MICROFUNGI FROM MANGROVE SWAMPS OF WEST BENGAL, INDIA

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ABSTRACT

A total of 184 species of fungi have been isolated from mangrove swamps of West Bengal using soil plate, dilution plate and baiting technique methods. Of these, 7 species belonged to Oomycetes, 10 to Zygomycetes, 43 to Ascomycetes and remaining to Fungi Imperfecti. Species of the genus *Aspergillus* out number those of any other in the mangrove swamps. Next in abundance ranks the genus *Penicillium* followed by *Fusarium*. In the mangrove swamps which offer high salt concentration, high moisture and anaerobic conditions, the occurrence of such a large number of terrestrial fungi may be attributed to the fact that a prolonged and continuous impact of these ecological conditions has developed certain degree of ecological specialization among these micro-organisms. The amount of available organic matter present in the swamp appears to be mainly responsible for the activity of these fungi despite high salinity and anaerobic conditions.

INTRODUCTION

Mangrove environment is basically a marine habitat but it is quite distinct from the typical marine conditions. The mangrove mud is the result of plant debris accumulated by the growing vegetation and soil brought by the rivers. Due to the water logging by sea tides, these soils become swampy. The mangrove mud remains undisturbed due to lack of agricultural practices and affords an unusual habitat for the growth and existence of various organisms due to very high osmotic concentration, low oxygen and high water contents, except for the special halophytic vegetation, i.e. mangrove.

Studies on the taxonomy and ecology of fungi in relation to mangrove soils are rather scanty except that some meagre information on the fungi occurring in mangrov swamps is available through the work of West (1956), Swart (1958, 1963), Craeger (1962), Walsh (1967), Kohlmeyer and Kohlmeyer (1965), Kohlmeyer (1969a ; 1969b), Lee and Baker (1972a, 1972b, 1973).

In India, vast areas of mangrove forests occur on the saline soils of the Gangetic estuarine deltas near the Bay of Bengal—the Sunderban areas, near the sea coasts of Bombay and Kerala and Godavari delta in Andhra Pradesh. Little is known about their fungal population except for some scanty information available through the work of Rai *et al.* (1969). Consequently, investigations have been undertaken to screen and isolate the various fungi inhabiting these swamps.

The present paper embodies a detailed account of the study of fungal microflora of mangrove collected from Kagh Islands (West Bengal), India. It is a small group of Islands in the delta region of the river Ganges, about 50 Km south of Diamond Harbour. The geographical position of Kagh Islands in 24 Parganas lies between the longitude 88° 12′ and lattiude 21° × 52′. A list of the isolated species of fungi has also been given.

MATERIAL AND METHODS

Mangrove mud samples were analysed for their fungal population by soil dilution and soil plate methods (Waksman & Fred, 1922 ; Warcup, 1950, 1955 and Johnson *et al.*, 1960). The pH and salinity of the mud samples were noted in each case. Czapek-Dox-

agar, and Czapek-Dox-agar with 6 per cent NaCl were the media and three soil dilutions (1/100, 1/1000 and 1/10000) were used each with 4-6 replicate plates. Culture plates were incubated at 29±1°C and colonies were counted and isolated on agar slants from 4th to 20th day. Different baiting techniques were also used in order to isolate various aquatic species. Boiled ants and hemp, maize, wheat and Sorghum seeds were used as baits.

OBSERVATIONS

During the course of study 184 species representing various groups of fungi were isolated and have been arranged alphabetically in Table-1. Of these, 7 species belonged to Oomycetes, 10 to the group Zygomycetes, 43 to Ascomycetes (including ascosporic Aspergilli and Penicillia) and remaining species to Fungi Imperfecti. All the Zygomycetes belonged to the order Mucorales including 2 species each of *Absidia*, *Circinella* and *Mucor* and one each of *Choanephora*, *Rhizopus*, *Syncephalis* and *Syncephalastrum* whereas, *Achlya*, *Dictyuchus*, *Pythium* and *Saprolegnia* represented the Oomycetes. The Ascomycetes were represented by 17 perithecial and 25 cleistothecial forms and a single species of *Arachnoitus* belonging to Gymnoascaceae. It includes 2 new species of the genus *Achaetomium* and a new genus belonging to cleistothecial ascomycetes with *Aspergillus* state, named as *Hemisartorya maritima* Rai & Chowdhery. Among the Ascomycetes *Chaetomium* was the most dominant form being represented by 10 species, next to it was the genus *Achaetomium*. *Thielavia* and *Preussia* rank next to *Achaetomium* in order of dominance. Few unidentified forms have also been isolated.

Of the total number of forms isolated, Fungi Imperfecti formed the major part of the mycoflora of these muds. The genus *Aspergillus* was the most dominant form being represented by 46 species and 7 varieties, including 9 new species. One mutant of *A. fumigatus* i.e., *A. fumigatus* var. *grisei-brunneus* has also been isolated from this habitat. *Penicillium* was represented by 25 species including 8 ascosporic forms *Fusarium* ranks next to *Penicillium* in order of dominance and was represented by 8 species followed by the species of *Humicola*, *Cephalosporium*, *Stachybotrys*. Both dark coloured and hyaline fungal forms were represented in the mangrove mud mycoflora.

Table I—List of fungi isolated from Mangrove swamps

1.* *Absidia blakesleeana* Lendner
2. *A. ramosa* (Lindt.) Lendner
3.* *Achaetomium fusisporus* Rai & Chowdhery
4.* *A. globosum* Rai & Tewari
5.** *A.* sp. (i)
6.** *A.* sp. (ii)
7.* *Achlya americana* Humphrey
8.* *Acrophialophora nainiana* Edward
9.* *Alternaria tenuis* Nees
10.* *Anixiella reticulata* (Saito & Minoura) Cain
11.* *Arachniotus citrinus* Massee & Salmon
12.* *Aspergillus aeneus* Sappa
13.* *A. allahabadii* Mehrotra & Agnihotri
14. *A. candidus* Link
15.* *A. carneus* (v. Tiegh.) Blochwitz

16.* *A. clavatus* Desmazieres
17.* *A. flavipes* (Bain & Sart.) Thom. & Church
18.* *A. flavus* Link
19. *A. foetidus* (Nakazawa) Thom. & Raper
20.* *A. fumigatus* Fres.
21.* *A. fumigatus* var. *grisei-brunneus* Rai & Singh
22.* *A. fumigatus* var. *sclerotiorum* Rai, Agarwal & Tewari
23.* *A. janus* Raper & Thom.
24.* *A. japonicus* Saito
25.* *A. montevidensis* Talice & Mac Kinnon
26. *A. niger* van Tieghem
27.* *A. niveus* Blochwitz
28. *A. ochraceus* Wilhelm
29.* *A. panamensis* Raper & Thom.
30.* *A. parasiticus* Speare
31.* *A. penicilliformis* Kamyschko
32.* *A. phoenicis* (cda.) Thom.
33.* *A .puniceus* Kwon & Fennell
34. *A. rugulosus* Thom. & Raper
35.* *A. sclerotiorum* Huber
36.* *A. sulphureus* (Fres.) Thom. & Church
37. *A. sydowi* (Bain & Sart.) Thom. & Church
38.* *A. tamarii* Kita
39. *A. terreus* Thom.
40.* *A. terreus* var. *africanus* Fennell & Raper
41. *A. terreus* var. *aureus* Thom. & Raper
42.* *A. tubingensis* (Schober) Mosseray
43.* *A. unguis* (Emile- Weil & Gaudin) Thom. & Raper
44. *A. ustus* (Bain.) Thom. & Church
45. *A. versicolor* (Vuill). Tiraboschi
46.* *A. versicolor* var. *rutilo-brunneus* Rai, Agarswal & Tewari
47. *A. wentii* Wehmer
48.** *A.* sp. (i)
49.** *A.* sp. (ii)
50.** *A.* sp. (iii)
51.** *A.* sp. (iv)
52.** *A.* sp. (v)
53.** *A.* sp. (vi)
54.** *A.* sp. (vii)
55.** *A.* sp. (viii)
56.** *A.* sp. (ix)
57.* *Cephalosporium acremonium* Coda
58. *Cephalosporium* sp.
59.* *Chaetomium angustum* Chivers
60.* *C. apiculatum* Lodha
61.* *C. bostrychodes* Zopf.
62.* *C. brasiliense* Batista & Pontual
63.* *C. erraticum* Ames

112-113. *Humicola* spp.
114.* *Melanospora caprina* (Fr.) Saccardo
115.* *Memnoniella echinata* (Rivolta) Galloway
116.* *Monilia sitophila* (Montagne) Saccardo
117.* *Mucor hiemalis* Wehmer
118. *M. racemosus* Fres.
119.* *Myrothecium striatisporum* Preston
120. *Mycogone* sp.
121-128. *Mycelia sterilia*
129.* *Neocosmospora vasinfecta* Smith
130.* *Nigrospora sphaerica*(Sacc.) Mason
131.* *Olpidiopsis* sp.
132. *Paecilomyces indicus* Rai, Tewari & Mukerji
133. *P. fusisporus* Saksena
134.* *P. varioti* Bainier
135. *Penicillium chrysogenum* Thom.
136. *P. citrinum* Thom.
137. *P. cyclopium* Westling
138. *P. funiculosum* Thom.
139. *P. lividum* Westling
140.* *P. pallidum* Smith
141.* *P. piceum* Raper & Fennel
142. *P. restrictum* Gilman & Abbott
143.* *P. vinaceum* Gilman & Abbott
144-151. *Penicillium* spp.
152.* *Pestalotia monogrhincha* Speg.
153. *Phoma eupyrena* Saccardo
154.* *P. hibernica* Grimes, O'Conner & Cummins
155.* *Preussia dispersa* (Clum) Cain
156.* *P. globosa* (Rai & Tewari) Rai & Tewari
157.* *P. multispora* (Saito & Minoura) Cain
158. *Pythium aphanidermatum* (Edson) Fitzpatric
159. *Pythium* sp.
160.* *Rhizopus nigricans* Ehrenberg
161. *Rhizoctonia* sp.
162. *Saprolegnia ferax* (Gruith) Thuret
163. *Sclerotium rolfsii* Saccardo
164. *Scopulariopsis brevicaulis* (Sacc.) Bain.
165. *Sordaria fimicola* Ces & de Not.
166.* *Stachybotrys atra* Corda
167.* *S. bisbyi* (Srinivasan) Barron
168.* *S. sacchari* (Srinivasan) Barron
169. *Stysanus stemonites* (Persoon) Corda
170.* *Syncephalastrum racemosum* (Cohn.) Schroeter
171.* *Syncephalis cornu* van Tieghem & Le Monnier
172.* *Talaromyces stipitatus* Thom. & Emmons
173.* *T. wortmanni* Klocker
174-175. *Talaromyces* spp.

176.* *Thielavia sepedonium* Emmons
177.* *T. setosa* Dade
178.* *T. terricola* (Gilman & Abbott) Emmons var. *minor* (Rayas & Borat) Booth
179.* *Torula alli* (Harz) Saccardo
180. *Trichoderma koningi* Oud.
181. *T. lignorum* (Tode) Harz.
182. *Trichothecium roseum* Link.
183.* *Trichurus spiralis* Hasselbring
184. *Tritirachium* sp.

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*New records from mangrove swamps
**New Species
***New genus of cleistothecial ascomycetes with *Aspergillus* state.

DISCUSSION

Out of the 184 forms isolated 97 species have been recorded for the first time from mangrove swamps belonging to different groups. It is interesting to note that many forms which are of common occurrence in other soil types are of frequent occurrence in these highly saline and anaerobic swamps, which is an indication of some degree of ecological adaptation by these forms in relation to these abnormal conditions. Earlier, RAI AND MUKERJI (1959), RAI *et al.* (1968b, 1970a, 1970b), RAI AND AGARWAL (1971, 1973, 1974) and RAI (1974) have shown that a continuous and prolonged impact of high pH (8.0—11.0), low moisture content, high osmotic concentration and intense solar radiation during summers tend to develop some degree of ecological specialization in h· micro-organisms native to saline-alkali ('Usar') soils. Ecological studies on some native fungi isolated from mangrove swamps have also clearly indicated that a prolonged impact of the highly saline and anaerobic conditions in these soils tend to develop certain degree of adaptability and ecological specialization to the abnormal conditions prevalent in this habitat (RAI & CHOWDHERY, 1975).

The occurrence of such a large number of common terrestrial fungi in mangrove swamps can be attributed to the fact that the fungal mycelia and spores alongwith soil brought by rivers get deposited in this deltaic region where in presence of rich organic matter they get adapted to the highly saline and anaerobic conditions and develop in a native mycoflora in due course. ELLIOTT (1930) who has given the first account of fungi inhabiting salt marsh sediments observed that the number of fungi increases with the increase in the amount of organic matter in the sediments despite high salinity and poor aeration. He was surprised to note the occurrence of terrestrial forms in highly saline sediments and concluded that the organic matter is mainly responsible for the activity of fungi in such an abnormal habitat. Similar observations on various other soil types have been made by PAINE (1927), JENSEN (1931), COBB (1932), TRESNER *et al.* (1954), SAXENA (1955), MILLER *et al.* (1957), BROWN (1958), COOKE AND LAWRENCE (1959), SEWELL (1959), MISHRA (1966a, 1966b).

It is evident from the data that Fungi Imperfecti constitute the major part of the mycoflora of the investigated swamps followed by Ascomycetes, Zygomycetes and Oomycetes. Basidiomycetes were not encountered. Ascomycetes include several perithecial and cleistothecial forms and a single species of *Arachnoitus* belonging to Gymnoascaceae. Presence of 4 species of the Genus *Achaetomium* in mangrove swamp indicates their preference to grow in habitats with relatively high salinity. RAI AND CHOWDHERY

(1973a, 1973b) reported the occurrence of various species of the genus in 'Usar' (Alkaline) soils. *Arthrobotrys*, *Epicoccum*, *Haplochalara*, *Heterosporium*, *Hormiscium*, *Mycogone*, *Nigrospora*, *Pestalotia*, *Stilbella*, *Stysanus*, *Trichothecium* and *Trichurus* rarely reported from soils, were found to inhabit these swamps.

Aspergillus fumigatus, *A. flavipes*, *A. flavus*, *A. niger*, *A. terreus* and *Chaetomium globosum* were encountered in almost all the isolations whereas, *Aspergillus aeneus*, *A. allahabadii*, *A. clavatus*, *Eupenicillium brefeldianum*, *Corticium solani*, *Gliocladium catenulatum*, *Nigrospora sphaerica*, *Paecilomyces fusisporus*, *Stachybotrys bisbi* and *S. sacchari* were rarely isolated. The sequence of abundance of species of the genus *Aspergillus* followed by those of *Penicillium* and then *Fusarium*, found in the present investigation for mangrove muds, has been the same as reported earlier for Indian 'Usar' soils by RAI AND MUKERJI (1959) ; RAI *et al.* (1971) and RAI (1974). RAI *et al.* (1969) have also reported the dominance of Aspergilli, Mucorales, Penicillia and other Fungi Imperfecti in the mycoflora of mangrove mud. The dominance of Aspergilli has been reported to be the characteristic of the soils of warmer regions (WAKSMAN, 1927 ; JENSEN, 1931 ; SAXENA, 1955 ; RAI *et al.* 1968b, 1968c and RAI & AGARWAL, 1970). SWART (1958) also observed the dominance of Aspergilli and Penicillia in the mycoflora of Inhaca Islands which figure among the saprophytic sugar fungi in Garrett's classification of fungi based on the nutritional grouping. In the mangrove swamps where probably more simple carbohydrates are present, their dominance is quite natural and they are among the first fungi to get established on the available nutrient sources.

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