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Soil Fungi of South India

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In the present paper the distribution of mycoflora of South Indian soil fungi were studied with special reference to C/N ratio. Two hundred and fifty one different fungi were identified. Maximum number of fungi were isolated by soil plate method. Basidiomycetes and Mycelia sterilia were not encountered. *Microascus shumacheri*, *Penicillium aculeatum*, *Trichoderma hamatum* and *I. piluliferum* were new records from India.

No definite correlation could be established with regard to the distribution of fungi in relation to C/N ratio. However, in some of the cases if the C/N ratio is higher, the number of fungi is usually increased and vice versa.

Key Words: Soil fungi, Distribution, India

Introduction

Many aspects of soil fungi have been studied in India attributing much emphasis on their distribution in various agroclimatic conditions (Saksena 1955, Saksena & Sarbhoy 1963, Mukerji 1966, Saksena et al. 1967a Kamal & Bhargava 1970, 1971). Fungi constitute a natural group of organisms and the bulk of nitrogen supply of any normal soil is present in the ecosystems of plants and animal material including microbes and all of these grouped under organic matter. The quantities of both inorganic and organic nitrogen vary greatly from soil to soil. Out of the total nitrogen about 1% is available for plants, the two are linked through a biological system in which the later is transformed into the former by the action of soil microbes.

Saksena et al. (1967 b) have followed Garrett (1951) in classifying these microorganisms on the basis of utilization of carbon compounds, although it is not easy to pin point various fungi into distinct ecological groups. Sugar fungi usually predominate in the upper horizon which is rich in organic matter while cellulose and lignin decomposing fungi comprizing of many Ascomycetes, Basidiomycetes and Fungi-imperfecti thrive in lower strata.

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Table 1 *Showing the distribution of fungi in different soils collected at various depth in cm*

S. No.	Species	Cultivated soil						Forest soil		Black soil	
		Kasaragod			Mangalore	Trivandrum		Kasaragod	Puttur	Coimbatore	
		COF	TUF	PDF	PDF	TUF	COF	KAF	PUF	CTF	GAS
1	2	3	4	5	6	7	8	9	10	11	12
Phycomycetes											
1.	*Absidia coerulea* Bain.	—	—	—	—	+	—	+	+	—	—
2.	*A. corymbifera* (Cohn) Sacc. and Trotter	—	—	—	+	+	—	—	—	—	—
3.	*A. ramosa* (Lindt.) Lend.	—	—	—	—	—	—	+	—	+	—
4.	*A. reflexa* van. Tieghem	—	—	—	—	+	—	—	+	—	—
5.	*Absidia spinosa* Lend.	—	—	—	—	—	—	—	+	—	—
6.	*Cunninghamella echinulata* Thaxter	—	—	—	—	+	+	—	—	—	—
7.	*C. elegans* Lender	—	+	—	—	—	—	—	—	—	—
8.	*Gongronella butleri* (Lend.) Peyromel and Dal Vesco	+	+	+	+	+	+	+	+	—	+
9.	*Mucor racemosus* Fres.	—	+	—	—	—	—	—	—	—	—
10.	*Mucor* sp.	—	—	—	—	—	—	—	+	—	—
11.	*Rhizopus arrhizus* Fischer	+	+	+	+	+	—	—	+	—	—
12.	*R. oryzae* Went and Gerlings	—	—	—	—	+	—	—	—	—	—
13.	*R. stolonifer* (Ehrenb. ex. Fr.) Lind.	—	—	—	—	—	—	—	+	+	—
14.	*Rhizopus* sp.	—	—	—	+	—	—	—	—	—	—
15.	*Syncephalastrum racemosum* (Cohn) Schroet	—	—	—	—	+	—	—	—	—	—

Ascomycetes

16. *Achaetomium globosum* Rai and Tewari	—	+	—	—	—	—	—	—	—	+
17. *Carpenteles brefeldianum* (Dodge) Shear	—	—	—	—	—	—	+	—	+	—
18. *C. javanicum* van Beyma	—	—	—	+	—	—	—	—	—	—
19. *C. levitum* (Raper & Fennell) Benjamin	—	—	+	—	—	+	—	—	—	—
20. *Chaetomium bostrychodes* Zopf	—	+	—	—	+	—	—	—	+	—
21. *Chaetomium* sp.	—	—	—	—	—	—	+	—	—	—
22. *Emericella nidulans* (Eidam) Vuill	+	+	+	+	+	+	+	+	+	+
23. *E. nidulans* (Eidam) Vuill. var. *acristata* (Fennell & Raper) Subram.	+	—	—	+	—	—	+	+	+	—
24. *E. nidulans* (Eidam) Vuill. var. *dentata* (Sandu & Sandhu) Subram.	+	—	—	—	—	+	—	+	—	—
25. *E. nidulans* (Eidam) Vuill. var. *echinulata* (Fennell & Raper) Subram.	+	+	+	+	+	+	+	+	+	+
26. *E. striata* (Rai, Tewari & Mukerji) Malloch and Cain	—	+	+	—	—	—	—	—	—	—
27. *E. variecolor* Berk. and Br.	—	+	—	+	—	—	—	—	+	—
28. *Eurotium amstelodami Mangin*	—	—	—	—	—	—	+	—	+	—
29. *Microascus cinereus* (Emile-Weil & Gaudin) Curzi	—	—	—	—	—	—	—	—	+	—
30. **M. shumacheri* (Hans). Curzi	—	—	—	—	—	—	—	+	—	—
31. *Neocosmospora africana* von Arx	—	—	—	—	—	—	—	—	—	+
32. *N. vasinfecta* E F Smith	—	+	—	+	+	—	—	—	—	—

Table 1 (*contd.*)

1	2	3	4	5	6	7	8	9	10	11	12
33.	*Sartorya fumigata* Vuill.	—	—	—	+	—	—	—	+	+	—
34.	*S. fumigata* Vuill. var. *glabra* (Fennell & Raper) Udagawa and Kawasaki	—	—	—	+	—	—	—	+	+	—
35.	*S. fumigata* Vuill. var. *spinosa* (Raper & Fennell) Udagawa and Kawasaki	+	—	—	—	—	—	+	+	—	—
36.	*Talaromyces striatus* (Raper & Fennell) Benjamin	—	—	—	+	—	—	—	—	—	—
37.	*Thielavia sepedonium* Emmons	+	+	+	+	—	—	—	—	—	—
38.	*T. terricola* (Gilman & Abbott) Emmons	—	+	+	—	—	—	—	—	—	+
	Fungi-imperfecti										
39.	*Alternaria alternata* (Fries) Keissler	+	+	+	—	—	—	—	—	—	—
40.	*A. solani* Sorauer	—	—	+	—	+	—	—	—	—	—
41.	*Aspergillus aculeatus* Iizuka	+	—	—	—	—	—	+	+	—	—
42.	*A. allahabadi* Mehrotra and Agnihotri	—	+	+	—	+	—	—	—	—	—
43.	*A. awamori* Nakazawa	+	—	+	+	+	—	+	+	—	—
44.	*A. carneus* (van Tiegh) Bloch	+	—	—	+	+	—	—	—	—	—
45.	*A. flavipes* (Bains. & Sart.) Thom and Church	—	—	—	—	+	—	+	+	—	—
46.	*A. flavus* Link	+	+	+	+	+	+	+	+	—	+
47.	*A. fumigatus* Fresenius	+	+	+	+	+	+	+	—	—	+
48.	*A. janus* Raper and Thom	—	—	—	—	—	—	+	—	—	—
49.	*A. melleus* Yukawa	—	—	—	—	—	—	+	—	—	—
50.	*A. niger* van Tieghem	+	+	+	+	+	+	+	+	+	+

51. *A. oryzae* (Ahlb.) Cohn	+	+	+	+	+	+	+	+	—	+
52. *A. parasiticus* Speare	—	—	—	—	—	—	+	—	—	—
53. *A. sulphureus* (Fres.) Thom and Church	—	+	+	—	+	—	—	+	—	—
54. *A. sydowi* (Bain. & Sart.) Thom and Church	+	—	+	+	+	+	—	—	—	—
55. *A. tamari* Kita	—	+	—	—	—	—	—	+	—	—
56. *A. terreus* Thom	+	+	+	—	+	+	+	—	—	+
57. *Bartalinia bischofiae* Nag Raj	+	+	+	—	—	—	—	—	—	—
58. *Cephalosporium* sp.	—	—	+	—	—	—	—	—	—	—
59. *Cladosporium herbarum* (Pers.) Link	—	—	—	—	—	—	+	—	—	—
60. *Curvularia pallescens* Boedijn	—	+	+	—	—	—	—	—	+	+
61. *Fusarium moniliforme* Scheldon	—	+	+	—	—	—	—	—	—	+
62. *E. semitectum* Berk. and Rav.	—	—	+	—	—	—	—	—	—	—
63. *F. solani* (Martius) Sacc.	—	—	+	+	+	+	+	+	—	—
64. *Helminthosporium* sp.	—	—	—	—	—	—	—	—	—	+
65. *Humicola brevipes* (Gilman & Abbott) Gilman	—	—	—	—	—	—	—	+	—	+
66. *Humicola* sp.	—	+	+	—	—	—	—	—	—	—
67. *Myrothecium roridum* Tode	—	—	—	—	—	—	—	—	—	+
68. *Paecilomyces* sp.	—	—	+	—	—	—	—	—	—	—
69. **Penicillium aculeatum* Raper and Fennell	—	—	—	—	—	—	—	—	—	+
70. *P. camemberti* Thom	—	—	—	—	—	+	—	—	+	—
71. *P. chrysogenum* Thom	+	—	—	—	+	+	+	—	—	—
72. *P. frequentans* Westling	—	—	—	+	—	—	+	+	—	—
73. *P. funiculosum* Thom	—	—	—	—	+	+	—	+	—	+
74. *P. levitum* Raper and Fennell	—	—	—	—	—	+	—	—	—	—

Table 1 *(contd.)*

1	2	3	4	5	6	7	8	9	10	11	12
75.	*P. liliacinum* Thom	—	—	—	+	—	+	+	+	—	+
76.	*P. notatum* Westing	—	—	—	—	—	+	—	—	+	—
77.	*P. phoenicum* van Beyma	—	—	—	—	—	+	—	—	+	—
78.	*P. roseopurpureum* Dierck	—	—	—	—	+	—	—	—	+	—
79.	*Phoma* sp.	—	—	+	—	—	—	—	—	—	+
80.	*Stechy botrys* atra Corda	—	—	+	—	—	—	—	—	—	—
81.	**Trichoderma hamatum* (Bon.) Bain	—	—	—	—	—	+	+	—	—	—
82.	*T. harzianum* Rifai	—	—	+	+	+	+	+	+	—	—
83.	*T. koningii* Oud.	—	—	+	+	+	+	—	+	—	—
84.	**T. piluliferum* Webster and Rifai	—	—	—	—	+	—	—	—	—	—
85.	*T. viride* Persoon ex S F Gray	—	—	—	—	+	+	—	—	—	—
	Mycelia sterilia	—	—	—	—	—	—	—	—	—	—
	Actinomycetales	+	—	+	+	+	+	—	—	+	—

*New records from India (*Indian Phytopath* 30 77–79, 1977 and *Curr. Sci.* 47 55–56, 1978)

COF=Coconut field; CTF=Cotton field; GAS=Garden soil; KAF=Kasaragod forest; PDF=Paddy field; PUF=Puttur forest; TUF=Turmeric field

A scruitiny of the pertinent literature reveals that very few reports have appeared on soil mycoflora of South Indian soils (Subramanian 1952, 1954, Ramakrishnan 1955, 1956). Keeping this in view, it was thought desirable to study the distribution of South Indian mycoflora and their possible relationship with regard to carbon and nitrogen ratio in different types of soils with special emphasis on cultivated black and forest soils. The soils of varying types from deep sand in arid regions, black to clay and red loam were chosen for the present study.

Soils

The soils of Kasaragod (Kerala) comprise of sandy loam, and laterite which are acidic in reaction. They are well-drained and poor in nutrients. These soils are used for growing a wide range of crops viz., coconut, turmeric, arecanut etc.

Trivandrum (Kerala) soils are red which is due to the haemalite like substance. These are deficient in organic matter, poor in nutrients and acidic in reaction. Coconut is the main crop in this region. At Mangalore (Karnataka), alluvial, laterite and lateritic soils are found which are heavy in texture, rich in organic matter, nitrogen, potash but lack phosphate and lime and strongly acidic in reaction. The common cropping patterns are paddy, coconut, arecanut and turmeric. The predominant soils in Coimbatore (T N) are red, black and mixed type which are generally alkaline in reaction. Cotton, sugarcane, sunflower are major crops of this region.

Method for the collection of soil samples

One hundred soil samples were collected in sterilized containers from 0–15 cm of depth during the year 1973–74. These samples were mixed together and in all ten samples were made, hence no depth of the particular soil has been given in the table.

Soil analysis

The *p*H of the soils was determined with the help of Toshniwal *p*H meter. The nitrogen and carbon percentages were estimated by Kjeldahl's and Walkley's methods respectively.

Isolation of mycoflora from the soil samples

The fungi were isolated mainly by three methods, viz., Direct (Waksman 1916), soil dilution (Waksman 1927) and soil plate (Warcup 1955) on four different media, viz., Potato dextrose agar, Czapek Dox, Malt extract and Hay extract.

Sterilized and inoculated Petri plates from which the isolations were to be made, were incubated at 20, 25 and 30°C. Observations were recorded after an interval of 2 days up to 8 days. The number of colonies in each plate was counted and the number of fungi per gram of dry soil was determined by multiplying the dilution factor with the actual number of colonies. Purification was done by single spore technique. The fungi were identified using the relevant literature (Raper & Thom 1949, Gilman 1957, Raper & Fennell 1965 and Domosch & Gams 1972).

Results and Discussion

Eighty-five different fungi belonging to three major classes viz., Phycomycetes, Ascomycetes and Fungi-imperfecti were isolated (table 1). The maximum number of fungi were isolated by soil plate followed by soil dilution and direct isolation methods. Phycomycetes comprising of 15 species distributed into six genera viz., *Absidia*, *Cunninghamella*, *Gongronella*, *Mucor*, *Rhizopus* and *Syncephalastrum*, while

Ascomycete constitute 23 species belonging to the ten genera *Achaetomium, Carpenteles, Chaetomium, Emericella, Eurotium, Microascus, Neocosmospora, Sartorya, Talaromyces* and *Theilavia*. However, Fungi-imperfecti consisting of 47 species belong to 15 genera *Alternaria, Aspergillus, Bartalinia, Cephalosporium, Cladosporium, Curvularia, Fusarium, Helminthosporium, Humicola, Myrothecium, Paecilomyces, Penicillium, Phoma, Stachybotrys* and *Trichoderma*. No fungi representing Basidiomycetes and Mycelia sterilia were recorded. Besides, Actinomycetes represented its presence by 6 strains only. The maximum number of fungi were encountered from acidic soils as compared to alkaline soils. These results are in conformity with Waksman (1932) and Saksena and Sarbhoy (1963).

It is also evident from the present investigation that the members of Fungi-imperfecti formed the major part of microflora encountered in all the soils except in black cotton soil where Ascomycetes predominate. Further, maximum number of fungi were isolated from cultivated fields than the forest and black soils (figure 1). Phycomycetes were abundant in cultivated soils of turmeric field. Pugh (1963) stated that the chief factor determining the presence of fungi in soils is the available food supply, and only when this requirement is satisfied do the gross characters of the soils become

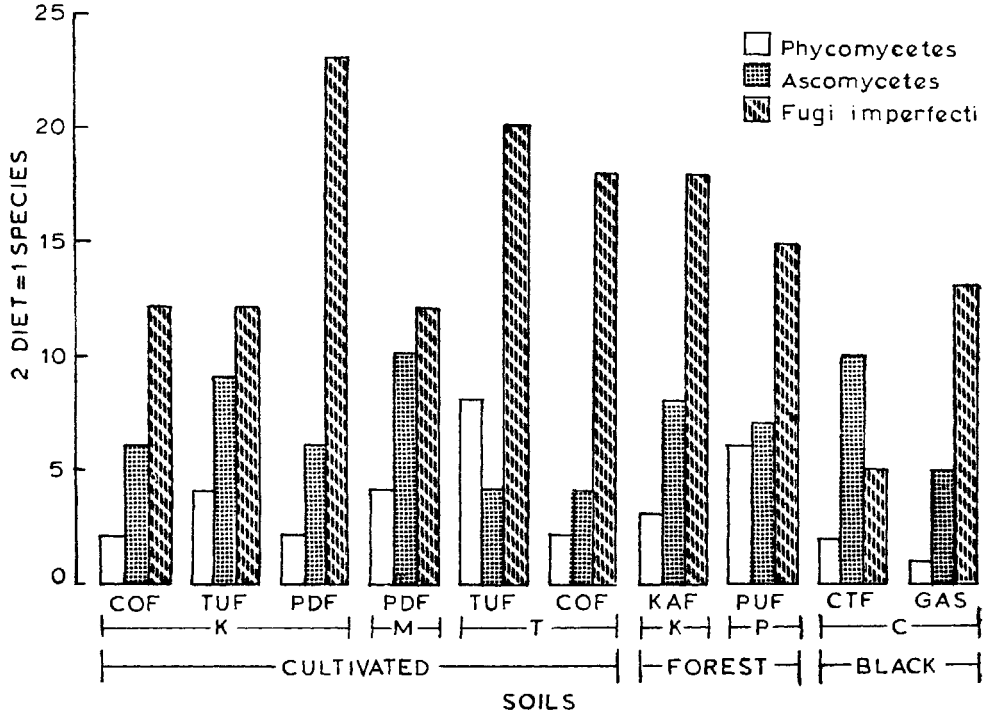

Figure 1 Comparative account of the total groupwise species distributed in various soils

K=Kasaragod; *M*=Mangalore; *T*=Trivandrum; *P*=Puttur; *C*=Coimbatore; *COF*=Coconut field; *TUF*=Turmeric field; *PDF*=Paddy field; *KAF*=Kasaragod forest; *PUF*=Puttur forest; *CTF*=Cotton field; *GAS*=Garden Soil

Table 2 *Showing the pH, percentage of nitrogen and carbon of various soils*

Soil samples		pH	% Nitrogen	% Carbon
Cultivated	COF	5.5	0.198	1.68
Kasaragod	TUF	4.9	0.102	1.18
	PDF	4.9	0.148	1.16
Mangalore	PDF	5.4	0.250	1.68
	TUF	4.8	0.058	1.00
Trivandrum	COF	5.0	0.070	0.71
Forest				
Kasaragod	KAF	4.9	0.256	1.68
Puttur	PUF	5.5	0.198	1.68
Black				
Coimbatore	CTF	4.9	0.256	1.68
	GAS	7.6	0.096	0.63

COF—Coconut field; CTF—Cotton field; KAF—Kasaragod forest; PDF—Paddy field; PUF—Puttur forest; GAS—Garden soil; TUF—Turmeric field

important. The dominance of Aspergilli and Penicillia from these soils is in accordance with the findings of Waksman (1932), Saksena and Sarbhoy (1963), Saksena et al. (1967), Kamal and Bhargava (1971).

No definite correlation could be established with regard to the distribution of fungi in relation to C/N ratio (table 2). However, it is clear that in some of the cases if C/N ratio is higher, the number of fungi is usually increased and vice versa. Similar were the findings of Dwivedi and Dwivedi (1965).

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