Ecology of Soil Fungi: Population Variation in Relation to Varying Cover Vegetation and Soil Factors

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Summary. The role of cover vegetation on the distribution of microflora of three ecosystems viz., forest, grassland and barren land was studied. The effect of physico-chemical characters of soil on microflora was also investigated. In the fungistatic study the correlation between occurrence of species and inhibition property of soil on spore germination of certain fungi was found to be insignificant.

Introduction

During the last few decades much emphasis has been put to the ecological studies of the soil microflora of cultivated fields (Warcup, 1957, Mishra, 1966; Kein, Webster and Wick, 1975), and grasslands (Mishra, 1966 a; Mishra and Kanaujia, 1972; Roy and Dwivedi, 1966; Kathleenangel and Wicklow, 1975). In India very little information is available regarding the microbial complexes of the forest soil (Saksena, 1955; Saksena, Nanda and Sarbhoy, 1967; Mishra, 1966 b; and Johri et al. 1975). The north-eastern region of India where the ecological conditions are very conducive for the development of forest, provide an interesting habitat for such studies. In the present study effort has been made to compare the microflora of three different ecosystems, viz; forest (*Tectona* sp., *Shorea robusta*, *Terminalia* sp. and *Phyllanthus emblica*), grassland (*Saccharum spontaneum* and *Themeda* sp.) and barren land (hotspring bed and a place adjacent to hotspring).

The fungistasis of the soil samples of the different localities has been investigated to establish any correlation between frequency of fungal species and inhibition property of different soil samples.

Material and Methods

Six plots were selected for the present study. Three plots were located in different forests, one plot was in grassland and other two selected plots were hotspring bed and a place adjacent to hotspring. The plots were quite apart from each other (except grassland and hotspring) with diverse dominant plant species. The three forest plots were covered with differrent plantations. First plot was dominated by *Tectona grandis*, second by *Shorea robusta* and third with *Terminalia* sp. and *Phyllanthus emblica* plantation. The grassland was dominant

with *Saccharum spontaneum* and *Themeda tremula* species. In the fifth plot there was no vegetation except few algal species and the sixth plot was the barren bed of a hotspring.

Each plot was sampled for soil from three different places and one composite sample of one kg was collected separatly for each locality in sterilized polythene bags after removing the one centimeter humus layer. The temperature of hotspring was also recorded at the time of sampling. All soil samples were analysed for moisture contents, pH and conductivity by oven dry weight method, electric pH meter and conductivity meter respectively.

Organic carbon was determined by the volumetric method (WALKELY, 1947), available potassium by the method suggested by TOTH and PRINCE (1949) and available phosphorus was determined according to BRAY and KURTZ's (1945) method.

The soil dilution plate method was used to isolate the fungi, actinomycetes and bacteria. 10 g of soil was placed in 100 ml of distilled water in 250 ml Erlenmayer flask and blended for one minute. Final dilutions of 1 : 10.000 were used for the isolation. 1 : 10.000 dilution was used for fungi, and for actinomycetes and bacteria 1 : 10.000 dilution was used. Three replications were used for each set. The media selected for fungi, actinomycetes and bacteria were: Martin's Rose $\pm$ Bengal Agar (MARTIN, 1960), Soybean Meal Glucose Agar (TSAO et al., 1960) and Sodium albuminate Agar (WAKSMAN and FRED, 1920) respectively. Plates for fungi incubated at $25\pm1°$ C for five days and for actinomycetes and bacteria at $30\pm 1°$ C for 7 days and 48 hrs. respectively.

Fungistasis was studied by indirect method (JOHNSON, 1972). Equal amount of soil was filled in sterilized petridishes, packed nicely and moistened. Small discs of whatman filter paper were kept on the upper surface of the soil. Agar blocks (1.5% agar, 0.5% peptone bacteriological) of 0.5 cm diameter were placed on the filter paper discs and soil plates were allowed to incubate for 8 hrs. at $25\pm1°$ C. For control 2% agar was poured in petridishes instead of soil. Thereafter, spore suspension of the test fungi viz. *Penicillium* sp., *Trichoderma viride* and *Cladosporium* sp. obtained from six days old culture was pipetted on agar blocks and plots were again incubated for 24 hrs. at $25°\pm1°$ C and thereafter germination of spores was calculated (KLEIN, 1975).

$$\% \text{ inhibition of spores} = \frac{(\% \text{ germination on Control medium}) - (\% \text{ germination on assay medium})}{\% \text{ germination on Control medium}} \times 100$$

Since the sample was small and the number of pairs (N) was low, Spearman's rank difference correlation method (one tail test) was used (WOLF, 1968).

$$\sigma = 1 \frac{6\ \varepsilon D2}{N\ (N2-1)}$$

Results

Results of the present study are tabulated in tables 1 & 2 and plates 1 & 2. Quantitatively maximum micropopulation was harboured by *Terminalia* sp. and *Phyllanthus emblica* forest soils which was followed by grassland. The minimum micropopulation was obtained in hotspring sediment soil. Fungal species isolated from different soils varied to some extent. A number of fungi viz, *Cunninghamella echinulata*, *Syncephalastrum racomosum*, *Acremonium* sp.,

Table 1. Physico chemical characters of different soil Samples

Soil samples	Moisture Content (%)	pH	Soil temperature	Conductivity (Ece)	Organic Carbon %	Available Phosphorus	Available Potassium
Tectona grandis (Ist)	1600	5.45	33° C	0.097	1.69	5.8	450
Shorea robusta (IInd)	22.05%	5.40	24° C	0.19	1.48	13.5	202.5
Terminalia and *Phyllanthus* sp (IIIrd)	25.34%	5.50	31° C	0.26	3.02	7.3	493.3
Saccharum and *Themeda* sp (IVth)	29.00	7.3	28° C	0.32	2.04	9.6	1.000
Adjacent to hotspring (Vth)	41.00	6.00	25° C	0.24	1.98	Trace	265
Sediment of hotspring (VIth)	62.00	5.40	56° C	0.16	—	—	—

Gliocladium sp., *Verticillium terrestre* and *Scopulariopsis repens* were found to be specific to certain plots only (Table 2). Certain other fungi viz., *Penicillium* spp., *Trichoderma* spp., *Mucor* spp., *Absidia spinosa* and *Cladosporium* spp. were common to almost all the plots.

Bacteria and actinomycetes are expressed as a total number of colonies per g of oven dry soil (Plate 1). The maximum bacterial population was harboured by grassland soil followed by *Terminalia* sp. and *Phyllanthus emblica* forest soil. While highest actinomycetes population was found in *Terminalia* sp. and *Phyllanthus* forest soil followed by *Tectona grandis* forest soil.

All the soil samples showed a tendency towards acidity except grassland soil. Maximum organic was present in *Terminalia* sp. and *Phyllanthus emblica* forest soil followed by grassland soil and minimum organic carbon was observed from *Shorea robusta* forest soil. The maximum phosphorus was estimated from *Shorea robusta* soil, while in soil adjacent to hotspring it was recorded in traces only. Maximum available potassium was noted in grassland soil and minimum was observed in *Shorea robusta* forest soil.

Different degree of spore inhibition was recorded in different soil samples. The fungistatic values of the fungi which are presented in Plate 2 varied differently. The maximum inhibition of spore germination was found in almost all the plots except hotspring. The maximum inhibition in all the soil samples was noted in *Penicillium* sp. The minimum inhibition was recorded for *Cladosporium* sp. In case of *Trichoderma viride* spores inhibition was comparatively low.

The coefficient of correlation between inhibition of spore germination and occurrence of fungal species was found to be insignificant at 5 P level.

Table 2

Distribution of Different Groups of Fungi in Soil Samples

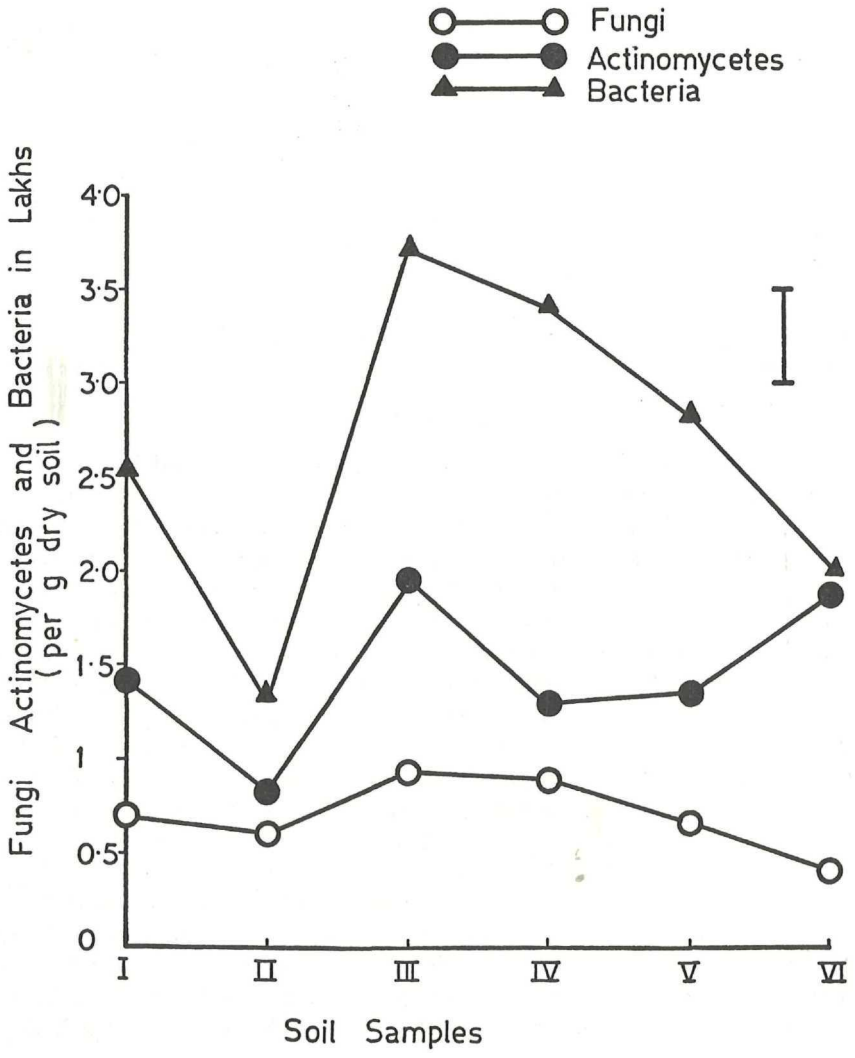
Fungal spp.	I	II	III	IV	V	VI
Mucor hiemalis	+	+	+	+	+	−
M. racemosus	+	−	+	+	−	−
Syncephalastrum racemosum	+	−	−	+	−	−
Rhizopus nigricans	−	+	−	+	−	−
Absidia spinosa	+	+	+	+	+	−
Cunninghamella echinulata	−	+	+	−	−	−
Aspergillus spp.	+	−	−	−	−	−
Penicillium spp.	+	+	+	+	+	+
P. roseum	−	−	−	+	−	−
P. sp. (blue colour)	−	−	−	−	−	+
Trichoderma viride	+	+	+	+	+	−
T. lignorum	+	−	−	+	−	−
Cladosporium herbarum	+	+	+	+	+	−
Cladosporium sp.	−	−	−	−	+	+
Gliocladium sp.	−	+	+	−	−	−
Scopulariopsis repens	+	+	+	+	−	−
Acremonium sp.	−	+	−	−	+	−
Verticillium terrestre	−	−	+	+	−	−
Fusidium sp.	+	−	−	−	−	−
Mycelia sterilia	−	−	−	+	+	−
Total No. of species	11	10	10	13	8	3

Discussion

The microbial population in soil is greatly affected by physico-chemical characters of the soil and the cover vegetation. The effect of surface vegetation on soil microflora (MISHRA, 1966a) has been found to be very effective. A perusal of the tables 1 and 2 clearly indicates that *Terminalia* and *Phyllanthus* consociations possessed highest microflora where not only the organic carbon content was highest but other soil parameters were also quite conducive for the growth of the soil microbes. This consociations were closely followed by grassland where also the organic carbon content was high. KEIN (1975) found that high organic carbon contents of soil may influence micro-populations upto ten fold than the soil with less carbon contents. The effect of fresh organic matter has stimulatory effects on the first colonizing fungi (HUBER and WATSON, 1970; WATSON, 1972 and JACKSON, 1958). Low microflora in case of other two forest localities, which were slopy areas, may be explained in terms of low organic carbon contents. This may also be due to washing away of the plant material from the slopes along with rains. *Tectona grandis* and *Shorea robusta* being timber plants of high economic value are regularly cut from the forest leaving the slopes with thin plant cover. The area is characterised by heavy

rains during premonsoon month which follow the leaf fall period. Along with the plant material considerable amount of microbial population associated with them is also removed from the soil surface. These factors work to minimise the soil microbial population. Stress of human interference with grassland, *Terminalia* sp. and *Phyllanthus emblica* forest is low and run off is also not high due to the even and smooth nature of the plots. The microbial population consequently was comparatively high. In the other two localities i. e. hotspring bed and the area adjacent to it were very poor in nutrient regime and the

PLATE - 1.



moisture content was also very high (Table 1). Such conditions normally are not very conducive for luxurient growth of microflora (MISHRA 1966b). From table 2 it is apparent that the bacterial and actinomycetes population was not affected adversely by the prevailing soil conditions. The fungal population, however, was considerably low. In case of hotspring bed *Penicillium* sp. (blue pigmented) was recorded with very high percentage, the other fungal species was *Cladosporium* sp. whose occurrence was very low. These two pigmented forms seem to have high resistance to unfavourable conditions like high temperature. NICOT (1960) and MISHRA (1966b) also reported the occurrence of pigmented forms in soil with high temperature, low humidity and poor organic matter content. The tolerance range of actinomycetes and bacterial species being high as compared to fungal species (plate 1), the former two groups of microorganisms were recorded with high frequency.

The fungistatic value expressed in terms of percent inhibition for the three fungal species (plate 2) i. e. *Trichoderma viride*, *Cladosporium* sp. and *Penicillium* sp. varied differently. HSU and LOCKWOOD (1973) studied the fungistasis behaviour and found that spore germination is significantly related to nutrient value of soil. The present study shows that fungistasis and frequency of fungal species in the localities are insignificantly related.

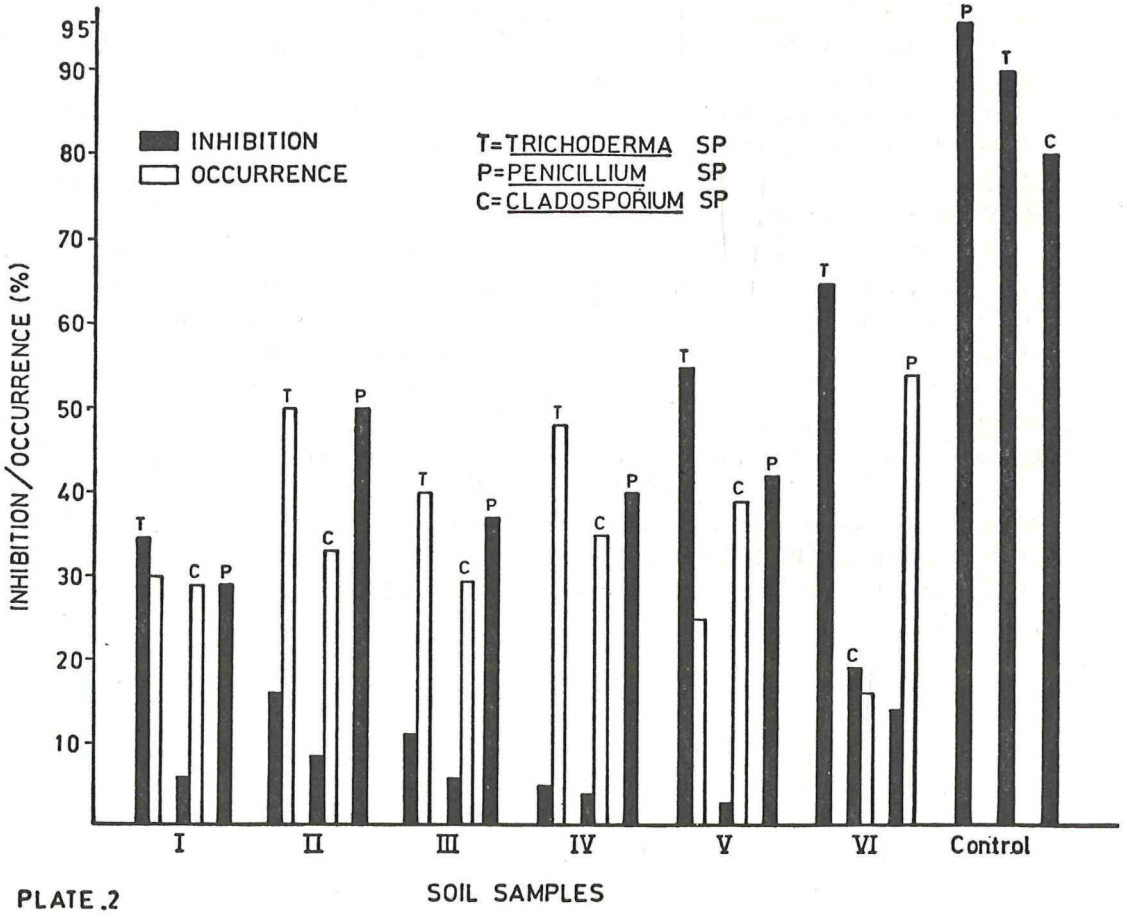


PLATE .2

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