

# OCCURRENCE AND COMPARATIVE ANALYSIS OF SOIL MYCODIVERSITY FROM DIFFERENT ANT-HILLS AND GARDENS OF JAMMU PROVINCE

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## Abstract

An investigation of mycoflora was carried out from various ant-hills and gardens of Jammu province in order to study mycodiversity and comparatively analyse its occurrence in different sites. During the period of investigation, a total of 50 soil samples from different areas like Mansar, Surinsar, Jhajjar kotli, Bani, Thana Mandi, Nasri and Nangali of Jammu province. In all, 30 fungal species belonging to 14 genera were collected from ant-hill soils. From the other soil samples, a total of 17 fungal species belonging to 11 genera were recovered. The results so far received from the present investigation indicate that soil is the potent reservoir of fungal diversity and can be one of the most value able sources of studying the mycodiversity.

**Keywords:** Soil; Mycodiversity; Jammu; comparative analysis

## Introduction

Biological diversity of this planet comprises of innumerable varieties of living organisms with multitude activities but none are more marvellous than the fungi. These are major decomposers in certain ecosystems, provide drugs and serve as experimental organisms. Since soil samples are rich in organic matter, they form one of the most suitable habitats for the microfungi (Elmes, 1991; Hulugalle, 1995; Cammeraat *et al.*, 2002; Dostal *et al.*, 2005). In 1991, a landmark paper estimated that there are 1.5 million fungal species on the earth (Hawksworth *et al.*, 1991). This estimate was derived by extrapolation from data of known fungi from well studied habitats. Out of the 1.5 million species, about 98,998 fungal species have been described so far (Kirk *et al.*, 2008), which implies that approximately 1.4 million species remain undescribed. This large number of undescribed fungi has given impetus to search for more fungal species from relatively unexplored habitats of soil, water, plants, etc., (Hawksworth and Rossman, 1997). One such microhabitat of soil which has not been explored in Jammu and Kashmir State so far, and may be a reservoir of diverse fungal diversity is an ant- hill. In addition to ant-hill soil, samples were also collected from various

types of soils in order to study their respective mycodiversity.

Ant-hill is tremendously important for studying mycodiversity because it is built by worker ants that carry tiny pieces of dirt, leaf debris, animal and agricultural wastes from a particular area and deposit them at the mouth of ant colony (Stone, 1985). Thus, fungal diversity of ant-hill represents the fungal diversity of a particular area. Moreover, Jammu region has sub-tropical and humid kind of climate which is favourable for development of both ants and fungi. In addition, there is dynamic mutualism between ants and fungi inside ant-hill, so study of fungi associated with it becomes important.

### Material and Method

Soil samples were collected from soil of various ant-hills and gardens of Jammu province in order to study fungal biodiversity of these areas.

### Sampling of soil from ant-hills

The areas from where ant-hill soil samples were collected include:

- |                                |                            |
|--------------------------------|----------------------------|
| a) Mansar (Dist. Samba)        | 670 metres above sea level |
| b) Surinsar (Dist. Udhampur)   | 305 metres above sea level |
| c) Jhajjar Kotli (Dist. Jammu) | 350 metres above sea level |
| d) Jammu Tehsil (Dist. Jammu)  | 332 metres above sea level |
| e) Nagbani (Dist. Jammu)       | 332 metres above sea level |

### Collection sites for garden soil samples

The areas from where garden soil samples were collected include:

- |                                |                             |
|--------------------------------|-----------------------------|
| a) Bani (Dist. Kathua)         | 1280 metres above sea level |
| b) Nasri (Dist. Doda)          | 1524 metres above sea level |
| c) Thana Mandi (Dist. Rajouri) | 609 metres above sea level  |
| d) Nangali (Dist. Poonch)      | 1002 metres above sea level |

Both the ant-hill soil collection sites and garden soil type collection sites are shown in figure 1 and figure 2.

The fungal species associated with different soils were recovered by dilution plate method. In this method 1 gram of soil sample was transferred aseptically in 9 ml. of sterile water and suspension of various dilutions was prepared. About 1 ml of the final suspension (1:10000) was poured in sterile Petri plates followed by 15-20 ml of molten modified Czapek Dox Agar medium (CDA). The petriplates were incubated at  $28 \pm 2^\circ\text{C}$  for 7 days to get proper growth of

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the fungal colonies. Identification of fungal species was done by using various keys and other relevant literature given by Brown and Smith (1957), Gilman (1957), Rapper and Fennel (1965), Tandon (1968), Rifai (1969), Booth (1971), Ellis (1971, 1976), Barron (1972), Pitt (1979), Domsch *et al.* (1980), Onions *et al.* (1981) Schipper (1984), Pitt and Hocking (1985), Gams (1997) and Chowdhary *et al.* (2000)

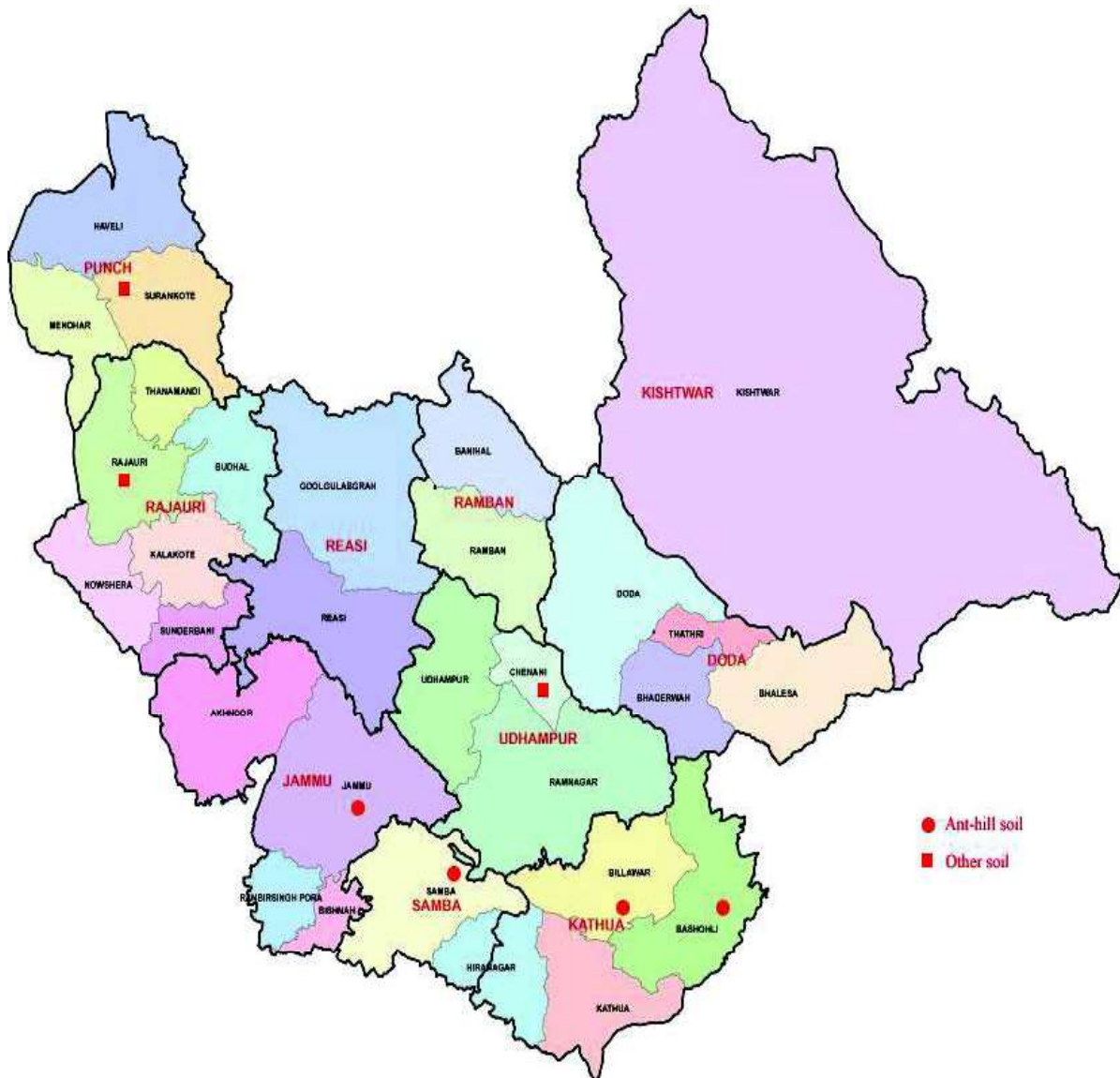


Fig. 1: District map of Jammu province depicting collection sites.

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Figure 2. Different collection sites

a. Nasri

b. Bani

c. Thana Mandi

d. Nangali

e. Crater shaped ant -hill

f. Epigeic ant-hill

## Results

During the period under investigation (September 2014 – September 2015), 25 soil samples collected from ant- hills situated in and around Jammu were studied for fungal flora. In all, 30 fungal species belonging to 14 genera were collected from ant-hill soils (Table 1). The fungal species recovered from the various ant-hill soil included members of Zygomycetes, Ascomycetes and Deuteromycetes. Class Zygomycetes was represented by two species of *Mucor* (*M. hiemalis* and *M. microsporus*) and one species of *Rhizopus* (*R. stolonifer*). Ascomycetes was represented by *Emericella nidulans* var. *echinulatus* whereas Deuteromycetes consisted of maximum representation including nine species of *Aspergillus* (*A. candidus*, *A. japonicus*, *A. flavus*, *A. fumigatus*, *A. niger*, *A. nidulans*, *A. parasiticus*, *A. ochraceous*, *A. terreus* and *A. sydowii*); five species of *Penicillium* (*P. chrysogenum*, *P. fellutanum*, *P. griseofulvum*, *P. oxalicum*, and *P. waksmanii*); two species each of *Fusarium* (*F. pallidoroseum* and *F. solani*); *Cladosporium* (*C. cladosporioides* and *C. oxysporum*) and *Paecilomyces* (*P. liliacinus* and *P. victoriae*) and one species each of *Acremonium* (*Acremonium implicatum*); *Alternaria* (*Alternaria alternata*); *Doratomyces* (*Doratomyces purpureofuscus*); *Curvularia* (*Curvularia lunata*); *Scopulariopsis* (*Scopulariopsis brumptii*) and *Trichothecium* (*Trichothecium roseum*). These samples were taken from ant-hills situated in various gardens of Jammu city and from other areas including Mansar, Surinsar, Jhajjar Kotli and Nagbani.

From the other soil samples, a total of 17 fungal species belonging to 11 genera were recovered. The fungal species recovered from the various soil samples included members of Zygomycetes and Deuteromycetes. Class Zygomycetes was represented by only one species of *Rhizopus stolonifer*. Class Deuteromycetes was represented by three species of *Aspergillus* (*A. niger*, *A. flavus* and *A. ochraceous*), five species of *Penicillium* (*P. brevicompactum*, *P. chrysogenum*, *P. expansum*, *P. oxalicum*, and *P. restrictum*) and one species each of *Acremonium* (*Acremonium alternatum*); *Alternaria* (*Alternaria alternata*); *Chaetomium* (*Chaetomium globosum*); *Cladosporium* (*Cladosporium cladosporioides*); *Eurotium* (*Eurotium chevalieri*); *Syncephalastrum* (*Syncephalastrum racemosum*); *Ulocladium* (*Ulocladium consortiale*) and *Verticillium* (*Verticillium suchlasporium*).

## Comparative analysis

In all 47 fungal species belonging to 19 fungal genera were recovered from both ant-hill soil and other types of soil samples. Some of the fungal species that were found in both ant-hill soil samples and other soil samples viz., *Aspergillus niger*, *A. flavus*, *A. ochraceous*, *Alternaria alternata*, *Cladosporium cladosporioides*, *Penicillium chrysogenum*, *P. oxalicum* and *Rhizopus*

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*stolonifer*. In ant-hill soils, *Aspergillus* was dominant and represented by 9 species while in other type of soil, *Penicillium* was dominant and represented by 5 species. Among the 19 genera, majority were present in ant-hill soils while fungal genera like *Chaetomium*, *Eurotium*, *Syncephalastrum*, *Ulocladium* and *Verticillium* were absent in ant-hill soils and were present in various other types of soils.

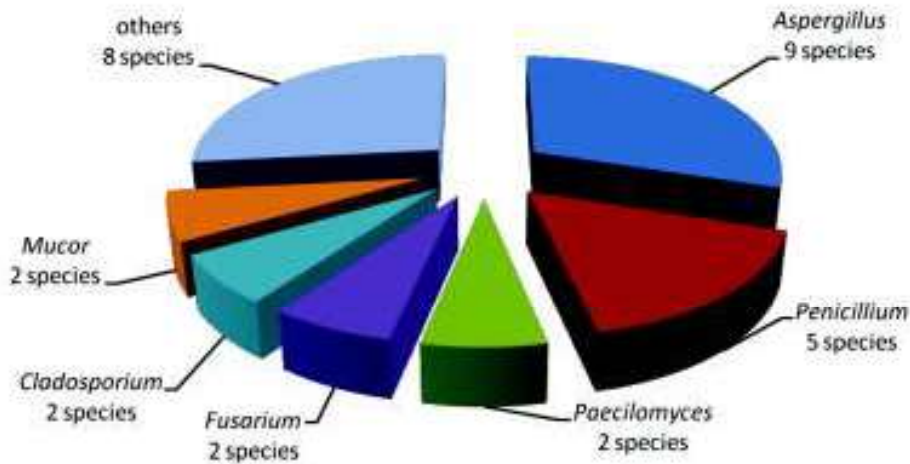


Fig. 3: Major fungal genera recovered from ant-hill soil at different sites

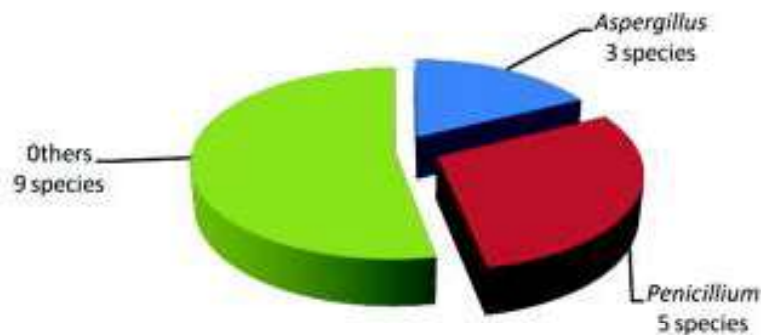


Fig. 4: Major fungal genera recovered from other soil at different sites

OBSERVATION TABLES

Table 1: List of fungal species recovered from ant-hill soil

fungal species recovered	occurrence in different sites					
	Site-1	Site-2	Site-3	Site-4	Site-5	Site-6
<i>Acremonium implicatum</i> (Gillman and Abbott) W. Gams	+	+	-	-	+	-

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<i>Alternaria alternata</i> (Fr.) Keissler	+	+	+	+	+	+
<i>Aspergillus japonicus</i> Saito	+	-	+	+	+	+
<i>Aspergillus niger</i> van Tiegham	+	+	+	+	+	+
<i>Aspergillus parasiticus</i> Speare	+	+	+	+	+	+
<i>Aspergillus flavus</i> Link	+	+	+	+	+	+
<i>Aspergillus fumigatus</i> Fresineus	-	+	+	+	+	-
<i>Aspergillus nidulans</i> (Eidem) Winter	+	+	+	+	+	+
<i>Aspergillus ochraceus</i> Wilhelm	+	-	+	+	-	+
<i>Aspergillus sydowii</i> (Bain and Sart.) Thom and Church	+	+	-	+	+	-
<i>Aspergillus terreus</i> Thom and Church	+	-	+	+	+	+
<i>Cladosporium cladosporioides</i> (Fresen.) de Vries	+	+	+	+	+	+
<i>Cladosporium oxysporum</i> Berk. and Curt.	+	+	+	-	+	-
<i>Curvularia lunata</i> (Wakker) Boedijn	+	+	+	+	+	+
<i>Doratomyces purpureofuscus</i> (Fr.) Morton & G. Sm	-	+	-	-	-	-
<i>Emericella nidulans</i> (Eidam) Vuill.	+	+	+	-	+	+
<i>Fusarium pallidoroseum</i> (Cooke) Sacc	-	-	+	+	+	+
<i>Fusarium solanii</i> (Mart.) Sacc.	+	+	+	+	+	+
<i>Mucor hiemalis</i> Wehmer	+	+	+	+	+	+
<i>Mucor microsporus</i> Wehmer	+	+	-	+	+	-
<i>Paecilomyces lilacinus</i> (Thom) Samson	+	+	+	+	+	+
<i>Paecilomyces victoriae</i> (Szilvinyi) comb.nov.	+	+	+	+	+	+
<i>Penicillium chrysogenum</i> Thom	+	+	+	+	+	+
<i>Penicillium fellutanum</i> Biourge	+	+	+	+	+	+
<i>Penicillium griseofulvum</i> Dierckx	-	-	+	+	+	+
<i>Penicillium oxalicum</i> Currie and Thom	+	-	-	+	+	+
<i>Penicillium waksmanii</i> Zaleski	+	+	+	+	+	+
<i>Rhizopus stolonifer</i> (Ehren. ex Fr) Linder	+	-	+	-	+	+
<i>Scopulariopsis brumptii</i> (Salvanet –Duval)	+	+	+	+	+	-

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<i>Trichothecium roseum</i> (Pers.) Link ex Gray	-	-	+	+	+	-
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‘+’ indicates presence and ‘-’ indicates absence of fungal species.

Site- 1 - Botanical garden (University of Jammu) Site- 2 - Green Belt park (Gandhinagar)

Site- 3 - Bagh-e-Bahu garden (Bahu Fort) Site- 4 - Rajinder park (Canal road)

Site- 5 - Jhajjar kotli Site- 6 - Parks of Surinsar and Mansar

**Table 2: List of fungal species recovered from garden soil samples**

fungal species recovered	occurrence in different sites			
	Site-1	Site-2	Site-3	Site-4
<i>Acremonium alternatum</i> Link	+	-	-	-
<i>Alternaria alternata</i> (Fr.) Keissler	-	+	+	+
<i>Aspergillus niger</i> van Tiegham	+	+	-	+
<i>Aspergillus flavus</i> Link	+	-	+	-
<i>Aspergillus ochraceus</i> Wilhelm	-	-	+	+
<i>Chaetomium globosum</i> Kunze ex Fries	+	+	-	-
<i>Cladosporium cladosporioides</i> (Fresen.) de Vries	+	-	-	+
<i>Eurotium chevalieri</i> Mangin	+	-	-	+
<i>Penicillium brevicompactum</i> Dierckx	-	+	+	+
<i>Penicillium chrysogenum</i> Thom	+	+	+	-
<i>Penicillium expansum</i> Link ex Gray	+	-	+	+
<i>Penicillium oxalicum</i> Currie and Thom	+	+	+	+
<i>Penicillium restrictum</i> Gilman and Abbott	-	-	-	+
<i>Rhizopus stolonifer</i> (Ehren. ex Fr) Linder	+	-	+	-
<i>Syncephalastrum racemosum</i> Schroter	+	-	-	+
<i>Ulocladium consortiale</i> (Thom) Simmons	+	-	-	+
<i>Verticillium suchlasporium</i> W. Gams and Dackman	-	-	+	-

‘+’ indicates presence and ‘-’ indicates absence of fungal species.

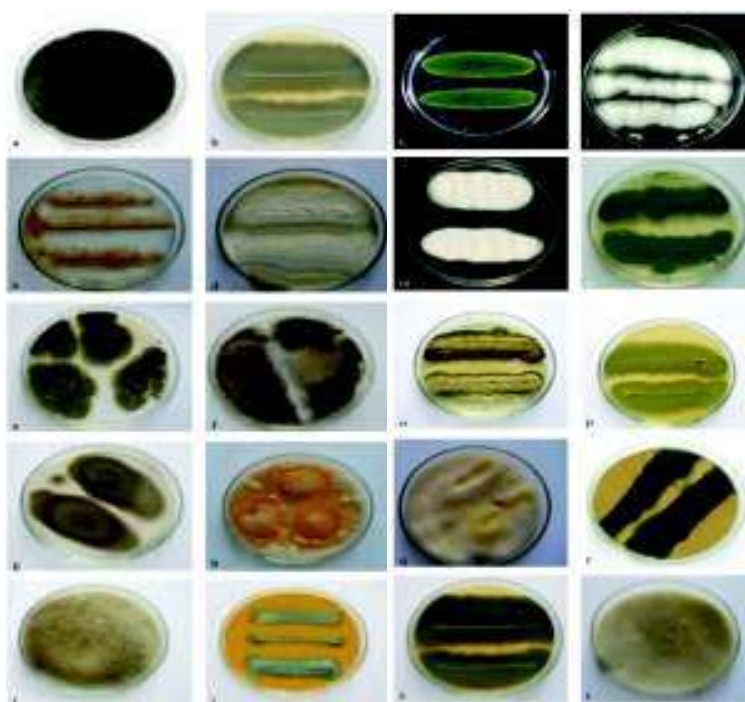
Site 1- Bani (Dist. Kathua) Site 2- Nasri (Dist. Doda) Site 3- Rajouri Site 4- Poonch



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**Conclusion**

The results so far received from the present investigation indicate that soil is the potent reservoir of fungal diversity and can be one of the most valuable source of studying their biodiversity. In all 47 fungal species were recovered from both ant-hill soil and garden soil samples. Some of the fungal species that were found in both anthill soil samples and garden soil samples viz., *Aspergillus niger*, *A. flavus*, *A. ochraceous*, *Alternaria alternata*, *Cladosporium cladosporioides*, *Penicillium chrysogenum*, *P. oxalicum* and *Rhizopus stolonifer*. Further work in this respect is under progress as more sites need to be explored to discover the unknown fungi that can contribute significantly to our research field and industries. Moreover, the lignocellulolytic ability of these organisms is also very wee known. Hence, these organisms can also be harnessed for the industrial production of enzyme cellulase that has utmost importance in textile, laundry, detergent, pulp and paper industries. We believe that this research article justify the launching of more detailed investigations on the role of ant-hills and the garden soils in diverse environments and the possible use of fungi associated with these ant-hills and garden soil in different kind of industries.



- |                                      |                                        |                                    |                                 |
|--------------------------------------|----------------------------------------|------------------------------------|---------------------------------|
| a. <i>Curvularia lunata</i>          | b. <i>Doratomyces purpureofuscus</i>   | c. <i>Aspergillus terreus</i>      | d. <i>Acremonium implicatum</i> |
| e. <i>A. Flavus</i>                  | f. <i>A. Niger</i>                     | g. <i>Scopulariopsis brumptii</i>  | h. <i>Trichothecium roseum</i>  |
| i. <i>Mucor hiemalis</i>             | j. <i>Penicillium citrinum</i>         | k. <i>A. parasiticus</i>           | l. <i>Fusarium solani</i>       |
| m. <i>Verticillium suchlasporium</i> | n. <i>A. fumigatus</i>                 | o. <i>Penicillium fellutanum</i>   | p. <i>Emerecilla nidulans</i>   |
| q. <i>Fusarium pallidoroseum</i>     | r. <i>Cladosporium cladosporioides</i> | s. <i>Drechslera australiensis</i> |                                 |
| t. <i>Rhizopus stolonifera</i>       |                                        |                                    |                                 |

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