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Some sugar fungi in coastal sand dunes of Orissa, India

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Occurrence and distribution of sugar fungi was studied from soil and leaf litter in coastal sand dunes of Orissa for a period of two years covering three distinct seasons. Fungal succession of litter was also studied. Microbial isolation and soil analysis was performed using standard procedures. Maximum population density was observed in the rainy season followed by winter and lastly summer. Higher microbial populations were encountered in plantation soil than the barren sand. They corresponded to the fluctuation of prevailing temperature, moisture and total organic carbon content of the said habitat. A total of 8 species of sugar fungi were isolated of which soil and the leaf litter had a share of 8 species each. Maximum population of sugar fungi was recorded from coastal sand dunes with *Casuarina* plantation which can be due to less competition with other fungi.

Key words: Sugar fungi, coastal sand dune, fungi, leaf litter.

INTRODUCTION

India has a rich diversity of fungi and forms an important geographical region for fungal distribution (Subramanian, 1962) . The variety and galaxy of fungi not only occupy prime position in biodiversity but perform unique and indispensable activity in industry, agriculture, medicine, biogeochemical cycles (Cowan, 2001; Gates et al., 2005; Manoharchary et al., 2005) and many other ways on which other organisms including human depends. Sugar fungi, the members of Mucorales, are often the primary colonizers in a forest floor in tropical regions. They utilize the simplest carbohydrates and thereby play a pivotal role in initiation of cellulose decomposition in a soil eco-system. Though numerous species of fungi have been reported from forest soils (Behera et al., 1991; Behera and Mukherji, 1985; Mohanty and Panda, 1994) and the pattern of colonization and succession of fungi in leaf litter from different habitats have been studied by some workers (Chapela and Boddy, 1988; Mishra and Dickinson, 1984; Thomas and Ghattock, 1986). However, there appears to be no study in coastal sand dune which is considered as most unproductive and sterile habitat (Panda et al., 2007; Panda, 2009). It is especially true in case of Orissan coast with around 480 km long barren coast line filled with sand dunes only. Presently, uniculture plantations of *Casuarina equisetifolia* L. are created along coast line to check wind blast and erosion of sand dunes. Although, it has solved the purpose to some extent, the effect of this plantation on occurrence and distribution of sugar fungi are yet to be studied. Hence a study was made with reference to sugar fungi in coastal sand dunes of Orissa.

MATERIALS AND METHODS

The study site was situated in Ganjam district of Orissa (19°15'N and 84°50'E) having 60 km of coastline along the Bay of Bengal at a height of 6 – 8 m above MSL. The unproductive uplands and coastal sand dunes are extensively covered by 30 - 40 rows of *C. equisetifolia* L. plants. Two sites of about one hectare each were selected for the present investigation. First site was on the sea shore without any vegetation and the second was along a coastal sandy bed with 6 - 8 years old uniculture plantation of *Casuarina* without any undergrowth. The study was conducted for a period of two years. Soil samples from surface and sub- surface (15 cm depth) were collected from two sites by random sampling method at monthly intervals in sterilized test tubes. Senescent leaf and three different types of litter that is, fresh litter, partially decomposed litter and highly decomposed litter were collected at monthly intervals by polythene bags. The samples were temporarily stored in an ice chest for isolation of microbes. The micro fungi were isolated by dilution plate (Waksman, 1927) and soil plate (Warcup, 1950) using PDA medium. Physico- chemical properties of soils were estimated as per Jackson (1967).

Table 1. Edaphic factors and fungal population of study site.

Sites		Temp (°c)	Moisture content (%)	pH	Total organic carbon (%)	Total nitrogen (%)	Total fungal population (10^2 g.dry wt.)	Total fungal species	Sugar fungi species
Site without vegetation	Surface soil	32.3	0.38	7.5	0.2	0.0108	36.47	91	6
	Sub-surface soil	30.8	0.96	7.5	0.17	0.0105	35.49	80	4
Site with *Casuarina* plantation	Surface soil	30.3	0.57	7.1	0.32	0.0143	41.84	78	7
	Sub-surface soil	28.9	1.21	7.4	0.24	0.0106	38.5	85	5

Average of 2 years data.

Table 2. Population of fungi and moisture content of leaf litter at site with *Casuarina* plantation.

Site with C*asuarina* plantation	Total fungal population (10^3 g.dry wt.)	Moisture content (%)	Total fungal species	Sugar fungi species
Senescent leaf	340.8	50.7	81	6
Fresh litter	376	7.4	82	5
Partially decomposed litter	388.6	7.9	69	7
Highly decomposed litter.	400.8	12.3	60	7

Average of 2 years data.

RESULTS AND DISCUSSION

A comparative study on composition of soil status at two sites revealed that soil from site with *Casuarina* plantation had low temperature, high moisture and better nutrient status and therefore, harboured more fungi (Table 1). Micro fungi of both soils showed positive correlation with soil moisture and total organic carbon but were negatively correlated with soil temperature. The qualitative and quantitative differences of microbial population, genera and species at two sites indicated that surface vegetation as well as nutrient composition influenced micro fungal inhabitants of the soil (Mohanty et al., 1991; Panda et al., 2009). Similar results have been obtained from the soils of lower depth in all the sampling sites. Total population of fungi isolated from highly decomposed litter were more than that of the other three leaf litters (Table 2).The higher population associated with highly decomposed litter may be ascribed to the greater surface area available for microbial colonization.

The leaf surface mycoflora was richer in comparison to litter mycoflora even some species which were constantly recorded from senescent leaves never reported in highly decomposed litter (Table 3). The finding is akin to Mathur and Mukherji (1985). Moreover, the similarity in species composition between the highly decomposed litter and the soil with *Casuarina* plantation was found to be more akin than the soil without vegetation. The species composition in soil and leaf litter shows marked difference with change in habitat and surface vegetation (Table 4). A total of 141 species belonging to 69 genera from soil and 108 species belonging to 60 genera were isolated from leaf litter (Table 5). Species of Deutoromycotina contributed 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. Twenty four fungal species were common in all the samples. The occurrence of other species varied (Table 5). Total number of genera and species of sugar fungi isolated from soils and leaf litters (Table 6) during present study indicated that they never occur significantly at higher population levels in soils in comparison to leaf litters. It is noted that except a few genera, most of the Mucorales are never restricted to one

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

Fungi	Soil from site without vegetation		Soil from site with *Casuarina* plantation		Senescent leaf		Fresh litter		Partially decomposed litter		Highly decomposed litter	
	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank	%	Rank
Absidia butleri	-	-	2.21	15	-	-		-	.64	19	1.76	16
A. glauca	-	-	-	-	-	-	-	-	5.3	6	10.04	03
A. spinosa	-	-	-	-	-	-	-	-	0.81	18	4.47	08
Alternaria alternata	-	-	-	-	5.05	06	3.18	07	-	-	-	-
Aspergillus awamori	8.99	2	3.21	10	9.65	03	7.96	03	12.72	02	9.22	04
A. candidus	-	-	2.1	17	-	-	-	-	-	-	-	-
A. flavus	2.04	16	6.86	03	-	-	1.06	18	.55	20	2.12	15
A. fumigates	6.95	03	3.32	09	6.99	14	2.86	08	4.83	09	3.8	10
A. nidulans	14.97	01	-	-	-	-	-	-	-	-	-	-
A. niger	5.38	5	6.09	04	4.88	07	6.68	04	9.03	05	8.86	05
A. terreus	2.76	13	3.77	7	0.78	15	2.02	12	-	-	-	-
Chaetomium homopilatum	3.36	11	-	-	-	-	-	-	-	-	-	-
Cladosporium cladosporoides	6.71	04	3.54	08	4.16	08	5.78	05	5.09	07	2.98	13
C. oxysporum	2.28	14	2.28	11	2.66	13	1.86	13	-	-	-	-
Cunninghamella verticilata	-	-	-	-	-	-	-	-	5.09	08	3.45	11
Curvularia eragrostidis	4.32	08	-	-	2.94	12	1.27	17	2.12	13	-	-
C. lunata	4.8	07	2.55	12	5.21	05	5.68	06	1.15	14	-	-
Cytosporina species	-	-	-	-	16.97	02	20.58	01	1.15	16	-	-
Cytosporella species	3.6	09	-	-	-	-	-	-	-	-	-	-
Drechslera australiensis	-	-	2.32	14	-	-	-	-	-	-	-	-
Fusarium species	-	-	5.2	06	4.16	09	1.8	14	4.37	10	6.9	06
Mucor species	-	-	-	-	-	-	-	-	-	-	4.27	09
Nigrospora sphaerica	-	-	-	-	3.05	11	0.64	20	-	-	-	-
Paecilomyces varioti	3.48	10	-	-	-	-	-	-	-	-	-	-
Penicillium citrinum	4.92	06	5.76	05	3.83	10	2.28	11	9.2	04	3.37	12
P. oxalicum	-	-	-	-	2.33	14	2.33	10	0.89	17	-	-
P. rubrum	-	-	2.43	13	-	-	-	-	-	-	-	-
P. verruculosum	2.16	15	6.98	02	-	-	1.59	15	10.64	03	11.57	02
Pestalotia species	-	-	-	-	17.14	01	15.0	02	1.31	15	-	-
Rhizopus nigricans	-	-	2.21	16	0.61	16	1.54	16	4.11	11	5.22	07
Syncephalastrum recemosum	-	-	-	-	-	-	0.95	19	2.42	12	1.57	17
Trichoderma viride	3.0	12	7.2	01	0.55	17	2.6	9	13.26	01	11.61	01

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

Site	Total genera	Total species
Site without vegetation		
Surface soil	54	91
Sub surface soil	46	80
Site with *Casuarina* plantation		
Surface soil	36	78
Sub surface soil	38	85
Senescent leaf	43	81
Fresh litter	42	82
Partially decomposed litter	36	69
Highly decomposed litter	34	60

Table 5. List of fungi isolated from the study sites.

S/No.	Fungi	Soil from site without vegetation		Soil and leaf litter from site with *Casuarina* plantation					
		Surface	Sub surface	Surface	Sub surface	Senescent leaf	Fresh litter	Partially decomposed litter	Highly decomposed litter
1	*Absidia butleri*	+	+	+	+	+		+	+
2	*A. glauca*		+	+	+			+	+
3	*A. spinosa*			+	+	+	+	+	+
4	*Acremonium furcatum*	+	+	+			+	+	+
5	*Alisidium resinae*		+		+				+
6	*Alternaria alternata*	+	+			+	+	+	
7	*A. padwickii*	+				+	+	+	+
8	*A. solani*	+	+			+	+	+	+
9	*Aphanocladium album*		+	+	+	+	+		
10	*Arachniotus terrestris*	+	+	+	+	+	+	+	+
11	*Arthrinium sacchari*			+		+	+		
12	*Aspergillus awamori*	+	+	+	+	+	+	+	+
13	*A. caepitosus*	+	+	+	+				
14	*A. candidus*			+	+		+	+	+
15	*A. carbonarius*				+				
16	*A. clavatus*			+	+	+	+	+	+
17	*A. fischeri*			+	+				
18	*A. flavus*	+	+	+	+	+	+	+	+
19	*Afoncecaceous*				+				
20	*A. fumigatus*	+	+	+	+	+	+	+	+
21	*A. funiculosus*	+	+			+	+	+	
22	*A. humicola*				+				+
23	*A. konongi*			+	+				
24	*A. luchuensis*	+		+	+	+	+		
25	*A. nidulans*	+	+	+	+	+	+	+	
26	*A. niger*	+	+	+	+	+	+	+	+
27	*A. quadrIlineatus*	+							
28	*A. repens*	+	+						
29	*A. sparsus*			+					
30	*A. sulphureus*			+		+	+	+	+
31	*A. sydowi*		+	+	+	+	+	+	+
32	*A. tammari*				+				
33	*A. terreus*	+	+	+	+	+	+	+	+

Table 5. Continues.

34	*A. terricola*	+	+	+	+	+	+	+		
35	*A. ustus*			+	+					
36	*A. variecolor*							+		+
37	*A. versicolor*	+	+	+	+					
38	*Asteromella species*				+					
39	*Beltrania rhombica*	+	+	+	+	+	+			
40	*Beltraniopsis esenbeckiae*	+						+		
41	*Bispora catenula*	+	+	+						
42	*Botryosphaeria* species					+				
43	*Candida albicans*	+	+	+	+	+	+	+		
44	*Catinula* species	+			+			+		
45	*Cephalosporium roseogriseum*	+	+							
46	*Cheatomium fimeti*				+					+
47	*C. funicola*			+	+					
48	*C. homopilatum*	+	+				+			
49	*C. magnum*	+		+						
50	*C. nigricolor*	+	+	+	+					+
51	*Choanephora cucurbitarum*	+				+				
52	*Chrysosporium tropicum*	+	+							
53	*Cladosporium cladosporoides*	+	+	+	+	+	+	+		+
54	*C. oxysporum*	+	+	+	+	+	+	+		
55	Cleistothecial form					+		+		+
56	*Cunninghamella verticilata*	+		+			+	+		+
57	*Curvularia clavata*	+				+	+			
58	*C. eragrostidis*	+		+	+	+	+	+		+
59	*C. lunata*	+	+	+	+	+	+	+		+
60	*C. lunata aeria*	+				+	+			
61	*C. ovoidea*	+	+		+	+	+			
62	*C. pallescens*				+	+	+			+
63	*C. tuberculata*			+			+	+		
64	*Cytosporella* species	+	+	+	+	+		+		
65	*Cytosporina* species	+	+	+	+	+	+	+		+
66	*Diplodina butleri*		+							
67	*Dichomera capparidis*	+	+							
68	*Drechslera australiensis*	+	+	+	+	+	+	+		+
69	*D. halodes*	+	+			+	+			
70	*D. hawaiensis*	+	+	+	+	+	+	+		+
71	*D. oryzae*					+	+	+		+
72	*D. iridis*						+			+
73	*Emericilopsis humicola*	+	+			+	+			
74	*Endocalyx indica*	+	+							
75	*Epicoccum nigrum*		+		+					
76	*Eurotium omstelodami*							+		+
77	*E. repens*	+			+			+		
78	*Fusarium oxysporum*	+	+	+	+	+	+	+		+

Table 5. Continues.

79	*Fusicoccum indicum*	+		+		+	+			
80	*Gilmaniella humicola*	+	+	+	+	+				
81	*Gliomastix species*							+		
82	*Haplosporangium accedens*	+					+	+		
83	*Humicola fuscoatra*	+	+	+	+	+		+		
84	*Isaria pulcherima*		+				+	+		
85	*Lacellina graminicola*	+	+	+						+
86	*Melanospora zamiae*	+					+			
87	*Monilia grisea*	+	+			+				+
88	*Monodictys antiqua*	+	+			+	+			
89	*M. fluctuata*			+						
90	*M. putredinis*		+							
91	*Mucor hiemalis*	+		+	+	+	+	+		+
92	*Myrothecium roridum*	+		+		+	+	+		+
93	*Neopeckia fulcita*		+			+	+			+
94	*Nigrospora oryzae*	+	+			+	+			
95	*N. sacchari*	+	+							
96	*N. sphaerica*	+	+	+	+	+	+	+		+
97	*Oidiodendron kalari*			+			+			
98	*Paecilomyces varioti*	+	+	+	+	+				+
99	*Penicillium adametezi*				+					
100	*P. citrinum*	+	+	+	+	+	+	+		+
101	*P. chermesinum*			+						
102	*P. chrysogenum*			+		+	+			
103	*P. cyaneum*			+	+					
104	*P. decumdens*			+	+	+	+			
105	*P. expansum*	+	+			+	+	+		
106	*P. fellutatum*			+	+	+	+			
107	*P. glabrum*			+	+	+		+		
108	*P. granulatum*			+						
109	*P. islandicum*	+	+	+	+	+	+	+		
110	*P. javanicum*	+	+							
111	*P. lanosum*	+	+	+	+	+	+	+		+
112	*P. minio-luteum*		+	+	+	+	+	+		+
113	*P. nigricans*	+	+	+	+	+	+	+		+
114	*P. oxalicum*	+	+	+	+	+	+	+		+
115	*P. purpurogenum*	+	+							
116	*P. resticulosum*		+	+	+	+	+	+		
117	*P. roseo-purpureum*	+	+	+	+		+	+		+
118	*P. rubrum*	+	+	+	+	+	+	+		+
129	*P. rugulosum*	+	+	+	+					
120	*P. variable*				+					
121	*P. verruculosum*	+	+	+	+	+	+	+		+
122	*Periconia byssoides*		+	+	+	+		+		+
123	*P. digitata*				+					

Table 5. Continues.

124	*Pithomyces sacchari*	+							
125	*Pestalotia* species	+	+	+	+	+	+	+	+
126	*Phialophorophoma* species	+							
127	*Phoma species*	+	+		+	+	+		+
128	*Phylosticta acetosa*				+				
129	*Pyrenochaeta cajani*	+	+		+	+	+		
130	*Pyronomella species*	+	+			+	+		
131	*Rhizopus nigricans*	+	+	+	+	+	+	+	+
132	*Rhynchophoma raduloid*				+				
133	*Scopulariopsis brumptii*	+	+			+	+		
134	*Spegazzinia ornata*			+				+	
135	*Staphylotrichum coccosporium*	+				+	+		
136	*Syncephalastrum recemosum*	+	+	+	+	+	+	+	+
137	*Theilavia terricola*	+	+	+	+	+	+	+	+
138	*Theilaviopsis paradoxa*				+		+		+
139	*Torula calligans*	+	+	+	+			+	+
140	*T. herbarum*	+			+				
141	*Trichocladium opacum*		+					+	
142	*Trichoderma album*				+				
143	*T. koningi*					+	+		
144	*T. viride*	+	+	+	+	+	+	+	+
145	*Verticillium dahliae*	+				+	+		
146	*Black sterile*	+			+	+	+	+	+
147	*White sterile*	+			+	+	+	+	+

Table 6. Sugar fungi isolated from different sites.

Ascogenous fungi	Soil from site without vegetation		Soil and leaf litter from site with C*asuarina* plantation					
	Surface	Sub surface	Surface	Sub surface	Senescent leaf	Fresh litter	Partially decomposed litter	Highly decomposed litter
Absidia butleri	+	+	+	+	+	-	+	+
A. glauca	-	+	+	+	-	-	+	+
A. spinosa	-	-	+	-	+	+	+	+
Choanephora cucurbitarum	**+**	**-**	**-**	**-**	+	-	-	-
Cunninghamella verticilata	**+**	**-**	**+**	**-**	-	+	+	+
Mucor hiemalis	+	-	+	+	+	+	+	+
Rhizopus nigricans	+	+	+	+	+	+	+	+
Syncephalastrum recemosum	+	+	+	+	+	+	+	+

or neither the other samples nor they are common to all. This corroborates to the findings of Behera and Mukherji (1985). Their isolation is found to be dependant more on final growth and formation of mature colony in the culture plate than on the technique employed for the purpose. During the present study, it was observed that more varieties and higher population of Mucorales were recorded in partially decomposed litter and highly decomposed litter than the other samples. It may be due to low competition with other categories of fungi which are less abundant in this soil compared to unproductive virgin coastal sand dunes. Moreover, less number of sugar fungi was recorded in the present study looking their large varieties in tropical forest soils (Mohanty and Panda, 1998; Behera and Mukherji, 1985).

It can be concluded that species diversity of micro fungi was related to the particular habitats and ecosystem. Overall micro fungal diversity seems to be higher in unproductive coastal sand dunes without vegetation in spite of its low nutrient status which can be due to low competition with other categories of fungi. From the present study, it is clear that edaphic factors greatly influence the growth and development of micro fungi. It is suggested that a large number of permutations and combinations of media and technique should be employed to unravel the innumerable sugar fungi still unreported in coastal soils of Orissa.

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