

Microfungi isolated from wood of Scots pine in Finland

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Non-basidiomycetous fungi were isolated from the wood of Scots pine (*Pinus sylvestris*) from 30 localities in Finland. They include blue-stain fungi, soil fungi and coprophilous and nematophagous fungi. The commonest fungus species were wind-borne blue-staining fungi. Fungi occurring with a frequency of more than 1% were *Aureobasidium pullulans* (de Bary) Arnaud, *Cladosporium cladosporioides* (Fres.) de Vries, *Geomyces pannorum* (Link) Sigler & Carm., *Leptodontidium beauverioides* (de Hoog) de Hoog, *Oidiodendron cerealis* (Thüm.) Barron, *Ophiostoma piceae* (Münch) H. & P. Syd., *O. piliferum* (Fr.) H. & P. Syd., *Phialophora fastigiata* (Lagerb. & Melin) Conant, *Rhinocladiella atrovirens* Nannf., *Trichoderma polysporum* (Link) Rifai, *T. viride* Pers. and *Ulocladium consortiale* (Thüm.) Simmons. As many as 35 species are apparently new to Finland, three of these belonging to the Zygomycotina, six to the Ascomycotina and 26 to the Deuteromycotina.

Key words: blue-stain fungi, microfungi, *Pinus*, wood

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Introduction

Most studies on the microfungi living in the wood of Scots pine (*Pinus sylvestris*) have dealt with harmful fungi, such as the extensively investigated blue-stain fungi, (e.g. Lagerberg et al. 1927, Rennerfelt 1950, Mathiesen-Käärik 1953, 1960, Pechmann et al. 1964, Dowding 1969, 1970, Käärik 1980, Lilja 1984). The succession and interactions of basidiomycetous fungi in wood have attracted the attention of many researchers (Butcher 1968, Käärik 1975, Rayner & Boddy 1988). The hyphomycetous species in Canada have been studied by Sutton (1973), whose material was collected from many plant species, not especially from conifers. However, the microfungi in the wood of Scots pine are still poorly known.

A project to study microfungi in wood was started in Finland at the end of the 1960s. The original purpose was to identify blue-staining fungi in the wood of Scots pine, but later attention was paid to all the microfungi (Zygomycotina, Ascomycotina and

Deuteromycotina). The fungi inhabiting Scots pine in northern Finland were of special interest. The collection and identification of the material were completed by 1972, but its publication has had to wait 20 years and the senior author, A. Salonen is no longer with us. This paper contains only a part of the results, because during these years some of the notes on the material have been lost and some were not found until the manuscript had already been written. The original drawings and descriptions of the fungi in Finnish have been published elsewhere (Salonen & Ruokola 1991).

Material and methods

The material consisted of samples collected from 30 sites throughout Finland in 1968–1971. The samples were taken aseptically with an increment borer from timber, logging wastes, stumps and the wastes of sawmills. They were taken both from fresh trees

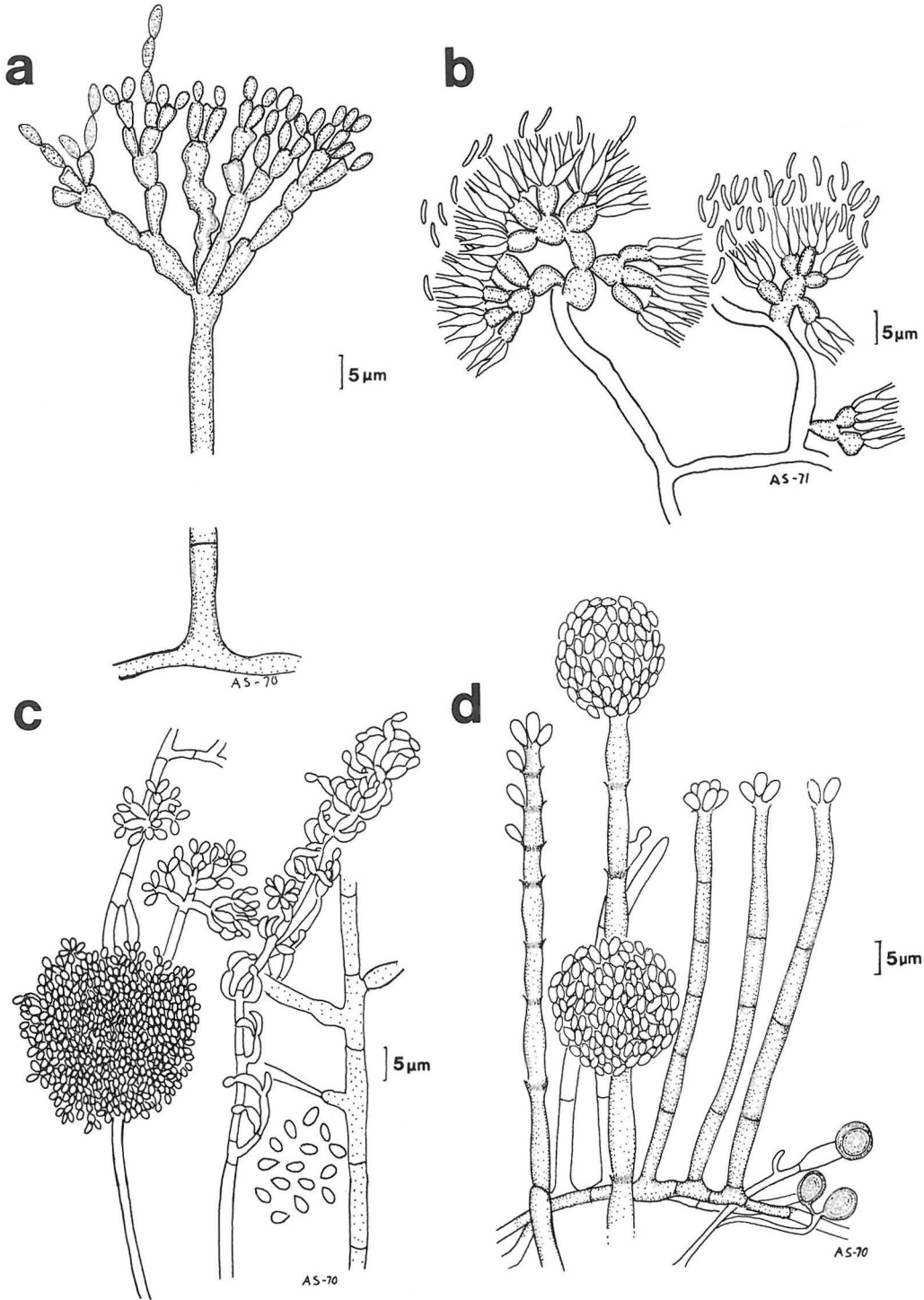


Fig. 1. Microfungi isolated from the wood of Scots pine in Finland. a. *Cladosporium variabile*. South Häme: Jämsä, Alhojärvi. Isol. 483.69. b. *Phialophora repens*. Inari Lapland: Inari, Kaamanen. Isol. 1132.70. c. *Leptodontidium beauverioides*. Inari Lapland: Inari, Ivalo. Isol. 643.69. d. *Chloridium virescens* var. *chlamydosporum*. Sompio Lapland: Sodankylä, Vuotso. Isol. 958.70. Drawn by Arvi Salonen.

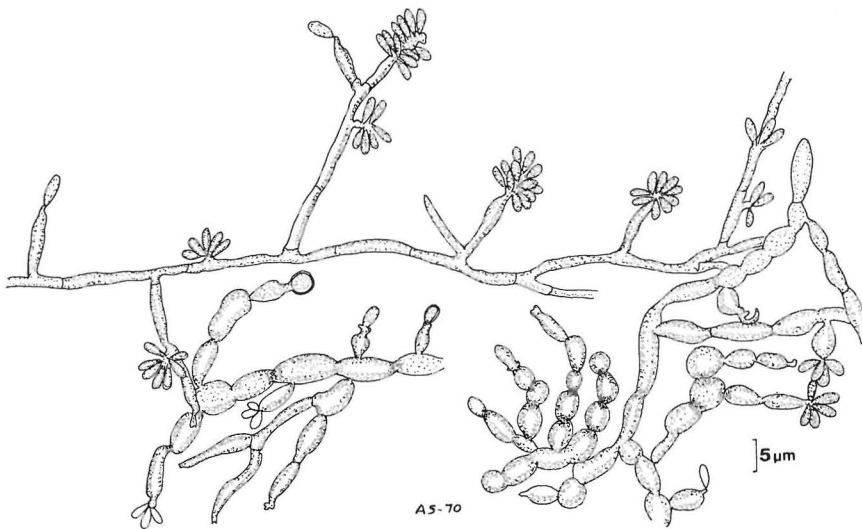


Fig. 2. *Rhinocladiella spinifera*. Inari Lapland: Inari, Kaamanen. Isol. 888.70. Drawn by Arvi Salonen.

felled during the current year and from timber which had been in the forest for several years. The condition of the trees furnishing the samples e.g. the moisture and degree of decomposition of the wood, is unknown.

The bore chips taken from the sample wood were transferred to corn meal agar (CMA). Pure cultures were grown on potato dextrose agar (PDA) and on CMA to which had been added 2% glucose. Malt extract agar (MEA) and Czapek agar were also used. The fungi were also cultured on autoclaved wood chips in test tubes. The cultures were kept in normal room temperature, 21–22°C. Some fungi were identified directly from the wood samples.

Fungi were isolated from 310 samples, 178 samples (57%) of which originated from Lapland, 142 (46%) having been taken in Inari (c. 68°40' N, 27°33' E), chiefly in the vicinity of Helsinki University Experimental Farm at Muddusjärvi. All the notes on this work are deposited in the Department of Plant Pathology, University of Helsinki, but no specimens or slide collections have been preserved.

The identifications were primarily made by Arvi Salonen. Most of the Ascomycotina were identified by Anna-Liisa Ruokola, who also conducted much of the culturing work. Sirkka Savonmäki compiled the material and wrote the present manuscript in cooperation with Ruokola. As far as possible, the nomenclature of the fungi in this paper follows Ellis (1971), Gams & Holubová-Jechová (1976), Hoog (1977), Oorschot (1980), Sutton (1980), Cannon et al. (1985), Wingfield (1985) and Ellis & Ellis (1988).

Results

The numbers of fungi isolated from the wood of Scots pine are given in Table 1. The isolates totalled 804, 33 of them being Zygomycotina (4.1%), 115 Ascomycotina (14.3%) and 656 Deuteromycotina (81.6%). The fungi comprise 145 taxa. The Zygomycotina are represented by 11 taxa (7.8%), the Ascomycotina by 25 (17.7%) and the Deuteromycotina by 105 (74.5%). The fungi which could be identified to species level numbered 104, most of them being Deuteromycotina (Figs. 1 & 2). The number of species apparently new to Finland is 35 (3 Zygomycotina, 6 Ascomycotina and 26 Deuteromycotina).

Discussion

The fungi living in Scots pine mainly depend on the condition of the wood, for example the degree of decomposition. The material was collected from both fresh and older timber left in forests and from the wastes of sawmills. Some of the species were primary fungi attacking fresh timber, but most of them were secondary saprophytic fungi, common in debris and also in dung. Besides these, there were some nematophagous fungi. Most of the fungus species occurring with a frequency of at least 1% in the wood of Scots pine (Table 1) were air-borne blue-staining fungi (Zimmermann & Butin 1973).

The isolates belonging to the Zygomycotina and Ascomycotina include especially many species normally occurring in dung (e.g. *Sporormiella*) (Ahmed

Table 1. Fungi isolated from wood samples of Scots pine (*Pinus sylvestris*). The figures refer to the number of samples in which each species was recorded.

Fungus	No of samples recorded			
	I	II	III	Σ
ZYGOMYCOTINA				
<i>Absidia glauca</i> Hagem	2	0	1	3
* <i>Circinella simplex</i> van Tieghem	0	3		3
<i>Circinella</i> sp.	1	0	1	2
* <i>Mortierella polycephala</i> Coemans	1	0	1	2
<i>Mortierella</i> spp.	6	3		9
<i>Mucor mucedo</i> (L.) Fres.	2	1		3
<i>Mucor racemosus</i> Fres.	0	4		4
<i>Mucor</i> spp.	0	6		6
<i>Rhizopus stolonifer</i> (Ehrenb.) Vuill.	0	1		1
* <i>Syncephalastrum racemosum</i> Cohn ex Schrötö	1			1
<i>Thamnidium elegans</i> Link	0	1		1
	Σ	12	20	1 33
ASCOMYCOTINA				
<i>Cephaloscyus fragrans</i> Hanawa	1	0		1
<i>Ceratocystis coerulea</i> (Münch) Bakshi	1	0		1
<i>Ceratocystis</i> / <i>Ophiostoma</i> spp.	6	2		8
<i>Chaetomium elatum</i> Schm. & Kunze	1	1		2
<i>Chaetomium globosum</i> Kunze	1	1		2
<i>Chaetomium spirale</i> Zopf	1	0		1
<i>Chaetomium</i> sp.	0	1		1
* <i>Coniochaeta ligniaria</i> (Grev.) Cooke	0	1	1	2
<i>Coniochaeta</i> spp.	0	2		2
<i>Gelasinospora tetrasperma</i> Dowding	0	0	1	1
<i>Gelasinospora</i> sp.	0	1		1
<i>Gymnoascus reessii</i> Baranetzky	1	2	1	4
<i>Melanospora</i> sp.	0	1		1
* <i>Myxotrichum berkeleyi</i> Apinis	0	2		2
* <i>Ophiostoma minus</i> (Hedg.) H. & P. Syd. (= <i>Ceratocystis minor</i> (Hedg.) Hunt)	1	1		2
<i>Ophiostoma piceae</i> (Münch) H. & P. Syd. (= <i>Ceratocystis piceae</i> (Münch) Bakshi)	6	4	1	11
<i>Ophiostoma piliferum</i> (Fr.) H. & P. Syd. (= <i>Ceratocystis pilifera</i> (Fr.) C. Moreau)	22	28	1	51
* <i>Schizothecium vesticola</i> (Berk. & Broome) Lundq. (= <i>Pleuraea minuta</i> (Fuckel) Kunze)	0	1		1
<i>Sordaria fimicola</i> (Rob. ex Desm.) Ces. & de Not.	0	3	1	4
<i>Sordaria macrospora</i> Auersw.	0	2		2
* <i>Sphaerodes fimicola</i> (Hansen) P. Cannon & Hawksw.	1	1		2
<i>Sporormiella intermedia</i> (Auersw.) Ahmed & Cain (= <i>Sporormia intermedia</i> Auersw.)	0	6		6
* <i>Sporormiella octomera</i> (Auersw.) Ahmed & Cain (= <i>Sporormia octomera</i> Auersw.)	0	1		1
<i>Sporormiella</i> sp. (= <i>Sporormia</i> sp.)	0	1		1
<i>Thelebolus crustaceus</i> (Fuckel) Kimb. (= <i>Pezizula crustacea</i> (Fuckel) Karst.)	0	5		5
	Σ	42	67	6 115 (Contnd.)

Table 1. Contnd.

Fungus	No of samples recorded			
	I	II	III	Σ
DEUTEROMYCOTINA				
<i>Acremonium butyri</i> (van Beyma) W. Gams	0	6		6
* <i>Acremonium roseum</i> (Oud.) W. Gams	0	1		1
<i>Acremonium</i> spp.	6	21		27
* <i>Acrodontium crateriforme</i> (van Beyma) de Hoog (= <i>Chloridium crateriforme</i> van Beyma)	0	1		1
<i>Alternaria alternata</i> (Fr.) Keissler	2	2		4
<i>Alternaria</i> sp.	3	1		4
* <i>Amblyosporium botrytis</i> Fres.	0	2		2
* <i>Aphanocladium album</i> (Preuss) W. Gams	1	0		1
<i>Arthrinium phaeospermum</i> (Corda) M.B. Ellis (= <i>Papularia sphaerosperma</i> (Pers.) Höhnelt)	0	1		1
<i>Arthrobotrys superba</i> Corda	1	0		1
<i>Aspergillus fumigatus</i> Fres.	4	0		4
<i>Aspergillus niger</i> van Tieghem	0	1		1
<i>Aspergillus</i> spp.	6	9		15
<i>Aureobasidium pullulans</i> (de Bary) Arnaud	9	22		31
* <i>Beauveria nivea</i> (Rostrup) von Arx (= <i>Pachybasium niveum</i> Rostrup) (= <i>Tolypocladium inflatum</i> W. Gams)	0	2		2
<i>Bloxamia</i> sp.	1	0		1
* <i>Botryotrichum piluliferum</i> Sacc. & March.	0	1		1
<i>Botrytis cinerea</i> Pers.	0	1		1
<i>Botrytis</i> sp.	0	1		1
<i>Chalara</i> sp.	4	20		24
* <i>Cheirromyces microscopica</i> (Karst.) Hughes	1	0		1
* <i>Chloridium virescens</i> (Pers.) W. Gams & Hol.-Jech. var. <i>chlamydosporum</i> (van Beyma) W. Gams & Hol.-Jech.	0	1		1
(= <i>C. chlamydosporis</i> (van Beyma) Hughes)				
* <i>Chloridium virescens</i> (Pers.) W. Gams & Hol.-Jech. var. <i>virescens</i> (= <i>C. viride</i> Link)	0	1		1
<i>Chloridium</i> (s.lat.) spp.	0	8		8
<i>Chromelosporium fulvum</i> (Link) McGinty et al.	3	0		3
<i>Chrysosporium</i> (s.lat.) spp.	0	2		2
<i>Cladosporium cladosporioides</i> (Fres.) de Vries	10	13		23
<i>Cladosporium herbarum</i> (Pers.) Link	0	2		2
* <i>Cladosporium macrocarpum</i> Preuss	0	1		1
<i>Cladosporium sphaerospermum</i> Penz.	3	1		4
* <i>Cladosporium variabile</i> (Cooke) de Vries	1	0		1
<i>Cladosporium</i> spp.	9	13		22
<i>Cordana pauciseptata</i> Preuss	0	3		3
<i>Cylindrocarpon</i> sp.	2	3		5
<i>Dactylella gephyropaga</i> Drechsler	1	0		1
<i>Dendrodochium</i> sp.	1	1		2
<i>Doratomyces nanus</i> (Ehrenb.) Morton & Smith	0	2		2
<i>Doratomyces stemonitis</i> (Pers.) Morton & Smith	0	2		2
<i>Epicoccum purpurascens</i> Ehrenb. (= <i>E. nigrum</i> Link)	2	0		2
<i>Fusarium culmorum</i> (W.G. Sm.) Sacc.	1	0		1
<i>Fusarium moniliforme</i> Sheld.	2	0		2
<i>Fusarium oxysporum</i> Schlecht.	1	0		1
<i>Fusarium poae</i> (Peck) Wollenw.	0	1		1
<i>Fusarium</i> sp.	1	2		3
<i>Fusidium</i> sp.	1	0		1

(Contnd.)

Table 1. *Contnd.*

Fungus	No of samples recorded			
	I	II	III	Σ
<i>Geomyces pannorum</i> (Link) Sigler & Carm. var. <i>pannorum</i>	1	11	1	13
(= <i>Chrysosporium pannorum</i> (Link) Hughes)				
<i>Geotrichum candidum</i> Link	1	0		1
<i>Gliocladium viride</i> Matr. (= <i>G. deliquescens</i> Sopp)	1	0		1
<i>Gliocladium roseum</i> (Link) Bainier	1	0		1
<i>Graphium</i> spp.	10	6		16
* <i>Helminthophora sphaerocephala</i> (Berk.) de Hoog	0	1		1
(= <i>Cladobotryum leptosporum</i> (Sacc.) W. Gams & Hoozemans)				
<i>Leptodontidium beauverioides</i> (de Hoog) de Hoog	1	22	2	25
(= <i>Leptodontium beauverioides</i> de Hoog)				
* <i>Leptographium antibioticum</i> (Kendrick) Wingfield	0	0	1	1
(= <i>Verticicliadiella antibiotica</i> Kendrick)				
<i>Leptographium brachiatum</i> (Kendrick) Wingfield	1	0		1
(= <i>Verticicliadiella brachiata</i> Kendrick)				
<i>Leptographium lundbergii</i> Lagerb. & Melin	2	1		3
<i>Leptographium procerum</i> (Kendrick) Wingfield ³ (= <i>Verticicliadiella procerata</i> Kendrick)	1			4
<i>Leptographium</i> sp.	0	1		1
* <i>Malbranchea pulchella</i> Sacc. & Penz.	1	3		4
<i>Monodictys levis</i> (Wiltshire) Hughes	0	3		3
<i>Monodictys</i> sp.	0	1		1
* <i>Myceliophthora vellerea</i> (Sacc. & Speg.) van Oorschot	0	1		1
(= <i>Chrysosporium asperatum</i> Carm.)				
* <i>Myrothecium verrucaria</i> (Alb. & Schw.) Ditm.: Fr.	0	0	1	1
<i>Nematoctonus lignicola</i> Salonen & Ruokola, nom. inval.	0	1		1
<i>Oedocephalum</i> sp.	0	1		1
<i>Oidiodendron cerealis</i> (Thüm.) Barron	8	9		17
<i>Oidiodendron griseum</i> Robak	1	4		5
* <i>Oidiodendron maius</i> Barron	0	1		1
* <i>Oidiodendron rhodogenum</i> Robak	1	2		3
* <i>Oidiodendron tenuissimum</i> (Peck) Hughes	0	2		2
<i>Oidiodendron</i> spp.	4	22		26
<i>Paecilomyces penicillatus</i> (Höhnelt) Samson (= <i>Spicaria elegans</i> (Corda) Harz)	1	0		1
<i>Paecilomyces variotii</i> Bainier	0	1		1
<i>Paecilomyces</i> sp.	6	7		13
* <i>Penicillium thomii</i> Maire	1	0		1
<i>Penicillium</i> spp.	10	12		22

(Contnd.)

Table 1. *Contnd.*

Fungus	No of samples recorded			
	I	II	III	Σ
* <i>Phaeostalagmus tenuissimus</i> (Corda) W. Gams	0	0	1	1
(= <i>Verticillium tenuissimum</i> Corda)				
* <i>Phialophora cinerescens</i> (Wollenw.) van Beyma	1	3	1	5
<i>Phialophora fastigiata</i> (Lagerb. & Melin) Conant	5	27	1	33
<i>Phialophora lagerbergii</i> (Melin & Nannf.) Conant	2	2		4
<i>Phialophora lignicola</i> (Nannf.) Goidanich	1	1		2
* <i>Phialophora repens</i> (Davidson) Conant	0	4	1	5
* <i>Phialophora richardsiae</i> (Nannf.) Conant	2	3		5
<i>Phialophora verrucosa</i> Medlar	0	4		4
<i>Phialophora</i> spp.	7	17		24
<i>Phoma herbarum</i> Westend.	1	4	1	6
<i>Phoma</i> spp.	1	11		12
<i>Ramichloridium anceps</i> (Sacc. & Ellis) de Hoog ⁰ (= <i>Rhinoctadiella anceps</i> (Sacc. & Ellis) Hughes)	1	1		2
<i>Rhinoctadiella atrovirens</i> Nannf.	6	13	2	21
<i>Rhinoctadiella spinifera</i> (Nielsen & Conant) de Hoog	0	5		5
(= <i>R. mansonii</i> (Castell) Schol-Schwarz)				
<i>Rhinoctadiella</i> spp.	5	37		42
<i>Sclerophoma</i> sp.	1	1		2
<i>Sporothrix</i> sp.	1	1		2
<i>Stemphylium botryosum</i> Westend.	0	1		1
<i>Sterigmatobotrys macrocarpa</i> (Corda) Hughes	0	1		1
* <i>Thysanophora penicilloides</i> (Roum.) Kendrick ¹	0	1		1
<i>Tilachlidium</i> sp.	0	2		2
<i>Torula</i> sp.	5	14		19
<i>Trichocladium asperum</i> Harz	1	2		3
<i>Trichocladium opacum</i> (Corda) Hughes	1	0		1
<i>Trichoderma polysporum</i> (Link) Rifai	5	7		12
<i>Trichoderma viride</i> Pers.	11	11		22
<i>Trichoderma</i> sp.	6	2		8
<i>Truncatella angustata</i> (Pers.) Hughes (= <i>T. truncata</i> (Lév.) Stey.)	0	1		1
<i>Ulocladium consortiale</i> (Thüm.) Simmons	4	7		11
(= <i>Stemphylium consortiale</i> (Thüm.) Groves & Skolko)				
* <i>Wardomyces anomalus</i> Brooks & Hansf.	0	3		3
Σ	197	446	13	656
Σ	251	533	20	804

I = South and Central Finland

II = Lapland

III = unknown collecting site

* = species new to Finland

& Cain 1972), and common in soil (Domsch et al. 1980). Though mucoraceous fungi are usually isolated from soil or dung they are also associated with wood. *Mortierella* species have been isolated from wood at different stages of decomposition (Rayner &

Boddy 1988), and Merrill & French (1966) isolated *Mucor*, *Absidia* and *Rhizopus* species from wood buried in soil. In this material, Zygomycotina did not occur abundantly. Some fungi were typical of wood in contact with soil. *Aspergillus* spp., *Alternaria* spp.,

Trichoderma viride and *Penicillium* spp. are among the first invaders of wood in soil and have earlier been isolated from Ponderosa pine (*Pinus ponderosa*) (Merrill & French 1966). In Butcher's (1968) study of the succession of fungi colonizing untreated stakes, the most common species were *Trichoderma viride*, *Fusarium* spp., *Epicoccum purpurascens* and *Alternaria tenuis*. The present isolates also include fungicolous species, such as *Helminthophora sphaerocephala* (Hoog 1978).

Nematophagous fungi were rarely isolated in our study (Table 1). Three species were identified: *Arthrotrix superba*, *Dactylella gephyrophaga* and *Nematoctonus lignicola*. *N. lignicola* has been described from Finland (Salonen & Ruokola 1968), but was not validly published (Thorn & Barron 1986).

The fungi living in the wood of Scots pine have not been widely studied previously in Finland. Although no definite conclusions can be drawn about their occurrence on the basis of this material, certain species appear to be concentrated in Lapland. For example, most of the samples of *Leptodontidium beauverioides* were from Lapland. This species has earlier been isolated from the wood of Norway spruce (*Picea abies*) in Finland (Hoog 1977, 1979).

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