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Aerial distribution of some wood-inhabiting fungi in Finland

Eräiden kuusen puuaineksessa kasvavien sienien Suomessa ilmateitse tapahtuva leviäminen

Tauno Kallio

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AERIAL DISTRIBUTION OF SOME WOOD-INHABITING FUNGI IN FINLAND

ERÄIDEN KUUSEN PUUAINEKSESSA KASVAVIEN SIENIEN SUOMESSA ILMATEITSE TAPAHTUVA LEVIÄMINEN

TAUNO KALLIO

HELSINKI 1971

PREFACE

In connection with studies of the aerial distribution of the root-rot fungus in 1967—68 attempts were made to identify the other fungi which had also spread aerially to spruce discs and caused discoloration of the wood. The identification grew into a rather considerable study which, since it could not suitably be integrated with the report on the studies of the root-rot fungus, is now published separately.

I have received invaluable assistance in this work from Dr. AINO KÄÄRIK, of the Royal College of Forestry, Stockholm, Sweden. Sparing no pains, she has for several years instructed me in the identification of fungi from cultures and at the same time personally identified a number of cultures. She has also perused the manuscript and has made several much appreciated suggestions for the amendments and changes. Mr. ARVI SALONEN, of the Department of Plant Pathology, University of Helsinki, has taught me how to identify *Fungi imperfecti* and, in the course of the study, has identified many of them personally. Mrs. ANNA-MAIJA HALLAKSELA has carried out the main part of the laboratory work conscientiously and with precision.

I received financial support from the University of Helsinki and from The Foundation for Research of Natural Resources in Finland.

I wish to express my deep gratitude to all those mentioned above.

Helsinki, January 1971

Tauno Kallio

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Suomalaisen Kirjallisuuden Kirjapaino Oy Helsinki 1971

INTRODUCTION

Aerial distribution of fungi has been studied since the late 19th century (HANSEN 1882, ROSTRUP 1908). More recently GREGORY among others (1945, 1952a, 1952b) has studied the atmospheric distribution of the spores. Fungal spores have been detected at considerable altitudes in the atmosphere (STAKMAN et al. 1923, HIRST et al. 1967a, 1967b). The aerial occurrence of fungal spores causing human allergy has been an important subject of study during the last few decades (FEINBERG and LITTLE 1936, DURHAM 1938, HYDE and WILLIAMS 1946, 1953). RISHBETH (1951), in England, found that a fungus causing root and butt rot of conifers (*Fomes annosus* (Fr.) Cooke) was aerially distributed to the cut surfaces of healthy and fresh pine (*Pinus silvestris* L.) stumps and thence to the roots and other trees. Subsequently the aerial distribution of *F. annosus* has been intensely studied in many countries. At the same time, however, increasing attention has been devoted to the aerial occurrence of the diaspores of other decay fungi.

The purpose of the present study was to investigate the aerial distribution of fungi capable of developing on the wood of spruce (*Picea abies* (L.) Karst.) in Finland. A more detailed account of *F. annosus* has been published earlier (KALLIO 1970).

MATERIAL AND METHODS

The study was carried out by exposing spruce discs to the aerial deposition of diaspores at a given site for a given time. The discs were kept in the laboratory for two weeks after which the areas covered by *F. annosus* colonies were outlined on the disc surface under a stereomicroscope. The discs so treated were kept in the laboratory for another two weeks. During this period, fungal mycelia developing from the diaspores produced colonies visible to the naked eye. Fungi from stained areas with no *F. annosus* conidiophores were cultured on malt agar for identification by their mycelia. As the first step the aerial distribution of fungi was studied between June 7, 1967 and May 29, 1968, on the basis of samples collected mainly from air fields in different parts of Finland. Subsequently, the deposition of fungal diaspores in three spruce stands in the south of Finland was investigated in 1968 by taking samples of diaspore deposition at regular intervals during day and night.

The method was as follows. A spruce free from decay was felled in Helsinki once a week (in the winter, once every two weeks). A 1-meter long bolt was sawn at one meter from the butt end. It was barked in the forest, swabbed with alcohol and transported in plastic wrapping to the laboratory. As aseptically as possible, sections about 18 mm thick were sawn in the laboratory by power saw. The teeth in the cutting edge of the band saw blade were filed so as to be at an oblique angle to the sawn surface. In this way the sawdust produced was so coarsely granular that it did not block the cavities in the cells of the cross-sectioned wood. Immediately after the sawing, using a circular iron punch 134 mm in diameter, again as aseptically as possible, discs of identical size (cross section area 141 sq.cm) were cut from the sections, always from the same side of the stem. The discs were placed in plastic Petri dishes which were inserted into plastic bags. At the time of exposure, the discs were 24–48 hours old. They often lost some of their moisture during exposure and the subsequent culture for mycelial growth in the laboratory. The measured loss averaged ca. 2 per cent of the total weight. Rain during exposure of the discs increased their moisture content.

In the first study observations were made at six open sites in different parts of Finland and at one forest site in South Finland. The open sites of observation were (Fig. 1): the air fields of Ivalo, Oulu, Jyväskylä, Turku

Fig. 1. Observation sites

and Lappeenranta, and the Viikki meteorological station on an open site near Helsinki. The forest site was also near Helsinki. Discs were exposed to diaspore fall on set dates, usually at hours which suited the aeronautical meteorological station staff. The substrates of the study were not exposed simultaneously at all observation sites. All discs, however, were exposed a few times at night. No daytime observations are available for these dates. There were three discs on each site. One served as a control and was not exposed. The other two were exposed simultaneously, one for 2, the other for 4 hours. After exposure the substrates from outside Helsinki were airmailed to the laboratory.

In the second study the sites of observations consisted of spruce stands infected by *F. annosus* in Helsinki, Anjala and Jokioinen (Fig. 1). The stands were 50—100 years old and grew on soils of approximately identical productivity level. The discs were placed on a plate on the ground while exposed. The exposure started at 13 on Wednesday and ended at 13 on Thursday. This 24 hour period constituted an observation day. In Helsinki one observation day was arranged weekly from March 13 to December 5, 1968, and at other times once every two weeks. The discs were usually exposed for two-hour periods: from 13 to 15, and so on, making 12 recording periods per 24 hours. From July 31 to September 26 the period in Helsinki was shortened to one hour any time between 21 and 05 during the night. At Anjala and Jokioinen the 24 hour observation day was once a forthnight throughout the year from January 3 to December 19. The discs were exposed for twohour periods on the same weekdays and at the same hours as in Helsinki. Such a precise timing of the exposure was necessary for the study on the factors affecting the distribution of *Fomes annosus* spores (Kallio 1970). For the present survey into the aerial occurrence of the spores of other fungi it was less important. The discs were mailed to the respective localities and back.

IDENTIFICATION OF THE FUNGI

Two weeks after the exposure *Fomes annosus* was identified on the substrates by its conidiophores (Brefeld 1889). After a month of incubation the other fungi were cultured from the stained spots of the discs (see Fig. 29) on malt agar as used by Nobles (1948).

The following method was used. A small chunk was broken off a stained spot of the wood, and wiped with alcohol. Some wood from the centre of the chunk was aseptically transferred onto malt agar. This method has been used by several authors (Kääriк and Rennerfelt 1957, Hendrix and Kuhlman 1962, Kääriк 1967, Pechmann et al. 1967).

Kääriк (1965), among others, has developed a classification based on oxidation reactions between the phenolic compounds used as indicators and the enzymes excreted by the fungi in their malt agar cultures, to

help identification of the decay fungi. This classification was used in the present study. For verification of identification of the isolated decay fungi the macroscopic and microscopic characteristics of the isolates were compared with authentic culture samples of the most important decay fungi of Norway spruce, obtained from the USA (Dr. F. Lombard, Forest Disease Lab. Laurel, Maryland), Canada (Dr. R. D. Whitney, Forest Disease Lab. Winnipeg, Manitoba), Norway (Dr. F. Roll-Hansen, Norwegian Forest Research Institute, Vollebekk), and Sweden (Dr. A. Käärik, Royal College of Forestry, Stockholm). Help in the identification of the fungi from cultures was provided by Dr. A. Käärik and, for *Fungi imperfecti*, by Mr. A. Salonen (Department of Plant Pathology, University of Helsinki).

The identification of fungi was based the following publications. The number of the picture of the fungus, if any, is also given.

Actinomycetes:

Streptomyces Waksman & Henrici (Pridham et al. 1958).

Phycomycetes:

Rhizopus nigricans Ehr. (Gilman 1966),
Mucor Micheli (Gilman 1966).

Ascomycetes:

Chaetomium Kunze and Schmidt (Arx and Müller 1954, Gilman 1966),
Coryne sarcoides (Jacq.) Tul. (Etheridge, 1954, Etheridge and Carmichael 1955, Etheridge 1957, Fig. 2).

Basidiomycetes:

Agaricaceae:

Armillaria mellea (Vahl) Fr. (Nobels 1948, Lampson 1954, Nobles 1965, Käärik 1965, Sokolov 1964),
Flammula Fr. (Nobles 1958a, Denyer 1960, Käärik 1965, Nobles 1965),
Flammula sapinea (Fr.) Sacc. (Käärik 1965),
Hypholoma fasciculare (Huds) Sacc. (Käärik 1965, Fig. 3),
Pholiota Fr. (Davidson et al. 1942, Nobles 1948, 1965, Käärik 1965, Maloy 1968, Fig. 6).

Thelephoraceae:

Coniophora (Fr.) (Wakefield and Pearson 1918, Nobles 1948, Lentz 1957, Nobles 1965),
Corticium Pers. (Wakefield and Pearson 1918, Davidson et al. 1942, Robak 1942, Jackson 1950, Käärik and Rennerfelt 1957, Mckay and Lentz 1960, Käärik 1965, Nobles 1965, 1967, Fig. 4 and 5),
Merulius molluscus Fr. (Harmsen 1954, Boidin 1958, Eriksson 1958, Christiansen 1960, Käärik 1965, Lowe 1966, Ginns 1968, Fig. 7 and 8),
Merulius tremellosus (Schrad.) Fr. (Davidson et al. 1942, Harmsen 1954, Boidin 1958, Nobles 1958b, Käärik 1965, Fig. 9 and 10),
Peniophora cinerea (Fr.) Massee-group (Eriksson 1950, Boidin 1958, Nobles 1958a, Christiansen 1960, Käärik 1965, Fig. 14),
Peniophora gigantea (Fr.) Massee (Nobles 1948, Käärik and Rennerfelt 1957, Boidin 1958, Nobles 1958a, Christiansen 1960, Käärik 1965, Nobles 1965, Fig. 11 and 12),
Peniophora incarnata (Pers. ex Fr.) Karst. (Eriksson 1950, Boidin 1958, Christiansen 1960, Käärik 1965),
Peniophora pithya (Pers.) Eriksson (Eriksson 1950, Nobles 1956, Käärik and Rennerfelt 1957, Boidin 1958, Nobles 1958a, Christiansen 1960, Käärik 1965, Nobles 1965, Fig. 13),
Stereum abietinum (Pers. ex Fr.) Karst. (Nobles 1948, Boidin 1958, Christiansen 1960, Käärik 1965),
Stereum purpureum (Pers.) Fr. (Robak 1942, Boidin 1958, Käärik 1965, Fig. 17),
Stereum sanguinolentum (Alb. & Schw) Fr. (Robak 1942, Nobles 1948, Käärik and Rennerfelt 1957, Boidin 1958, Käärik 1965, Fig. 16),
Trechispora brinkmanni (Bres.) Rogers & Jackson (Käärik and Rennerfelt 1957, Boidin 1958, Christiansen 1960, Teixeira 1960, Käärik 1965, Fig. 21 and 22).

Hydnaceae:

Grandinia (Pers.) Bourd. & Galz (Käärik and Rennerfelt 1957, Christiansen 1960, Eriksson 1958, Käärik 1965).

Polypraceae:

Fomes pinicola (Sn) Gillet (Campbell 1938, Nobles 1948, Bondartsev 1953, Käärik and Rennerfelt 1957, Lowe 1957, Nobles 1958b, Sokolov 1964, Käärik 1965, Fig. 23, 24, 25),
Lenzites sepiaria (Wulf.) Fr. (Robak 1942, Nobles 1948, Bondartsev 1953, Overholts 1953, Käärik and Rennerfelt 1957, Nobles 1958b, Käärik 1965, Fig. 20),
Polyporus abietinus (Dicks.) Fr. (Robak 1942, Nobles 1948, Bondartsev 1953, Overholts 1953, Käärik and Rennerfelt 1957, Nobles 1958b, 1965, Käärik 1965, Fig. 15),
Polyporus adustus (Willd.) Fr. (Nobles 1948. Bondartsev 1953, Overholts 1953, Nobles 1958b, 1965, Käärik 1965),
Polyporus albellus Peck (Nobles 1948, Bondartsev 1953, Overholts 1953, Nobles 1958b, 1965, Käärik 1965),
Polyporus arcularius (Batsch) Fr. (Refshauge and Proctor 1936, Cunningham 1946, Nobles 1948, Overholts 1953, Bondartsev 1953, Ursing 1953, Nobles 1958b, 1965, Käärik 1965, Fig. 18),

Polyporus borealis Fr. (NOBLES 1948, BONDARTSEV 1953, OVERHOLTS 1953, KÄÄRIK and RENNERFELT 1957, NOBLES 1958b, 1965, KÄÄRIK 1965, Fig. 19),
Polyporus brumalis (Pers.) Fr. (NOBLES 1948, BONDARTSEV 1953, OVERHOLTS 1953, NOBLES 1958b, 1965, KÄÄRIK 1965, Fig. 26),
Polyporus fumosus (Pers.) Fr. (NOBLES 1948, BONDARTSEV 1953, OVERHOLTS 1953, NOBLES 1958b, 1965, KÄÄRIK 1965),
Polyporus hirsutus (Wulf.) Fr. (NOBLES 1948, BONDARTSEV 1953, OVERHOLTS 1953, NOBLES 1958b, 1965, KÄÄRIK 1965),
Polyporus resinosus (Schrad.) Fr. (NOBLES 1948, BONDARTSEV 1953, NOBLES 1958b, 1965, KÄÄRIK 1965),
Polyporus versicolor (L.) Fr. (REFSHAUGE and PROCTOR 1936, DAVIDSON et al. 1942, CUNNINGHAM 1946, NOBLES 1948, BONDARTSEV 1953, OVERHOLTS 1953, NOBLES 1958b, TEIXEIRA 1960, KÄÄRIK 1965, NOBLES 1965),
Polyporus zonatus (Nees) Fr. (NOBLES 1948, BONDARTSEV 1953, NOBLES 1958b, 1965, KÄÄRIK 1965, Fig. 27 and 28),
Poria candidissima (Schw.) Cooke (BONDARTSEV 1953, NOBLES 1958b, KÄÄRIK 1965, LOWE 1966),
Trametes serialis Fr. (NOBLES 1948, BONDARTSEV 1953, OVERHOLTS 1953, KÄÄRIK and RENNERFELT 1957, NOBLES 1958b, SARKAR 1959, KÄÄRIK 1965, NOBLES 1965, LOWE 1966).

Fungi imperfecti:

Acremoniella Sacc. (BARRON 1968),
Alternaria (Nees) Wallr. (GILMAN 1966, BARRON 1968),
Aspergillus Link (GILMAN 1966, BARRON 1968),
Botrytis cinerea Pers. (GILMAN 1966, BARRON 1968),
Cephalosporium Corda (GILMAN 1966, BARRON 1968),
Cladosporium Link (BARNETT 1967, BARRON 1968),
Cylindrocarpon Wollen. (GILMAN 1966, BARRON 1968),
Epicoccum Link (GILMAN 1966, BARRON 1968),
Fusarium Link (GILMAN 1966, BARRON 1968),
Papularia Fr. (GILMAN 1966, BARRON 1968),
Penicillium Link (BARRON 1968),
Pestalotia de Not (GILMAN 1966, BARRON 1968),
Phialophora Medl. (BARNETT 1967, BARRON 1968),
Stemphylium Wallr. (GILMAN 1966, BARRON 1968),
Torula Pers. (GILMAN 1966, BARRON 1968),
Trichoderma album Preuss (GILMAN 1966),
Trichoderma viride Pers. (BARRON 1968).

RESULTS AND DISCUSSION

Table I lists the fungi found in the first study in South Finland (Helsinki, Turku, Jyväskylä, Lappeenranta) and Table II those found in North Finland (Oulu, Ivalo). About 20 per cent of the fungal cultures could not be identified. The diaspore deposition of fungi was at its maximum in South Finland from early September to mid-November and in North Finland from early September to mid-October. In the spring the real start of appearance of stained spots on test discs in South Finland was in late March and in North Finland about a month later.

The most common fungi identified were *Peniophora gigantea* and *Trichoderma viride*. Both *Polyporus zonatus* and *Polyporus versicolor* are included in the tables under *Polyporus zonatus* because the colonies are difficult to differentiate reliability. These were isolated from stained spots on spruce discs exposed in South Finland from late March onwards, but about a month later in North Finland such spots occurred subsequently almost throughout the year, except in mid-winter. No distinct difference was discernible in this respect between North and South Finland. The early appearance of these spots which then proceeded almost without interruption, perhaps suggests that sporophores were producing spores relatively early in the spring and continued until the snow fell. Colonies caused by *Stereum sanguinolentum* were noted in South Finland almost throughout the snowless season, but numbers of these were greatest on discs exposed in July-August. In North Finland the occurrence of this fungus was restricted to the interval from June to August. The most common *Agaricaceae* obtained were species of *Hypholoma:* isolations were mainly restricted to September, October and November at all sites. Of the *Thelephoraceae*, species of *Corticium* occurred in South Finland almost throughout the snowless period, but in North Finland mainly from July to October. *Trechispora brinkmanni* was one of the most commonly isolated fungi in South Finland, being observed from late July to mid-November: in North Finland it was found on only four occasions, twice in both July and October.

Of the *Fungi imperfecti*, relatively high numbers of not only *Trichoderma viride* but also of the *Alternaria* and *Fusarium* species were isolated. The number of species of *Fungi imperfecti* isolated from spruce discs was unexpectedly high, especially for South Finland. On the other hand, many fungi of this group

TABLE I

South Finland 1967–1968
Fungi isolated from spruce discs

	1967							1968				
	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Chaetomium spp.		2										
Mucor spp.				1								1
Streptomyces sp.						1						
Armillaria mellea						2	1				1	1
Collybia sp.				1								
Coniophora cerebella	2											
» *spp.*	3		1									
Corticium subseriale				1								
» *spp.*	2	1	4	1	4	6					1	
Flammula penetrans						1						
» *sapinea*		1										
Fomes annosus[1]	+	+	+	+	+	+	+				+	+
» *pinicola*					3	1				1	5	1
Grandinia spp.	3		3	1	3	7					2	1
Hypholoma fasciculare					1	1						
» *spp.*				4	10	21	3				1	
Merulius molluscus		1	1									
» *tremellosus*		4	5		3	1					3	4
Peniophora cinerea group			2			1					1	
» *gigantea*	8	5	24	10	21	9					22	17
» *incarnata*			1	1	2	2	1					
» *pithya*	1	1	2	1	3	2						
Pholiota sp.						1						
Polyporus abietinus	1	2	7	1	1							1
» *adustus*			2	1	6	2					3	3
» *albellus*						1						
» *arcularius*	1	1	2			2						
» *borealis*	1					1						
» *brumalis*				1								
» *fumosus*						1						
» *hirsutus*		1				1					1	
» *resinosus*											1	
» *zonatus*		11	7	3	9	5				2	9	2
Poria candidissima											1	
» *spp.*				3	11	8	2				1	
Stereum abietinum					1							
» *purpureum*		1										
» *sanguinolentum*	7	10	9	4	4	1				2	7	2
Trametes serialis			1		10	5				1	1	
Trechispora brinkmanni		2	4	4	14	5						
Acremoniella spp.				2								
Alternaria spp.			5	17	5	3						
Botrytis cinerea					2							
Cephalosporium sp.						1						
Cladosporium spp.			2	2								
Cylindrocarpon sp.						1						
Epicoccum spp.			1	5	2							
Fusarium spp.			4	10	3	5						
Papularia sp.				1								
Penicillium spp.					1	2	1					
Pestalotia spp.								1			2	
Phialophora spp.		1				1						
Rhizopus nigricans				8							5	
Stemphylium spp.			1	3	2							
Torula spp.						1					2	
Trichoderma viride		1	23	38	29	20	4				4	10
Bacteria				1		4	1				5	
Unknown	11	38	15	28	46	20	3			3	15	6

[1] +conidiophores on the cross sections

TABLE II

North Finland 1967—1968
Fungi isolated from spruce discs

	1967							1968				
	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Chaetomium sp.		1										
Coryne sarcoides			1									
Mucor spp.				8								
Corticium spp.		3	2	1	2							1
Fomes annosus[1]		+										+
» *pinicola*		1	1									
Grandinia spp.					1	3						
Hypholoma fasciculare					1							
» *spp.*				5	5	2						
Lenzites sepiaria		4										
Merulius tremellosus						1						1
Peniophora cinerea group				1								
» *gigantea*		3	21	11	11	3						3
» *pithya*		2	2									
Polyporus abietinus		2		3	1							
» *adustus*		2		1		1						1
» *arcularius*			2	1	1							1
» *borealis*					1							
» *hirsu'us*												1
» *resinosus*				1								
» *zonatus*	1	4	2	2	2	11					1	6
Poria candidissima					1							1
Poria spp.						8						
Stereum sanguinolentum	3	10	3									
Trametes serialis		1	1		1	3						
Trechispora brinkmanni		4			2							
Alternaria spp.			1	2								
Aspergillus sp.												1
Fusarium spp.				2	1							
Papularia sp.		1										
Stemphylium spp.				1	1							
Trichoderma album		1										
» *viride*			13	8	16	6						3
Rhizopus nigricans				1								
Bacteria				1								
Unknown	4	17	7	14	4	3						4

[1] + conidiophores on the cross sections

grew relatively rapidly on malt agar, and therefore inhibited or at least restricted the possible growth of other species on the agar.

According to the investigation, species of several fungal groups seem to participate in the early stages of the decayed process of spruce (Maloy 1968). On the other hand, a fungus like *Stereum purpureum*, which is known to cause the decay of deciduous trees, may also be found in the initial stage of spruce decay.

In the second study (Helsinki, Anjala and Jokioinen), for each observation day (from 13 on Wednesday to 13 on Thursday) the fungi isolated from the disc exposed from 13 to 15 were chosen to represent the day-time deposition of diaspores and those isolated from the disc exposed from 01—03 hours (in Helsinki, between Jul. 31 and Sep. 26, from 01—02) the night-time deposition. The results are presented in Table III, which combines the fungi isolated from the discs of all the three sites of observation.

Stereum sanguinolentum was considerably more common in the samples collected from South Finnish forests than it had been in the samples of the first study which were mainly collected from open observation sites. Its isolations were made from late March to late May, after which there was a long break

TABLE III

South Finland 1968
Fungi isolated from spruce discs

	Jan.		Feb.		Mar.		Apr.		May		Jun.		Jul.		Aug.		Sep.		Oct.		Nov.		Dec.	
	d	n	d	n	d	n	d	n	d	n	d	n	d	n	d	n	d	n	d	n	d	n	d	n
Armillaria mellea							1		2															
Corticim spp.							1	1			1						1							
Fomes annosus[1]							+	+	+	+	+	+	+	+	+	+	+	+	+			+		
» *pinicola*																			1					
Grandinia spp.					1										1		1							
Hypholoma sp.													1											
Merulius tremellosus ..										2		1		2				1	2		1			
Peniophora cinerea group																1								
» *gigantea*							2	1	2	8	2	1	4	23	1	11	3	5	4	2				
» *pithya*															1			2		1			1	
Polyporus abietinus											1	1	9		5	4	3							
» *adustus*							2	1					2			1				2				
» *hirsutus*								1																
» *zonatus*								6	1	2			1						1					
Poria candidissima					1	1					1				1									
Stereum purpureum								1											1		1			
» *sanguinolentum*					2	2		2	1						2	1	1	8	4	2	1		1	
Trametes serialis						1											1							
Trechispora brinkmanni																				1				
Alternaria spp.		1											1											
Botrytis cinerea																		1						
Cephalosporium sp.																			1					
Rhizopus nigricans							1	1																
Trichoderma viride								3	3	2	3	9	2		1		4		4	3	1	4	1	2
Bacteria							2					1	1	1										
Unknown		1		1					2	2	2	3						1				1		

d = day
n = night
[1] + conidiophores on the cross sections

until a nearly uninterrupted catch of isolations was recorded from mid-August to early December. Day-time and night-time observations did not seem to differ. *Polyporus abietinus* accounted for about 2 per cent of the total cultivated fungi in the first study, whereas the percentage in the second study was about 10 per cent. It was caught almost uninterruptedly from early June to late September, and no appreciable difference was noted between day-time and night-time rates.

Although the stained chunks of wood were always taken from those parts of the spruce discs which showed no *Fomes annosus* conidiophores growing on the wood surface, *F. annosus* was nevertheless occasionally isolated from these chunks.

Polyporus zonatus (and *Polyporus versicolor*) was obtained in the second study immediately after the snow had melted in the spring. On other counts, too, the result corresponds with the findings of the forst study. *Armillaria mellea* was identified on three occasions in the spring, before the end of May. This would suggest that its spores perhaps had wintered in a viable condition. A *Hypholoma* sp. was isolated from the disc exposed on July 17.

The identification of the mycelia from cultures of the diaspores of the numerous aerially distributed fungal flora composed of many species, is an almost overwhelming task. In the present study approximately one-fifth of the cultures could not be identified. The malt agar which was used as the substrate, may not be the best substrate for all wood-inhabiting fungi. *Armillaria mellea*, for example, cannot easily be grown on malt agar. The mutual antagonism of several fungi (microbes) may have led to the result that only the successful competitor on a malt agar substrate could be identified from the cultures. Laboratory conditions of fungal cul-

ture, even on a wood substrate, differ from natural conditions, e.g. in temperature, humidity and light. This, in laboratory conditions, may have favoured fungal species which perhaps might not have predominated on the same wood substrate in natural fungal colonies.

Despite the shortcomings of the methods currently available, it is nevertheless important for forest pathology to study the aerial distribution of fungi found in growing trees and in wood under natural conditions. As shown by MEREDITH (1959,1960), SHIGO (1965, 1967) and MALOY (1968), in natural fungal colonies there is a sequence of species. One results of this is that sporophores found on a substrate in nature do not always disclose the fungus which is the primary cause of the infection or which has caused the most severe damage to the substrate (cf. MALOY and ROBINSON 1968, SCHÖNHAR 1969, 1970).

SUMMARY

Fungal diaspores were caught in Finland in 1967—68 on exposed discs of *Picea abies* (L.) Karst. wood. In the laboratory, the diaspores on the discs developed mycelia which stained the wood. A month after exposure fungi and bacteria were isolated from stained areas.

The number of identified fungal species was relatively high and included fungi of different taxonomic groups. The identified fungi are listed in Tables I—III.

REFERENCES

ARX, J. A. von, and MÜLLER, E. 1954. Die Gattungen der amerosporen *Pyrenomyceten*. Beitr. Kryptogamenflora Schweiz, 11: 1—434.

BARNETT, H. L. 1967. Illustrated genera of imperfect fungi. 2nd ed. Burgess Publ. Co Minneapolis. 225 p.

BARRON, G. L. 1968. The genera of *Hyphomycetes* from soil. The Williams and Wilkins Co Baltimore. 364 p.

BOIDIN, J. 1958. Essai biotaxonomique sur les *Hydnés* résupinés et les *Corticiés*. Etude spéciale du comportement nucléaire et les mycélliums. Rev. Mycol. Mém. Hors-série 6. 387 p.

BONDARTSEV, A. S. 1953. Trutovye griby Evropejskoj tsasti SSSR i Kavkaza. Akademija Nauk SSR, Botanitseskij Institut im. V. A. Komarova. Moskva — Leningrad. 1106 p.

BREFELD, O. 1889. Untersuchungen aus dem Gesamtgebiete der Mykologie. Fortsetzung der Schimmel- und Hefenpilze. VIII. Heft: *Basidiomyceten* III. *Autobasidiomyceten* und die Begründung des natürlichen Systemes der Pilze. Leipzig. 305 p.

CAMPBELL, W. A. 1938. The cultural characteristics of the species of *Fomes*. Bull. Torrey Bot. Club. 65: 31—69.

CHRISTIANSEN, M. P. 1960. Danish resupinate fungi, part II *Homobasidiomycetes*. Dan. Bot. Ark. 19: 57—388.

CUNNINGHAM, G. H. 1946. Notes on classification of the *Polyporaceae*. New Zealand J. Sci. Techn. 28: 238—251.

DAVIDSON, R. W., CAMPBELL, W. A., and VAUGHN, D. B. 1942. Fungi causing decay of living oaks in the Eastern United States and their cultural identification. USDA Techn. Bull. No. 785, 65 p.

DENYER, W. B. G. 1960. Cultural studies of *Flammula alnicola* (Fr.) Kummer and *Flammula conissans* (Fr.) Gillet. Can. J. Bot. 38: 909—920.

DURHAM, O. C. 1938. Incidence of air-borne fungus spores. II. *Hormodendrum*, *Alternaria*, and rust spores. J. Allergy 10: 40—49.

ERIKSSON, J. 1950. *Peniophora* Cke Sect. Coloratae Bourd. & Galz. A taxonomical study with special reference to the Swedish species. Symb. Bot. Upsal. 10: 1—76.

—»— 1958. Studies in the *Heterobasidiomycetes* and *Homobasidiomycetes-Aphyllophorales* of Muddus national park in North Sweden. Symb. Bot. Upsal. 16: 1—172.

ETHERIDGE, D. E. 1954. Occurrence of a purple agar-staining fungus with decay in Alberta. Can. Dep. Agric. Bi-mon. Res. Notes 10, 4: 3—4.

—»— 1957. Comparative studies of *Coryne sarcoides* (Jacq.) Tul. and two species of wood-destroying fungi. Can. J. Bot. 35: 595—603.

ETHERIDGE, D. E., and CARMICHAEL, E. 1955. Further observations on the occurrence of *Coryne sarcoides* (Jacq.) Tul. on spruce in Alberta. Can. Dep. Agric. Bi-mon. Progr. Rep. 11: 3.

FEINBERG, S. M., and LITTLE, H. T. 1936. Studies on the relation of microorganisms to allergy. III. A year's survey of daily mold spore content of the air. J. Allergy 7: 149–155.

GILMAN, J. C. 1966. A manual of soil fungi. 2nd ed. Iowa State Univ. Press. Ames. Iowa. 450 p.

GINNS, J. H., Jr. 1968. The genus *Merulius* I. Species proposed by Burt. Mycologia, 60: 1211—1231.

GREGORY, P. H. 1945. The disperson of air-borne spores. Trans. Brit. Mycol. Soc. 28: 26—72.

—»— 1952a. Fungus Spores. Trans. Brit. Mycol. Soc. 35: 1—18.

—»— 1952b. Spore content of the atmosphere near the ground. Nature (London) 170: 475—477.

HANSEN, E. C. 1882. Undersøgelser over de organismer, som til forskjellige tider af aaret findes i luften i og omkring Carlsberg, og som kunne udvikle sig i ølurt. Medd. Carlsberg Lab. 1: 381—415. Kjøbenhavn.

HARMSEN, L. 1954. De danske *Merulius*- arter. Bot Tidsskr. 50: 146—162.

HENDRIX, F. F., Jr., and KUHLMAN, E. G. 1962. A comparison of isolation method for *Fomes annosus*. Plant Dis. Rep. 46: 674—676.

HIRST, J. M., STEDMAN, O. J., and HOGG, W. H. 1967a. Longdistance spore transport: Methods of measurement, vertical spore profiles and the detection of immigrant spores. J. Gen. Microbiol. 48: 329—355.

HIRST, J. M., STEDMAN, O. J., and HURST, G. W. 1967b. Longdistance spore transport: Vertical sections of spore clouds over the sea. J. Gen. Microbiol. 48: 357—377.

HYDE, H. A., and WILLIAMS, D. A. 1946. A daily census of *Alternaria* spores caught from the atmosphere at Cardiff in 1942 and 1943. Trans. Brit. Mycol. Soc. 29: 78—85.

—»— 1953. The incidence of *Cladosporium herbarum* in the outdoor air at Cardiff, 1949—50. Trans. Brit. Mycol. Soc. 36: 260—266.

JACKSON, H. S. 1950. Studies of Canadian *Thelephoraceae*. VII. Some new species of *Corticium*, section Athele. Can. J. Res. C. 28: 716—725.

KÄÄRIK, A. 1965. The identification of the mycelia of wood-decay fungi by their oxidation reactions with phenolic compounds. Studia Forestalia Suecia 31: 1—80.

—»— 1967. Colonisation of pine and spruce poles by soil fungi after six months. Mater. u. Organ. 2: 97—108.

KÄÄRIK, A., and RENNERFELT, E. 1957. Investigations on the fungal flora of spruce and pine stumps. Medd. Statens Skogsforskn. Inst. 47. 7: 1—88.

KALLIO, T. 1970. Aerial distribution of root-rot fungus *Fomes annosus* (Fr.) Cooke in Finland. Acta For. Fen. 107.

LAMPSON, P. 1954. Untersuchungen über das Myzelwachstum des Hallimasch [*Armillaria mellea* (Vahl) Quel.] Unpublished manuscript in the Dep. of Forst., Univ. of Göttingen. Hann. Münden. 93 p.

LENTZ, P. L. 1957. Studies in *Coniphora*. I. The basidum. Mycologia 49: 534—544.

LOWE, J. L. 1957. *Polyporaceae* of North America. The genus *Fomes*. St. Univ. Coll. For. Syracuse Univ. Technical Publication No. 80. Syracuse N.Y. 97 p.

—»— 1966. *Polyporaceae* of North America. The genus *Poria*. St. Univ. Coll. For. Syracuse Univ. Technical Publication No. 90. Syracuse N.Y. 183 p.

MALOY, O. C. 1968. Decay fungi in young grand fir. Plant. Dis. Rep. 52: 489—492.

MALOY, O. C., and ROBINSON, V. S. 1968. Microorganisms associated with heart rot in young grand fir. Can. J. Bot. 46: 306—309.

MCKAY, H. H., and LENTZ, P. L. 1960. Descriptions of some fungi associated with forest tree decay in Colorado. Mycopathol. Mycol. Appl. 13: 265—286.

MEREDITH, D. S. 1959. The infection of pine stumps by *Fomes annosus* and other fungi. Ann. Bot. (N.S.) London 23: 455—476.

—»— 1960. Further observations on fungi inhabiting pine stumps. Ann. Bot. (N.S.) London 24: 63—78.

NOBLES, M. K. 1948. Studies in forest pathology. VI. Identification of cultures of wood-rotting fungi. Can. J. Res. C. 26: 281—431.

—»— 1956. Studies in wood-inhabiting *Hymenomycetes*. III. *Stereum pini* and species of *Peniophora* Sect. Coloratae on conifers in Canada. Can. J. Bot. 34: 104—130.

—»— 1958a. A rapid test for extracellular oxidase in culture of wood-inhabiting *Hymenomycetes*. Can. J. Bot. 36: 91—99.

—»— 1958b. Cultural characters as a guide to the taxonomy and phylogeny of the *Polyporaceae*. Can. J. Bot. 36: 883—926.

—»— 1965. Identification of cultures of wood-inhabiting *Hymenomycetes*. Can. J. Bot. 43: 1097—1139.

—»— 1967. Conspecificity of *Basidioradulum* (Radulum) *radula* and *Corticium hydnans*. Mycologia 59: 192—211.

OVERHOLTS, L. O. 1953. The *Polyporaceae* of the United States, Alaska and Canada. Univ. of Michigan Press, Ann Arbor. Michigan. 466 p.

PECHMANN, H. VON, AUFSESS, H. VON, LIESE, W., and AMER, U. 1967. Untersuchungen über die Rotstreifkeit des Fichtenholzes. Forstwiss. Cbl. Beihefte 27, 112 p.

PRIDHAM, T. G., HESSELTINE, C. W., and BENEDICT, R. G. 1958. A guide for the classification of *Streptomycetes* according to selected groups. Appl. Microbiol. 6: 52—79.

REFSHAUGE, L. D., and PROCTOR, E. M. 1936. Wood-destroying *Basidiomycetes*. Proc. Roy. Soc. Victoria (N.S.) 48. 2: 105—123.

RISHBETH, J. 1951. Observations on the biology of *Fomes annosus* with particular reference to East Anglian pine plantations. II. Spore production, stump infection, and saprophytic activity in stumps. Ann. Bot. (N.S.) London 15: 1—21.

ROBAK, H. 1942. Cultural studies in some Norwegian wood-destroying fungi. Medd. Vestl. Forstl. Forsøkssta. 25: 1—248.

ROSTRUP, O. 1908. Nogles undersøgelser over luftens inhold af svampekim. Bot. Tidsskr. 29: 32—41.

SARKAR, A. 1959. Studies in wood-inhabiting *Hymenomycetes*. IV. The genus *Coriolellus* Murr. Can. J. Bot. 37: 1251—1270.

SCHÖNHAR, S. 1969. Untersuchungen über das Vorkommen von Rotfäulepilzen in Fichtenbeständen der Schwäbischen Alb. Mitt. Ver. Forstl. Standorstkunde Forstpfl Zücht. 19: 20—28.

—»— 1970. Kernfäuleverursachende Pilze in Kiefernbeständen Baden-Würtembergs, Allg. Forst u. Jagdztg. 141: 41—44.

SHIGO, A. L. 1965. Organism interactions in decay and discoloration in beech, birch, and maple.

U.S. For. Serv. Res. Pap. Ntheast. For. Exp. Sta NE—43, 23 p.

SHIGO, A. L. 1967. Succession of organisms in discoloration and decay of wood. Intern. Rev. For. Res. Vol. 2. Edited J. A. Romberger and P. Mikola. Academic Press. New York-London, p. 237—299.

SOKOLOV, D. V. 1964. Kornevaya gnill'ot openki i bor'ba s nei. (Root rot caused by *Armillaria mellea* and its control). Izdatel'stvo "Lesnaya Promyshlennost» p. 1—183. Moscow 1964. Translated: Canada, Dep. For. Translation No 37. Ottawa 1966.

STAKMAN, E. C., HENRY, A. W., CURRAN, G. C., and CHRISTOPHER, W. N. 1923. Spores in the upper air J. Agric. Res. 24: 599—606.

TEIXEIRA, A. R. 1960. Characteristics of the generative hyphae of *Polypores* of North America, with special reference to the presence or absence of clamp connections. Mycologia 52: 30—39.

URSING, B. 1953. Svenska växter i text och bild. Kryptogamer. Nordisk Rotogravyr Stockholm. 529 p.

WAKEFIELD, E. M., and PEARSON, A. A. 1918. Resupinate *Hymenomycetes* from the neighbourhood of Weybridge, Surrey. Trans. Brit. Mycol. Soc. 6: 68—75.

SELOSTE:

Eri osissa Suomea (Fig. 1) pidettiin 1967—1968 kuusen kiekkoja avoinna ilmasta tapahtuvalle itiölaskeutumalle. Itiöistä kasvaneet sienirihmat aiheuttivat kasvaessaan kuusen kiekkoon värjäytyneitä kohtia, joista eristettiin ja viljeltiin sienet tunnistamista varten. Tunnistaminen perustui s. 5—6 mainittuihin julkaisuihin.

Taulukossa I on kesäkuun alusta 1967 toukokuun loppuun 1968 pääasiassa Etelä-Suomen lentokentillä avoinna pidetyistä kuusen kiekoista eristetyt sienet ja taulukossa II vastaavana aikana Oulussa ja Ivalossa avoinna pidetyistä kiekoista eristetyt sienet. Taulukossa III on Anjalassa, Jokioisissa ja Helsingissä (Viikki) 1968 kuusimetsissä ympäri vuorokauden avoinna pidetyistä kiekoista erikseen päivällä (d) klo 13—15 ja yöllä (n) klo 01—03 eristetyt sienet.

Itiöitä alkoi keväällä laskeutua runsaasti ilmasta Etelä-Suomessa maaliskuun lopussa, Pohjois-Suomessa kuukautta myöhemmin. Itiölaskeutuma oli Etelä-Suomessa runsainta syyskuun alusta marraskuun puoliväliin ja Pohjois-Suomessa syyskuun alusta lokakuun puoliväliin. Yksi tavallisimmista kuusen kiekoille levinneistä sienistä oli *Peniohpora gigantea*. Sen itiöitä laskeutui samanaikaisesti maannousemasienen itiöiden kanssa. Tämä koskee sekä vuodenaikojen että vuorokaudenaikojen mukaista itiölaskeutumaa. *Stereum sanguinolentumin* (punertuva verinahkasieni) itiöitä laskeutui miltei koko lumettoman ajan, ja itiölaskeutuma oli tavallisempaa metsässä kuin aukealla. Myös *Polyporus abietinuksen* (kuusenkääpä) itiöitä laskeutui runsaammin metsässä kuin aukealla. Tämän sienen itiöitä tavattiin lähes keskeytyksettä kesäkuun alusta syyskuun loppuun. Helttasienistä tavattiin mm. *Hypholoma* (lahokka)-lajeja ja *Armillaria mellea* (mesisieni). Homesieniä eristettiin kuusen kiekoista verrattain runsaasti. Tavallisimpia oli *Trichoderma viride*.

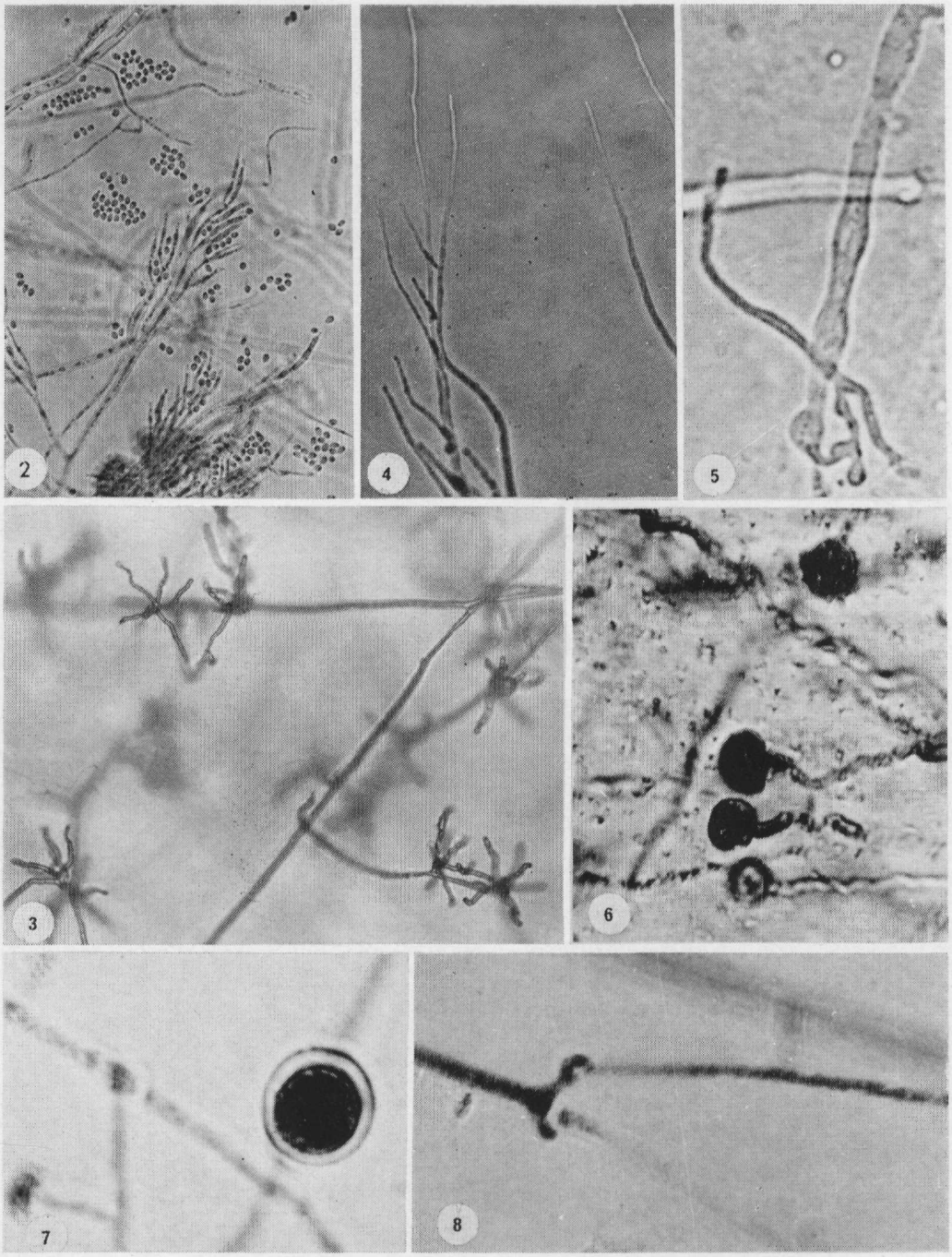

Fig. 2. *Coryne sarcoides*. Conidiophores and conidia in a 2-month old malt agar growth. x approx. 800. Fig. 3. *Hypholoma* sp. Aerial hyphae and lines of conidia in advancing zone. x approx 150. Fig. 4. *Corticium* sp. Mycelia in advancing zone in a 14-day old malt agar growth. x approx. 400. Fig. 5. *Corticium* sp. Fiber hyphae in a 6-month old malt agar growth. x approx. 1000. Fig. 6. *Pholiota* sp. Chlamydospores in a 14-day old malt agar growth. x approx. 1000. Fig. 7. *Merulius molluscus*. Chlamydospore in a 14-day old malt agar growth. x approx. 2000. Fig. 8. *Merulius molluscus*. Submerged hyphae with clamp connections in a 6-month old malt agar growth. x approx. 900.

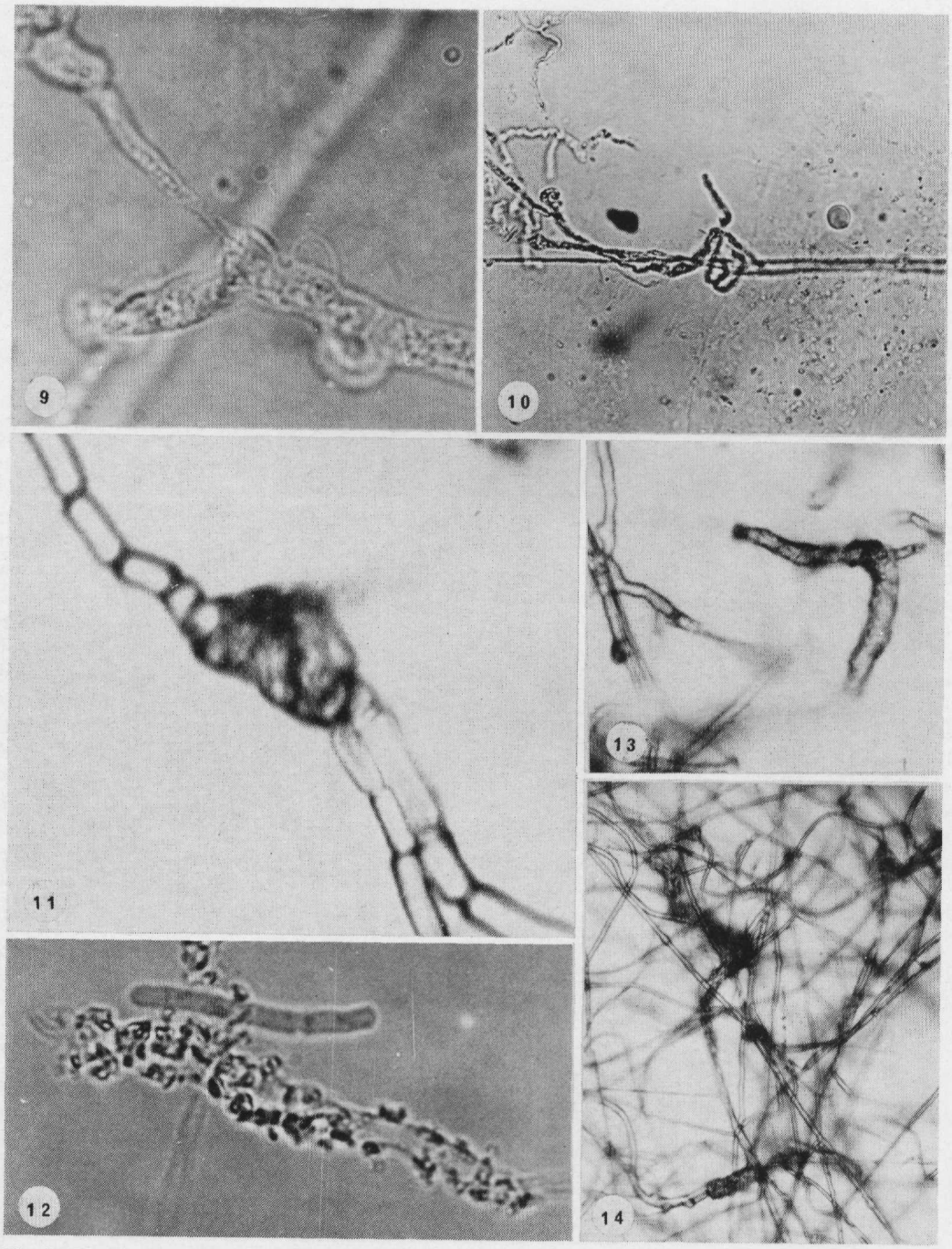

Fig. 9. *Merulius tremellosus.* Clamp connections ina 9-day old malt agar growth. x approx. 1200. Fig. 10. *Merulius tremellosus.* Hyphae and spherical chlamydospore in a malt agar growth. x approx. 160. Fig. 11. *Peniophora gigantea.* Oidia in aerial hyphae of a 7-day old malt agar growth. x approx. 1200. Fig. 12. *Peniophora gigantea.* Incrusted hyphae in 1 -month old aerial mycelia of a malt agar growth. x approx. 1200. Fig. 13. *Peniophora pithya.* Clusters of crystals in a 1-month old malt agar growth. x approx. 400. Fig. 14. *Peniophora cinerea.* Clusters of crystals in a 2-month old malt agar growth. x approx. 1000.

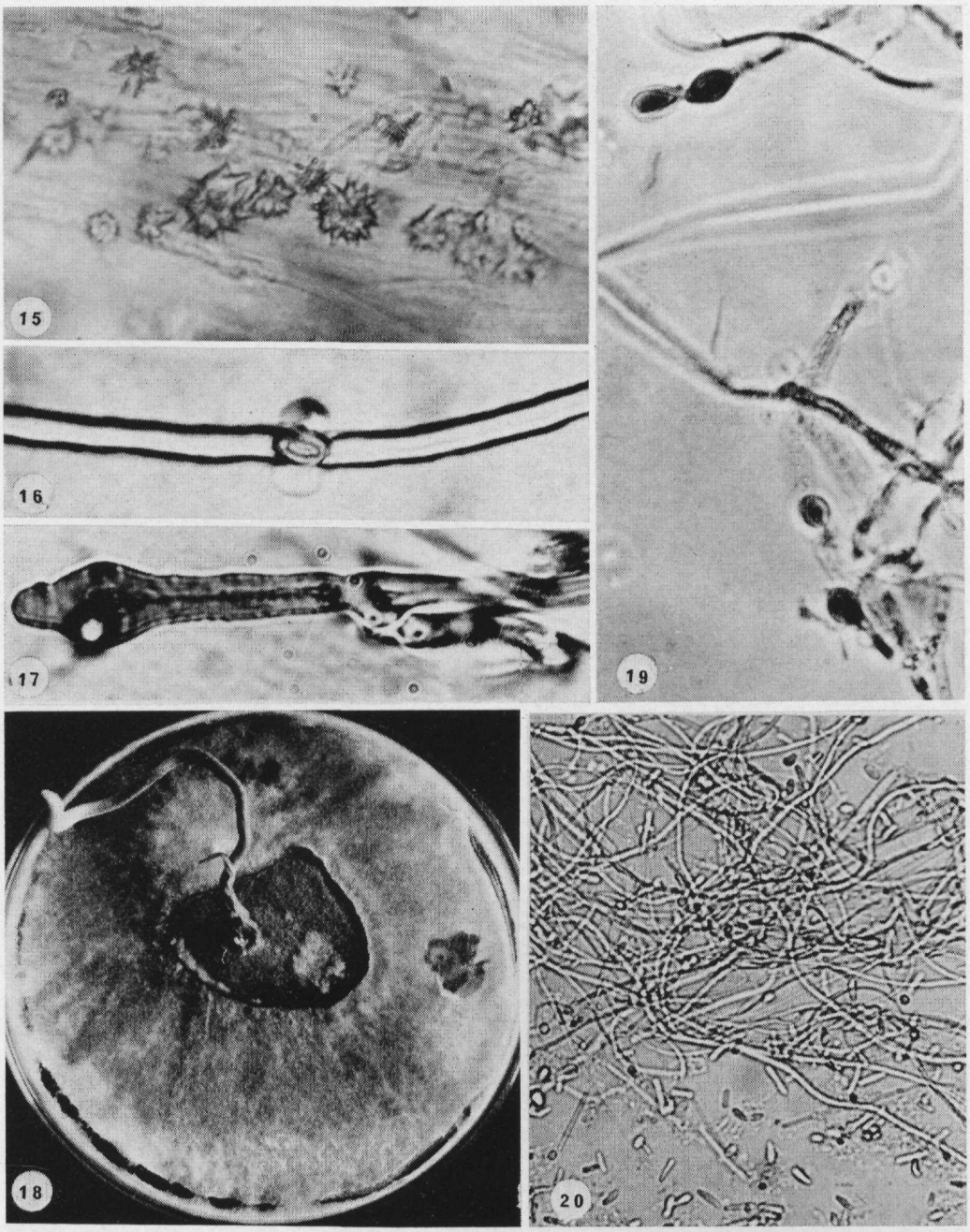

Fig. 15. *Polyporus abietinus*. Cystidia on the surface. of a spruce disc kept for one month in the laboratory. x approx. 900. Fig. 16. *Stereum sanguinolentum*. Large clamp connections, in advancing zone, in a malt agar growth. x approx. 1000. Fig. 17. *Stereum purpureum*. Cystidium in a 2-month old malt agar growth. x approx. 1300. Fig. 18. *Polyporus arcularius*. Sporophore in a 7-week old malta gar growth. Natural size. Fig. 19. *Polyporus borealis*. Chlamydospores in a 6-month old malt agar growth. x approx. 550. Fig. 20. *Lenzites sepiaria*. Oidia and mycelia in a 1-month old malt agar growth. x approx. 400.

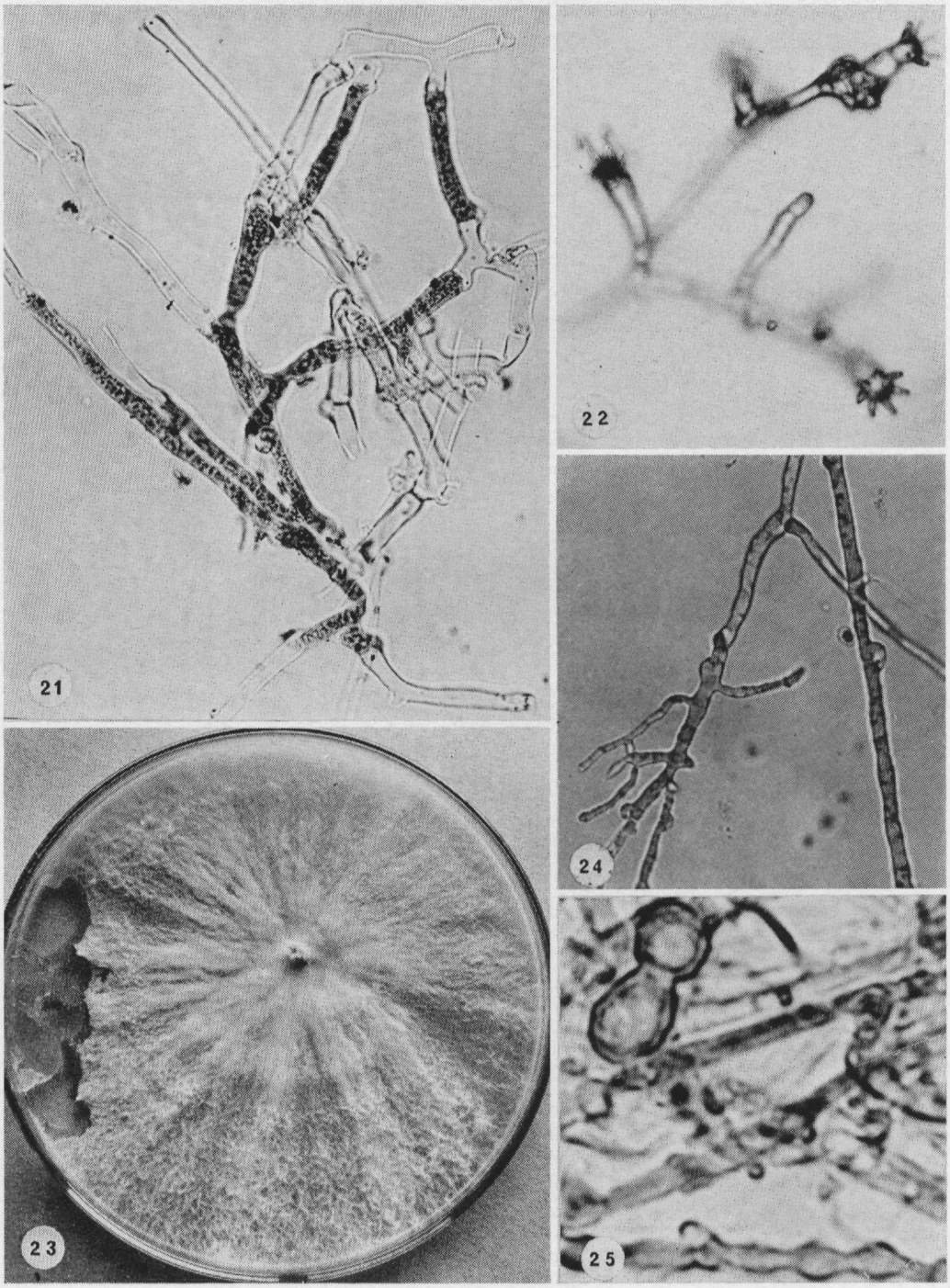

Fig. 21. *Trechispora brinkmanni.* Mycelia in a malt agar growth. x approx. 700. Fig. 22. *Trechispora brinkmanni.* Mycelia, basidia and sterigmata in a 3-month old malt agar growht. x approx. 1200. Fig. 23. *Fomes pinicola.* A 3-week old malt agar growth. Natural size. Fig. 24. *Fomes pinicola.* Mycelia in advancing zone of a malt agar growth. x approx. 600. Fig. 25. *Fomes pinicola.* Chlamydospores in a 2-month old malt agar growth. x approx. 800.

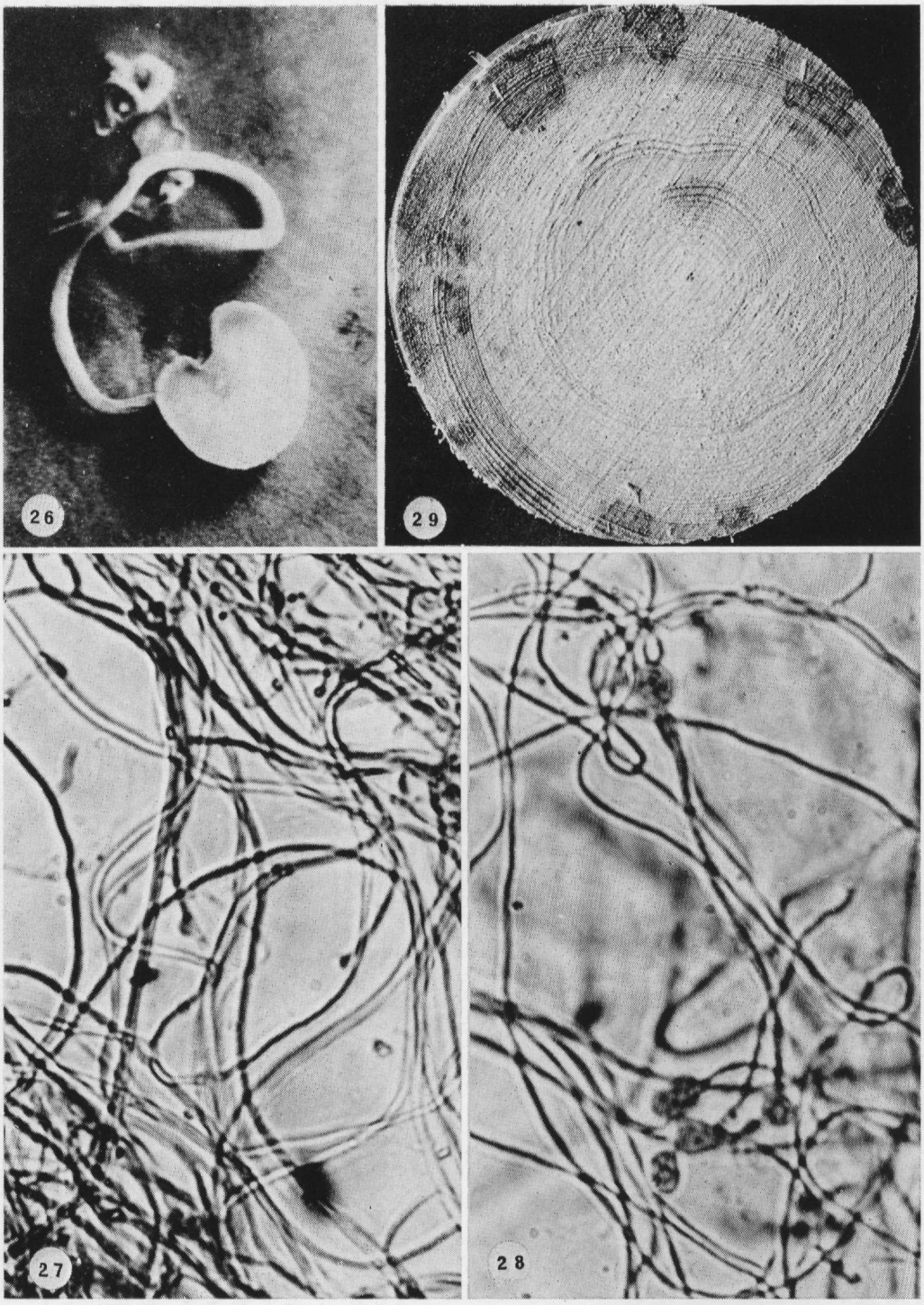

Fig. 26. *Polyporus brumalis*. Sporophore in a 2-month old malt agar growth. x approx. 2.5. Fig. 27. *Polyporus zonatus*. Mycelia in a 10-day old malt agar growth. x approx. 500. Fig. 28. *Polyporus zonatus*. Chlamydospores in a 2-month old malt agar growth. x approx. 400. Fig. 29. Spruce disc 4 weeks after exposure in Lappeenranta on 14 June at 12.30 — 14.30. *Coniophora* sp., *Corticium* sp., *S. sanguinolentum* and *P. gigantea* were isolated from the stained spots. Reduced to about 0.6 x natural size.

KALLIO, TAUNO O.D.C. 172.8

1971. Aerial distribution of some wood-inhabiting fungi in Finland. – ACTA FORESTALIA FENNICA 115. 17 p. Helsinki.

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KANNATTAJAJÄSENET — UNDERSTÖDANDE MEDLEMMAR

CENTRALSKOGSNÄMNDEN SKOGSKULTUR

SUOMEN PUUNJALOSTUSTEOLLISUUDEN KESKUSLIITTO

OSUUSKUNTA METSÄLIITTO

KESKUSOSUUSLIIKE HANKKIJA

SUNILA OSAKEYHTIÖ

OY WILH. SCHAUMAN AB

OY KAUKAS AB

RIKKIHAPPO OY

G. A. SERLACHIUS OY

TYPPI OY

KYMIN OSAKEYHTIÖ

SUOMALAISEN KIRJALLISUUDEN KIRJAPAINO

UUDENMAAN KIRJAPAINO OSAKEYHTIÖ

KESKUSMETSÄLAUTAKUNTA TAPIO

KOIVUKESKUS

A. AHLSTRÖM OSAKEYHTIÖ

TEOLLISUUDEN PAPERIPUUYHDISTYS R.Y.

OY TAMPELLA AB

JOUTSENO-PULP OSAKEYHTIÖ

TUKKIKESKUS

KEMI OY

MAATALOUSTUOTTAJAIN KESKUSLIITTO

VAKUUTUSOSAKEYHTIÖ POHJOLA

VEITSILUOTO OSAKEYHTIÖ

OSUUSPANKKIEN KESKUSPANKKI OY

SUOMEN SAHANOMISTAJAYHDISTYS

OY HACKMAN AB

YHTYNEET PAPERITEHTAAT OSAKEYHTIÖ