Current Research Journal of Biological Sciences 2(3): 195-200, 2010
ISSN: 2041-0778

Submitted Date: April 05, 2010 Accepted Date: April 22, 2010 Published Date: May 20, 2010

Ecological Evaluation of Ascomycotina Species Associated with *Anacardium occidentale* in Coastal Sand Dunes of Orissa, India

[1]P.K. Pani, [2]R.B. Mohanty and [3]T. Panda
[1]Department of Botany, Agarpara College, Agarpada,Agarpada, Bhadrak, Orissa, India
[2]Department of Botany, N.C. Autonomous College, Jajpur, Orissa, India
[3]Department of Botany, S.N.College, Rajkanika, Kendrapara- 754220, Orissa, India

Abstract: Abundance of Ascomycotina was studied from soil in coastal sand dunes of Orissa for a period of two years covering three distinct seasons. A total of 16 species of fungi belonging to 9 genera were enumerated of which site without vegetation surface soil had a share of 8 genera and 10 sp. while sub surface soil produced 7 genera and 10 species. Site with *Anacardium* plantation; the surface soil contributed 5 genera and 7 species while sub surface soil contributed 5 genera and 9 species. The diversity index varies from 3.6 to 3.74 (Shannon) and 0.32 to 0.35 (Simpson). Similarity index shows that barren sand dune is less akin to sand dune with monoculture plantation of *Anacardium*. Despite poor fungal population and nutrient composition in site without vegetation in comparison to soil with Anacardium plantation, more species were recorded from barren coastal sand dunes, which may be due to less competition with other fungi.

Key words: Ascomycotina, coastal sand dune, diversity indices, sac fungi

INTRODUCTION

Defining the number of fungi on earth has always been a point of discussion and several studies have focused on enumerating the worlds fungal diversity (Crous, 2006). From the late 1940s there has been a growing interest in soil mycology and soil borne fungal diseases of plants and this too has motivated the studies on soil fungi and their ecology (Subramanian, 1986). There are over 1.5 million fungal species distributed widely throughout the globe (Hawksworth, 2004) and many of these fungi, particularly sac fungi, the members of Ascomycotina are the chief agents of cellulose decomposition; have great potential in the daily life of human beings besides their utilization in industry, agriculture, medicine, biotechnology, in recycling nutrients and decomposing the dead organic matter in soil and litter (Cowan, 2001; Gates, 2005; Manoharchary *et al*., 2005). Recent evidence suggests that out of 1.5 million fungi, about one third exist in India and of this only 50% are identified until now (Manoharchary *et al*., 2005; Swapna *et al*., 2008). Patent literature in this field indicates that most of the work was carried out in forest soils (Behera *et al*., 1991; Behera and Mukherji 1985; Mohanty and Panda 1994a; Nilima *et al*., 2007). Relatively few reports have been published in view of the role of beach plantation on abundance, composition and diversity of fungal flora particularly in coastal sand dunes (Panda *et al*., 2007, 2008, 2009; Manoharchary, 2008). It is especially true in case of Orissa coast with around 480 km long barren coastline filled with sand dunes only. Presently, monoculture plantations of *Casuarina equisetifolia* L. and *Anacardium occidentale* are created along coastline to check windblast and erosion of sand dunes. Although, it has solved the purpose to some extent, the effect of *Anacardium occidentale* on occurrence and distribution of sac fungi are yet to be studied. Hence a study was made with reference to sac fungi in coastal sand dunes of Orissa.

MATERIALS AND METHODS

The study site was in Kanishi block under Ganjam district of Southern Orissa (19º15'N and 84º50'E) having 60km of coastline along the Bay of Bengal at a height of 6-8m above MSL. The climate of the region is monsoonal with coastal characteristics. The atmosphere temperature ranges from 37ºC in summer to 13ºC in winter. The annual rainfall is about 130 cm.Some of the unproductive uplands and coastal sand dunes are extensively covered by *Casuarina* and Cashew (*Anacardium occidentale*) plants. Cashew plantation at the inner belt of study site covers an area of about 1500 ha extending 4-5 km with a width of 250-450 m, varying at places and a shelter belt cum wind break vegetation of *Casuarina* about 30-40 rows covering 15-20 m in the outer belt along the coast of the sea. Cashew plant has been preferred over many others because of its physiological adaptation to tolerate extreme drought conditions, good growth in nutritionally poor soils, extensive near surface lateral roots and dense

Corresponding Author: Dr. T. Panda, Department of Botany, S.N.College, Rajkanika, Kendrapara- 754220, Orissa, India

Table 1: Edaphic factors and fungal population of study site

Sites		Temp (°C)	Moisture content (%)	pH	Total organic carbon (%)	Total nitrogen (%)	C/N ratio	Phosphorous (mg/100g)	Potassium (mg/100g)	Fungal number $x10^4$
Site without vegetation	Surface soil	34.1	.699	6.2	0.21	0.016	13.8	0.45	1.53	54
	Sub-surface soil	32.3	1.56	6.1	0.131	0.01	12.7	0.74	0.99	40
Site with *Anacardium* plantation	Surface soil	30.28	1.26	6.9	0.403	0.0246	17.2	0.2	1.7	66
	Sub-surface soil	28.74	2.03	6.3	0.275	0.0195	14.97	0.31	1.1	45

Table 2: ANOVA

Sources	DF	SS	MSS	F-value		p-value	
Varieties	3n	1164	388	7.8	4.8 *	9.8 **	23.7***
Season	2n	614	307	6.2	5.1*	10.9**	27.0***
Error	6n	298	49.7				
Total	11						

*: p<0.05, **: p<0.01, ***: p<0.001

canopy due to broad leaf and horizontal growth. Two sites of about one hectare each were selected for the investigation. First one on the sea shore without any vegetation and the second along a coastal sandy bed with 6-8 yr old plantation of *Anacardium occidentale* without any undergrowth. The study was conducted for a period of two years from June 2002 to May 2004. Soil samples from surface and sub-surface (15 cm depth) were collected from two sites in sterilized test tubes by randomly sampling at monthly intervals. The samples were temporarily stored in an ice chest prior to isolation of microbes. The micro fungi were isolated by dilution (Waksman, 1927) and pour plate (Warcup, 1950) techniques using PDA medium. Fungi were studied after 3-7 days of incubation. Fungi were identified by adopting standard procedures (Barnett and Hunter, 1972; Ellis 1971, 1976; Gilman, 1966; Sarabhoy, 1983; Subramanian 1962, 1971). Physico-chemical properties of soils were estimated as per Jackson (1967).

Statistical analysis: The following indices of diversity were calculated based on species level identification (Krebs, 1989; Ludwig and Reynolds, 1988).

Shannon-Wiener index $H = -\sum_{i=0}^{s} Pi \ln Pi$

where *Pi* is the proportion of the individual found in the i^{th} species, *ln* denotes natural logarithm and H is the Shannon -Wiener index.

Simpson's index $D = \sum_{i=0}^{s} (Pi)^2$

where, *Pi* is the proportion of the individual found in the i^{th} species and D Simpson's index

Evenness index (E) = H/*ln*S

where, H is the Shannon -Wiener index of diversity, S total number of species and *ln* is the natural logarithm.

Jacquard's index $S_{ab} = S_{AB} / (S_A + S_B - S_{AB})$

where, S_{AB} is the number of species shared by two locations (A and B), S_A the total number of species in location A and S_B the total number of species in location B. S_{ab} is the extent of similarity between the species in location A and B.

Richness index (Margalef, 1963) R = S-1/*ln*N

where, S is the total number of species and N is the sampling number.

RESULTS AND DISCUSSION

A comparative study on composition of soil status at two sites revealed that soils from site with *Anacardium* plantation had low temp, high moisture, better nutrient status and therefore harboured more fungi (Table 1). Micro-fungi of both soils showed a positive correlation with soil moisture and total organic carbon but were negatively correlated with soil temp. The qualitative and quantitative differences of genera and species at the two sites indicated that surface vegetation as well as nutrient composition influenced microfungal inhabitants of the soil (Buresh and Tian, 1997; Christensen, 1969; Corre, 1991; Lavelle and Spain, 2001; Manlay *et al*., 2000; Mohanty *et al*., 1991; Panda, 2009; Panda *et al*., 2009). Similar results have been obtained from the soils at lower depth in all sampling sites. The higher population associated with plantation site may be ascribed to the greater surface area available for microbial colonization. Fungal number of two sites differed significantly (t test 5.34< p 0.01). Anova clearly indicated significant seasonal difference between the samples of soil (Table 2).

A distinct pattern of fungal community structure was observed in all the samples during the study period. The percentage composition and rank abundances of different fungal species fluctuated (Table 3). The majority was from the genus *Aspergillus*; the next two in order of dominance were *Penicillium* and *Trichoderma* . Earlier reports have indicated that these genera appeared

Table 3: Percentage contribution and ranks of some dominant fungi isolated from samples at study sites

	Soil from site without vegetation						Soil from site with *Anacardium* plantation					
	Surface			Subsurface			Surface			Subsurface		
Fungi	No. of colony	%	Rank	No. of colony	%	Rank	No. of colony	%	Rank	No. of colony	%	Rank
Absidia butleri	14	1.99	21	15	2.27	19	45	5.32	4	38	5.12	4
A. glauca	-	-		-	-	-	23	2.72	10	19	2.56	15
A. spinosa	-	-		-	-	-	17	2.01	20	22	2.96	10
Alternaria alternata	13	1.85	22	-	-	-	-	-		-	-	
Aspergillus awamori	56	7.98	1	47	7.11	1	57	6.74	1	48	6.47	1
A. flavus	24	3.2	8	21	3.18	13	24	2.84	9	18	2.43	16
A. flavus fonsecoeus	-	-	-	-	-	-	21	2.48	11	-	-	-
A. fumigatus	28	3.99	6	27	4.08	7	25	2.96	8	21	2.83	12
A. luchuensis	18	2.56	14	21	3.17	14	18	2.13	16	13	1.75	24
A. niger	43	6.12	2	42	6.35	2	49	5.79	3	46	6.2	2
A. terreus	19	2.71	13	25	3.78	8	16	1.89	21	16	2.16	18
Chaetomium homopilatum	22	3.13	10	24	3.63	9	14	1.66	25	14	1.89	22
C. murorum	-	-	-	14	2.12	20	13	1.54	27	-	-	-
Cladosporium cladosporoides	18	2.56	15	28	4.24	5	20	2.36	12	26	3.5	9
C. oxysporum	15	2.14	19	18	2.72	16	16	1.89	22	30	4.0	8
Curvularia eragrostidis	27	3.85	7	23	3.48	10	-	-	-	16	2.16	19
C. lunata	17	2.42	16	12	1.82	21	15	1.77	23	15	2.02	20
C. pallescens	12	1.71	23	18	2.72	17	-	-	-	14	1.89	23
Drechslera australiensis	16	2.28	17	13	1.97	23	-	-	-	12	1.62	26
Fusarium sp.	16	2.28	18	17	2.57	18	20	2.36	13	18	2.43	17
Mucor sp.	-	-	-	-	-	-	13	1.66	26	-	-	-
Penicillium citrinum	30	4.27	4	28	4.24	6	44	5.2	5	33	4.45	5
P. cyaneum	-	-	-	-	-	-	-	-	-	15	2.02	21
P. javanicum	39	5.56	3	39	5.9	3	32	3.78	7	32	4.3	6
P. minio-leuteum	22	3.13	11	23	3.48	11	19	2.25	15	21	2.8	13
P. nigricans	11	1.57	24	12	1.82	22	18	2.13	17	13	1.75	25
P. oxalicum	20	2.85	12	19	2.87	15	15	1.77	24	22	2.96	11
P. rubrum	15	2.14	20	11	1.66	24	18	2.13	18	20	2.7	14
P. rugulosum	-	-	-	-	-	-	19	2.25	14	-	-	-
P. verruculosum	30	4.27	5	29	4.39	4	52	6.15	2	44	5.93	3
Rhizopus nigricans	-	-	-	-	-	-	18	2.13	19	12	1.62	27
Trichoderma viride	23	3.28	9	22	3.33	12	44	5.2	6	32	4.3	7

Table 4: Total count of fungi isolated during the study period

Sites	Total genera	Ascomycotinagenera	Total species	Ascomycotina species
Site without vegetation				
Surface soil	51	8	112	10
Sub Surface soil	37	7	87	10
Site with *Anacardium* plantation				
Surface soil	45	5	114	7
Sub surface soil	41	5	93	9

abundantly in soils (Mohanty and Panda, 1994b; Panda *et al*., 2007; Rai and Kumar, 1988). This may be due to the faster growth rate of these fungi in addition to their better intrinsic prolific sporulating capacity to utilize the substrate. Considering the dominant species it is clear that fungal succession in plantation site greatly differed from without plantation.

The surface mycoflora was richer in comparison to sub-surface mycoflora; some species, which were constantly recorded from surface layers were never detected in sub-surface layers (Table 3). Similar observations have been made by Mathur and Mukherji (1985). Moreover, the similarity in species composition between the surface layers was found to be more akin than the subsurface soil. The species composition in soil showed marked differences with a change in habitat and surface vegetation (Table 4). A total of 177 species of fungi belonging to 71 genera were enumerated (Table 5). Species of Deutoromycotina were maximum followed by Zygomycotina and Ascomycotina. Their occurrence might be due to ability of the concerned group of fungi for survival in adverse condition and adjustment with the environment. Fifty-two fungal species were detected common to site without vegetation or with *Anacardium* plantation. Soil without vegetation revealed 26 restricted species in surface and 13 species in subsurface. *Anacardium* plantation soil revealed 19 in the surface and 12 in the subsurface.

Total number of genera and species of Ascomycotina isolated from soils (Table 6) during the present study indicated that they never occur in higher numbers. It is noted that except a few genera, most of the Ascomycotina are not restricted to one or neither the other samples nor they are common to all. This corroborates to the findings of Behera and Mukherji (1985). Their isolation seems to be dependant more on final growth and formation of mature colony in the culture plate than the technique employed for the purpose. During present study it was observed that more species of Ascomycotina were recorded in virgin sand dunes at the first site without any vegetation than in the other site with vegetation. It may be due to low competition with other categories of fungi,

Table 5: List of fungi isolated from the study sites

SL No.	Fungi	Soil from site with vegetation		Soil from site with out vegetation		SL No.	Fungi	Soil from site with vegetation		Soil from site without vegetation	
		A1	A2	A1	A2			A1	A2	A1	A2
1	*Absidia butleri*	+	0	+	+	89	*Melanospora zamiae*	0	+	+	+
2	*A. glauca*	+	0	+	-	90	*Meria coniospora*	0	+	-	-
3	*A. spinosa*	+	0	+	+	91	*Monodictys levis*	-	-	-	+
4	*Alisidium resinae*	-	0	-	-	92	*Mucor hiemalis*	0	+	+	+
5	*Alternaria alternata*	+	0	+	+	93	*M.* sp.	0	-	+	-
6	*A. longipes*	+	-	+	-	94	*Myrothecium roridum*	-	-	+	-
7	*A. padwickii*	+	-	-	-	95	*Neopeckia fulcita*	0	-	+	+
8	*A. tenuisima*	-	-	+	-	96	*Nigrospora oryzae*	0	-	+	-
9	*Arachniotus terrestris*	-	-	+	+	97	*N.sphaerica*	0	+	+	+
10	*Aspergillus awamori*	+	0	+	+	98	*Oidiodendron maeius*	-	+	-	-
11	*A. caepitosus*	-	-	+	-	99	*O. rhodogenum*	0	+	-	-
12	*A. candidus*	0	+	+	+	100	*Paecilomyces fusisporus*	0	+	+	+
13	*A. carbonarius*	0	+	+	+	101	*P. varioti*	0	+	-	+
14	*A. flavipes*	0	-	+	-	102	*Penicillium atromerotosom*	-	-	-	+
15	*A. flavus*	0	+	+	+	103	*P. adametezi*	0	-	-	-
16	*A. foncecaceous*	0	+	+	-	104	*P. brefaldianum*	0	+	+	+
17	*A. fumigatus*	0	+	+	+	105	*P. canadens*	0	-	-	-
18	*A. funiculosus*	0	+	+	-	106	*P. charlesi*	-	-	+	-
19	*A. humicola*	-	+	-	-	107	*P. chermesinum*	0	-	+	+
20	*A. luchuensis*	0	+	+	+	108	*P. chrysogenum*	0	-	+	-
21	*A. niger*		0	+	+	+	109 *P. citrinum*		0	+	++
22	*A. niveus*	-	+	+	-	110	*P. citroviride*	0	-	-	+
23	*A. oryzae*	-	-	-	+	111	*P. corrylophylum*	0	+	+	+
24	*A. restrictum*	-	-	-	+	112	*P. cyaneum*	0	+	+	+
25	*A. repens*	-	+	-	-	113	*P. decumdens*	0	+	+	+
26	*A. rugulosum*	-	-	+	-	114	*P. diversum*	0	+	-	-
27	*A. sulphureus*	-	+	-	+	115	*P. ehrlichii*	0	-	-	-
28	*A. sydowi*	0	-	-	-	116	*P. fellutatum*	0	-	+	-
29	*A. terrestre*	-	-	+	-	117	*P. funiculosum*	+	-	-	-
30	*A. terreus*	+	+	+	+	118	*P. glabrum*	+	-	-	-
31	*A. terricola*	+	-	+	-	119	*P. harvei*	-	-	-	+
32	*Asteromella* sp.	-	+	-	-	120	*P. implicatum*	+	-	-	-
33	*Aurobasidium* sp.	-	-	+	-	121	*P. islandicum*	-	+	+	-
34	*Beltrania rhombica*	-	-	+	-	122	*P. janthinelum*	+	-	+	+
35	*Bispora butulina*	-	+	-	-	123	*P. javanicum*	0	+	+	+
36	*B. punctata*	-	-	-	+	124	*P. lanosum*	+	+	+	+
37	*Botrytitis cinera*	-	-	+	-	125	*P. leuteum*	+	-	-	+
38	*Botryosphaeria* sp.	-	-	+	-	126	*P. lepidosum*	-	-	-	+
39	*Candida albicans*	-	-	+	-	127	*P. levitum*	-	+	-	-
40	*Catinula* sp.	0	+	+	+	128	*P. minio-luteum*	0	+	+	+
41	*Cephalosporium acremonium*	0	+	+	-	129	*P. minutissima*	+	-	-	-
42	*Cheatomium fimeti*	-	+	-	+	130	*P. nigricans*	0	+	+	+
43	*C. homopilatum*	0	+	+	+	131	*P. oxalicum*	+	+	0	+
44	*C. magnum*	-	+	-	+	132	*P. purpurogenum*	+	+	0	+
45	*C. murorum*	0	-	-	+	133	*P. resticulosum*	-	-	+	-
46	*C. olivacium*	-	+	-	-	134	*P. restrictii*	-	+	-	+
47	*C. trilaterate*	-	-	+	-	135	*P. roseo-purpureum*	-	-	+	+
48	*C.* sp.	0	-	+	-	136	*P. rubrum*	+	+	+	-
49	*Choanephora cucurbitarum*	0	+	+	+	137	*P. rugulosum*	0	+	+	+
50	*Chloridium sacchari*	0	+	-	-	138	*P. spinulosum*	-	-	-	+
51	*Chrysosporium tropicum*	-	-	-	+	139	*P. turbatum*	+	-	-	-
52	*Cladosporium chloro*	-	-	-	+	140	*P. variable*	+	+	-	+
53	*C. cladosporoides*	0	+	+	+	141	*P. verruculosum*	+	+	+	+
54	*C. herbarum*	-	-	-	+	142	*P. waksmani*	+	+	+	-
55	*C. oxysporum*	0	+	+	+	143	*Periconia cambrensis*	+	-	-	-
56	*C. spero*	0	-	-	-	144	*P. cooki*	+	-	-	-
57	*Coniothyrium*	-	-	+	+	145	*P. hypsidula*	-	-	+	-
58	*Cunninghamella echinulata*	0	+	-	-	146	*P. glycericola*	+	-	-	
59	*Curvularia brachyspora*	0	+	+	+	147	*P. minutissima*	+	-	-	-
60	*C. clavata*	-	-	+	-	148	*P. saraswatipurensis*	+	+	+	+
61	*C. eragrostidis*	0	+	+	+	149	*P.* sp.	-	+	-	-
62	*C. lunata*	0	+	+	+	150	*Pestalotia* sp.	+	+	+	+
63	*C. lunata aeria*	-	-	+	-	151	*Phaeotrichonis crotolarie*	-	-	+	-
64	*C. pallescens*	0	+	+	+	152	*Phoma* sp.	+	+	+	+
65	*Cytosporina* sp.	0	+	+	+	153	*Pithomyces sacchari*	-	-	+	-
66	*Dendrophoma* sp.	-	-	+	-	154	*Pycnidial* form	+	+	-	+
67	*Diplococcum spictum*	-	-	+	-	155	*Pyrenochaeta cajani*	+	-	+	-
68	*Diplodina* sp.	0	-	+	+	156	*Rhinocladiella* sp.	-	-	-	+
69	*Drechslera avenaceae*	0	-	-	-	157	*Rhizopus conhii*	+	-	-	-
70	*D. australiensis*	0	+	+	+	158	*R. nigricans*	+	+	+	+
71	*D. cohliobolus heterosporum*	-	-	+	-	159	*R. oryzae*	+	+	+	-
72	*D. hawaiensis*	0	+	+	+	160	*Scolicobasidium constrictum*	+	+	+	-

Table 5: Continued

73	*Ellisiopsis*	0				161	*Sepedonium*	+	+	-	-
74	*Emericilopsis humicola*	0	+	+	+	162	*Spegazzinia tessarthii*	-	-	+	-
75	*E. terricola*	-	+	-	-	163	*Syncephalastrum recemosum*	+	+	+	+
76	*Epicoccum andropogonis*	0	-	+	-	164	*Tetraploa aristata*	-	-	-	+
77	*Eurotium repens*	-	+	-	+	165	*Thamnidium elegans*	+	-	-	+
78	*Fusarium liseola*	0	-	-	-	166	*Theilavia terricola*	+	+	+	+
79	*F. moniliforme*	-	-	+	+	167	*Torula calligans*	+	+	+	+
80	*F. hypocastani*	-	+	+	-	168	*Trichocladium canadense*	+	-	+	-
81	*F. oxysporum*	0	+	+	+	169	*Trichoderma album*	+	+	+	+
82	*F. solani*	0	-	+	+	170	*T. glabrum*	+	+	-	-
83	*F.* sp.	0	-	+	+	171	*T. koningi*	+	+	+	+
84	*Gelanispora clereatis*	-	-	+	-	172	*T. viride*	+	+	+	+
85	*Gleosporium norvisium*	-	-	+	-	173	*Trichurus spiralis*	+	-	-	-
86	*Gilmaniella humicola*	0	-	-	-	174	*Verticillium glaucum*	+	-	-	-
87	*Haplosporangium parvum*	0	+	+	-	175	Black sterile	-	-	+	-
88	*Isaria pulcherima*	-	+	-	-	176	Grey sterile	+	+	+	-
						177	White sterile	0	+	+	+

(+) =Presence, (-) =Absence

Table 6: Ascogenous fungi isolated from different sites

	Soil from site with *Anacardium* plantation		Soil from site without vegetation	
Ascogenous fungi	Surface	Subsurface	Surface	Subsurface
Arachniotus terrestris	-	-	+	+
Botryosphaeria species	-	-	+	-
Cheatomium fimeti	-	+	-	+
C. homopilatum	0	+	+	+
C. magnum	-	+	-	+
C. murorum	0	-	-	+
C. olivacium	-	+	-	-
C. trilaterate	-	-	+	-
C. sp.	0	-	+	-
Emericilopsis humicola	0	+	+	+
E.terricola	-	+	-	-
Eurotium repens	-	+	-	+
Melanospora zamiae	0	+	+	+
Neopeckia fulcita	0	-	+	+
Theilavia terricola	+	+	+	+
Gelaniospora sp.	-	-	+	-

(+) =Presence, (-) =Absence

Table 8. Dominance, diversity, evenness and richness indices of fungi in different samples at study sites.

Sites	Samples	D	1-D	H	E	R
Site without vegetation	Surface soil	0.0323	0.968	3.718	0.881	21.08
	Sub surface soil	0.035	0.965	3.528	0.921	14.16
Site with *Anacardium* plantation	Surface soil	0.032	0.968	3.744	0.869	23.28
	Sub surface soil	0.0333	0.967	3.608	0.904	16.68

D = Simpson dominance index, H = Shannon diversity index, E = Evenness, R = Richness

which are less abundant in this soil compared to monoculture plantation of *A. occidentale*. More over, less number of Ascomycotina were recorded in the present study despite reports on large number of species in tropical forest soils (Mohanty and Panda, 1994b; Behera and Mukherji, 1985).

The β diversity (Jacquard's index) value indicates changes in species composition from one location to another (Table 7). It is similar to the findings of Wilson and Shimda (1984) and Aparajita (2007). Shannon's diversity index is reasonably high varying from 3.608 to 3.744 correspondingly the dominance values are low varying from 0.032 to 0.035 (Table 8). The D value and H value in both the soil indicates many species with maximum diversity. The evenness index varies from 0.869 to 0.921 an indication that species were fairly evenly distributed. The surface layers have the highest species richness where as subsurface shows lowest richness (Table 8). It has also been observed that a change in the habitat variable can effect species composition and diversity. Thus vegetation is a major factor controlling the distribution and diversity of fungal species and subsequently deforestation can lead to loss of biological diversity as a whole.

Table 7: Comparison of different samples by coefficients of comparison

Samples	A_1	A_2	B_1	B_2
A_1	1.0	0.54	0.55	0.46
A_2		1.0	0.47	0.5
B_1			1.0	0.44
B_2				1.0

A_1 = Inside plantation surface, A_2 = Inside plantation sub-surface, B_1 = Outside plantation surface, B_2 = Outside plantation sub-surface,

REFERENCES

Aparajita, D., 2007. Pattern of plant diversity in the forest corridor of Rajaji-Corbet National parks, Uttaranchal, India. Curr. Sci., 92(1): 90-93.

Barnett, H.L. and B.B. Hunter, 1972. Illustrated Genera of Fungi Imperfecti. 3rd Edn., Burgess Publishing Co., Minneapolis.

Behera, N. and K.G. Mukherji, 1985. Seasonal variation and distribution of micro fungi in forest soils of Delhi. Folia Geo Botanica. Et. Phyto., 20: 291-312 .

Behera, N., D.P. Pati and S. Basu, 1991. Ecological study of soil micro fungi in a tropical forest soil of Orissa, India. Trop. Ecol., 32(1): 136-143.

Buresh, R.J. and G. Tian, 1997. Soil improvement by trees in Sub-Saharan Africa. Agroforest Sys., 38: 51-76.

Christensen, M., 1969. The soil micro fungi of dry mesic conifer hardwood forests in Northern Wisconsin. Ecology, 50: 9-27.

Cowan, A., 2001. Fungi-life support for ecosystems. Essential ARB, 4: 1-5.

Corre, J.J., 1991. The sand dunes and their vegetation along the Mediterranean coast of France. Their likely response to climate change. Landscape Ecol., 6(1-2): 65-75.

Crous, P.W., 2006. How many species are there in tip of Africa. Stud. Mycol., 55: 13.

Ellis, M.B., 1971. Dematiaceous Hypomycetes. Kew: Common Wealth Agricultural Bureaux.

Ellis, M.B., 1976. More Dematiaceous Hypomycetes. Kew: Common Wealth Agricultural Bureaux.

Gates, G.M., D.A Ratkowsky and S.J. Grove, 2005. A comparison of macrofungi in young Silvicultural regeneration and mature forest at the Warra LTER siet in the southern forests of Tasmania. Tasforests, 16: 127-134.

Gilman, J.C., 1966. A Manual of Soil Fungi. The Iowa State University Press, Ames, Iowa.

Hawksworth, D.L., 2004. Fungal diversity and its implications for genetic resource collections. Stud. Mycol., 50: 19.

Jackson, M.L., 1967. Soil Chemical Analysis. Prentice Hall Pvt. Ltd. New Delhi.

Krebs, C.J., 1989. Ecological Methodology. Harper and Row Publisher, New York.

Lavelle, P. and A.V. Spain, 2001. Soil Ecology. Kluwier Academic Publishers, Dordrecht, The Netherlands, pp: 654.

Ludwig, J.A. and J.F. Reynolds, 1988. Statistical Ecology. John Willey, New York.

Manlay. R.J., P. Cadet, J. Thioulouse and J.L. Chotte, 2000. Relationship between abiotic and biotic soil properties during fallow periods in Sudanian zone of Senegal. Appl. Soil Ecol., 14: 89-101.

Manoharchary, C., K. Sridhar, R. Singh, A. Adholeya, S. Rawat and B.N. Johri, 2005. Fungal biodiversity, distribution, conservation and prospecting of fungi from India. Curr. Sci., 89(1): 59-70.

Manoharchary, C., K.C. Mohan, I.K. Kunwar and S.V. Reddy, 2008. Phosphate solubilizing fungi associated with *Casuarina equisetifolia*. J. Mycol. Plant Pathol., 38(3): 507-513.

Margalef, R., 1963. On certain unifying principles in ecology. Am. Nat., 97: 357-374.

Mathur, and K.G. Mukherji, 1985. Phylloplane fungi of *Crotolaria juncea* during growth and decomposing leaves. Ind. Phytopathol., 38: 683-687.

Mohanty, R.B., T. Panda and P.K. Pani, I991. Seasonal variation and distribution of microfungi in a tropical forest soil of south Orissa. J. Ind. Bot. Soc., 70: 267-271.

Mohanty, R.B. and T. Panda, 1994a. Ecological studies of the soil microfungi in a tropical forest of South Orissa in relation to deforestation and cultivation. J. Ind. Bot. Soc., 73: 213-216.

Mohanty, R.B. and T. Panda, 1994b. Sac fungi of a dwindling forest soil ecosystem in South Orissa, India. J. Ind. Bot. Soc., 73: 351-352.

Nilima, S., S. Sadika and V. Nanjundiah, 2007. Diversity of soil fungi in a tropical deciduous forest in Mudumalai, Southern India. Curr. Sci., 93(5): 669-677.

Panda, T., B. Panda and N. Mishra, 2007. A comparative study of Penicillia from soil, leaf, litter and air in a coastal sandy belt of Orissa. J. Phytol. Res., 20(2): 335-336.

Panda, T., R.B. Mohanty, B. Panda and N. Mishra, 2008.Seasonal incidence of Aspergilli in a depletive forest soil of Orissa. J. Phytol. Res., 20(2): 327-328.

Panda, T., 2009. Diversity of sac fungi in coastal sand dunes of Orissa, India. J. Mycol. Plant Pathol., 39(1): 94-98.

Panda, T., B. Panda, B.K. Prasad and N. Mishra, 2009. Influence of soil environment and surface vegetation on soil micro flora in coastal sand dunes of Orissa, India. J. Hum. Ecol., 27(1): 69-73.

Rai, B. and A. Kumar, 1988. Microbial decomposition of a forest leaf litter as influence by certain edaphic factors. J. Ind. Bot. Soc., 67: 18-26.

Sarabhoy, A.K., 1983. Advanced Mycology. Today and Tomorrow Printers and Publishers, New Delhi.

Subramanian, C.V., 1962. The classification of hyphomycetes. Bull. Bot. Survey India, 4: 249-259.

Subramanian, C.V., 1971. Hypomycetes. An Account of Indian Species, Except Cercosporae. ICAR, New Delhi.

Subramanian, C.V., 1986. The progress and status of mycology in India. Pcoc. Ind. Acad. Sci., 96: 379-392.

Swapna, S., S. Akber and M. Krishnappa, 2008. Diversity of macrofungi in semi-evergreen and moist deciduous forest of Shimoga District-Karnataka, India. J. Mycol. Pl. Pathol., 38(1): 21-26.

Waksman, S.A., 1927. Principles of Soil Microbiology. Williams and Willikins Co. Baltimore, pp: 897.

Warcup, J.H., 1950. The soil plate method for isolation of fungi from soil. Nature, 166: 117-118.

Wilson, M.V. and A. Shmida, 1984. Measuring β diversity with presence absence data. J. Ecol., 72: 1055-1064.