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MICROFUNGI IN THE HUMUS LAYER OF PINE, SPRUCE AND BIRCH STANDS IN SOUTHERN FINLAND

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SELOSTE:

ETELÄ-SUOMEN MÄNTY-, KUUSI-, JA KOIVUMETSIKÖIDEN HUMUSKERROKSEN HOMESIENET

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The microfungal populations of a VT-pine, MT-spruce, and OMT-birch stand humus layer were studied during one growing season. The dilution plate and soil-plate methods and two different media were used.

The largest microfungal populations were found in the VT and the smallest in the OMT stand, but the differences were surprisingly small. The methods used possibly gave a somewhat one-sided picture of the microfungal populations. Rapidly growing species with relatively small environmental requirements were the majority of the isolated fungi. Among these, some fairly effective cellulose decomposers were isolated. Species with high nutritional requirements were only found in OMT humus. It must be emphasized that the study probably gives a distorted picture of the abundance of slow-growing fungi in undisturbed forest soils.

Introduction

Surprisingly little attention has been paid to the microfungi of forest lands. Studies of such microfungi to be found in the warm and temperate zones include those made by COBB (1932), FEHÉR (1933), BISBY, TIMONIN and JAMES (1935),

Tresner, Backus and Curtis (1954), Mishustin (1956), Orpurt and Curtis (1957) and by Jensen (1963), in respect of predominantly deciduous forests, and those by Morrow (1932), Wright and Bollen (1961), and Kendrick and Burges (1962), concerned with coniferous forests.

The subartic zone has been accorded even less attention in this regard than the zones mentioned above, despite it being, in a forestal sense, the most extensive, the most homogeneous, and from an economic standpoint the most significant region of the globe, with the nutritional economy of trees connected with decomposition of the rapidly accumulating humus layer. The most important studies of the microfungi present in the forests of this zone include those made by Svinhuvud (1937), Gyllenberg, Hanioja and Vartiovaara (1954), Paarlahti and Vartiovaara (1958), Reddy and Knowles (1965), and Schalin (1966), to name but a few.

However, the studies embarked upon provide no more than an overall picture of the microfungal populations of these forests, a picture which is in many respects very obscure, either because selection of the objects of study, with regard to the sites, has not been entirely successful or sufficiently comprehensive, with too few observations, or because the collection of material from the various sampling areas has not been coordinated in respect of time.

The aim of the present study was that of throwing light, with due attention paid to the defects referred to above, and endeavours to eliminate them, upon the microfungal populations of certain nearly natural forest lands, dry and moist, in the subarctic zone, and to establish the similarities and differences between them. The circumstances for carrying this study into effect were propitious, as the sampling areas consisted of raw humus land with favourable environmental conditions for the microfungi, but less favourable conditions for other microbes.

The principal aim in view was that of clarifying the qualitative composition of microfungal populations, including the cellulose-decomposing types. A quantitative evaluation was also made: this had as the sole objective the establishment of the microfungal populations with respect to place and time. Dilution plate and soil-plate methods were applied. The dependability of these methods has been examined very thoroughly in various connections (Vartiovaara 1935, Burges 1958, Alexander 1961, Jensen 1962, 1963).

Material and methods

Sampling areas and samples

The research material comprised three forest types, viz. pure pine, spruce and birch stands growing on sites typical of each, VT, MT and OMT*), respectively. These sampling areas were situated in a climatically uniform region

*) The forest types of Cajander.

approximately 200 km north of Helsinki (North lat. 61° 49′); the height was 150 metres above sea level. This is a rather barren watershed region with a mean temperature in July of +17° C, and in February of —8° C. Sample plots of 10 ares, of which the most essential information is indicated below, were marked out in the sampling areas:

Sample plot/ forest type *Näyteala/ metsätyyppi*	Tree species *Puulaji*	Age of stand, yaers *Metsikön ikä, v.*	Thickness of humus layer, *Humuskerroksen paksuus, mm*	Subsoil *Kivennäismaa*
VT	Pine 100 % *Mänty*	90	16± 4	sand *hiekka*
MT	Spruce 100 % *Kuusi*	80	26± 7	fine sandy soil *hieno hiekka*
OMT	Birch 100 % *Koivu*	60	20± 5	fine sandy soil *hieno hiekka*

The samples were removed from the humus layer, between June and October, at intervals of two weeks in the summer and less frequently in the late autumn. Each sample comprised 25 sub-samples weighing from 4 to 5 g. Regular measerement of the moisture content, temperature and pH of the humus layer was effected in connection with the sampling. The extreme values were as follows:

	Moisture, % *Kosteus, %*	Temperature, °C *Lämpötila, °C*	pH
VT	33.9—74.3	5.9—18.6	3.8—4.5
MT	46.6—73.7	4.4—14.2	4.0—5.0
OMT	32.4—57.6	4.3—16.1	4.6—6.1

The moisture content was highest in October, almost as high at the beginning of June, and lowest at the end of August: this applied to the humus layers in all the sample plots. The maximum temperature and the minimum pH were found at the end of June, and the minimum temperature and maximum pH in October.

Cultures

All the handling of the samples occurred immediately after their collection. The dilution plate cultures for quantitative and qualitative determination of the microfungal populations (apart from the cellulose decomposing fungi) were prepared from a dilution in which the proportion of the well-homogenized sample represented 1 : 10 000 of the volume. The nutrient medium consisted of Martin's medium for fungi (Martin 1950). The incubation time was five days, and the incubation temperature +25° C. There were ten replicate dishes. All the colonies were counted and examined.

The soil-plate method (WARCUP 1950) was applied for cultivation of the cellulose-decomposing fungi. The medium was an adapted cellulose agar (VARTIOVAARA 1935), with pure cellulose as the source of carbon. The incubation time was 21 days, and the temperature +15° C.

All the stages of taking the samples, preparing the cultures, and making inventory, were standardidized with a view to ensuring greater reliability in the results.

Results

Microfungal density in the humus layer

The microfungal density, that is to say the number of microfungal units in one cc of fresh humus layer in the different sample plots at different dates, is indicated in Table 1.

Table 1. The microfungal density per cc. of humus layer
(Martin's medium for fungi)
Taulukko 1. Homesieniä per cm³ humuskerrosta.

Date of sampling *Näyte, pvm*	Sample plots *Näytealat* VT	MT	OMT
6. VI. 66	153 000	—	—
16. VI. 66	85 000	123 000	125 000
30. VI. 66	453 000	423 000	270 000
14. VII. 66	127 000	152 000	168 000
29. VII. 66	177 000	198 000	203 000
9. VIII. 66	158 000	110 000	62 000
18. VIII. 66	87 000	112 000	103 000
31. VIII. 66	30 000	60 000	57 000
28. IX. 66	232 000	98 000	105 000
22. X. 66	145 000	98 000	20 000
$\bar{x}$	165 000	115 000	112 000

Although the results have been presented as absolute figures, they indicate no more than the relative microfungal density in the sample plots studied. It would obviously be impracticable to arrive at absolute figures even in those instances where determinations could be made regarding which of the colonies originated in spores, which in mycelial fragments, as to some extent individual evaluation can lead to error.

No really significant quantitative differences were observable between the microfungi in the humus layers of the various plots. Nevertheless, it must be pointed out that the research method applied conduced to this finding. Irrespective of the circumstances, however, indication of the number per volume unit does in any case provide a truer picture of the natural microfungal density than any other method.

In all of the sampling areas, variations in the microfungal density followed

almost the same pattern. Fungi were most in evidence at the end of June, when the highest temperatures were measured, and least in October, the month of the lowest temperatures in the humus layers. The only exception to this was in the VT pine stand. The gradual diminution in the microfungi towards the end of August can be regarded as being attributable to the diminution of decomposable material in the humus layers, and their rapid increase in September to the rise in the amount of such material.

The kind of interdependence discernible in respect of temperature was not found between moisture content and microfungal density. It is accordingly evident that the moisture content was suitable for the microfungi troughout (cf. SCHALIN 1966). The acidity can be passed over with the comment that it was of considerable advantage to the microfungi. The rather high pH (6.1) observed in the OMT in October exercised scarcely any influence upon the competition existent between the microfungi and other organisms, since the other factors, with the possible exception of the nutrition, were by then unfavourable for all microbes.

Identification was made in the manner described by ZYCHA (1935), LINNEMANN (1941), GILMAN (1957), BARNETT (1962), and AINSWORT (1963). No difficulty was experienced in identifying species from among ten different microfungal genera. In addition, the cultures included sterile mycelia, along with yeasts and yeast-like fungi. A proportion of the population remained unidentified. The findings are presented in table 2.

The proportion of the *Phycomycetes* fungus class was almost the same in all sampling areas: the seasonal variation was 5—30 %. *Mucor* and *Mortierella* were the predominat genera. It was not mere coincidence that the *Mucor* species constituted the predominant growth during the early part of summer and in the autumn, with the moisture content at its peak, as the increase in moisture leads to a consequent increase in the density of these fungi (cf. ORPURT and CURTIS 1957, MEYER 1959, SCHALIN 1966). It is evident that the relationship existent between the *Mortierella* fungi and the moisture content is almost the reverse.

The polymorphic *M. silvaticus* types were the commonest of the *Mucor* fungi. *M. vinaceae* and *M. isobellina* clearly formed the major proportion of the *Mortierella* fungi: moreover, a few unidentified species were encountered. »The other *Phycomycetes*» formed a group of fungi which clearly grew more slowly: by reason of the similarity between the mycellium and sporangio structures, these definitely fell in this fungi group, which further included a representative of the *Thamnidium* genus.

The largest class, with also the largest number of species, was constituted by multicellular filamentous fungi. The commonest of these was clearly the *Penicillia*, which prefer dryness (MENON and WILLIAMS 1957): these varied in amount from 22 to 93 %. The majority of these fungi were to be found in the barren VT, and the minority in the luxuriant OMT. The commonest types

Table 2. Composition (%) of the microfungal population in the humus layer based on samples cultured in Martin's medium for fungi.
Taul. 2. Humuskerroksen homesienipopulation koostumus (%) määritettynä näytteistä, jotka viljeltiin Martins medium for fungi'lla.

	Date of sampling in 1966 / Näytteenottopäivämäärä v. 1966													
	6. VI	16. VI			30. VI			14. VII			29. VII			
	Sample plot / Näyteala													
	VT	VT	MT	OMT	VT	MT	OMT	VT	MT	OMT	VT	MT	OMT	
Mucor	10.9	13.7	13.0	8.4	3.7	5.9	8.8	1.1	3.4	3.1	1.3	3.0	6.0	
Mortierella	1.1	16.8	16.9	7.4	7.3	8.2	16.0	3.2	—	2.5	3.9	12.0	37.6	
Other *Phycomycetes*	—	—	—	—	—	—	—	—	—	—	—	—	—	
Geotrichum	—	4.7	—	—	0.6	—	—	—	—	—	—	—	—	
Aspergillus	—	—	—	—	—	—	—	—	—	—	—	—	—	
Penicillium	70.6	46.3	22.1	22.1	84.7	78.4	56.9	93.5	94.8	67.3	89.5	84.3	38.0	
Scopulariopsis	—	—	5.2	—	2.6	4.2	3.3	—	0.7	1.2	—	0.7	3.9	
Verticillium	1.1	—	—	5.3	0.3	—	1.7	—	—	3.7	—	—	1.1	
Humicola	—	—	—	—	—	—	—	—	0.7	0.6	—	—	0.4	
Hormodendrum	—	—	—	—	—	—	—	—	—	—	—	—	—	
Yest and yestlike fungi	4.3	1.1	—	12.6	—	—	1.2	—	—	—	—	—	0.8	
Mycelia sterilia:														
hyalin	12.2	15.4	32.8	36.0	0.8	3.3	12.1	2.2	—	15.1	5.3	—	12.2	
dark	—	—	7.2	6.1	—	—	—	—	—	—	—	—	—	
Unidentified	—	2.5	2.8	2.1	—	—	—	—	—	2.8	—	—	—	

	Date of sampling in 1966 / Näytteenottopäivämäärä v. 1966													
	9. VIII			18. VIII			31. VIII			28. IX			22. X	
	Sample plot / Näyteala													
	VT	MT	OMT	VT	MT	OMT	VT	MT	OMT	VT	MT	OMT	VT	MT	OMT
Mucor	1.6	26.5	4.0	3.0	6.0	5.9	6.4	9.4	3.0	2.6	21.4	12.2	11.4	10.0	15.0
Mortierella	3.0	19.1	19.6	11.9	4.5	2.2	2.1	19.0	5.9	11.6	6.1	8.0	3.4	—	—
Other *Phycomycetes*	—	—	—	—	—	1.2	—	6.1	—	—	4.6	6.3	4.6	—	—
Geotrichum	—	—	—	—	—	—	2.1	—	—	—	—	—	—	—	—
Aspergillus	—	—	3.4	—	—	3.4	—	—	4.8	—	—	3.1	—	—	5.0
Penicillium	93.2	22.1	43.6	70.1	70.0	70.6	77.7	42.9	52.9	81.9	50.0	59.2	73.8	56.6	35.0
Scopulariopsis	—	5.9	—	1.6	—	—	1.6	—	15.6	—	3.6	1.5	—	6.7	5.0
Verticillium	—	—	—	—	—	—	1.6	—	—	0.7	—	5.1	—	—	—
Humicola	—	—	—	—	—	—	—	3.2	—	—	—	—	—	—	—
Hormodendrum	—	1.5	2.0	—	—	1.2		—	8.8	—	—	—	—	—	5.0
Yest and yestlike fungi	—	11.3	—	—	1.5	1.2	1.6	—	—	—	—	—	2.0	—	—
Mycelia sterilia:															
hyalin	2.2	9.9	22.1	13.4	16.1	15.3	5.3	19.4	—	3.2	12.0	3.1	4.8	7.0	25.0
dark	—	—	3.3	—	1.8	—	—	—	—	—	2.1	—	—	—	—
Unidentified	—	3.3	2.0	—	—	2.4	3.2	—	—	—	—	1.5	—	3.4	10.0

were *P. velutina* and *P. frequentas*, the former in the VT and the latter in the OMT.

With regard to the other fungi in this class, certain undefined *Scopulariopsis* species were the only ones to be encountered in all the sampling areas, although their proportion generally remained below 5 %. These fungi are the usual saphrophytes, with modest demands in regard to environmental conditions (RAPER and THOM 1949).

Most of the *Verticillium* species (ABBOTT 1926a and b, LE CLERG 1930, BISBY, JAMES and TIMONIN 1933) bear a close resemblance to the fungi last-mentioned in respect of their common appearance: at times they were observable in abundance in every sampling area. Many of these fungi live as parasites or saphrophytes on the mycelia of the *Basidiomycetes* (ISAAC 1953). Two types were identified, *V. effusum*, and *V. terrestre*.

An incidental finding in VT alone was the *Geotrichum* microfungus. Although this species has been regarded as a modest soil fungus, met frequently everywhere (JENSEN 1931, BISBY, TIMONIN and JAMES 1935), no previous indication has been made of its appearance in the forest of the subartic zone.

Furthermore, *Humicola* and *Hormodendrum* species, referred to as common soil fungi in the forests of the warm and temperate zones (GILMAN and ABBOTT 1927, SWIFT and POVAH 1929, JENSEN 1931, NIETHAMMER 1933, SABET 1935, WARCUP 1951), were also to be found in MT and OMT. However, it is obvious that as these fungi were present, at times in rather large quantities, in the moist forest lands now examined, they are in fact permanent members of the microfungal populations of forest lands of the subartic zone, perhaps as species which demand little more than do the fungi mentioned earlier.

During the late summer, and in the autumn, some *Aspergillus* species were found in the OMT. Although these fungi are amongst the commonest soil fungi

in the world (DALE 1912, WAKSMAN 1916, TAKAHASHI 1919, THOM and CHURCH 1926, PAINE 1927, GILMAN and ABBOTT 1927, RAILLO 1928, JANKE and HOLZER 1929, JENSEN 1931, FEHÉR 1933, THOM and RAPER 1945, SUBRAMANIAN 1952, FARROW 1954), they are as a rule rarely found in forest lands (TRESNER, BACKUS and CURTIS 1954, SAITÔ 1956, OHMASA, KAWADA and KAWADA 1957, REDDY and KNOWLES 1965), and only one previous report has been made on their appearance in forests in Finland (SVINHUFVUD 1937). The fact that the *Aspergilli* were found only in the OMT birch stand must mainly be explicable by the nutritional conditions prevailing in this site, primarily to meet the requirements of the tree species, being more favourable for the fungi than is the case in the VT pine and MT spruce stands. In examination of the environmental factors of moisture content and acidity, these can be ignored by reason of *Aspergillus* fungi closely resembling the microfungi mentioned above as far as these particular factors are concerned (THOM and CHURCH 1926), and being only slightly more demanding with respect to temperature. All the *Aspergilli* observed belonged to the *glaucus*- group.

All the yeasts and yeast-like fungi were put in the same class without separation of the *Ascomycetes* and *Fungi imperfecti*. The commonest genera were found to be *Candida* and *Sporobolomyces*.

The better the site, the more *Mycelia sterilia* there grew. Their relationship to the moisture content was approximately as that of the *Mucor* species. Clearly, all those fungi classified as *Mycelia sterilia* do not belong to these fungi a proportion may have been fungi of infrequent or scanty sporulation.

It appears from the foregoing that the differences discerned between the microfungal populations from the humus layers of VT pine, MT spruce and OMT birch stands — differences which are perhaps fewer than was to be expected — can be limited, with a few exceptions among the rarer microfungi

Table 3. Cellulose-decomposing microfungi and their quantity in the humus layer (cellulose medium).
Taulukko 3. Selluloosaa hajoittavat homesienet ja niiden määrä humuskerroksessa.

	Date of sampling in 1966 — *Näytteenottopäivämäärä v. 1966*														
	6. VI	16. VI			30. VI			14. VII			29. VII	9. VIII		19. VIII		
	Sample plots — *Näyteala*														
	VT	VT	MT	OMT	VT	MT	OMT	VT	MT	OMT	VT	MT	OMT	VT	MT	OMT
Mucor spp.	1	△	—	—	△	△	1	1	1	1	1	△	△	△	1	△
Other *Phycomycetes*	3	4	2	2	—	1	1	2	1	1	2	1	3	△	2	2
Geotrichum sp.	—	1	—	—	△	—	△	—	—	△	—	—	—	1	—	—
Molinia sp.	2	—	—	—	—	—	—	—	△	—	—	—	—	2	—	—
Gephalosporium sp.	—	—	1	—	△	—	△	—	—	△	—	—	—	—	—	△
Trichoderma sp.	1	3	5	4	5	4	3	△	△	3	—	3	5	1	4	3
Penicillium spp.	5	5	4	5	5	5	5	3	1	3	4	5	5	4	3	5
Scopulariopsis sp.	△	—	△	1	—	3	3	—	3	4	1	3	3	4	5	4
Acremonium sp.	3	—	2	△	—	—	—	3	1	1	—	1	—	—	△	3
Verticillium spp.	△	—	—	4	△	1	3	—	—	—	—	—	2	—	3	1
Mycogone nigra	—	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—
Humicola sp.	—	—	—	—	—	1	△	1	1	△	△	△	—	—	1	—
Hormodendrum sp.	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Yest and yestlike fungi	—	—	—	—	—	—	—	—	5	4	—	—	—	—	—	—
Mycelia sterilia hyalin	3	△	2	△	1	—	—	3	2	1	2	2	—	—	1	—
Mycelia sterilia dark	△	—	—	—	△	—	—	1	△	—	△	△	—	—	—	—

	31. VIII			28. IX			22. X		
	VT	MT	OMT	VT	MT	OMT	VT	MT	OMT
Mucor spp.	1	1	—	2	2	1	△	△	△
Other *Phycomycetes*	△	2	—	2	△	1	2	—	1
Geotrichum sp.	1	—	—	△	—	—	1	—	—
Molinia sp.	1	—	—	—	—	—	1	—	—
Gephalosporium sp.	—	△	—	—	—	—	—	—	—
Trichoderma sp.	4	2	1	2	5	4	4	5	5
Penicillium spp.	4	5	5	5	5	5	5	4	5
Scopulariopsis sp.	1	3	2	—	△	—	△	3	1
Acremonium sp.	1	1	—	2	—	—	3	1	—
Verticillium spp.	—	—	—	—	1	—	—	—	2
Mycogone nigra	—	—	—	—	—	1	—	—	1
Humicola sp.	1	—	1	—	—	—	—	—	—
Hormodendrum sp.	—	△	2	—	—	—	—	—	—
Yest and yestlike fungi	—	1	—	△	—	—	—	2	△
Mycelia sterilia hyalin	1	3	1	2	△	—	△	1	△
Mycelia sterilia dark	—	△	—	△	△	—	—	—	—

of moist forest lands, to no more than quantitative relationships between the species. The activity of each population, and its significance to its environment, remain undisclosed.

Although the findings indicate some of the features of microfungal flora compositions, it needs to be emphasized that they do not present a complete picture of the microbial group concerned: there is every reason to believe that aspects such as the quantity and the significance of fungi of slow growth in forest soils are completely lacking from the picture: this depends essentially upon the conditions of experiment and the method applied. Consequently, information on microfungi of incidental appearance should be approached with due caution.

Nonetheless, the reliability of the results arrived at is not appreciably affected by the limitations imposed by the conditions of experiment, or the method of study. Whenever determination is being made of the species composition, and the quantitative relationship between the species of microfungal populations in one or more of the sites, on the basis of fungi identified and the number of samples, with this being effected by means of standardized experimental techniques and the coordination of experimentation, there exits no reason to doubt that these experiments made in respect of time and place afford results which are fully comparative.

Cellulose-decomposing fungi

Table 3 presents the composition of the microfungal populations grown on cellulose agar in all the samples taken from each plot concerned. The qualitative relationships between the genera are indicated by figures ranging from one to five (cf. SCHALIN 1966). Symbol △ indicates the appearance of this fungus, which amounted to less than one colony per replicate dish.

It should here be remarked, by way of general observation, that in the main the same microfungi grew on the cellulose agar and on Martin's medium for fungi. As the new species encountered in samples from all the areas consisted of *Trichoderma*, appearing regularly and in large quantities, one *Acremonium* species, rather regularly in VT but rarely in OMT, *Mycogone nigra*, only in OMT, the *Monilia* species incidentally in VT, and the *Gephalosporium* species, found in both MT and OMT. In view of the selectivity of the cellulose agar, the absence of the *Aspergilli* was quite to be expected.

Trichoderma was found to be the most active cellulose-decomposing fungus. Although the hydrolization activity of the fungus is slow (MANDELS and REESE 1957), its significance in the decomposition of residues containing cellulose in forests should not be under-estimated by virtue of its common appearance.

Almost all the *Mycogone* species (BISBY, JAMES and TIMONIN 1932, RAILLO 1928), and most of the *Humicola* species (WHITE and DOWING 1952) effectively decompose cellulose, especially in soils of relatively acidic nature. Reliable evidence was acquired of the ability of the species encoutered to decompose cellulose. The finding that *Mycogone nigra* grew in OMT alone is obviously attributable to the site concerned offering it suitable decomposible organic material.

Large quantities of *Penicillia* were found on the cellulose agar, which proves, as could be established with increasing age of the populations, that these

fungi are capable, at least to some extent, of utilizing cellulose as nutrient, notwithstanding their generally being regarded as users of easily-soluble carbohydrates alone. In respect of behaviour in the presence of cellulose, the *Verticillium* species found in MT and OMT, together with the *Scopulariopsis* and *Acremonium* species, bore an obvious resemblance to the *Penicillia*. Against this, no decomposition of cellulose whatever was discernible in the case of *Geotrichum, Monilia, Gephalosporium* and *Hormodendrum* fungi, marked by the infrequent appearance of modest cultures in the populations.

The unexpected abundance of *Phycomycetes* fungi possibly proved their ability to consume as nutrients carbohydrates difficult to dissolve, to some extent at least (cf. SMITH 1948). Nonetheless their ability to decompose cellulose remained unconfirmed: in the populations, they were encountered only in the form of mixed cultures together with the *Trichoderma* and *Verticillium* genera.

The yeast fungi obviously contained a number of cellulose-decomposing species (di MENNA 1959) to which belonged those met on the cellulose agar.

The microfungi found on the cellulose agar supplement the comparatively scanty species included among the microfungal populations from the humus layers of VT pine, MT spruce and OMT birch stands when grown on Martin's medium for fungi. However, it is impossible to do more than make a rough guess at the significance of these fungi in the forests alongside other cellulose-decomposing organisms.

Summary

This study had as aim elucidation of the composition of the microfungal populations of the humus layer of three types — VT pine, MT spruce, and OMT birch pure stands. The results indicate that the microfungi encountered in these sites bear close resemblances. The number of species increased but little from VT to OMT. The main difference between the microfungal populations was limited to the quantitative relatioships between species.

The microfungal density in the humus layer was greatest in VT, and only slightly less in MT and OMT, in this order. In all the sampling areas, occurrence of the microfungi reached a maximum in the middle of summer, at a time when the maximum temperatures were registered in the humus layers. The quantitative abundance during the early autumn, again, obviously bears a relation to the yield of litter.

The microfungi most commonly encountered in all the sampling areas were those of rapid growth, *Mucor, Mortierella* and *Penicillium* species, along with *Trichoderma*, a little slower in growth, and actively decomposing cellulose. *Mucor* fungi, favouring moisture, were almost as common in all the sampling areas. They were found in greatest abundance during the early part of summer, and in the autumn. The *Mortierella* and *Penicillium* species, which survive

dryness, were most abundant in the middle of summer. Of the two genera last mentioned, the former was twice as common in MT and OMT as in VT, and the latter twice as common in VT as in OMT.

Scopulariopsis and *Verticillium* species were to be found regularly, although in quantities less abundant than those mentioned above, in MT and OMT, where they were almost concentrated in appearance. One *Acremonium* species appeared almost exclusively in VT. Some cellulose decomposition was discernible in respect of all of these.

Some *Aspergillus* species and *Mycogone nigra* were found in OMT alone. *Mycogone nigra*, together with *Humicola*, met on occasion in all the sampling areas, was found to be a cellulose-decomposing fungus.

Microfungi found only on rare occasions comprise the *Geotrichum, Monilia, Gephalosporium* and *Hormodendrum* species: however, the study did not present a truthful picture of their proportion and significance in a microfungal population. *Sterilia mycelia* was relatively abundant in MT and OMT in particular.

Apart from the microfungi, different kinds of yeast fungi were encountered generally in MT and OMT.

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SELOSTE:

ETELÄ-SUOMEN MÄNTY-, KUUSI- JA KOIVUMETSIKÖIDEN HUMUSKERROKSEN HOMESIENET

Tutkimuksen tarkoituksena oli perustietojen kartuttaminen eräiden metsämaiden mikrobistoista. Tutkimuksessa rajoituttiin VT-männikön, MT-kuusikon ja OMT-koivikon humuskerroksen homesienipopulaation määrän ja laadun tarkasteluun. Sen sijaan ko. mikrobien elintoimintoihin vaikuttaviin ympäristötekijöihin puututtiin vain soveltuvin osin, koska ne muodostavat oman erillisen aihepiirinsä, josta on seikkaperäisiä tietoja kirjallisuudessa.

Tutkimuksessa noudatettiin sekä maljahajoitus- että Warcup'in menetelmää. Ravintoalustana käytettiin ensin mainitussa tapauksessa Martin's medium for fungi'a ja jälkimmäisessä selluloosa-agaria.

Tulokset osoittivat, että homesieniä oli runsaimmin VT:n ja vähimmin OMT:n humuskerroksessa (taulukko 1). Erot olivat kuitenkin yllättävän pienet. Kaikissa kohteissa todettiin nousua kesäkuun lopulle mennessä, mikä kiinteästi liittyi lämpötilan samanaikaiseen nousuun. Syyskuun huippuarvot sen sijaan liittynevät karikkeiden kertymiseen. Todettakoon lisäksi, että VT:n ja MT:n suhteellisen alhainen pH on saattanut jossain määrin rajoittaa homesienipopulaation lajirunsautta, mitä ilmeisesti ei tapahtunut OMT:ssä.

Homesienipopulaatio oli kaikissa kohteissa melko niukkalajinen (taulukot 2 ja 3), mikä ainakin osittain johtunee menetelmistä. Tähän viittaa sekin, että yleensä tavattiin vain nopeakasvuisia sieniä, ja hidaskasvuisten sienien osuus ja merkitys jäivät vähäisiksi. Lajeja tavattiin kaikkiaan 20:stä eri suvusta.

Kaikissa kohteissa olivat yleisimmät homesienet kosteutta suosivat, lähei-

sesti toisiaan muistuttavat *Mucor*-kannat, kuivuutta kestävät *Mortierella*- ja *Penicillium*-lajit sekä aktiivisti selluloosaa pilkkova *Trichoderma*. Keväällä ja syksyllä tavattiin runsaasti *Mucor*'eita, keskikesällä sen sijaan pääasiassa *Mortierella*'a ja *Penicillium*'eja. *Trichoderma* oli yleinen kaikkina aikoina.

Säännöllisesti, vaikka edellä mainittuja sieniä huomattavasti vähemmän, esiintyi MT:ssä ja OMT:ssä eräitä *Scopulariopsis*- ja *Verticillium*-lajeja sekä melkein yksinomaan VT:ssä eräs *Acremonium*-laji. Kaikkien näiden todettiin hajoittavan vähäisessä määrin selluloosaa.

OMT:ssä tavattiin eräitä melko vaateliaita homesieniä, kuten *Aspergillus*-lajeja ja *Mycogone nigra*. Viimeksi mainitun, samoin tilapäisesti esiintyneen *Humicola*-lajin, havaittiin pilkkovan selluloosaa.

Lisäksi tavattiin eräitä suhteellisen hidaskasvuisia sienilajeja, jotka kuuluivat *Geotrichum*-, *Monilia*-, *Gephalosporium*- ja *Hormodendrum*-sukuihin.