.958*	0.030	-0.733	-0.390	-0.819	-0.886	0.075	0.252	0.640	1	
TFC	-0.824	-0.399	-0.176	0.520	0.546	0.486	0.806	0.979*	0.365	0.387	0.010	0.908	0.999**	-0.299	-0.616	-0.890	-0.896	1

TFC - Total Fungal Colony, SA - Salinity, 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 - Cat ion exchange capacity, CA - Calcium, MG - Magnesium, NA - Sodium, K – Potassium

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

Table.11 Correlation of Physico – chemical and total number of colony characteristics of the soil samples of Tuticorin in the year of 2012 -2013

	PH	SA	EC	OC	OM	AN	AP	AK	AZ	AC	AI	AM	CEC	CA	MG	NA	K	TFC
PH	1																	
SA	0.401	1																
EC	0.710	0.763	1															
OC	-0.446	-0.584	-0.181	1														
OM	-0.643	-0.765	-0.496	0.944	1													
AN	-0.612	-0.968*	-0.870	0.584	0.804	1												
AP	-0.993**	-0.309	-0.688	0.343	0.546	0.535	1											
AK	-0.080	-0.923	-0.668	0.295	0.472	0.827	0.022	1										
AZ	-0.791	-0.842	-0.759	0.774	0.939	0.925	0.714	0.572	1									
AC	-0.394	-0.867	-0.451	0.904	0.944	0.828	0.280	0.675	0.862	1								
AI	0.181	-0.798	-0.248	0.537	0.544	0.626	-0.291	0.854	0.455	0.790	1							
AM	0.126	-0.828	-0.292	0.566	0.584	0.667	-0.237	0.867	0.504	0.818	0.998**	1						
CEC	0.135	0.095	-0.348	-0.850	-0.636	-0.069	-0.058	0.164	-0.346	-0.578	-0.269	-0.276	1					
CA	0.867	0.728	0.963*	-0.354	-0.640	-0.872	-0.840	-0.534	-0.863	-0.526	-0.167	-0.219	-0.139	1				
MG	0.922	0.722	0.872	-0.555	-0.788	-0.870	-0.880	-0.455	-0.943	-0.645	-0.190	-0.245	0.109	0.968*	1			
NA	0.153	0.964*	0.587	-0.565	-0.685	-0.867	-0.050	-0.953*	-0.702	-0.862	-0.928	-0.945	0.141	0.520	0.518	1		
K	0.369	0.981*	0.828	-0.417	-0.638	-0.953*	-0.292	-0.956*	-0.771	-0.754	-0.748	-0.777	-0.100	0.751	0.697	0.937	1	
TFC	0.097	-0.872	-0.471	0.364	0.466	0.728	-0.190	0.968*	0.484	0.711	0.952*	0.955*	0.011	-0.341	-0.295	-0.962*	-0.877	1

TFC - Total Fungal Colony, SA - Salinity, 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 - Cat ion exchange capacity, CA - Calcium, MG - Magnesium, NA - Sodium, K – Potassium

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

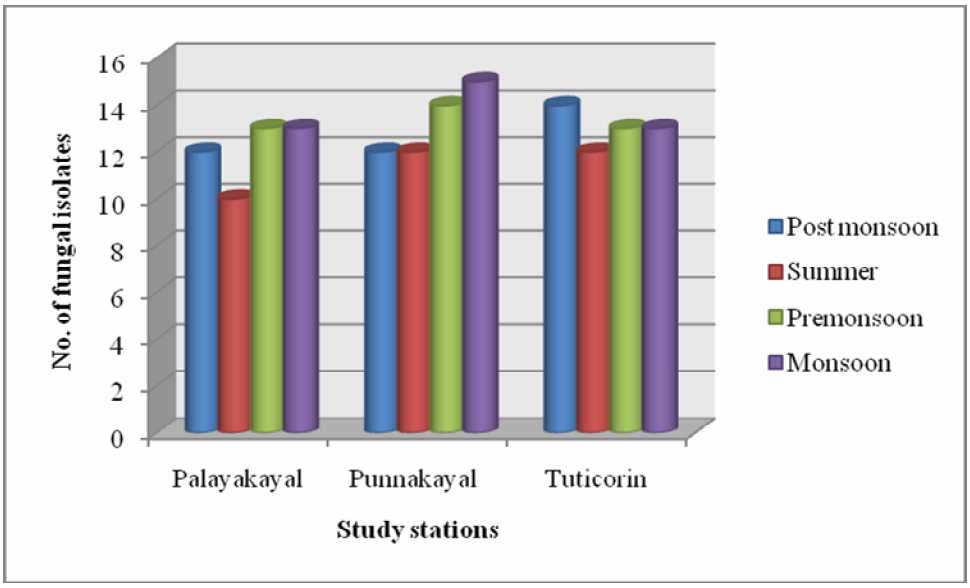
Figure.1 Study site & Collection of soil from coastal area of Tuticorin Dt**.**

Palayakayal

Punnakayal

Tuticorin

Figure.2 Seasonal variation of fungal isolates in the study stations



The maximum percentage of contribution was found with *Rhizopus stolonifer* (10.26%), *Alternaria fasciculata, Fusarium moniliforme* (10.87%), *Curvularia* sp. (10.98%) from Palayakayal, Punnakayal and Tuticorin stations respectively.

At Palayakayal station, *Acrocylindrium oryzae, Aspergillus conicus, A. fuscus, Penicillium granulatum* and *Rhizopus stolonifer* were the common one, which showed 100% frequency. At Punnakayal station, *A. flavus, A. fumigatus, A. nidulans, Aspergillus* sp. and *Bipolaris* sp. (75% each). were frequently isolated. *A. flavipes, A. flavus, Fusarium equiseti* and *Trichoderma polysporum* were occasionally isolated from Tuticorin station (Table 5).

Aspergilli formed in the bulk which together contributed maximum percentage. The dominance of Aspergilli in any kind of coastal or marine soils was reported as unique feature but several investigations have identified different species of *Aspergillus* as dominant one in different regions (Upadhyay *et al.,* 1978; Prabhakaran *et al.,* 1987; Prabhu *et al.,* 1991; Nadimuthu, 1998; Madhanraj *et al.,* 2010; Babu *et al.,* 2010; Thennarasu *et al.,* 2011; Anitha and

Nayak, 2014). Evidently, the tolerance and adaptive mechanism of *Aspergillus* to varying marine environmental characteristics were reported by Pawar and Thirumalachar (1966); Subramanian and Raghukumar (1974). Dominance of the genus *Aspergillus* in coastal marine habitats may be due to their greater rate of spore production, dispersal, partly due to their resistance over extreme environmental conditions and their suitability to grow in higher saline concentration.

All the soil samples analyzed during the research period of this study from all the stations were alkaline in nature. The pH of soil was ranged from 8.16 to 8.76. The major and minor elements such as nitrogen, phosphorus, potassium, zinc, copper, iron and manganese were showed variations in the study stations (Table 6, 7 & 8). Alkaline condition has been explained as the characteristic feature of marine soils (Nadimuthu, 1998). Marine habitats such as coastal and brackish environs (Subramanian and Raghukumar, 1974) sand dunes (Upathyay *et al.*, 1978) and mangroves soils (Tam *et al.*, 1995; Tam and Wong, 1998; Saravanakumar *et al.*, 2008; Latiffah *et al.*, 2010; Anitha and Nayak, 2014) showed alkaline conditions as reported in the present study.

In the present study, electrical conductivity was recorded in the range between 1.80 to 2.95dsm^{-1}. This was comparatively lower than the marine sediments of Madras coast (Subramanian and Ragukumar, 1974) and mangrove areas of Andaman (Chandhuri *et al.*, 2009).

The relationship between various physico-chemical parameters of soil and total fungal colonies were statistically analyzed (Table 5). Available potassium (r=0.979; P<0.05) and cat ion exchange capacity (r=0.999; P<0.01) showed positive correlation at Palayakayal station. At Tuticorin station, available potassium (r=0.968; P<0.05), available iron (r=0.952; P<0.05) and available manganese (r=0.955; P<0.05) showed positive correlation (Table 9, 10 & 11). Similar work was done by Madhanraj *et al.* (2010) who reported correlation analysis between physico – chemical parameters and fungal population revealed electrical conductivity (r = 0.338; P < 0.1) showed positive correlation. Recently, Anitha and Nayak (2014) reported that there is no significant relationship with physico chemical parameters and fungal population in the soils of Tamilnadu coast.

The overall investigation could be concluded that there is no uniformity in the diversity and distribution of marine fungi. Diversity of fungi are often influenced by the available nutrients and other physico - chemical conditions of the coastal ecosystems.

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