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Litter-Decomposing Mycoflora in Relation to Different Climatic Conditions

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Decomposition study of litter, collected from savanna ecosystem of Varanasi forest division, was carried out in Botanical Garden of Banaras Hindu University, by keeping the litter in nylon bags for one year. Litter-inhabiting mycoflora was isolated by standard mycological technique at monthly intervals. The fungi were grouped as 'dominant', 'common', 'frequent', and 'rare', depending on their percentage frequency, abundance, sporulation and time of appearance in different months. Monthly variation in quality and quantity of fungal population was correlated with some climatic factors, like moisture content, temperature and relative humidity. The fungi exhibited maximum population in the month of August (72.72×10^4) and minimum in the month of March (28.22×10^4).

Key Words: Litter decomposition, Mycoflora, Climatic factors

Introduction

The process of decomposition is extremely complex and is controlled by the multitude of organisms, the chemical and physical properties of litter and by the abiotic environment. The fungi play an important role in the cycling of mineral nutrients from decomposing plant tissue. Fungal succession on the aerial parts of plants was reviewed by Hudson (1968). The changes in the environmental conditions, the nutrient level of soil and litter have been correlated with the appearance of fungi (Ruscoe 1971). Detailed accounts of the fungal succession on naturally occurring plant debris are confined mostly to work on the litter of tree (Caldwell 1963, Macauley & Thrower 1966 and Hering 1967, Dwivedi & Shukla 1977, Sinha & Pandey 1979) and grasses (Webster 1956, 1957, Khanna 1964, Rai 1968, Sharma 1973, Eicher 1976 and Aneja & Mehrotra 1980). There is little information on the litter-inhabiting mycoflora of the savanna ecosystem of natural forest in this country. In the present paper the monthly variations in the quality and quantity of the litter-inhabiting mycoflora is recorded with an attempt to find out their correlations with various climatic factors.

Study Area and Climate

The study area selected, is a savanna ecosystem in the Chandraprabha Sanctuary (24°52′ to 24°58′N Lat, 83°3′ to 83°12′E long.) in the Varanasi forest division. The sanctuary is located at the outer escarpment of Vindhyan highlands at 140–380 m altitude above m.s.l. and 70 to 230 ma bove the surrounding Gangetic plains. The stand consisted of luxuriant grass cover with sparsely distributed shrub of single species *Zizyphus zuzuba*, giving an appearance of typical shrub savanna. Two perennial species i.e. *Heteropogon contortus* and *Bothriochloa pertusa*, dominated the grass vegetation. The other grass species having more than 5 Important Value Index during growing season were *Apluda mutica*, *Aristida adscensionis*, *Digitaria bifasiculata*, *D. sanguinalis*, *Echinochloa colonum*, *Eragrastis tenella*, *Echinochloa bifaria*, *Paspalidium flavidum* and *Paspalum scorbiculatum*. Only the grass litter was taken for fungal decomposition.

The climate is typically monsoonic characterized by three season viz., warm and moist rainy season (July-October), cold and dry winter season (November-February) and dry and hot summer season (March-June). The total rainfall for the period of June, 1976 to May, 1977 was 1280.74 mm of which 96% fell in rainy season alone.

Materials and Methods

The fungal decomposition of litter was studied by nylon net bag technique (Sinha 1979). The mixed herbaceous fresh litter in savanna was collected in the month of May by laying 20 quadrats randomly. Air dried material 50g was kept in nylon mesh bags of 30×25 cm size with the mesh size of 1 mm^2. A trench (6 m ×4 m ×10 cm) was made in the Botanical Garden of Banaras Hindu University and it was filled with forest soil. All the nylon bags were placed on the soil surface in the trench. Out of them four were picked up randomly in each month starting from June, 1976 to May, 1977 for the study of their mycoflora.

The usual oven-drying method was adopted for the determination of moisture content in litter. The litter inhabiting mycoflora was isolated in each month by direct observation of litter sample under binocular microscope and also by dilution plate technique (Warcup 1960). The litter sample from the nylon bag was powdered and 10g litter was suspended into 100 ml of sterilized distilled water. Further dilution series (1 : 10^3, 1 : 10^4, 1 : 10^5) were prepared from it and 1 ml of each dilution was poured in sterilized Petri-dishes. Czapeks-Dox-Yeast-extract 0.05% agar medium with streptomycin, was used as nutrient media. Five replicates of each dilution were prepared for each medium and the inoculated plates were incubated at 25±2°C for a week and fungi were recorded.

Frequency and abundance of fungi were determined and the frequency values were further classified into five classes (Saksena 1955). Only class values of frequency and absolute values of abundance are given in nearest whole number in the table. Total number of fungi/g of oven-dried litter was calculated.

Results and Discussions

In the present investigation an attempt was made to isolate those forms which were actually participating in the process of decomposition. Different isolation methods were used with the expectation that they would reduce the bias introduced by any single technique.

Direct observation was most significant in the present study because it provides the exact picture of the main decomposers which may have been parasitic or saprophytic in nature. By this method, 22 species were isolated, consisting of 1 Ascomycetes, 19 Deuteromycetes and 2 sterile forms (table 1). A total of 56 fungi were recorded by dilution plate technique (table 2). This technique was effective in isolation of only 5 members of Phycomycetes, only one genus with two species (*chaetomium globosum* and *C. spirale*) of Ascomycetes, 45 members of Deuteromycetes and 4 sterile forms. In the present study no Basidiomycetes have been isolated. Approximately 62 species of fungi including 5 Phycomycetes, 3 Ascomycetes, 48 Deuteromycetes and 6 Mycelia sterilia were isolated during the whole course of investigation.

For the study of qualitative nature of the litter mycoflora, the litter fungi may be classified into following four groups depending upon their frequency, abundance, sporulation and time of appearance in different months:

GROUP I—Dominant

This group includes fungi like *Aspergillus flavus*, *A. niger*, *Penicillium citrinum*, *Trichoderma harzianum*, *Cladosporium herbarum*, *Fusarium semitectum* and Dark sterile mycelia, which are most dominant occurring in all the months of the year.

GROUP II—Common

This group consisted of those fungal forms which appeared more than six months of the year with less frequency and abundance than the dominant one. Common fungi are *Rhizopus nigricans*, *Mortierella subtilissima*, *Robillarda phragmitis*, *Aspergillus luchuensis*, *Penicillium rubrum*, *Auerobasidium pullulans*, *Alternaria alternata*, *Epicoccum nigrum* and *Papulaspora* sp.

GROUP III—Frequent

The fungi of this group have normal frequency and abundance occurring in almost six months of the year. The fungi of this groups are *Rhizopus oryzae*, *Phoma hibernica*, *Aspergillus sydowi*, *Cephalosporium acremonium*, *Curvularia lunata*, *C. pallescens*, *Torula graminis*, *Pseudotorula* sp., *Humicola grisea*, *Nigrospora sphaerica* and white sterile mycelium.

GROUP IV—Rare

The fungi of this group appeared only once or twice in a year with very low frequency and abundance. The fungi of this group are *Mucor racemosus*, *Pythium aphanidermatum*, *Choanephora cucubitarum*, *Chaetomium globosum*, *Neocosmospora vasinfectum*, *Botryodiploidia theobromae*, *Phomopsis* sp., *Aspergillus fumigatus*, *A. nidulans*, *A. candidus*, *A. sulphureus*, *Penicillium citrinum*, *P. javanicum*, *P. notatum*, *Monilia acremonium*, *Acrophialophora fusispora*, *Verticillium alboatrum*, *Paecilomyces silvatica*, *Trichothecium roseum*, *Trichoderma viride*, *Dictyosporium prolificum*, *Curvularia geniculata*, *Beltrania indica*, *Beltraniella* sp., *Hormiscium stilbosporum*, *Cercospora apii*, *Tetraploa aristata*, *Fusarium chlamydosporum*, *F. oxysporum*, *Myrothecium roridum*, Pink sterile mycelia and yellow sterile mycelia.

The appearance of different fungal species was noted to be dependent on the climatic conditions of the site on one hand and the biochemical nature of the substrate on the other. Dwivedi and Shukla (1977) have reported that the fresh litter was colonized by a lesser number of fungi, half decomposed litter was colonized by a wide range of fungal species and the decomposed litter was invaded by only a few fungi. With the start of rainy season, fast growing and sugar

loving Phycomycetes like *Rhizopus oryzae*, *R. nigricans*, *Mucor racemosus* and *Mortierella subtilissima* and some weak parasite like *Alternaria alternata*, *Curvularia lunata*, *Cladosporium herbarum* and *Papulaspora* sp. were recorded at the initial stages of decomposition which were further replaced by some pycnidial fungi *Robillarda phragmitis* and *Phoma hibernica*. Competition play an important role in disappearance of some fungi during colonization of litter as has been emphasized by earlier workers (Macauley & Thrower 1966, Sharma 1967 and Rai 1968).

There was monthly variation in the number of fungi/g of dry litter (figure 1). The maximum fungi were recorded in the month of August (72.72×10^4) and minimum in March (38.22×10^4). After first shower in June the litter was invaded by a large number of fungi due to favourable conditions of moisture and temperature and their population increases from June, 1976. Soon after the rains are over in October the population begins declining as the litter becomes dehydrated but in the month of January the population increases (54.49×10^4). This might be due to some winter rains in January which helps in increasing the microbial activity. The results are in agreement with the findings of Singh (1977).

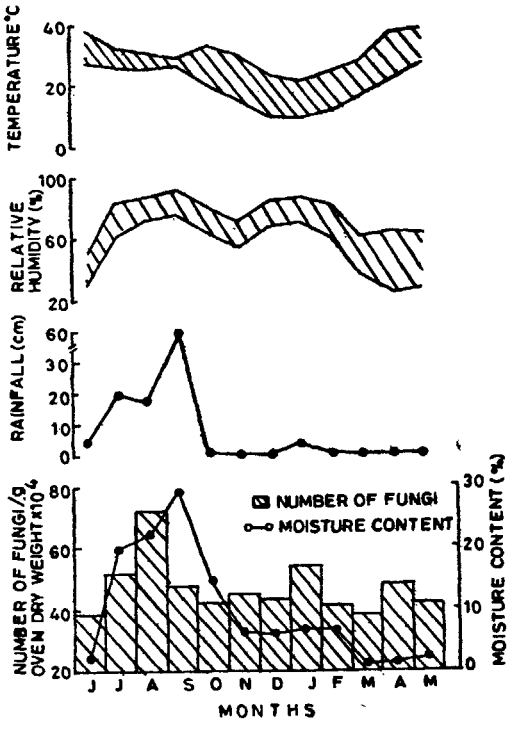

Figure 1 The climatic factors of the experimental site and fungal population of decomposing litter

The dynamics of microbial community can be attributed generally to abiotic variables principally moisture and temperature (Shukla et al. 1978). Increasing moisture content helps in increasing microbial activity. It was observed that in rainy season the population is highest both in terms of quality and quantity (tables 1, 2 and figure 1). In the month of September the moisture content of litter (29.14%) is higher than the August (22.08%) but the fungal population is low (47.74×10^4). The reduction in fungal population during this period may be due to water logging (figure 1). With the inception of rains a gradual increase in the number of fungal colonies and diversity in fungal forms were observed. The heavy rains seem to reduce the fungal population, as was evident in September. In dry summer months when the moisure content was low fungal population was minimum. Webster (1957), Hudson and Webster (1958), Webster and Dix (1960), Hudson (1962), Khanna (1964), Sharma and Dwivedi (1972) and Sinha and Pandey (1979) are of the opinion that moisture content is chiefly responsible for the colonization of decomposer organisms.

Besides the moisture content, relative humidity may also play a decisive role in the fungal colonization which has

Table 1 *Fungal colonies recorded on the litter by direct observation method*

Name of fungi	1976							1977				
	Jun.	Jul.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Chaetomium globosum	—	—	—	+	—	—	+	—	—	—	—	—
Robillarda phragmitis	—	+	—	—	—	—	+	+	—	—	—	—
Phoma sp.	—	—	—	—	+	+	—	+	—	+	—	—
Phomopsis sp.	—	—	—	—	—	—	—	—	—	+	—	—
Monilia acremonium	—	+	—	—	—	—	—	—	—	—	—	—
Trichoderma harzianum	—	—	+	—	—	+	—	—	+	—	+	+
Aspergillus niger	—	+	—	+	+	—	—	+	—	—	+	—
Penicillium citrinum	—	+	—	—	—	+	—	—	+	—	—	—
Acrophialophora fusispora	—	—	—	—	—	—	—	—	—	+	—	—
Aureobasidium pullulans	—	—	—	—	—	—	+	—	—	—	+	—
Alternaria alternata	+	—	+	+	—	—	+	—	—	—	+	—
Curvularia lunata	+	+	+	—	—	—	—	+	—	—	—	+
Cladosporium herbarum	+	+	—	—	+	—	—	—	—	+	—	—
Cercospora apii	—	—	—	—	+	—	—	—	—	—	—	—
Epicoccum nigrum	—	—	—	—	—	—	—	+	—	—	—	—
Humicola grisea	+	—	—	—	—	+	—	—	—	—	—	—
Nigrospora sphaerica	—	—	—	—	+	—	—	—	—	—	—	—
Tetraploa aristata	—	+	—	—	—	+	—	—	—	—	—	—
Fusarium semitectum	—	+	—	—	—	+	+	—	—	+	—	—
Myrothecium roridum	—	—	+	—	—	—	—	—	—	—	—	—
Dark sterile mycelium	+	—	+	—	—	—	—	—	+	—	—	+
Yellow sterile mycelium	—	—	—	—	—	—	+	—	—	—	—	—

—=Absent, +=Present

Table 2 *Frequency (F) and abundance (A) of litter-inhabiting fungi on Czapeks-Dox Agar medium (Dilution Plate Technique)*

Name of fungi	1976														1977									
	Jun.		Jul.		Aug.		Sept.		Oct.		Nov.		Dec.		Jan.		Feb.		Mar.		Apr.		May	
	F	A	F	A	F	A	F	A	F	A	F	A	F	A	F	A	F	A	F	A	F	A	F	A
Rhizopus nigricans	1	2	1	1	3	2	—	—	3	1	—	—	—	—	2	2	—	—	—	—	3	2	3	2
R. oryzae	—	—	1	2	2	2	1	1	1	4	—	—	—	—	—	—	—	—	—	—	3	2	2	3
Mucor racemosus	2	2	2	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Mortierella subtilissima	3	2	—	—	3	2	—	—	—	—	2	2	1	1	2	2	5	4	2	4	2	3	—	—
Pythium aphanidermatum	—	—	—	—	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Chaetomium globosum	—	—	1	1	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Choanephora cucurbitarum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—
Neocosmospora vasinfectum	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Botryodiplodia theobromae	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Diplodia vagans	—	—	—	—	1	1	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Robillarda phragmitis	—	—	—	—	4	3	2	3	5	5	5	4	5	3	5	5	5	3	—	—	—	—	1	3
Phoma hibernica	—	—	—	—	4	1	—	—	1	1	2	2	—	—	2	6	—	—	1	3	—	—	—	—
Monilia acremonium	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	2
Cephalosporium acremonium	—	—	—	—	2	2	—	—	—	—	2	2	—	—	—	—	3	2	5	2	3	2	—	—
Verticillium albo-atrum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—
Trichoderma harzianum	3	2	5	3	5	4	4	5	5	7	4	3	4	8	5	6	5	3	5	3	5	7	5	7
T. viride	—	—	—	—	2	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Aspergillus candidus	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
A. flavus	4	2	5	4	5	4	4	3	5	4	5	3	4	3	5	2	4	3	5	2	3	2	3	2
A. fumigatus	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—
A. nidulans	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—
A. niger	5	5	5	8	5	6	5	7	5	10	5	10	5	7	5	7	5	6	4	4	4	3	5	6
A. luchuensis	2	1	1	2	1	2	—	—	—	—	1	1	1	1	1	1	—	—	—	—	3	2	3	2
A. sulphureus	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	2	—	—	—	—	—	—	—	—
A. sydowi	—	—	2	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	3	1	1	—	—

Penicillium citrinum	5	6	5	3	5	4	3	5	5	6	4	5	3	4	5	7	4	4	1	2	2	6	2	3
P. javanicum	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—
P. notatum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—
P. rubrum	3	4	2	5	1	3	—	—	—	—	—	—	—	—	2	2	—	—	5	5	5	4	4	10
Acrophialophora fusispora	—	—	—	—	1	1	—	—	—	—	—	—	—	—	1	1	—	—	1	1	—	—	—	—
Paecilomyces silvatica	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—
Trichothecium roseum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—
Alternaria alternata	4	4	4	4	5	6	2	2	—	—	1	1	—	—	1	2	—	—	—	—	1	1	—	—
Aureobasidium pullulans	1	2	2	3	—	—	5	6	—	—	—	—	—	—	5	6	4	4	3	4	3	6	3	3
Beltrania indica	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Beltraniella sp.	—	—	—	—	1	2	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Cladosporium herbarum	5	5	4	3	5	8	3	3	2	2	3	2	4	3	4	2	2	2	1	1	4	3	4	3
Curvularia geniculata	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—
C. lunata	2	3	1	2	2	3	1	2	—	—	1	1	—	—	1	2	—	—	—	—	—	—	—	—
C. pallescens	—	—	—	—	—	—	—	—	1	2	1	1	—	—	1	1	—	—	—	—	—	—	—	—
Dictyosporium prolificum	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hormiscium stilbosporum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	2	2
Humicola grisea	—	—	1	2	1	2	—	—	—	—	—	—	1	2	—	—	—	—	—	—	—	—	—	—
Nigrospora sphaerica	—	—	1	2	—	—	—	—	1	1	—	—	1	1	—	—	—	—	—	—	—	—	—	—
Pseudotorula sp.	—	—	1	1	—	—	—	—	1	1	—	—	—	—	2	2	—	—	—	—	—	—	—	—
Torula graminis	1	1	—	—	4	2	3	3	—	—	—	—	4	5	1	1	1	1	—	—	—	—	—	—
Epicoccum nigrum	1	1	—	—	1	2	—	—	1	2	4	3	1	2	1	4	—	—	—	—	1	1	—	—
E. purpurascens	—	—	—	—	1	1	2	2	—	—	—	—	1	2	—	—	—	—	1	1	—	—	—	—
Fusarium chlamydosporum	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	1	2	2	2	—	—
F. oxysporum	—	—	—	—	—	—	—	—	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—
F. semitectum	5	4	5	5	5	5	5	3	5	4	4	3	4	4	5	2	5	4	4	4	5	4	5	6
Myrothecium roridum	—	—	—	—	1	3	—	—	—	—	—	—	—	—	2	2	—	—	—	—	—	—	—	—
Papulaspora sp.	2	2	2	2	4	3	2	2	2	3	—	—	2	2	3	4	—	—	—	—	—	—	2	2
Dark sterile mycelium	3	3	4	5	4	5	5	4	4	3	4	4	4	4	3	4	4	5	3	2	4	4	3	6
Pink sterile mycelium	—	—	—	—	1	1	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
White sterile mycelium	1	1	—	—	2	2	—	—	—	—	—	—	2	3	—	—	2	2	2	2	—	—	—	—

been studied by Webster (1956, 1957), Webster and Dix (1960). Dickinson and O'Donnell (1977) have observed that a high humidity which was insufficient to keep the leaf surface permanently wet, resulted in extensive fungal growth, as was evident in the month of July and August in the present study. The atmospheric conditions viz., temperature, light intensity etc., would have little effect upon the fungal colonization. The rise in temperature during March and April may affect the colonization and appearance of fungi in two ways—first by directly affecting the germination of fungal spores and mycelial growth and secondly by indirectly lowering the moisture content of the substrate and relative humidity of the atmosphere. During the rainy season temperature and relative humidity are most favourable which encouraged the colonization of litter by maximum number of fungi. The results show that there is significant difference in both qualitative and quantitative nature of the mycoflora in different seasons of the year.

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