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J. Sci. Trans. Environ. Technov. 2012, 5(3) :147-155

Scientific Transactions in Environment and Technovation

Diversity and distribution of soil micro fungi from different evergreen forest types of Tamil Nadu, Southern India.

K. Saravanakumar[1*], V. Kaviyarasan[1]

[1]Centre for Advanced Studies in Botany, Mycology Lab, University of Madras, Chennai - 600 025, Tamil Nadu, India.

Abstract

The fungal diversity of natural soils was monitored over two seasons (before and after summer rainfalls) in three types of Tropical Evergreen forest types *viz.*, Wet Evergreen Forest, Semi Evergreen Forest and Dry Evergreen Forest of Tamil Nadu, Southern India. Of the 64 soil samples examined 71 taxa belonging to seventeen genera were isolated. Majority of fungi belonged to *Hyphomycetes* followed by *Zygomycetes, Ascomycetes* and *Coelomycetes*. *Penicillium* and *Aspergillus* were the most dominant genera in all the three forest types. The diversity indices of forest soil fungi for two seasons were 2.57, 2.49; 2.65, 2.21 and 2.78, 2.70 (Shannon-Weineer), 0.87, 0.84; 0.88, 0.81; and 0.91, 0.90 (Simpson index) and 10.51, 11.1; 8.68, 6.04 and 8.38, 7.87 (Fishers's alpha), respectively. The fungal diversity as well as composition differed among the three forest types. The highest fungal flora was recorded in the wet ever green forest, where the soil was rich in macro and micro nutrients. Most of the fungi were common in all three types of forests.

Keywords: fungal diversity, fungal flora, natural soil, soil fungi, seasonal distribution

INTRODUCTION

Soil is the outer covering of the earth, which consists of loosely arranged layers of materials composed of inorganic and organic compounds in different stages (Tate 1995; Kapoor *et al*., 2002). It is a natural medium in which microbes live, multiply and die. Microbial diversity in the soil is a critical environmental topic that concerns people from all walks of life. Interest in microbial diversity has grown rapidly in the scientific community recently (Wilson 1988; Benizri *et al*., 2002). Increasing attention is being drawn to microorganisms because the fertility of soil depends not only on its chemical composition, but also on the qualitative and quantitative nature of microorganisms inhabiting it. Maintenance of viable, diverse populations and functioning microbial communities in the soil is essential for sustainable agriculture and existence of natural soil (Beare *et al*., 1995; Benizri *et al*., 2002). Soil contains a wide range of microorganisms described as a 'black box' (Paul and Clark 1989), among which, fungi are abundant in soil next to bacteria. Each forest type has its own distinctive features such as soil texture, colour and chemical composition. Soil fungi provide an excellent indicator group for determining changes in ecosystem function arising from natural succession events, climate change, and pollution. Tamil Nadu, India, has vast area of forests which are rich in bio-diversity. Forests are classified in different ways depending on climate, soil type, topography and elevation. Many studies were carried out worldwide on the diversity of micro fungi and yeasts in agricultural or cultivated soil (Baath, 1981; Kok *et al*., 1984;Vishniac, 1996; Sampo *et al*., 1997; Persiani *et al*., 1998; Benkova, 1999; Buckova *et al*., 2000; Cabello and Arambarri, 2002), but least in natural soils and particularly in India there are very few studies on micro fungi of forests. The present study was undertaken to investigate soil nutrients and soil mycoflora of three forest soils *viz*., Tropical Wet Evergreen, Semi Evergreen and Dry Evergreen forests in Tamil Nadu, South India.

METHODS

Study site and location

Tropical Wet Evergreen forest *ie.*, Marian Shola of Nilgiris and Anaikundhi Shola of Pollachi, South India situated at an elevation of 2000 to 2,980 metres above MSL was selected for study. During summer the temperature ranges in the forests between of 11°C to 15°C and reaches a minimum of 2°C to 5°C. During winter the temperature reaches a maximum of -2°C to 12°C and a minimum of -12°C. Canopy is extremely dense without any stratification, generally climbers are not conspicuous, epiphytes are numerous and ground vegetation almost absent.

Tropical Semi Evergreen forest in the Minchikuli Valley, Erode District located on the Eastern slopes of Tamil Nadu (250 – 550 m) with rain fall of 1900 to 2500 mm was investigated. The vegetation includes evergreen, deciduous species and buttressed stems of evergreen trees. It occurs over limited areas where moisture is adequate.

Tropical Dry Evergreen forests are situated at an elevation of 1800 metres. The canopy consists of short boles, spreading crown and numerous climbers. Tropical dry evergreen forests located on the East coast

*Corresponding Author
email: *subhulakshmisaravanan@gmail.com*

from Tamil Nadu especially in low hills and lateritic soil, with an annual rainfall of 1200 mm was studied.The samples were obtained from the Kilputhupattu, Kurumbanam and Marakkanam villages of Villupuram District and Guindy National Park of Tamil Nadu.

Methods of the collection of soil samples

The soil samples were collected before and after summer rainfalls during 2007 – 2008, the flora of all the three forest areas remain covered for a long time by plant litter. The method used for taking soil samples was a slight modification of that was described by Goddard (1913). It was slightly modified by Saksena and Mehrotra (1952) for their studies. In the present case, the pit was 12 inches (30 cm) deep instead of 9 inches from surface layer and samples collected from 10 different sites were kept in sterile polythene bags and carried to the laboratory. All random soil samples of each site were mixed to make a single sample for each forest.

Determination of physicochemical properties of soil samples

The pH values, electrical conductivity, soil moisture content, organic carbon, Nitrogen, Phosphorous, Potassium, Iron, Manganese, Copper and Zinc were determined (Table – 1). The macro nutrients such as Nitrogen (Alkali permanganate method), Phosphorous – (Olsen method), Potassium- (Neutral Normal Ammonium Acetate method), organic Carbon – (Walkley and Block method), micro nutrients such as Copper, Iron, Manganese and Zinc were analyzed by DTPA extract method using Atomic Absorption Spectrophotometer.

Isolation of soil mycoflora

The soil micro fungi were enumerated by two methods, namely, Soil dilution method (Waksman 1927), and Soil plate method (Warcup 1950) on two different media such as Czapek's Dox and Rose Bengal Agar at pH 6.5. All the petridishes were incubated at room temperature 27± 3°C for a period of 4 – 7 days are examined.

The first set of observations were made at the end of two days to make sure that the fast growing flocculent types such as *Rhizopus*, *Mucor*, *Trichoderma*, etc., has not grown excessively to interfere with observations of other species. Second observation was made when these had come to an advanced stage to enable identification. Finally, the slow growing organisms has to be sub cultured in different media for the purpose of further growth to save them from being overrun by the more aggressive types. The number of colonies per plate in 1 gram of soil was counted.

Identification

Identification of the organisms was made by microscopic analysis by using taxonomic guides, standard procedures and relevant literature (Raper and Fennel, (1965), Raper and Fennel, (1968), Ellis (1971) and Domsch *et al.*, (1980).

The percent contribution of each isolate was calculated by using the following formula:

$$\frac{\text{Total no. of CFU of an individual species}}{\text{Total no. of CFU of all species}} \text{ X } 100$$

The following indeices were analyzed

Shannon–Wiener index

$$\mathbf{H'} = -\sum_{i=1}^{S} p_i \log_2 p_i$$

Table -1. Nutrient consent during the seasons in different types of Evergreen forest soils studied.

S.NO	MACRO AND MICRO NUTRIENTS	WET EVER GREEN FOREST		SEMI EVER GREEN FOREST		DRY EVER GREEN FOREST	
		I season	II season	I season	II season	I season	II season
1	Soil moisture	14.2	16.70	13.8	14.63	8.6	9.1
2	Soil pH	6.19	6.07	6.192	6.10	6.192	6.19
3	Electrical conductivity (Dsm-1)	0.644	0.061	0.06	0.06	0.115	0.13
4	Nitrogen Kg/ac	65.51	79.67	65.89	67.17	47.49	51.57
5	Organic carbon %	0.40	0.44	0.396	0.49	0.156	0.150
6	P_2O_5 Kg/ac	4.66	5.41	5.16	6.17	1.0	1.33
7	K_2O Kg/ac	141.11	153.33	23.776	31.87	22.77	24.01
8	Iron (ppm conc)	9.7577	11.44	10.8311	13.94	4.0588	7.38
9	Copper (ppm conc)	0.3311	0.380	0.6572	1.02	0.5322	0.55
10	Manganese (ppm conc)	15.2166	22.2	22.8588	28.20	8.5244	11.73
11	Zinc (ppm conc)	0.528	0.551	0.610	0.671	0.340	0.392

Where S is the number of OTUs and p_i *is* the proportion of total samples belonging to the i^{th} OTU. H' varies between 0 and $\log_2$. S is the information content of the relevant sample (units, bits per OTU). H' close to 0 indicates low diversity; whereas a value closes to $\log_2$ and S indicates high diversity.

Simpson's index (modified by Pielou):

$$1 - D = 1 - \sum_{i=1}^{S} - n_i (n_i - 1) / [N (N-1)]$$

Where n_i is the number of individuals in the i^{th} OTU, S *is* the total number of OTUs and N is the total number of individuals. The diversity is minimum when only one OTU exists, i.e., if $ni = N$ for some i and $ni = 0$ otherwise, $1 - D = 0$. It is a maximum when all species are represented equally (each $ni = N/S$). Then $1 - D = (1 - 1/S)$ approximately for large values of N.

Fisher's index ('alpha diversity'): $S = \alpha \ln(1 + N/\alpha)$,

Where S is the number of OTUs in the sample, N is the number of individuals in the sample and α is the Fisher's index of diversity. The assumption here is that the number of OTUs increases logarithmically with the number of individuals. If so, α is a measure of the rate of increase of the number of OTUs with respect to increasing (logarithmic) population size when the size is large.

Evenness index (1) $E = H'/\ln(S)$,

Where H' is the Shannon–Wiener index of diversity and S is the number of OTU.

RESULTS

Soil nutrient analysis

Data on various physic-chemical parameters (soil moisture, pH, and electrical conductivity) as well as macro (N_2, organic carbon, P_2O_5, K_2O,) and micro nutrients (Fe, Mn, Cu, and Zn) of thethree different types of evergreen forests soils were given in Table 1.

It is observed that soil moisture had significantly increased in all the three types of forest after summer rain. The soil pH and electrical conductivity were almost similar in Wet and Semi evergreen forests, whereas in the Dry Evergreen forests the electrical conductivity was too low. When the macro-nutrients are taken into account, organic carbon, nitrogen and potassium were predominant in all the natural soils, but the micro nutrients like Fe, Cu, Mn and Zn were significantly higher in the Semi Evergreen forest. Potassium content of Wet Evergreen forest was relatively higher (141.11 kg/ac) when compared to Semi Evergreen and Dry Evergreen forests.

Wet Evergreen forest

From the two collections carried out from the Wet Evergreen forest seventy one species were recorded. Forty four species assignable to sixteen genera were recorded from Wet Evergreen forest, Mariyan Shola of Nilgiris district and Anaikundhi Shola of Pollachi near Coimbatore. Among these, five species belonged to *Zygomycotina,* one to *Coelomycetes* one to *Ascomycetes* and all the others were members of *Deuteromycotina.* The genus *Penicillium* was represented by more number of species (21) followed by *Aspergillus* (10). The other genera were represented by *Fusarium* (2), *Trichoderma* (4), *Curvularia* (3), and *Paecilomyces* (2) which contributes to the total biodiversity H = 2.571. The fungi are listed in Table 3. The propagules of *Aspergillus niger* (22.98%), were most abundant and it is the most predominant species. This was closely followed by *Trichoderma aeroviride* (17.88%), *Aspergillus japonicaus* and *A. flavus* which occurred third in the order of dominance. Most of the genera occurred in insignificant numbers during first season. In the second season forty five fungi were recorded. Of the total biodiversity (H= 2.497), *Aspergillus niger* (31.91 %) dominated others followed by *Trichoderma aureoviride* (14.85%). *Aspergillus japonicus* (12.94%) and *Fusarium latteritium* (9.41%). *Syncephalastrum racemosum* (0.58%), *Cunninghamella elegans* (0.58%), *Rhizopus stolonifer* (0.29%) *and Absidia cylindrospora* (0.29%) exhibited less representation in the Wet Evergreem forest soil.

Table 2. Various measures of diversity indices over the two seasons for soil microfungi in the forests studied

S.No	Diversity indices	WET EVER GREEN FOREST		SEMI EVER GREEN FOREST		DRY EVER GREEN FOREST	
		Season - I	Season -II	Season - I	Season -II	Season - I	Season -II
1	Taxa_S	44	46	27	24	33	31
2	Dominance_D	0.128	0.152	0.113	0.187	0.0891	0.093
3	Shannon_H	2.57	2.49	2.65	2.21	2.78	2.70
4	Simpson_1-D	0.87	0.84	0.88	0.81	0.91	0.90
5	Evenness_e^H/S	0.29	0.26	0.52	0.37	0.49	0.47
6	Fisher_alpha	10.51	11.1	8.68	6.04	8.38	7.87

Semi Evergreen forest

Out of 12 samples, 36 fungi were recorded from Semi Evergreen forest of Minchikuli valley, Erode district in the first season. Among these, three were *Zygomycetes* and others belonged to *Deuteromycotina*. *Aspergillus niger* was the dominant species which contributed higher than the other genera (25.78 %). This was followed by *Aspergillus flavus, Cladosporium cladosporiodes, Trichoderma* sp.6 *and Penicillium frequentans* which contributed to the total biodiversity H= 2.659 (Table -2). During the second season, six soil samples of Semi Evergreen forest at Minchikuli valley of Erode district were studied. Out of 12 samples, Twenty five species belonging to 9 genera were recorded. These include one species of *Ascomycotina,* two of *Zygomycotina* and remaining twenty two species of *Deuteromycotina. Aspergillus niger* (36.11 %) showed the highest total number of colonies (117X10^3 Total CFU), followed by *Trichoderma* sp.5, *Aspergillus fumigatus* and *Trichoderma harzianum* which constituted 16.04%, 7.40% and 4.93%, respectively, to the total biodiversity (H=2.21). The pathogenic fungi such as *Curvularia, Fusarium, Paecilomyces*, and *Myrothecium* were significantly less. Some fungi such as*Trichurus, Alternaria*, and *Drechslera* were totally absent. The total number of taxa in the forest type was very less when compared to the other two forest types.

Dry EverGreen forest

Twenty soil samples were obtained from Kilputhupattu, Kurumbaram and Marakkanam of Villupuram district, Guindy National Park. In the 20 samples, thirty three species assignable to eleven genera were found. Out of these species one belonged to *Ascomycotina*, four to *Zygomycotina* and others belonged to *Deuteromycotina*. *Aspergillus flavus* was the most dominant species with 16.82 %, and followed by *A. terreus* (14.69 %), *A. ochraceous* (10.19 %), *Penicillium variabile* (9.95%) and *Trichoderma koningii* (8.53 %). *Aspergillus japonicus, A. nidulans* and *A. niger* were represented only 0.47 % to the total biodiversity (H=2.786). Thirty one species assignable to 10 genera were isolated from the second season, and these include one species belonging to *Zygomycotina*, one species of *Ascomycotina* and twenty eight of *Deuteromycotina* contributing to the total biodiversity (H= 2.70). *Penicillium janthinellum* (17.37 %) was the most dominant species, *Aspergillus niger* and *Aspergillus nidulans* (13.39 %) ranked second in the order of dominance followed by *Aspergillus terreus* (8.44 %), *Aspergillus japonicus* (5.96 %), *Trichoderma koningii* (5.7 %) and *Trichoderma* sp.5 (3.72 %). The *Cladosporium cladosporioides, C. oxysporum, Fusarium solani, Alternaria alternata* and *Chaetomium* sp. 1 were absent in the second season.

The diversity indices varied considerably between the three forest types (Table 2). In Dry Evergreen forest, the Simpson index was slightly higher (0.91 and 0.90) than other two forests, and most evenness indices were less for Wet Evergreen forest (Evenness_e^H/S 0.29 and 0.26) than the others, while Fisher alpha index was greater in the first and second season of Wet Evergreen forest. Species dominance was very high (Dominance D 0.1875) in the second season of Wet Evergreen forest.

DISCUSSION

Each type of forest has its own soil edaphic characteristics, although they vary with time. From the present study, it was clear that the pH of the soil samples generally ranged 6 – 6.5, being slightly acidic. There was no significant difference among three forests with regard to pH. Several species of *Penicillium* and *Trichoderma* were isolated in soils of acidic pH; *Penicillium* species prefer acid pH (Gams1992). *Absidia* and *Mortierella* species were usually isolated at pH 6 and pH 8. However, Sampo *et al*., (1997) have found high frequencies of *Zygomycota* in acidic soils from Italy. It has been the general view that fungi grew abundantly in acidic soils and bacteria predominate in alkaline soils. But Jensen (1931) and others have proved that fungi might also abundantly found in alkaline soils and play dominant position in the microbiological activity of such soils (Waksman, 1927). Soil moisture is important for growth of soil micro fungi with pronounced effect on the distribution of soil fungi (Saksena, 1955).

Nitrogen, Phosphorous and Potassium were the most predominant among the soil mineral nutrients of the three forest types. The availability of organic carbon was high in Wet Evergreen forest. The organic carbon largely controls microbial growth in the soil. It is a key factor governing nitrogen, phosphorous and sulphur cycles. Mineralization of P and S mediated by phosphatase and sulphatase, is always dertermined by microbial demand for P and S independent of organic carbon. Nitrogen also mineralize the demand of biota. (Sappanen *et al*., 2007). The availability of micro nutrients such as Fe, Mn, Cu and Zn was relatively low in the present study. All the micronutrients are required at a range of 1 – 25 ppm for prominent fungal growth (Alexander, 1986). The organic carbon, nitrogen, phosphorous, potassium etc., are important for fungi. In the absence of any one of these, the growth and sporulation of moulds as well as the other microorganisms are hampered a lot. Magnesium, Manganese and Iron though needed in very small quantities, are also essential (Saksena, 1955). The results in the present study clearly showed that when compared to the earlier studies on the soil fungal diversity in the present study area were significantly higher. *Aspergillus* and *Penicillium* of *Deuteromycotina* dominate in all the forest soils, followed by *Trichoderma* and *Fusarium*. The frequency occurrence of these fungi is shown in

Table 3. Total CFU and percentage contribution of various fungi in the soils of Wet Evergreen, Semi Evergreen and Dry Evergreen forests of Tamil Nadu in two different seasons

S. No.	Name of Fungi (Genius & Species)	Wet Evergreen Forest				Semi Evergreen Forest				Dry Evergreen Forest			
		Season I		Season II		Season I		Season II		Season I		Season II	
		Total CFU	% contribution	Total CFU	% contribution	Total CFU	% contribution	Total CFU	% contribution	Total CFU	% contribution	Total CFU	% contribution
	Ascomycotina												
1	*Chaetomium globosum*	--	--	8	2.46	--	--	--	--	--	--	--	--
2	*Chaetomium sp.1*	--	--	--	--	--	--	--	--	6	1.42	1	0.25
	Zygomycotina												
3	*Absidia cylindrospora*	1	0.16	2	0.29	--	--	--	--	--	--	--	--
4	*Cunninghamella elegans*	1	0.16	4	0.58	--	--	--	--	--	--	--	--
5	*Mucor racemosus*	1	0.16	5	0.73	--	--	--	--	--	--	--	--
6	*Mucor circinelloides*	--	--	--	--	--	--	--	--	8	1.89	2	0.49
7	*Rhizopus stolonifer*	3	0.43	2	0.29	2	1.05	2	0.61	5	1.18	--	--
8	*Syncephalastrum racemosum*	3	0.43	4	0.58	--	--	--	--	14	3.32	8	1.98
	Deuteromycotina												
9	*Alternaria alternata*	10	1.48	2	0.29	--	--	--	--	7	1.66	1	0.25
10	*Aspergillus clavatus*	--	--	--	--	--	--	1	0.30	--	--	--	--
11	*Aspergillus flavus*	85	12.4	19	2.79	24	12.6	13	4.01	71	16.8	17	4.22
12	*A. flaviceps*	--	--	--	--	--	--	3	0.92	--	--	--	--
13	*A. fumigatus*	8	1.17	2	0.29	4	2.10	24	7.40	1	0.23	15	3.72
14	*A. japonicus*	100	14.6	88	12.94	18	9.47	11	3.39	2	0.47	24	5.96
15	*A. chevalieri*	--	--	1	0.14	--	--	--	--	--	--	--	--
16	*A. nidulans*	1	0.16	1	0.14	5	2.63	--	--	2	0.47	54	13.3
17	*A. niger*	157	22.9	217	31.91	49	25.7	117	36.1	2	0.47	54	13.3
18	*A. ochraceous*	3	0.43	4	0.58	2	1.05	--	--	43	10.1	6	1.49
19	*A. tamarii*	1	0.16	3	0.44	--	--	--	--	--	--	--	--
20	*A. terreus*	25	3.66	4	0.58	14	7.36	7	2.16	62	14.6	34	8.44
21	*A. versicolor*	6	0.87	6	0.88	4	2.10	3	0.92	--	--	--	--
22	*Aspergillus sp.* (white)	--	--	--	--	1	0.52	--	--	--	--	--	--
23	*Asergillus sp.(Green)*	--	--	--	--	--	--	12	3.7	--	--	--	--
24	*Cladosporium cladosporioides*	1	0.16	4	0.58	4	2.10	28	8.64	--	--	1	0.25
25	*C. oxysporum*	2	0.29	--	--	--	--	--	--	--	--	1	0.23
26	*Curvularia lunata*	14	2.04	1	0.14	2	1.05	--	--	--	--	--	--

27	*C. ovoidea*	2	0.29	1	0.14	--	--	--	--	--	--	--	--	--
28	*C. tuberculata*	--	--	--	--	1	0.52	--	--	--	--	--	--	--
29	*Fusarium lateritium*	--	--	64	9.41	--	--	--	--	--	--	--	--	--
30	*F. oxysporum*	--	--	12	1.76	4	2.10	1	0.30	1	0.23	--	--	--
31	*F. redolens*	1	0.16	1	0.14	--	--	--	--	--	--	--	--	--
32	*F. solani*	2	0.29	--	--	--	--	--	--	26	6.16	1	0.25	--
33	*Myrothecium sp*	5	0.73	1	0.14	--	--	--	--	--	--	--	--	--
34	*Paecilomyces variotii*	4	0.58	2	0.29	2	1.05	6	1.85	6	1.42	3	0.74	--
35	*P.lilacinus*	--	--	--	--	--	--	1	0.30	--	--	--	--	--
36	*P. fumorosens*	2	0.29	--	--	--	--	--	--	--	--	--	--	--
37	*Penicillium brevicompactum*	7	1.04	--	--	--	--	--	--	--	--	--	--	--
38	*P. camembertii*	--	--	--	--	--	--	--	--	2	0.47	3	0.74	.
39	*P. citrinum*	--	--	1	0.14	1	0.52	3	0.92	13	3.08	1		
40	*P. citreoviride*	--	--	--	--	--	--	--	--	2	0.47	4	0.99	
41	*P. corylophylum*	--	--	--	--	8	4.21	--	--	--	--	--	--	
42	*P. charlesii*	8	1.17	--	--	--	--	--	--	--	--	--	--	
43	*P. cyaneum*	--	--	5	0.73	--	--	--	--	--	--	--	--	
44	*P. duclauxi*	--	--	21	3.08	--	--	--	--	11	2.6	1	0.25	
45	*P. expansum*	1	0.16	--	--	--	--	--	--	--	--	--	--	
46	*P. fellutanum*	3	0.43	1	0.14	--	--	--	--	7	1.66	1	0.25	
47	*P. frequentans*	--	--	1	0.14	10	5.26	--	--	--	--	--	--	
48	*P. funiculosum*	7	1.04	--	--	2	1.05	2	0.61	--	--	4	0.99	
49	*P. islanticum*	3	0.43	2	0.29	--	--	--	--	--	--	--	--	
50	*P. janthinellum*	5	0.73	--	--	--	--	--	--	6	1.42	70	17.3	
51	*P. jenseni*	2	0.29	4	0.58	--	--	--	--	--	--	--	--	
52	*P. oxalicum*	3	0.45	--	--	3	1.57	--	--	2	0.47	--	--	
53	*P. piceum*	6	0.87	3	0.44	--	--	--	--	--	--	--	--	
54	*P. purpurogenum*	2	0.29	3	0.44	2	1.05	1	0.30	4	0.95	1	0.25	
55	*P. restrictum*	--	--	--	--	--	--	1	0.30	--	--	--	--	
56	*P. simplicissimum*	--	--	--	--	--	--	--	--	1	0.23	1	0.25	
57	*P. variabile*	13	1.90	--	--	--	--	3	0.92	42	9.95	2	0.49	
58	*P. viridicatum*	--	--	--	--	1	0.52	2	0.61	--	--	--	--	
59	*P. waksmani*	--	--	3	0.44	--	--	--	--	--	--	--	--	
60	*Penicillium sp 6*	21	3.07	23	3.38	9	4.73	--	--	--	--	--	--	
61	*Penicillium sp. 11*	2	0.29	2	0.29	--	--	--	--	2	0.47	5	1.24	

62	*Penicillium sp. (white)*	--	--	8	1.17	3	1.57	--	--	2	0.47	--	--
63	*Penicillium sp. GV3*	--	--	--	--	--	--	--	--	5	1.18	8	1.98
64	*Trichoderma aureoviride*	122	17.8	101	14.85	--	--	--	--	5	1.18	14	3.47
65	*T. harzianum*	3	0.43	1	0.14	1	0.52	16	4.93	--	--	--	--
66	*T. koningii*	1	0.16	--	--	--	--	--	--	36	8.53	23	5.7
67	*T. viride*	--	--	24	3.52	--	--	1	0.30	2	0.47	--	--
68	*Trichoderma sp. 5*	4	0.58	1	0.14	7	3.68	52	16.0	21	4.98	15	3.72
69	*Trichrus sp*	2	0.29	1	0.14	--	--	--	--	--	--	--	--
70	*Unidentified sp1*	--	--	2	0.29	--	--	--	--	--	--	--	--
71	*Pestalotiopsis sp*	--	--	1	0.14	--	--	--	--	--	--	--	--
	Nonsporulating	29	4.24	22	3.23	3	1.57	5	1.54	2	0.47	20	4.96

Table -3. Earlier reports also indicate that *Aspergillus* and *Penicillium* were dominant in forest soils (Galloway, 1936 and Moubasher and El-Dohlob, 1970). In our case, the pattern of distribution of common forms, though not of the rare forms, repeat over the two seasons. Chaudhary and Sachar (1934), Saksena (1955), Miller *et al*., (1957) and Saksena and Sarbhoy (1964) reported seasonal variations in forest soil fungi which drastically differed from season to season in a particular soil. Trenser *et al*., (1954), Miller *et al*., (1957), Mishra (1966), Rama rao (1969) and Persiani *et al*., (1998) also observed seasonal variations in forest soil mycoflora.

Most of the *Zygomycotina* members were only recorded from Wet Evergreen forest. In Semi Evergreen forest, the member of *Ascomycotina* were absent. Only one *Coelomycetes* was found in the Wet Evergreen forest. In the Wet Evergreen forest, *Aspergillus niger, Trichoderma viride* and *Aspergillus japonicus* were more dominant and had high CFU in both the seasons. *Aspergillus niger* was the most predominant species in Wet Evergreen and Semi Evergreen forests. On the other hand *Aspergillus terreus* was recorded in highest number in the case of Dry Evergreen forest (Fig. 3). *Aspergillus flavus* and *Trichoderma* sp.5 were the second dominant species in the Wet Evergreen forest (Fig.1) and *A. flavus*, *P. janthinellum* followed by *A. niger, A. nidulans* and *Trichoderma koningii* in the Dry Evergreen forest of the present study. Only one species of *Paecilomyces* was isolated from the Dry Evergreen forest of the present study. *Penicillium* was the dominant genus in all the forest types studied. Twenty species of *Penicillium and* ten species of *Aspergillus* were isolated from the Wet Evergreen forest and eleven species of *Aspergillus*, eleven species of *Penicillium* from the Semi evergreen forest and 4 species of *Penicillium* and 7 species of *Aspergillus* from the Dry evergreen forest of the present study(Fig 3).

The highest total number of taxa _ S was recorded in the first and second seasons of Wet Evergreen forest, but least in Semi Evergreen forest. The Fisher alpha was more or less same in the both seasons of Wet Evergreen forest, but too low in the second season of Semi Evergreen forest. All our estimates of Simpson index are close to 1, meaning that the probability is very low. Further, a number of indices of fungal diversity – number of genera, Fisher's alpha, Shannon – Weiner index and Simpson index were almost similar in all the three forest types studied. This may be a reflection of the fact that we have monitored only culturable living soil fungi and not fungi associated with plants and trees (Satish Nilima *et al*., 2007). The species Evenness_e^H/S was least in the Wet Evergreen forest. But in the case of total taxa _S it was much higher than in the other two types of forests. The total number of fungal genera increased with the extent of area monitored. Thomas and Shattock (1986) and Krebs (1989) also found that the logarithmic and log normal distributions were best suited for a

description of the abundance of 33 genera of filamentous fungi.

In conclusion a total of 71 taxa were recorded from three types of Wet Evergreen forest of Tamil Nadu. *Penicillium* and *Aspergillus* spp. were dominant in both the seasons studied due to high sporulation capacity. *Penicillum* spp. produces antibiotics and *Aspergillus* spp. produces of toxins such as aflotoxins and achrotoxins, which may prevent the growth of other fungal species. There were no significant differences in the abundance and distributions of fungi between the seasons studied; however pathogenic species of *Fusarium laterium* contributed a high proportion followed by *Fusarium oxysporum* in the second season, while in the first season, *Curvularia lunata* and *Alternaria alternata* contributed a high proportion. Results obtained in the present study clearly indicated that there was a marked decline in the number of colonies with decreasing soil micro and macro nutrients. The highest number of fungal colonies isolated in the second season of Wet Evergreen forest might be due to the presence of adequate quantity of macro and micro elements for the fungal growth and sporulation. It was found that the soil pH and moisture content were important factors for fungal development in the natural soils studied. Population of soil fungi might also get affected by climate.

ACKNOWLEDGEMENT

We are thankful Prof. R. Rengasamy, Director, Centre for Advanced Studies (CAS) in Botany and Prof. B.P.R. Vittal for their assistance and helpful discussions. Research at University of Madras was funded by grants from Tamil Nadu Forest Department (TNFD), India.

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