J. Indian bot. Soc. 65 : 33—40, 1986

EDAPHIC FACTORS AFFECTING MICROFUNGAL DISTRIBUTION AT VARIOUS TOPOGRAPHIES OF CHAMBAL RAVINES[1]

I. J. JOSHI

School of Studies in Botany, Jiwaji University, Gwalior

ABSTRACT

The undulated terrain of the Chambal ravines of Bhind district (M. P.), India were explored for their soil fungi in relation to vegetative cover and edaphic factors. Seventy five fungal species were isolated from various topographies of ravines viz., top, upper slope, middle slope, lower slope and valley. Quantitatively, top exhibited the highest fungal population whereas lower slope harboured the lowest population. Amongst the edaphic factors, carbon and nitrogen contents of the soil showed a significant positive correlation with fungal population whereas soil texture, temperature, moisture, pH, calcium, potassium and phosphorus failed to exhibit any significant correlation with fungal population.

INTRODUCTION

Ever since the first intentional isolations of soil fungi (Adametz, 1886), a large number of workers have emphasized the importance and critical role played by surface vegetation, edaphic factors and soil micro-climate (Tresner *et al.*, 1954 ; Saksena, 1955 ; Pirozynski, 1968) in governing the distribution of soil mycoflora. Christensen (1969) has emphasized that climate, vegetation and edaphic factors were also effective in limiting the distribution of soil microorganisms. Mycofloral investigations, though, have been carried out by numerous workers, very little attention is paid to the mycoecology of ravine soils (Webley *et al.*, 1952 ; Sharma, 1967). In the present study, an attempt is made to observe the mycofloral variations on various topographies of Chambal ravines of Bhind district (M. P.), India which, inspite of being close to one another, differ with regard to vegetative cover and edaphic conditions.

MATERIALS AND METHODS

The Chambal ravines of Bhind district show an undulated terrain exhibiting various topographies due to extensive soil erosion through water. Five distinct topographies viz., top, upper slope, middle slope, lower slope and valley were recognized on the basis of phytosociological studies carried out in these areas (Joshi, 1979). The vegetation is scrub type and the climate is semi-arid.

Prosopis juliflora (SW) DC was the dominant tree species on all the topographies followed by *Dichrostachys cineria* L. *Commiphora mukul* Jacq., *Salvadora oleoides* DC and *Dalbergia sissoo* Roxb. were the other dominant trees on upper slope,

1. Accepted for publication on January 16, 1985.

Author is thankful to Prof. S. B. Saksena, F. N. A. for the helpful suggestions, to Dr. A. Johnston, Director, CMI, England for fungal identification and to Prof. R. R. Das, Head, School of Studies in Botany, Jiwaji University, Gwalior for providing laboratory facilities.

lower slope and valley respectively. Among the shrubs, *Grewia flavescens* Juss. and *Capparis decidua* L. dominated top, upper slope and middle slope whilst lower slope and valley were dominated by *Adhatoda vasica* Nees and *Capparis zeylanica* L. respectively. The ground vegetation is dominated by *Sporobolus diander* Beauv, *Vernonia cineria* Schreb, *Justicea simplex* L. and *Apluda mulica* L.

The soil sampling was done during February 1975. Seventy five soil samples were collected (15 samples from each topography) from 6" depth under aseptic contions. 5 plates were poured for each sample by inoculating soil on Martin's medium (Martin, 1950) using soil plate method (Warcup, 1950). Soil texture, temperature, moisture, pH and organic carbon were determined by methods suggested by Piper (1966). Total nitrogen, exchangeable calcium and potassium and available phosphorus were determined by methods suggested by Jackson (1967). For precise conclusions, the data were subjected to statistical analysis.

RESULTS AND DISCUSSIONS

A total of 75 fungal species were isolated from various topographies of these ravines (Table I). The present investigation has shown that the common soil

TABLE I

FUNGAL SPECIES SPECTRUM OF VARIOUS TOPOGRAPHIES OF CHAMBAL RAVINES

	Topographies				
Fungus	T	US	MS	LS	V
PHYCOMYCETES					
Candida Sp.	—	—	—	+	+
Cunninghamella echinulata (Thaxt.) Thaxt. ex. Blakeslee	—	+	—	—	—
Mortierella camargensis W. Gams & R. Moreau	—	—	—	—	+
Mucor racemosus Fresenius	+	+	+	+	+
Rhizopus oryzae Went & Prinsen Geerligs	—	+	—	—	—
ASCOMYCETES					
Chaetomium jodhpurense Lodha	+	+	+	+	+
Chaetomium sp.	—	—	—	+	—
Gymnoascus zuffianus Morini	—	—	+	—	—
Microascus trigonosporus Emmons & B. Dodge	—	+	—	—	+
Neocosmospora vesinfecta E. F. Smith	—	+	+	+	+
Otthia spiraeoe (Fuckel) Fuckel	—	—	+	—	—
Thielavia terricala (Gilman. & Abbot) Emmons	—	+	—	—	—
FUNGI IMPERFECTI					
Acremonium kiliense Grutz	+	+	+	+	—
Acrophialophora fusispora (Saksena) Samson	+	+	+	—	+
Alternaria alternata (Fr. Keissler)	+	+	+	—	+

TABLE I—(*Contd.*)

Fungus	Topographies				
	T	US	MS	LS	V
Aspergillus aculeatus Lizuka	—	—	—	+	+
A. flavipes (Bain. & Sart.) Thom & Church	+	—	—	+	—
Aspergillus flavus Link ex. Fr. (Strain I)	+	+	+	+	+
A. flavus Link ex. Fr. (Strain II)	—	—	+	—	+
A. fumigatus Fres. (Strain I)	+	+	+	+	+
A. fumigatus Fres. (Strain II)	+	+	+	+	+
A. fumigatus Fres. (Strain III)	+	+	+	+	+
A. nidulans (Eidam) Wint. (Strain I)	+	+	+	+	+
A. nidulans (Eidam) Wint. (Strain II)	—	+	—	—	+
A. niger Van Tieghan (Strain I)	+	+	+	+	+
A. niger Van Tiegham (Strain II)	+	+	—	+	+
A. niveus Blockwitz	—	+	—	—	+
A. ochraceous Wilhelm	—	+	—	+	—
A. stellatus Curzi	+	+	+	+	+
A. terreus Thom	+	+	+	+	+
A. ustus (Bainier) Thom & Church	+	+	+	+	+
Coleophoma empetri (Rostrup) Petrak	+	+	+	+	+
Curvularia borreriae (Viegas) M. B. Ellis	—	—	+	—	—
C. lunata (Wakker) Boedijn	+	+	+	+	+
Cylindrocladium floridanum Sobers & Seymour	—	—	—	—	+
Fusarium moniliforme Sheld	—	—	+	+	—
F. oxysporum Schlecht	+	+	+	+	+
F. solani (Mart.) Sacc.	+	+	+	+	+
Helminthosporium sativum Pammel, King & Bakke	+	+	+	+	—
Humicola fusco-atra Traaen (Strain I)	+	+	+	+	+
H. fusco-atra Traaen (Strain II)	—	+	—	—	+
Macrophomina phaseolina (Tassi) Goid.	—	+	+	—	—
Memnoniella subsimplex (Cda) Deighton	—	—	+	+	—
Monocillium constrictum W. Gams	+	+	+	+	—
Monodictys fluctuata (Tandon & Bilgrami) M. B. Ellis	+	+	+	+	—
Myrothecium leucotrichum (PK) Tulloch	+	—	+	+	—

TABLE I—(*Contd.*)

Fungus	Topographies				
	T	US	MS	LS	V
M. verrucaria (Alb. & Schw.) Ditm. ex Fr.	+	+	+	+	+
Narsimhella hyalinospora (Kuehn, Orr & Ghosh) Von Arx.	—	+	—	—	—
Paecilomyces lilocinus (Thom) Samsaon	—	+	+	—	—
Paecilomyces sp.	—	—	—	—	+
Penicillium funiculosum Thom	—	—	—	+	+
P. oxalicum Currie and Thom	+	—	—	+	+
P. spiculisporum Lehman	+	—	—	—	—
Pericoia sarswatipurensis Bilgrami	—	—	—	+	—
Periconia sp.	—	—	+	—	+
Phialophora cycliaminis Beyma	—	+	—	+	+
Phoma harbarum Westd	+	+	+	+	+
P. pomorum Thum	—	+	+	+	+
Phoma Sp.	—	—	—	+	—
Polyschema sp.	—	—	+	—	—
Pyrenochaeta abutilonis Mathur, Verma & Chauhan	—	+	+	—	—
P. indica Viswanathan	—	—	+	—	—
Scolecobasidium constrictum Abbott	—	—	—	+	—
S. terreus Abbott	—	+	+	—	+
Sphaerenaema allahabadense Chandra & Tandon	—	—	+	+	—
Stachybotrys atra Corda	—	—	—	—	+
S. bisbyi (Srinivasan) Barron	+	+	—	—	+
Trichoderma aureoviride Rifai aggr.	+	+	+	+	+
T. harzianum Rifai aggr.	—	—	—	+	—
Zalerion sp.	—	+	+	+	+
Unidentified colony I	—	+	+	—	—
Unidentified colony II	—	+	—	—	—
MYCELIA STERILA					
Sterile colony I (White)	+	—	—	+	—
Sterile colony II (Black)	—	+	—	—	+

+ = Presnet ; — = Absent
T = Top ; US = Upper slope ; MS = Middle slope ;
LS = Lower slope ; V = Valley

fungi are represented by members mucorales, *Chaetomium*, *Aspergillus*, *Curvularia*, *Humicola*, *Monocillium*, *Monodictys*, *Phoma* and *Trichoderma*. The dominance of aspergilli in the present study also confirms its abundance in tropical areas of world (Peyronel, 1956). The poor growth of mucorales, as represented in present investigation by only three genera (Garrett, 1963) and higher proportions of species from dematiaceae and sphaeropsidales (Park, 1968) indicate the desert soil environment of these ravines.

Of the 75 isolated species, 22 were common to all the topographies (Table I). The differences in the soil microenvironments of various topographies due to different edaphic conditions (Table II) and varied vegetative cover also led to certain specific fungal forms for each topography. Thus *Penicillium spiculisporum* was specific to top ; *Cunninghamella echinulata*, *Rhizopus oryzae*, *Thielavia terricola* and an unidentified colony were confined to upper slope ; *Gymnoascus zuffianus*, *Otthia spiraeae*, *Curvularia borreriae*, *Polyschema* sp. and *Pyrenochaeta indica* were restricted to middle slope ; *Chaetomium* sp. *Periconia saraswatipurensis*, *Phoma* sp., *Scolecobasidium constrictum* and *Trichoderma harzianum* were exclusive to lower slope; whereas *Mortierella camargensis*, *Cylindrocladium floridanum*, *Paecilomyces* sp. and *Stachybotrys atra* were isolated only from vallye. The restricted distribution of these fungal species renders them valuable

TABLE II

Factors		Topographies					Correlation coefficient (r)
		T	US	MS	LS	V	
Fungal pollution/gm soil		84463	77146	61537	61073	80317	
	Sand %	60.73	41.73	51.53	51.75	44.80	+0.04
Soil	Silt %	17.00	25.24	20.77	22.45	25.63	—0.06
Mechanical Composition	Clay %	17.77	22.69	18.03	15.47	20.57	+0.54
	$CaCO_3$	4.50	10.33	9.67	10.33	9.00	—0.65
Soil temperature °C		25.80	25.36	23.50	23.83	23.86	+0.73
Moisture %		4.68	3.03	2.37	3.80	4.29	+0.66
pH		7.5	7.5	7.6	7.5	7.5	—0.54
Carbon %		0.665	0.577	0.458	0.482	0.637	0.98**
Nitrogen %		0.096	0.084	0.066	0.050	0.114	+0.88*
Calcium mg/100 gm soil		125.00	135.42	129.17	141.67	147.92	—0.07
Potassium mg/100 gm soil		50	45	40	55	50	+0.13
Phosphorus ppm		10	8	15	15	13	—0.75

* Significant at 5% level

** Significant at 5% level

T=Top, US= Upper slope ; MS=Middle slope ;
LS=Lower slope ; V=Valley.

as indicator of certain specific soil environments (Cohen, 1949 ; Tresner *et al.*, 1944 ; Saksena, 1955).

The importance ot plant cover in influencing the soil mycopopulation has been emphasized by various workers (Tresner *et al.*, 1954; Saksena, 1955; Ramakrishnan, 1955; Ramarao, 1970). Lectard (1976) showed that the mycoflora depends upon the ecological variations which results in a zoning very characteristic of pheneregamic vegetation. In the present investigation also, various topographies, inspite of not being very far away from one another differed with regard to the vegetative cover, as mentioned earlier, thus also exhibiting a qualitative and quantitative variation in the soil mycoflora, the population (Table II) being highest at top (84463/gm soil) and lowest on lower slope (61073/gm soil) whilst the species spectrum (Table I) was narrowest at top (33 species) whereas upper slope exhibited widest species spectrum (48 species).

The mechanical composition of soil differed at various topographies (Table II) as the soils of top, middle slope and lower slope were sandy loam in texture ; the soil of upper slope was clayey loam ; whereas that of valley were sandy clay loam. Parr and Norman (1964) have recorded reduced fungal activity in soils of smaller particle systems like clay. The present investigation, however, failed to exhibit any significant correlation between particle size and fungal population (Table II).

The effect of soil temperature upon fungal population has been worked out by Saksena (1955) and Picci and Verona (1956). The present study did not reveal any significant correlation between soil temperature and fungal population (Table II). This is in conformity with the work done by Jensen (1931) who also ruled out the possibility of any actual correlation between the same. The positive effects of soil moisture on soil mycoflora have been shown by Tresner *et al.* (1954), Saksena (1955) and Dwivedi (1965) though Ramakrishnan (1955) and Orpurt and Curtis (1957) differed. The present study (Table II) did not reveal any relationship between soil moisture and fungal population as the correlation, though positive, was statistically insignificant. The results of present investigation reveal no significant correlation between soil pH and fungal population (Table II) thus confirming the work done by Warcup (1951) and Saksena (1955) who also showed that soil pH did not influence the fungal abundance.

Most of the workers (Waksman, 1944 ; Tresner *et al.*, 1954 ; Saksena, 1955 ; Ramarao, 1955) observed that organic matter had a great influence on fungal abundance though some workers (Vandecaveye and Katznelson, 1940) differed. The present investigation revealed that the carbon contents of the soil exhibit a highly significant positive correlation with fungal population (Table II.) Nitrogen which has been observed to influence the fungal quantity in positive direction (Saksena, 1955 ; Dwivedi, 1965, Mishra, 1966) also exhibited a significant positive correlation with fungal population (Table II).

The stimulatory effects of calcium (Saksena, 1955), Potassium (Guillemat and Montegut, 1958) and phosphorus (Ramakrishnan, 1955) on fungal population have been confirmed by many mycologists though some workers (Mishra, 1966; Ramarao, 1970) failed to observe any significant effect. In the present study the calcium, potassium and phosphorus contents of the soil failed to exhibit any significant correlation with fungal population (Table II).

Soils are noted for their spatial heterogenities and the resulting multiplicity of microenvironments. The differences in the nutritional level and physico-chemical characteristics of the soils which are remarkably closer to one another have been shown to give rise to marked local heterogenity espressed biologically in a mosaic of microhabitats or micro-environments (Alexander, 1971). Since the undulated terrian of the ravines afford a number of topographies differing from one another with regard to their vegetative cover, degree of steepness and the extent of solarization effect upon the plants, all these factors might have led to the differences in their soil microenvironments and hence in their mycoflora.

In a complex microbiological system like soil in which the micro-organic population is governed by a large number of interrelated factors, the characterization or elucidation of the role played by individual factor is very difficult. In the present investigation for measuring the amount of association between the fungal population and individual edaphic factors, correlation analysis was done for significant conclusions and interpretations as the need for the application of suitable statistical methods has not been realized inthe earlier investigations on soil fungal ecology. These results revealed that along all the edaphic factors, studied, only carbon and nitrogen seem to play a major role in fungal distribution as they exhibit a significant positive correlation with fungal population. The significance of these elements in the substrate composition has been critically reviewed by Graffin (1972).

REFERENCES

ADAMETZ, L. 1886. Untersuchungen uber die neiderm Pilze der Ackerkrumme. *Inaug. Diss. Leipzig.*, pp. 78.

ALLEXANDER, M. 1971. *Microbial Ecology.* John Wiley & Sons, Inc. New York, London, Sydney and Toronto, pp. 153.

CHRISTENSEN, M. 1969. Soil microfungi of dry to mesic conifer hardwood forest in northern Wisconsin. *Ecology* **50** : 9-27.

COHEN, C. 1949. Fungi as indicators of soil conditions. *Nature*, Lond. **154** : 498-409.

DWIVEDI, R. S. 1965. Ecology of soil fungi of some grasslands of Varanasi I. Edaphic factors and Fungi. *Proc. Nat. Acad. Sci. India.* **35** : 255.

GARRETT, S. D. 1963. *Soil fungi and soil fertility.* Oxford Pergamon Press, pp. 165.

GRIFFIN, M. 1972. *Ecology of soil fungi.* Chapman and Hall Ltd., London.

GUILLEMAT, J. AND J. MONTEGUT. 1958. Torisieme contribution a' e' etude e la microflora fongique des sols cultives (Third contribution to the study of fungal microflora of cultivated soils). *Ann. Epiphyt.*, **9** : 27-54.

JACKSON, M. L. 1967. *Soil chemical analysis.* Prentice-Hall of India Ltd., New Delhi.

JENSEN, H. L. 1931. The fungus flora of the soil. *Soil Sci.* **31** : 123-158.

JOSHI, I. J. 1979. *Development of soil microflora in relation to plant succession in certain areas of Chambal ravines.* Ph. D. Thesis, Jiwaji University, Gwalior, India.

LECTARD, P. 1976. Mycoflora and mycoecology of halophilic sites of Lorraine II. Evaluation of quantitative distribution of mycoflora. *Rev. Myco. Paris* **40** : 389-400.

MARTIN, J. P. 1950. Use of acid, rose bengal and streptomycin in the plate method for estimating soil fungi. *Soil Sci.* **69** : 215-232.

MISHRA, R. R. 1966. Studies on ecological factors governing distribution of soil mycoflora. *Proc. Nat. Acad. Sci. India* **35** : 205.

ORPURT, P. A. AND J. T. CURTIS 1957. Soil microfungi in relation to the prairie continuum in Wisconsin. *Ecology* 38.

PARK, D. 1968. The ecology of terrestrial fungi. *Apud The Fungi—An Advance Treatise* **III**: Eds. AINSWARTH G. C. & A. S. SUSSMAN. Academic Press, N. Y.

PARK, J. F. AND A. G. NORMAN, 1964. Growth and activity of soil microorganisms in glass micro-beads. I. CO_2 evolution. *Soil Sci.*, **97** : 361-366.

PEYRONEL, B. 1956. Considerazioni sulle microcenosi e sui metodi per studiarle. *Allionia* **3** : 85-109.

PICCI, G. AND P. VERNONA. 1956. Some biological researches on soils of the state of Sao Paulo, Brazil. *Bull Ist. Sieroter. Milano.*, **35** : 157-179.

PIPER, C. S. 1966. *Soil and plant analysis.* **Hans**

Publishers, Bombay, India.

PIROZYNSKI, K. A. 1968. Geographical distribution of fungi. *Apud The Fungi—An Advance Treatise* III. Eds. G. C. Ainsworth and A. S. Sussuan Academic Press, New York.

RAMAKRISHNAN, K. 1975. Some aspects of soil fungal ecology. *Proc. Nat. Acad. Sci. India*, **41** : 110-114.

RAMARAO, P. 1970. Studies on soil fungi III. Seasonal variation and distribution of microfungi in some soils of Andhra Pradesh (India). *Mycopath. Mycol. Appl.* **40** : 277-298.

SAKSENA, S. B. 1955. Ecological facors governing distribution of soil microfungi in some forest soils of Sagar. *Jour. Ind. Soc.*, **34** : 262-298.

SHARMA, M. C. 1967. Ecology of soil microfungi of Yamuna ravines. Ph.D. Thesis, Agra Univ., Agra, India.

TRESNER, H. D., M. P. BACKUS and J. T. CURTIS. 1954. Soil microfungi in relation to hardwood forest continuum in souther Wisconsin. *Mycologia* **46** : 314-333.

VANDECAVEYE S. C. AND H. KATZNELSON 1940. Microbial numbers and nature of organic matter in various genetic soil types. *Soil Sci.*, **50** : 295-311.

WAKSMAN, S. A. 1944. Three decades with soil fungi. *Soil Sci.*, **58** : 89-114.

WARCUP, J. H. 1950. The soil plate method for isolation of fungi from soil. *Nature London.* **166** : 117.

WARCUP, J. H. 1951. The ecology of soil fungi. *Trans. Brit. mycol. Soc.*, **34** : 376-399.

WEBLEY, D. M., D. J. EASTWOOD AND C. H. GIMINGHAM. 1952. Development of soil microflora in relation to plant succession on sand dunes including the 'rhizosphere' flora associated with colonizing species. *J. Ecol.* **40** : 168-178.