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Occurrence of Fungi in Rhizosphere, Rhizoplane & Non-Rhizosphere Zones of Some Mangroves

H J CHOWDHERY
Botanical Survey of India (Northern Circle), Dehradun 248 001
and
K L GARG & A K JAITLY
Mycology and Plant Pathology Laboratory, Department of Botany, University of Lucknow, Lucknow 226 007

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From the Sunderban mangrove swamps, West Bengal, a good number of fungi were isolated from rhizosphere, rhizoplane and non-rhizosphere zones of mangroves, viz. *Avicennia officinalis* L., *Carapa moluccensis* Lam., *Heritiera minor* Lam. and *Rhizophora mucronata* Lam. *p*H and salinity of rhizosphere mud were lower than non-rhizosphere while, the organic matter and moisture content were higher in the rhizosphere mud of all the plants. Highest number of fungi were isolated from rhizosphere zone. Ascomycetes were frequent in rhizoplane and Zygomycetes in rhizosphere; while, Basidiomycetes were conspicuous by their absence.

Rhizosphere and rhizoplane mycoflora of mangrove plants from other coastal areas are known[1-5] but such information from Indian coastal region is known only through the work of Garg[6], which has resulted in the isolation of a large number of fungi.

An attempt has been made to investigate the fungi occurring in an active state in the rhizosphere, rhizoplane and non-rhizosphere zones of some Indian mangrove plants and the results are presented in this paper.

Sunderban (21°30'-22°15'N; 88°10'-87°10'E), West Bengal, has a tropical estuarine swamp forest and is compact and criss crossed by creeks and channels of varying width and depth (Fig. 1).

Materials and Methods

Rhizosphere, rhizoplane and non-rhizosphere samples of *Avicennia officinalis* L., *Carapa moluccensis* Lam., *Heritiera minor* Lam. and *Rhizophora mucronata* Lam. were collected from different localities, viz. Bakhali, Gangasagar, Gosaba, Kakdwip, Pakhirala, Peerkhali, Sajanakhali and Sudnnakhali (Fig. 1). Actively growing species of fungi were isolated employing following methods:

Smears from soil samples (rhizosphere and non-rhizosphere) were made on microscopic slides for direct microscopic observation after staining them with lacto-phenol-blue.

Soil samples were plated with Czapek-Dox agar and incubated at 28° ± 1°C. Colonies appearing within 10-12 hr were transferred to agar slants for further studies.

Soil residue, obtained following the method of Warcup[7] for the isolation of fungi from hyphae present in the soil, was mixed with agar-agar solution and made into thin films on clean, sterilized slides and examined under the microscope. The hyphal fragments present were picked with the help of an inoculating needle or cataract knife and transferred to agar slants for their further growth.

For the isolation of actively growing fungi from rhizoplane, roots of the plants were thoroughly washed with sterile distilled water for several times to make them free of soil particles. These were directly examined under the microscope after cutting them into

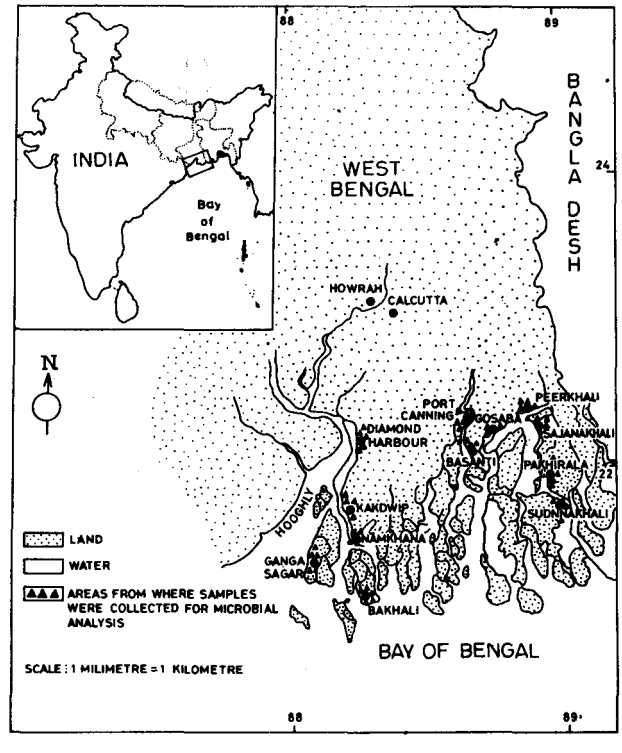

Fig. 1—Different localities of Sunderban, West Bengal, where samples were collected

smaller pieces. For the isolation of growing mycelium, these were kept in moist chambers and incubated at 28° ± 1°C. Fungal mycelia appearing within 10-12 hr on the root surface were isolated on agar slants for identification and other studies.

Results

Data on *p*H, salinity, organic matter and moisture content of rhizosphere and non-rhizosphere soil are presented in Table 1. Direct microscopic examination of the smear preparations reveals the presence of hyphal fragments, a clear indication of their active life in the soils of aforesaid zones. However, efforts to isolate and grow these hyphae in pure cultures were not successful in most of the cases. Microbial analysis of rhizosphere and non-rhizosphere samples of the 4 investigated plants using Warcup's method has resulted in the isolation of a number of actively growing forms (Table 2). From rhizosphere, rhizoplane and non-rhizosphere samples of *A. officinalis*, *R. mucronata*, *H. minor* and *C.moluccensis* 37, 48, 27 and 20 species of fungi were isolated respectively.

It is evident from Table 2 that fungi imperfecti were the most dominant group while, *Aspergillus* was the most frequent genus followed by *Fusarium* and *Penicillium*. Species of *Curvularia*, *Cladosporium* and

Table 1—*p*H, Salinity, Organic Matter and Moisture Content of Rhizosphere and Non-Rhizosphere Mud of Mangroves

	R. mucronata		*A. officinalis*		*H. minor*		*C. moluccensis*	
	RS	NRS	RS	NRS	RS	NRS	RS	NRS
*p*H	7.3	8	7.5	8.2	8	8.7	8.5	9
Salinity (‰)	23	31	28	36	40	49	47	58
Organic matter (%)	5.3	4.8	4.25	3.65	3.2	2.85	2.6	2.35
Moisture content (%)	50.5	47.5	39.5	37	23	21.5	20.5	18

RS—Rhizosphere Soil; NRS—Non-Rhizosphere Soil

Table 2—Frequency of Occurrence of Fungi in Rhizosphere, Rhizoplane and Non-Rhizosphere Zones of Mangroves

	A. officinalis			*R. mucronata*			*H. minor*			*C. moluccensis*		
	RS	RP	NRS	RS	RP	NRS	RS	RP	NRS	RS	RP	NRS
Zygomycetes												
Absidia blakesleena Lendner				++++	+++							
A.ramosa (Lindt.) Lendner	+++	++										
Cunninghamella echinulata Thaxt.							+++	+				
Mucor racemosus Fres.							++++	++				
Syncephalastrum racemosum (Cohn.) Schroeter										+++	++	
Ascomycetes												
Achaetomium globosum Rai *et* Tewari				++	+++							
A.indicum Rai *et* Chowdhery					+++							
A.luteum Rai *et* Tewari				++	++++							
Chaetomium arcuatum Rai *et* Tewari				++	++++							
C.funicolum Cooke					+++							
C.globosum Kunze	++	++++		++	+++++							
C.indicum Corda				+	++							
C.nigricolor Ames					+++							
Emericella nidulans (Eidam)Vuill.				+++++	+++	++						

Contd

Table 2—Frequency of Occurrence of Fungi in Rhizosphere, Rhizoplane and Non-Rhizosphere Zones of Mangroves—*Contd*

	A. officinalis			*R. mucronata*			*H. minor*			*C. moluccensis*		
	RS	RP	NRS	RS	RP	NRS	RS	RP	NRS	RS	RP	NRS
					Ascomycetes							
E. nidulans var. *lata* (Thom *et* Raper) Subramanian	+ + + +	+ +	+	+ + +	+ +	+ +	+ + +	+ +	+	+		
E.striata (Rai, Tewari *et* Mukerji) Malloch *et* Cain				+ + +	+ +							
Fennellia flavipes Wiley *et* Simmons	+ + +	+	+ +	+ + +	+ +	+ +	+ + +	+ +	+ +	+		
Neosartorya fischeri (Wehmer) Malloch *et* Cain	+ + +	+ +	+ + +				+ +	+	+ +	+ +	+	+ + +
Talaromyces wortmanni (Klöcker) Benjamin				+ +	+ + + +							
Thielavia sepedonium Emmons	+	+ +	+									
T.terricola (Gilman *et* Abott) Emmons-var. *minor* (Rayas *et* Borat) Booth				+ +	+							
					Deuteromycetes							
Acrophialophora fusispora(Saksena) M.B. Ellis				+	+ +							
A.nainiana Edward	+	+ +										
Alternaria alternata (Fr.)Keissler	+ + +	+ + +	+	+ +	+ + +			+ +		+ + +		
A.humicola Oudem.			+ +									
Aspergillus aeneus Sappa				+ +	+	+ + +						
A. carbonarius (Bain.) Thom	+ + +	+		+ + + +	+ +	+ + +		+		+ +	+	
A. carneus (v. Tiegh.) Blochwitz				+ +	+ +	+ + +	+ +	+	+ + +			
A.flavus Link	+ + + +	+ +	+ + +	+ + + +	+	+ + +	+ + + +	+	+ +	+ + +	+ +	+
A.fumigatus Fres.	+ + + + +	+ +	+ + +	+ + + + +	+ +	+ + +	+ + + +	+	+ + +	+ + +	+	+
A.fumigatus var. albus Rai, Tewari *et* Agarwal	+ +		+ + +	+ +		+ + +	+ + +		+ +	+ +		
A.niger van Tieghem	+ + +	+	+ + +	+ + + +	+	+ + +	+ +	+ +	+	+ +	+ +	
A.parasiticus Speare							+ +	+	+ + + +			
A.penicilliformis Kamyschko	+ + +		+	+ + + +		+ +						
A.sulphureus (Fres.) Thom *et* Church	+ + +		+	+ + +		+						
A.sydowi (Bain. *et* Sart.)Thom *et* Church						+				+ +	+	
A.tamarii Kita				+ +	+ +							
A.terreus Thom	+ + + +	+	+ + + +	+ + + +	+ +	+ + +	+ + +	+ +	+ +	+ + +	+ +	+
A.terreus var. *africanus* Fennell *et* Raper							+ +					

Contd

Table 2—Frequency of Occurrence of Fungi in Rhizosphere, Rhizoplane and Non-Rhizosphere Zones of Mangroves—*Contd*

	A. officinalis			*R. mucronata*			*H. minor*			*C. moluccensis*		
	RS	RP	NRS	RS	RP	NRS	RS	RP	NRS	RS	RP	NRS
					Deuteromycetes							
A.ustus (Bain.) Thom *et* Church							+	++				
A.versicolor (Vuill.) Tiraboschi	+	++										
Cephalosporium zonatum Sawada							+	++				
Cladosporium indicum Rai, Tewari *et* Mukerji	++	+										
C.oxysporum Berk. *et* Curt.	++	+++		++	++							
Curvularia lunata var.*aeria* (Batista, Lima *et* Vas.) M.B. Ellis	++	+++		+++	+++							
C.penniseti (Mitra) Boedijn										++	+	
Doratomyces microsporus (Sacc.) Morton *et Smith*	+	+++		++								
Drechslera hawaiiensis (Bugnicourt) Subram. *et* Jain ex M.B. Ellis				++								
Fungi Imperfecti (Unidentified)	+++			+++	++							
Fussarium dimerum Penzig	++	+++		+++	++++							
F.oxysporum Schlecht *et* Fr.	++	++		+++	++++							
F.solani (Martius) Sacc.	++	+++		++	+++		++	+++	++	++	+++	
Humicola grisea Traaen										++	+	
Mycelia sterilia (Dark)	++	+	+	+		+	++	+		+++		+++
Mycelia Sterilia (Hyaline)	++		+	+		+	+		++			
Paecilomyces varioti Bain.	++	+		+++		+	++					
Penicillium chrysogenum Thom	++++	++		++++	++		+++	++				
P.funiculosum Thom	++++	++++	++	++	++++		++	+++		++	+++	+
P.vinaceum Gilman *et* Abbott	++	++		++	++							
Penicillium sp.				++	+++							
Pestalotia sp.		++		+	+++							
Pestalotiopsis versicolor (Speg.)Steyaert							+		+++			++
Phoma eupyrena Saccardo	+	+++										
Rhizoctonia sp.	++						++					
Sporotrichum sp.				++	+++							
Trichoderma koningi Oud.	++	++++	+	++	+++++	+		+++		+	+++	
T.viride Pers. ex Fr.	++	++++	+	++	+++++	+	++	++++		+	+++	

Pestalotia were moderately frequent whereas, those of *Acrophialophora*, *Cephalosporium* and *Humicola* were rather rare. Ascomycetes were more frequent in the rhizoplane samples of plants growing at places where *p*H and salinity were low while ascosporic aspergilli were frequent in the rhizosphere samples. *Neosartorya fischeri* was frequent in both rhizosphere and non-rhizosphere soils, while Basidiomycetes were conspicuous by their absence.

Discussion

The rhizosphere soil harboured a good number of actively growing fungi as compared to that of non-rhizosphere (Table 2). Of the plants investigated *R. mucronata* yielded maximum number of actively growing fungi whereas, the lowest number was recorded in the case of *C. moluccensis*. This difference is due to ecological conditions found in the vicinity of these plants (Table 1). The presence of actively growing fungi in the mangrove swamps, which afford an unusual habitat for the growth and existence of soil fungi, is not very surprising since it is well known that the root system of higher plants is associated not only with the environment composed of organic and inorganic substances but also with a variety of metabolically active microbial population. The root system of higher plants affords a unique subterranean habitat congenial for the growth of microorganisms. The energy, carbon, nitrogen, etc. necessary for the growth of the microorganisms is provided by the excretion and sloughed-off root tissue of the plant. The data presented in Table 1 may testify that the rhizosphere and non-rhizosphere zones of *R. mucronata* contain the maximum amount of organic matter and moisture contents as compared to rest of the 3 plants.

Microorganisms are affected by the root respiration, as the carbondioxide liberated during respiration produces carbonic acid which lowers *p*H of the rhizosphere zone[8] (Table 1). Further, the root penetration likewise improves soil structure making it porous which favours easy microbial oxidation and for these obvious factors the greater population of actively growing fungi are found in the rhizosphere. There are evidences that the spores of many fungal species lying dormant in soil are stimulated to germinate by the proximity of plant roots[9-13]. Waid[14] has shown that temperature, moisture, carbondioxide, oxygen, soil pore and the durability of fungal mycelium, interaction between soil fauna and soil reaction are the main factors which influence the growth and mycelium production by the fungi in the soil.

The various species of fungi isolated growing actively during this investigation are those that have also been isolated more frequently and in abundance from rhizosphere, rhizoplane and non-rhizosphere zones of Sunderban mangrove plants[6].

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