

ECOLOGY OF THE SOIL FUNGI OF UTTAR PRADESH

II. SOILS OF THE HIMALAYAN FORESTS AND THEIR MICROFUNGI

by R. K. SAKSENA, F.N.I., KRISHNA NAND and A. K. SARBHOY,
Department of Botany, University of Allahabad, Allahabad

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This paper deals with different forest soils of the Himalayas (Chaubattia orchard, Ranikhet, Almora, U.P.), giving their chemical composition and distribution of fungi at various depths during different seasons. In all 105 soil samples were collected from maize, pod, wisenboden, brown and red soils. Seventy-five different species of fungi were isolated and identified belonging to Phycmycetes, Ascomycetes and Deuteromycetes. Out of these *Absidia ramosa* (Lindt) Lendner, *Cunninghamella bainieri* Naumov, *Penicillium verruculosum* Poyr., *P. tardum* Thom, *P. janthinellum* Biourge, *P. subtile* Berk., *Paecilomyces punttonii* Nannizzi, *Verticillium puniceum* Cooke and Ellis, *Allomyces* sp., *Stachylidium* sp., *Scopulariopsis* sp. and *Chlamydomyces* sp. were new records from Indian soils. The maximum number of Penicillia was recorded in the rainy season while Aspergilli in the winter and the maximum number of fungi were isolated by Warecup soil plate and dilution methods. In the winter and rainy seasons the occurrence of fungi was the maximum in wisenboden and red soils while the minimum was in brown soil. During the summer season the maximum number of fungi was recorded in red and wisenboden soils, less in brown and least in maize and podsol soils. Only one species of Basidiomycetes was recorded.

INTRODUCTION

The study of soil fungi was first initiated by a German biochemist Adametz (1886) who isolated several species from the hidden treasures of nature. This work, however, remained in the state of stagnancy till Oudemans *et al.* (1902) described 45 species of soil fungi of Holland, the majority of which were new to science. Such work received considerable impetus in the following years and many contributions have been made from different parts of the world. Though studies of soil fungi have been engaging the attention of a large number of workers, the ecological factors which govern their distribution have not received serious attention in India and, therefore, it was decided to undertake such studies in this country. According to Mukherji and Das (1940, 1941, 1942) the soils of Uttar Pradesh have been divided into four natural divisions: (i) Himalayan tract; (ii) Sub-Himalayan tract; (iii) Gangetic tract and (iv) Bundelkhand tract. The present study deals mainly with different forest soils of the Himalayas (Chaubattia orchard, Ranikhet, Almora, U.P.), giving their chemical composition and distribution of fungi at various depths during different seasons and their possible interrelations.

TABLE I
Showing results of mechanical and chemical analyses of the Himalayan tract soil in various seasons

Soils	Maize			Podsol			Wisenboden			Brown forest			Red		
	Summer	Rainy	Winter	Summer	Rainy	Winter	Summer	Rainy	Winter	Summer	Rainy	Winter	Summer	Rainy	Winter
Moisture contents from various depths (in inches)	SS* 19.8	15.6	10.5	8.9	17.8	10.5	10.0	13.0	9.5	10.2	19.8	16.5	4.2	15.0	8.5
2"	19.8	14.8	12.6	4.3	17.2	12.8	10.8	11.6	10.2	11.2	19.5	8.5	3.3	10.4	9.2
4"	19.2	12.2	13.9	4.7	12.0	13.5	8.7	8.9	12.6	11.7	20.8	10.2	3.7	10.7	12.5
6"	19.5	19.0	14.7	5.8	13.0	15.8	6.6	8.1	15.8	7.9	18.7	12.2	4.6	10.8	14.6
8"	19.5	15.2	18.8	6.8	13.7	16.2	6.4	7.8	15.1	12.9	18.0	12.8	5.9	9.1	14.8
10"	17.6	9.0	17.5	6.2	13.1	20.2	7.6	7.6	17.2	10.8	18.5	14.2	6.8	8.5	15.2
12"	17.1	8.6	19.5	8.9	13.0	21.5	11.7	6.8	20.6	9.2	18.0	15.7	10.4	8.5	17.2
Average pH	6.8	6.0	6.0	6.0	6.2	6.2	7.0	7.0	7.0	6.0	6.6	7.0	6.6	7.2	7.2
	7.4	8.0	8.0	6.8	6.8	6.8	7.4	7.8	5.8	6.8	7.2	7.2	7.0	7.8	7.8
Carbon (percentage)	2.7	0.9	1.07	3.6	1.26	1.05	2.9	1.9	1.2	4.2	2.86	2.90	0.80	0.72	0.71
Nitrogen (percentage)	0.021	0.7	0.58	1.016	1.106	1.075	0.014	0.098	1.17	0.014	0.112	0.90	0.22	0.42	0.62
Nitrate per acre (lb.)	3	3	3	3	3	3	2	3	3	2.8	3	2	3	3	3
Phosphorus per acre (lb.)	190	250	150	150	150	120	150	150	75	120	120	25	120	20	75
Calcium (percentage)	0.44	0.62	0.23	0.62	0.78	0.22	0.47	0.67	0.65	0.60	0.75	0.48	0.32	0.49	0.22

* SS = surface soil.

SOILS

Ranikhet is situated in latitude 29° 50' north and longitude 79° 26' east on the great ridge, stretching half-way across the district from west to east and forming the northern boundary of the Kosi basin. It comprises two distinct areas, viz. Ranikhet proper and Chaubattia. The old natural pure and oak forests and the roadsides have been much beautified by lines of deodars, cypresses and exotic trees. The Chaubattia fruit garden is situated between 6,100 ft. and 6,700 ft. on the Ranikhet-Chaubattia hill. The soil was classified according to their usual textural characteristics by Mukherji and Das (1940, 1941) into four groups:

(i) *Red Loam*: These profiles, which lie mostly along slopes of hills or along ridges, are generally sandy in nature. The soils, owing to the open sub-soil texture, allow free drainage and become more or less dry in a few hours after a heavy rainfall.

The soils of this nature are, however, not very common under the conditions of the locality and they occur at places which receive maximum solar radiation.

(ii) *Brown Forest Soil*: The majority of the Chaubattia orchards' soils are of this type. The first surface layer of soil is rich in humified matter and reaches a depth of about a foot. Brown colour of the horizon under all conditions is very apparent.

(iii) *Pod Soil*: This type of soil is met with under mild slope gradients and in pockets of hills in ridges and in shady places of the orchard. Soil colour shades from dark grey to brownish grey. This is due to considerable amount of accumulation of organic nutrients from decomposing leaves and grasses but the surface soil does not tend to be peaty.

(iv) *Wisenboden Soil*: This type of soil is not very common, usually met with near water streams and cool and shady low-lying places of the orchard.

Owing to the very high ground water-level, the soil remains always moist, and during the entire winter season a thick matting of frost covers the soil surface. The organic matter due to the water-logged conditions is not completely decomposed to humus and it is usual to find a horizon of organic debris of about an inch thick on the surface of the soil in a semi-decomposed state. The surface horizon is, therefore, very dark in colour and coarsely granular.

(v) *Cultivated Soil*: This is the soil in which maize and different vegetable crops are grown during the various seasons. This soil is mostly mixed with artificial manures (maize soil).

Climate

The climate is mild and not marked by any great variations of temperature. The summer is said to be somewhat depressing in its influence, a

disadvantage which is attributed to the excessive vegetation. The annual rainfall is about 40 inches.

Method for the collection of soil samples

The method used for taking out soil samples was the same as mentioned by Saksena and Sarbhoy (1963). The soil samples were collected during the months of October, February and June 1963-64 from all the five soils mentioned above. The samples were packed in sterilized containers and brought to the laboratory. Seven soil samples were taken at a time from each soil in every season. In all, 105 soil samples were collected.

Soil analysis

The mechanical and chemical analyses of the soils were made. The *pH* values, moisture contents, carbon, nitrogen, nitrates, phosphorus and calcium of the soils were determined (Table I). The methods used were the same as described in the previous paper (Saksena and Sarbhoy 1963).

Isolation of fungal flora from the soil samples

The soil microfungi were studied by four main methods, viz. soil dilution plate method, soil plate method, direct isolation method and hyphal isolation method, on three different media (potato dextrose agar, Czapek's medium, acidic as well as neutral, with rose Bengal and streptomycin and finally on the Hay extracts agar).

Isolation of water moulds was accomplished by using boiled hemp seeds as baits.

Observations were recorded thrice, i.e. after two days, six days and eight days respectively. The number of colonies per plate in 1 g of soils was counted. The fungi which produced the maximum number of colonies in all three seasons were taken as dominant species.

PURE CULTURES AND IDENTIFICATION

After the isolation of the microfungi pure cultures were made by the single spore culture method and sometimes by the hyphal isolation method (Warcup 1955a).

Identification of the organisms was made with the help of the relevant literature.

DISCUSSION

The following soil fungi were recorded in various seasons from different depths as shown in Tables II, III and IV.

A critical study of Tables II, III and IV shows that the dominant species were *Rhizopus stolonifer*, *Aspergillus fumigatus*, *Penicillium funiculosum* and *Trichoderma viride* which were found in different seasons.

TABLE II

Showing the occurrence of microfungi in the summer season in different soils collected at various depths in inches

Species	Podsol soil	Brown soil	Red soil	Wisenboden soil	Maize soil
PHYCOMYCETES					
1. <i>Absidia spinosa</i> Lendner ..	—	—	6	6	—
2. <i>Actinomicor elegans</i> (Eidam) Benj. and Hess. ..	—	—	—	4	—
3. <i>Rhizopus stolonifer</i> (Ehrenberg ex Fr.) Lind. ..	2	2, 6, 10	4, 10	SS	SS, 2
4. <i>R. oryzae</i> Went and Geerlings ..	4	—	2	6	—
5. <i>Mucor racemosus</i> Fres. ..	2, 4, 8	12, 4, 2	2, 4, 8	8, 10	2, 4
6. <i>M. globosus</i> Fischer ..	—	SS	—	SS	—
7. <i>M. hiemalis</i> Wehmer ..	—	SS	8	2, 4, 6, 8	—
8. <i>M. luteus</i> Linne ..	—	SS	—	3	—
9. <i>Cunninghamella echinulata</i> Thaxter ..	—	—	8	6	8
10. <i>C. verticillata</i> Paine ..	—	—	10	—	—
11. <i>Zygorhynchus vuilleminii</i> Namy-slawski ..	6, 10	—	12	—	—
12. <i>Allomyces arbusculus</i> Butler ..	2, SS	2	SS	2, 4	SS
FUNGI IMPERFECTI					
13. <i>Aspergillus luchuensis</i> Inui ..	2, 12	8, 10, 6	2, 4, 6	2, 8, 10	2, 4
14. <i>A. ustus</i> (Brain.) Thom and Church ..	—	—	—	—	8, 4
15. <i>A. fumigatus</i> Fres. ..	10	12	SS, 2, 10	2, 4	SS
16. <i>A. flavus</i> Link ex Fr. ..	—	—	10, 8	10, SS	10, 6
17. <i>A. oryzae</i> (Ahlburg) Cohn. ..	6, 4	2, 4	4, 8	6, 8	10, 12
18. <i>A. nidulans</i> (Eidam) Wint ..	—	—	12	—	—
19. <i>A. niger</i> van Tieghem ..	4	—	6	—	—
20. <i>A. awamori</i> Nakazawa ..	10, 4, 6	—	—	—	—
21. <i>A. terreus</i> Thom ..	—	2	—	—	—
22. <i>A. sydowii</i> (Bain. and Sart.) Thom and Church ..	2, 4	2, 4	8, SS	SS, 6	SS, 8
23. <i>A. varicolor</i> (Berk and Br.) Thom and Raper ..	—	—	10	—	—
24. <i>Penicillium brefeldianum</i> Dodge ..	—	—	10	—	—
25. <i>P. frequentans</i> Westling ..	2, 4	4, 2, SS	2, 4, 6	4, SS	2
26. <i>P. funiculosum</i> Thom ..	4, 8, 10	SS, 2, 10	4, 6, SS	2, SS	SS
27. <i>P. purpurogenum</i> Stoll ..	12, 10	SS, 10, 12	8, 2, 12	6, 8	4
28. <i>P. variabile</i> Sopp ..	—	—	2	—	SS
29. <i>Paecilomyces variotii</i> Bainier ..	—	4	SS	4	—
30. <i>Curvularia lunata</i> (Wakker) Boedijn ..	—	—	2	—	SS
31. <i>Humicola grisea</i> Traaen ..	—	4	—	SS, 10	—
32. <i>Fusarium avenaceum</i> (Fries) Sacc. ..	4, 6	6, 4	4, 8	10, 12	10, 8
33. <i>Fusarium</i> sp. ..	—	8	SS	—	SS
34. <i>Gloeosporium</i> sp. ..	2	4	12	6	8
35. <i>Trichoderma viride</i> Pers. ex Fries ..	SS	2, 4	4, 8	12, SS	10
36. <i>Rhizoctonia solani</i> Kühn ..	—	—	2	—	—

SS = surface soil.
 — = absence of the fungus.

The number of fungi goes on decreasing downwards in the profile. This shows that they are pronounced aerobes and would not thrive in deficiently aerated lower horizon soils.

PHYCOMYCETES

During the present studies the authors isolated 20 different species covering eight genera of sugar fungi in various seasons. Three different species, viz. *Absidia ramosa*, *A. spinosa* and *A. butleri* (= *Gongronella butleri*), were recorded in various seasons. The first two species were common in various soils in the rainy and winter seasons while *A. spinosa* in the summer. *Actinomyces elegans* was recorded from red and wisenboden soils in the winter and summer seasons respectively. *Rhizopus stolonifer*, *R. oryzae* and *R. arrhizus* were reported from various soils. The most common species was *R. stolonifer*. Different species of *Cunninghamella*, viz. *C. echinulata*, *C. verticillata* and *C. bainieri*, were common in maize, red and wisenboden soils but *C. bainieri* was recorded in the rainy season from maize soil only. Five different species of the genus *Mucor* were recorded. The maximum number of the Mucorales was found during the summer season. *Mucors* did not survive in the winter season except *M. fragilis* which was not recorded in the summer. *Syncephalastrum racemosum* was recorded in the winter season from wisenboden soil while it was absent in the other two seasons. This shows its restricted distribution. The genus *Zygorhynchus* which was recorded by various workers from lower strata was also collected from pod and red soils in the summer season.

Only two genera, viz. *Allomyces* and *Achlya*, of aquatic fungi were recorded from the various soils. *Allomyces arbusculus* was the common species while the other which is being identified was recorded during the rainy season only in pod, brown and maize soils. *Achlya* sp. was recorded in the winter season from wisenboden and maize soils.

Out of these 20 different species belonging to various genera, *Absidia ramosa*, *Cunninghamella bainieri* and *Allomyces* sp. were new records from Indian soils.

ASCOMYCETES AND FUNGI IMPERFECTI (CELLULOSE- DECOMPOSING FUNGI)

Only three genera, viz. *Thielavia*, *Melanospora* and *Neocosmospora*, were isolated during the course of the present studies. These species have been recorded previously by many workers from soils. No species of these was recorded during the summer season. *Neocosmospora vasinfecta* and *Melanospora* sp. were recorded from pod and maize soils respectively in the rainy season while *Thielavia terricola* was found in maize soil in the winter season. This shows that the above three genera could not survive the summer.

TABLE III

Showing the occurrence of microfungi in the rainy season in various soils collected at different depths in inches

Species	Podsol soil	Brown soil	Red soil	Wisenboden soil	Maize soil
PHYCOMYCETES					
*1. <i>Absidia ramosa</i> (Lindt) Lendner	4	—	10	—	—
2. <i>Gongronella butleri</i> (Lendner) Peyronel and Dal Vesco ..	—	—	2	2	—
3. <i>Rhizopus stolonifer</i> (Ehrenberg ex Fr.) Lind.	5	8, 2	4	SS	6
4. <i>Mucor fragilis</i> Bain. ..	—	8	—	2	2
5. <i>M. hiemalis</i> Wehmer ..	—	8	—	2	2
6. <i>Cunninghamella echinulata</i> Thaxter	6	—	10	2	—
*7. <i>C. bainieri</i> Naumov ..	—	—	—	—	6
8. <i>Allomyces arbusculus</i> Butler ..	SS, 2	4, 2	SS, 2	2, SS	2, 6
*9. <i>Allomyces</i> sp.	2, 4	2, 6	—	—	2, 4
ASCOMYCETES					
10. <i>Neocosmospora vasinfecta</i> Smith	2, 8	—	—	—	—
11. <i>Melanospora</i> sp. ..	—	—	—	—	2
FUNGI IMPERFECTI					
12. <i>Aspergillus niger</i> van Tieghem	—	—	4	—	SS
13. <i>A. fischeri</i> Wehmer ..	—	—	4	—	SS
14. <i>A. ustus</i> (Bain.) Thom and Church	—	—	—	—	SS
15. <i>A. ochraceus</i> Wilhelm ..	—	—	—	—	SS
16. <i>A. oryzae</i> (Ahlburg) Cohn ..	2	2	2	8	4, 2
17. <i>A. luchuensis</i> Inui ..	6	—	—	10	—
18. <i>A. awamori</i> Nakazawa ..	—	—	—	10	—
19. <i>A. fumigatus</i> Fres. ..	4, SS, 10	4	2	2	4
20. <i>Penicillium brefeldianum</i> Dodge	—	10	—	—	—
*21. <i>P. verruculosum</i> Peyronel ..	2	2, 8, 4	—	—	—
*22. <i>P. tardum</i> Thom	—	—	12	—	—
*23. <i>P. janthinellum</i> Biourge ..	—	SS	12	SS	SS
*24. <i>P. subtile</i> Berkeley ..	—	—	8	SS	SS
25. <i>P. stipitatum</i> Thom ex Emmons	—	SS	2	—	—
26. <i>P. funiculosum</i> Thom ..	2	4	6	SS, 8, 10	12
*27. <i>Scopulariopsis</i> sp. ..	SS	—	—	—	—
28. <i>Paecilomyces varioti</i> Bainier ..	—	—	2, 4	—	SS
29. <i>P. fusisporus</i> Saksena ..	—	—	12	—	—
30. <i>Verticillium terrestre</i> (Link) Lindau	—	—	—	4	—

SS = surface soil.

* = new records from Indian soils.

— = absence of the fungus.

TABLE III—concl'd.

Showing the occurrence of microfungi in the rainy season in various soils collected at different depths in inches

Species	Podsol soil	Brown soil	Red soil	Wisenboden soil	Maize soil
*31. <i>V. puniceum</i> Cooke and Ellis . .	—	—	—	SS	—
*32. <i>Stachylidium</i> sp.	—	—	SS	—	—
33. <i>Fusarium oxysporum</i> Schlechtendahl ex Fr.	2, 6	—	—	—	4
34. <i>F. poae</i> (Peck) Wollenweber . .	—	2	—	—	—
35. <i>Fusarium</i> sp.	SS	—	—	—	—
36. <i>Cladosporium herbarum</i> (Persoon) Link	—	—	4	—	—
37. <i>Gloeosporium</i> sp.	—	—	2	—	—
38. <i>Mycelia sterilia</i>	2	—	—	4	8

SS = surface soil.

* = new records from Indian soils.

— = absence of the fungus.

In cultures *Penicillia* and *Aspergilli* gave many colonies and grew luxuriantly in all seasons from various types of soils. Their maximum number was recorded in the rainy season while *Aspergilli* were comparatively more in the winter. *Aspergillus fumigatus* and *Penicillium funiculosum* were the most common species encountered in all the seasons. These were the dominant ones. *Penicillium verruculosum* Pey., *P. tardum* Thom, *P. janthinellum* Biourge and *P. subtile* Berkeley were new records from Indian soils.

Moniliales constitute the most common fungal flora of cosmopolitan distribution. They are well known for their cellulose decomposition properties (Kellerman and McBeth 1912).

Three different species of the genus *Paecilomyces*, viz. *P. fuisporus*, *P. variotii* and *P. puntonii*, were found in different soils. *P. puntonii* Nannizzi is a new report from Indian soils. *Fusarium oxysporum* was the most common species while *F. poae*, *F. solani*, *F. avenaceum* and *Fusarium* sp. had restricted distribution.

Verticillium terrestre and *V. puniceum* were also recorded from wisenboden soil in the rainy season. *Verticillium puniceum* Cooke and Ellis is a new record from soils of India. No species of *Verticillium* was recorded in the summer season from various soils. *Stachylidium* sp., *Scopulariopsis* sp., *Chlamydomyces* sp. and *Spicaria* sp. were discovered for the first time from Indian soils.

Two common species of the genus *Curvularia* were also recorded. They were absent in the rainy season in all the soils.

Cladosporium herbarum, *Gloeosporium* sp. and *Mycelia sterilia* were also isolated from various soils in different seasons.

TABLE IV

Showing the occurrence of microfungi in the winter season in different soils collected at various depths in inches

Species	Podsol soil	Brown soil	Red soil	Wisenboden soil	Maize soil
PHYCOMYCETES					
*1. <i>Absidia ramosa</i> (Lindt) Lendner	2, SS	2, 6, 8	2, 10	2, 10	2, 3
2. <i>Gongronella butleri</i> (Lend.) Peyronel and Dal Vesco ..	10, 8, 6	6	4, 2, 4	SS	—
3. <i>Actinomyces elegans</i> (Eidam) Benj. and Hess. ..	—	—	2	—	—
4. <i>Rhizopus oryzae</i> Went and Geerlings	10	—	2	4, 10	—
5. <i>R. arrhizus</i> Fischer ..	10, SS	2	4	8	4
6. <i>R. stolonifer</i> (Ehronberg ex Fr.) Lind	6, 10, 12	2, 4	2	8	4, 8
7. <i>Mucor fragilis</i> Bain. ..	—	SS	—	—	2
8. <i>Cunninghamella echinulata</i> Thaxter	—	—	2	8	2
9. <i>C. verticillata</i> Paine ..	12	—	—	—	2, 6
10. <i>Syncephalastrum racemosum</i> (Cohn) Schroeter ..	—	—	—	4	—
11. <i>Allomyces arbusculus</i> Butler ..	2, 4	2, 4	SS	SS, 2	2
12. <i>Achlya</i> sp.	—	—	—	SS	SS, 2
ASCOMYCETES					
13. <i>Thielavia terricola</i> (Gilman and Abbott) Emmons ..	—	—	—	—	SS
FUNGI IMPERFECTI					
14. <i>Aspergillus nidulans</i> (Eidam) Wint	—	SS	2, 4, 6	6	4
15. <i>A. niger</i> van Tieghem ..	—	—	10	2	—
16. <i>A. phoenicis</i> (Corda) Thom ..	—	—	8	2	—
17. <i>A. terreus</i> Thom	—	—	SS, SS	2, 4	—
18. <i>A. alliaceus</i> Thom and Church	SS	—	SS	—	—
19. <i>A. ustus</i> (Bain.) Thom and Church	8	—	4	—	—
20. <i>A. fumigatus</i> Fres.	10, 4	4	6	SS, 4, 10	4, 8
21. <i>A. quadrilineatus</i> Thom and Raper	—	—	2	—	—
22. <i>A. sydowi</i> (Bain. and Sart.) Thom and Church ..	—	—	—	—	2
23. <i>A. oryzae</i> (Ahlburg) Cohn ..	4	—	—	4	—
24. <i>A. flavus</i> Link	10	2	12	10	SS
25. <i>A. niveus</i> Blochw.	4	—	—	—	—
26. <i>A. candidus</i> Link	4	—	—	—	—

SS = surface soil.

* = new records from Indian soils.

— = absence of the fungus.

TABLE IV—concl'd.

Showing the occurrence of microfungi in the winter season in different soils collected at various depths in inches

Species	Podsol soil	Brown soil	Red soil	Wisenboden soil	Maize soil
27. <i>A. tamaritii</i> Kita	—	—	SS	—	—
28. <i>A. sclerotiorum</i> Huber	—	—	—	SS	—
*29. <i>Penicillium lilacinum</i> Thom ..	12	—	—	—	—
30. <i>P. funiculosum</i> Thom	10	—	2, 8, 10	2	4, 6
31. <i>P. chrysogenum</i> Thom	—	—	—	2, 12	—
32. <i>P. rubrum</i> Stoll	—	—	—	SS	—
*33. <i>Paecilomyces puntonii</i> Nannizzi	—	—	6	—	—
34. <i>Verticillium terrestre</i> (Link) Lindau	—	—	8	—	—
35. <i>Trichoderma viride</i> Pers. ex Fries	SS	2, 4, SS	8, 12	10	2, 4
36. <i>Curvularia lunata</i> (Wakker) Boedijn	—	—	SS	6	—
37. <i>C. pallescens</i> Boedijn	—	2	—	—	—
*38. <i>Spicaria</i> sp.	—	—	2	6	—
*39. <i>Chlamydomyces</i> sp.	—	—	—	—	8
40. <i>Fusarium avenaceum</i> (Fries) Sacc.	SS	4	2	4	—
41. <i>F. poae</i> (Peck) Wollenweber ..	—	—	—	4	—
42. <i>F. oxysporum</i> Schlectendahl ex Fr.	2	8, 12	2, 4	2	SS, 4
43. <i>F. solani</i> (Martius) Appel and Wollenw.	—	—	—	12	—
44. <i>Fusarium</i> sp.	—	—	—	SS	2
45. <i>Mycelia sterilia</i>	SS	2	2	2	SS

SS = surface soil.

* = new records from Indian soils.

— = absence of the fungus.

BASIDIOMYCETES

Corticium solani was recorded in the summer season only from red soil.

The maximum number of fungi was isolated from Wareup soil plate and dilution methods (Wareup 1955b).

Moisture which is an important factor for the growth of fungi has a pronounced effect on the distribution of fungi. The present studies clearly indicate that the moisture percentage first decreases downwards generally up to four inches and then increases in the rainy season and it is the same in the winter season also. On the other hand, in the summer it again decreased up to two to six inches but further down there were increases. The results show that the maximum number of colonies depends upon the available moisture in various depths (Tables I, II, III and IV). Their maximum number was

recorded in the winter and rainy seasons whereas in the summer, due to persistent drought and high temperatures, the colonies were found in less numbers.

The pH of soil samples generally ranged between six and eight, being neither very acidic nor very alkaline. The authors have isolated 75 different species of fungi from various types of soils of the Himalayan tract. In the winter and rainy seasons the maximum number of species was recorded in wisenboden and red soils, while the minimum was in brown soil.

In the summer the maximum number of fungi was recorded in red and wisenboden soils, less in brown soil and least in pod and maize soils.

Carbon, nitrogen, phosphorus, calcium, etc., were found important, as is the usual case, for the growth and sporulation of microfungi and in the absence of any one of these the distribution of fungi is markedly effected as is reported by many other authors also.

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* Originals not seen.