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Vegetation and macrofungi of acid oakwoods in the north-east of the Netherlands

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Abstract

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The book describes the fungal, phanerogamic, moss and lichen vegetation, soil profiles and soil chemistry in the ecological associations Dicrano-Quercetum, Querco-Betuletum, Violo-Quercetum and its subassociation ilicetosum (subass. nov.) in the Province of Drenthe in the Netherlands. New methods were used in estimation of chemical composition of soil ions expressed as mass concentration and as total ion supply and of vegetation, which was recorded separately for the moss and lichen vegetation of rotten wood, and in recording fungal vegetation (spatial frequency in subplots of 25 m^2). Spatial frequency was used in estimating the abundance of mycelia for each species, uniformity of plots, pattern of species, and correlations between species. Based on the association, Querco-Betuletum and Violo-Quercetum were closely related, and both belonged to the alliance Quercion robori-petraeae. Dicrano-Quercetum was less related, and did not belong to the same alliance. In the soil, there were differences between the syntaxa in the profiles and in 'total' available ions. The syntaxa had many differential fungal species, which supported conclusions about affinities based on associations of higher plants. Distribution patterns of fungal species within plots are discussed. Notes are included on identification and taxonomy of fungi, including a newly described one, Psathyrella fulvescens var. dicrani.

Free descriptors: Dicrano-Quercetum, Quercion robori-petraea, soil analysis, dependent synusia, fungal associations, differential fungal species, periodicity, distribution patterns, representative plot size.

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1 Introduction

The Biological Station at Wijster in the Province of Drenthe in the Netherlands is a section of the Agricultural University at Wageningen. For many years it has been a centre of research on the ecosystems and habitats of toadstool-like fungi (macrofungi), for which research has been done in juniper scrub (Barkman & De Vries), in grassland (Arnolds), in Picea wood, Calluna heath and oak scrub (various staff and students). It is hoped that wide knowledge of the socio-ecological range and status of macrofugi in Drenthe should clarify understanding of plant associations, especially those with few phanerogams, mosses or lichens.

The study covered all Agaricales and Gasteromycetes, and those Ascomycetes and Aphyllophorales with a well developed sizeable fruiting body. De Vries is also studying the small Ascomycetes and Aphyllophorales of juniper scrub.

The study of fungal vegetation requires special methods, since one cannot use the same methods as for higher plants. Like the phytocoenosis, the mycocoenosis (fungal vegetation) can be considered as part of the biocoenosis (association of organisms). The phytocoenosis characterizes the biocoenosis. We cannot separately describe fungal vegetation without reference to the plant association.

The fungal vegetation of oak scrub to fix drift sands, the Dicrano-Quercetum (studied by Ypelaar in 1972 and 1973), proved rich and included many rare species known only from this type of vegetation.

The object of this study was to describe the fungal vegetation of other types of oakwood on nutrient-poor acid sandy soil, and to compare it with that of the Dicrano-Quercetum. In addition to three plots of Dicrano-Quercetum three types of oakwood were chosen: Querco-Betuletum, oak-birch wood; Violo-Quercetum typicum, a type with a more varied herb layer, Violo-Quercetum ilicetosum, a type with a well developed holly (*Ilex aquifolium*) tree layer or shrub layer.

The association of phanerogams, mosses and lichens was described in order to characterize the plots and to identify the community and its relationships. Three plots were made in Dicrano-Quercetum, eight in Querco-Betuletum, ten in Violo-Quercetum typicum, and eight in Violo-Quercetum ilicetosum. The plots were marked with pegs in order to return to exactly the same place. This was necessary because several relevés in one year only are not sufficient to describe a fungal flora, as the presence of fruiting bodies depends on the weather, varying with a season and from year to year. In this study, plots were recorded in the summer and autumn of 1976, 1977, 1978 and 1979. The relevés in each plot were combined into one synthetical relevé.

The size of the plots was decided according to the size needed for a fungal relevé, though the plot area representative for fungal vegetation was unknown. People used different areas to suit the own situation, of 1-100 000 m^2 or even more. The minimum representative area has rarely been assessed. Ypelaar (1974) estimated the representative area for Dicrano-Quercetum at 600 m^2. Jahn et al. (1967) estimated a plot of 1000 m^2 in the Luzulo-Fagetum leucobryetosum to be representative. Winterhoff (1975) found in grassland of *Festuca lemani*-vegetation that 1000 m^2 was not representative.

A plot is preferably chosen in uniform vegetation. As uniformity of fungal vegetation is difficult to assess, plots were chosen where the vegetation looked uniform. Uniform plots of 1000 m^2 or more were scarce. However, in this study, plots of 1000 m^2 were taken. They were probably representative and allowed recording in 4-6 h. Sometimes a smaller plot was taken if 1000 m^2 was not uniform. An area of 500-2000 m^2 around the plot, according to uniformity with the plot area, was surveyed for species absent from the plot area.

Fruiting bodies of fungi were counted or estimated in an area of 1000 m^2. Numbers were adjusted for differences in plot area by dividing by area.

The number of fruiting bodies depends on the number of mycelia and the number of fruiting bodies per mycelium. The real abundance of fungi should be based on abundance of mycelia, which cannot be counted directly. Darimont (1975) counted the number of 'stations', the number of patches where fruiting bodies of a species occurred. A station might contain one network of mycelium or more, but two stations might represent one mycelium. Proportion of subplots of area 25 m^2 (spatial frequency) with fruiting bodies was used as an indication of abundance of mycelia, of uniformity, of distribution between plots and of correlations between species.

Phanerogams, terrestrial mosses and lichens were recorded in all plots, and mosses and lichens growing on rotten trunks, stumps, and logs were recorded separately, because this was the microhabitat of some fungi. Higher plants were recorded in plots of the same area as for fungi, to allow comparisons of presence and abundance. Where assessment of spatial frequency was not required, a smaller area was used for records of higher plants: 150-200 m^2.

In the tables, plots were grouped by vegetation type, and the same grouping was used for tables of soil characteristics and fungi.

2 Soils

2.1 SOILS IN DRENTHE

The soils of the Province of Drenthe are geologically young, Holocene and Pleistocene. The Drenthe formation, covering most of the province and adjoining areas (Drenthian District) consists of glacial sheet moraine (till) with some small fluvioglacial deposits, dating from the Saale Glaciation (Pleistocene). Over it lies a thin layer of the Twente Formation, dating from the last glacial phase, the Weichselien (Pleistocene), consisting of cover sands and, in east and south-eastern parts of Drenthe, of fluvio-periglacial peat with thin cover sands. The Griendtsveen Formation of Holocene date in the south-east consists of partially reclaimed peat. Scattered throughout Drenthe are inland sand dunes of the Kootwijk Formation (Holocene). The brook valleys contain organic deposits of the Singraven Formation (Holocene).

The influence of glaciers is also visible in the land forms. Most of the province consists of low hills of sheet moraine, usually with cover sands. Some valleys have been cut by overflow of melt water. Some other depressions can be considered as pingo remnants. Some ice-pushed ridges are found, usually with till, for instance in the south-west, near Steenwijk. The ridges in the east, such as the Hondsrug near Groningen, are tectonic formations. The relief of Drenthe is also marked by low inland dunes (with flat wind-blown sandy areas) and higher inland dunes. In the east and south-east are plains formed by reclamation of peat, and areas with peat hags (SWAN, 1963).

2.2 SOIL SURVEY

2.2.1 Survey methods

Soils were sampled in April 1978 and June 1979 with an auger 120-170 cm long and 6 cm wide. The profile was examined to a depth of 100-150 cm for thickness, colour, grain size, humus content and structure of each layer. The layers were studied macroscopically in the field, and afterwards with a binocular microscope (magnification ×30). Colours were described and coded according to the Munsell notation. The soil was described fresh and after drying for about 24 h at 105 °C.

Soils were named in line with De Bakker & Schelling (1966). The Drenthe area falls in Soil Map scale 1:50 000 sheets 12E (Stiboka, 1977), 17E and 17W (Stiboka, 1978). These maps class watertables into 7 classes ('grondwatertrappen', Gt) according to mean highest and mean lowest watertable (Stiboka, 1977). The class for each site sampled was read from the soil maps. For areas where the soil map has not yet been published, the watertable class was worked out from the soil profile.

2.2.2 Characteristic horizons

A00 Litter: last year's leaves, twigs, flowers. Data include thickness, proportion cover and proportion of each type of tree. In some literature, this horizon is called L (litter).

A0 Fermentation horizon: partly decomposed litter with recognizable leaf-like structures. Data include thickness and colour, which was constant, 5YR 3/3-2, dark reddish brown (in dried condition 5 YR 4/3 - 7.5YR 4/2, reddish brown to dark brown). In some literature, this layer is called F (fermentation).

A1 Humus horizon: decomposed litter, without visible plant structures. Thickness is indicated. Colour was constant in fresh humus, mostly 5YR 2/2, sometimes 5YR 2/1 - 3/2-4, black to dark reddish brown (in dried condition variation is somewhat larger, including 5YR 2/1-2, 3-4/2-3 and 7.5YR 4/4, black, dark reddish brown, reddish brown and dark brown). Sand grains were often scattered in the A1 horizon, which was clearly a humus layer, and not a mineral layer with infiltrated humus. The sand grains originated from animal activity. The humus always looked amorphous, only once with some 'moder' particles. Humification apparently involved fragmentation, and growth of fungal mycelia. This type of humus is called 'mor' or 'raw humus' (Wilde 1946; Kubiëna 1953). The literature sometimes calls this layer H (humus). In some soils under Violo-Quercetum ilicetosum, an A1 horizon was missing, and was replaced by an A1h horizon.

A1h Especially the soils under Violo-Quercetum ilicetosum included a black horizon consisting almost entirely of infiltrated amorphous humus. The layer was plastic and slippery when wet. Sand grains were scarce to very scarce, and always leached. When dried, very hard lumps formed. Colour: black, rarely dark reddish brown, 5YR 2/1-2, 7.5YR 2/0, 10YR 2/1 (dry black to dark gray, rarely dark reddish brown, 5YR 2-4/1, 2/2, 10YR 3-4/1). I have called it an A1 horizon, because of the organic matter and in spite of infiltration, and added h to indicate the richness in infiltrated humus. A horizon of this type can occur on badly drained soils (Wilde, 1946).

A21 Mineral horizon of leached sand grains with a moderate to large amount of infiltrated humus, which still predominates. Colours: black to dark gray, very dark brown, dark reddish brown, 5YR 2/1-2, 3/1, 7.5YR 2-3/0, 10YR 2-4/1, 2/2 (dry very dark gray to gray, to dark brown or dark reddish brown, 5YR 3/3, 5/1-2, 7.5YR 3-5/0, 3/2, 10YR 3-5/1, 2.5Y 4-5/0-1, 5/2).

A22 Mineral horizon of leached sand with some infiltrated humus. The sand fraction is always dominant. Eluvial layer with podzolic character. Colours: gray or grayish brown to very dark gray or grayish brown, 10YR 3-5/1-2, 2.5Y 4/0, 3-5/2 (dry dark brown or grayish brown, dark to light gray, 10YR 3/3, 4-6/1-2, 7/1, 2.5Y 4-7/0, 5-6/2).

Ap An A horizon, disturbed by human activity, such as ploughing. It is not known when the plots had been disturbed, but it was not recently. Disturbances were only encountered in Querco-Betuletum.

B Horizon characterized by accumulation of dispersed humus, coating the sand grains.

B2 Horizon with the largest amount of accumulated humus. Humus rich, black or very dark gray, to dark brown or dark reddish brown, rarely reddish yellow, 5YR 2/1, 3/1-3, 7.5YR 2/0, 10YR 2-3/1, 3/2 (dry very dark gray to gray and brown, rarely reddish brown, 5YR 4/1, 3/2, 7.5YR 3-4/0, 4-5/2, 10YR 3-5/1-2).

B3 Horizon with very little extremely fine humus (microhumus). Dark reddish brown, reddish yellow, yellowish red, brown or yellowish brown, 5YR 3-4/3, 3/4 - 4/6, 7.5YR 4/2-4 - 6/6, 10YR 3/2, 4/2-4, 5/4-6 (dry dark gray brown to brown, or light yellowish brown, 7.5YR 4/2, 5/6, 10YR 4-5/2-4, 6/4).

BC A transitional horizon, gradually becoming lighter deeper.

C More or less unchanged material: coarse to fine sand (yellowish brown to pale yellow), loamy sand, sandy loam, or loam (gray). Sometimes with pebbles, often with small rusty-brown iron spots.

D Layer below the C layer of quite different nature and origin. Rare, encountered only once (Plot 15).

2.2.3 Soil types

The soils (Appendix Table A) all developed in cover sand. Often gray loam was found in the subsoil. Nearly all were distinctly podzolic. By the B horizon with amorphous humus coating of sand grains, the soils were classed as humus podzols. Heating samples from a soil in Plot 20 indicated that the A21 horizon had less iron than the A1 horizon above it, the A22 horizon contained no iron, and the B2 horizon had much more iron than the A1 horizon. Apparently the iron together with the humus was washed out and accumulated in the B2, though not enough to coat sand grains. An iron pan was not encountered, indicating waterlogging. Sand or clay cover, if any, was thin. The A1 horizon was thin, and a peaty topsoil or an intermediate peaty horizon was generally absent. Such a soil is called a Veld Podzol and was encountered in 17 plots.

In some plots, the A1 horizon was peaty, the soil being classed as Moer Podzol. Two plots had a Haar Podzol, a dry type of humus podzol. One plot had no B horizon, and was classed as a Broek Earth.

The soils under Dicrano-Quercetum (Appendix Table A1) were all formed in young drift sands. The C horizon consisted of fine to rather coarse sand without loam. There were no clear horizons, except for micropodzols of a mean thickness of 13 cm. Soils like this are called Dune vague soils. Older soils were often buried under recent drift sand. As the depth of these older soils was variable, even within one plot, they were not marked in Appendix Table A1. The soils were very dry, watertable class VII.

Except for one, the soils under Querco-Betuletum were disturbed. Sometimes the soils had been dug and an Ap horizon was present. Sometimes drains had been laid, and the sand cover 11-24 cm thick between the drains had sometimes developed a shallow new profile. Under this sand cover was an old podzol. Veld Podzol soils were observed at 6 sites and a Moer Podzol once. The only undisturbed soil was a Haar Podzol. The vegetation was slightly different from that in the other Querco-Betuletum plots. Including the extra sand cover, the C horizon was at a mean depth of 70 cm. If the sand cover be ignored, the C horizon was at a mean depth of 60 cm, and consisted of faintly fine to rather coarse sand at 3 sites, loam at 2, or intermediates at 3 sites. The soils under Querco-Betuletum were wetter than those under Dicrano-Quercetum: the watertable class ranged from V (twice), to V (5 times) and VII (once).

The soils under Violo-Quercetum typicum were always undisturbed and had distinct horizons of a podzol. There were Veld Podzols (6 sites), Moer Podzols (2 sites) and a Haar Podzol (one site). The C horizon was at an average depth of 75 cm, and consisted of sand (4 sites), loamy sand to sandy loam (5 sites), and once red boulder clay. The soils under Violo-Quercetum were about 15 cm thicker than under Querco-Betuletum, and lacked gray loam (without sand) in the C horizon. Plots 19 and 20 with vegetation close to Violo-Quercetum ilicetosum (Section 3.2.2, Appendix Table C3) also had soils that were close to those under Violo-Quercetum ilicetosum: a thick profile and a distinct A1h horizon. The soils under Violo-Quercetum typicum were slightly dryer than those under Querco-Betuletum, watertable class V (3 sites), VI (4 sites), and VII (3 sites).

The soils under Violo-Quercetum ilicetosum were never disturbed. They were podzols except for one plot where a Broek Earth occurred. Both Veld Podzols (4 sites) and Moer Podzols (3 sites) were found. The C horizon was at a mean depth of 82 cm, and consisted of sand (3 sites), or loamy sand or sandy loam (5 sites). The soil here was on the average 7 cm thicker than under Violo-Quercetum typicum, and 22 cm thicker than under Querco-Betuletum. The C horizon was loamy or sandy as under Violo-Quercetum typicum, and slightly less loamy than under Querco-Betuletum. An A1h horizon occurred more often, and was thicker under Violo-Quercetum ilicetosum than under other associations. Such a horizon could only form in badly drained soils (Wilde, 1946). These soils were usually wetter than under other associations, watertable class III (3 sites), V (2 sites), VI (1 site), and VII (2 sites).

2.3 CHEMICAL AND PHYSICAL PROPERTIES

Samples for analysis were taken in September 1978 from the A0 and A21 horizons, because fungal mycelium and growth was maximum in these horizons (De Boois, 1976). Samples were taken from the A1h instead of the A21 horizon if the A1h horizon was 10 cm or more thick, because it was unlikely that a deep A21 would contain much mycelium.

With pF rings, 9 samples were taken each of volume 99 cm^3 from each plot and both horizons. The samples from each horizon were combined into 3 mixed samples of 3 samples each. They were stored until use in a freezer at -25°C. Before tests, they were dried at 50°C for 5-7 days and, for most tests, ground. This dried and ground soil is further referred to just as soil. Results for each plot were based on the 3 mixed samples. Conclusions for each (sub)association were based on averages and ranges for all measurements (Appendix Table B).

2.3.1 pH

To measure pH-H_2O and electrical conductivity, 5 g of soil was shaken with 50 ml of distilled water for half an hour. All pH values were measured with a glass electrode to 0.01 and averages were rounded to 0.1. The values for each group of samples had a normal distribution, so that the arithmetic mean was a valid parameter.

The soils were all very acid, ranging in pH-H_2O from 3.0 to 4.7 in the A0 horizon, and from 2.8 to 4.4 in the A21 horizon. There was little difference between the associations.

To measure pH-KCl, 5 g of soil was shaken for 1 h with 50 ml of an aqueous solution of KCl, substance concentration 1 mol/l. In the A0 horizon the pH of the supernatant ranged from 2.5 to 3.3 and was less than the pH-H_2O in all plots, mean difference 0.8. There was little difference between the associations. In the A21 horizon the pH-KCl ranged from 2.4 to 3.5 and it too was always less than the pH-H_2O, mean difference 0.9. It decreased in the order Dicrano-Quercetum, Querco-Betuletum, Violo-Quercetum typicum, Violo-Quercetum ilicetosum. The differences between the associations were not large, 0.5, but indicate that the A21 horizon under Violo-Quercetum ilicetosum was slightly more acid than under Dicrano-Quercetum. The horizon was, however, of different nature (Appendix Table A): under Dicrano-Quercetum, it consisted mainly of sand; under Violo-Quercetum ilicetosum, mainly of infiltrated humus.

The relation pH-KCl and pH-H_2O was nearly linear in both A0 and A21 horizons.

2.3.2 Electrical conductivity and 'total' ion supply

Electrical conductivity was measured in the same system as for pH-H_2O and corrected by subtracting the conductivity of hydrogen ions, according to pH. It was higher in the A0 horizon than in A21. Mean values in the A0 horizon were higher under Dicrano-Quercetum and under Violo-Quercetum ilicetosum than under Violo-Quercetum typicum and Querco-Betuletum. Contrary to initial expactations the differences were large and significant according to an F test on log-transformed observations.

In the A21 horizon under Dicrano-Quercetum, conductivity was markedly less than under Querco-Betuletum and Violo-Quercetum typicum, and under Violo-Quercetum ilicetosum was higher than under Querco-Betuletum and Violo-Quercetum typicum. The differences were highly significant according to an F test on log-transformed observations.

Conductivity indicates the concentration of total ionic equivalent in a system. The supply of ions depends also on the thickness of the layer. To calculate ion supply in horizons A0 and A21, the conductivity of the A0 horizon was multiplied by the combined thickness of horizons A0 and A1. Likewise that of the A21 horizon was multiplied by the thickness of horizons A1h and A21 to indicate supply in A1h+A21. The sum of the two values reflects 'total' ion supply (Table 1). This calculation assumed that the conductivity of the A1 horizon equalled that of the A0 horizon, and that in the A1h horizon equalled that of the A21 horizon. Conductivity of the A1 horizon was, however, probably lower than of the A0 horizon, so that the calculation would give a value too high. The conductivity of the A21 horizon was assumed to be lower than of the A1h horizon. In most plots, an A1h horizon was not present, so the approach should reflect reality. If the A1h horizon were thin, the value would be slightly too low; if the A1h horizon were thick and conductivity were measured in that horizon (so not in A21), the estimate would be slightly too high.

The ion supply of the A0+A1 horizons was almost equal under Dicrano-Quercetum, Querco-Betuletum and Violo-Quercetum typicum, and was much higher under Violo-Quercetum ilicetosum. The ion supply of the A1h+A21 horizons was very low under Dicrano-Quercetum, much more under Querco-Betuletum and Violo-Quercetum typicum, and still more under Violo-Quercetum ilicetosum. The 'total' ion supply was highest under Violo-Quercetum ilicetosum, was less by half under Violo-Quercetum typicum and Querco-Betuletum, and was still less under Dicrano-Quercetum.

2.3.3 Volumic mass

The volumic mass (formerly called specific gravity) of dried A0 soil was highly uniform and did not vary with vegetation. That of the A21 horizon varied with mass fraction of humus. The values were used to convert mass fractions of ionic components to mass concentrations.

Table 1. 'Total' ion supply as reflected by electrical conductivity (σ) and thickness of the horizons (d).

Veg. type	Plot No.	σd(μS)		
		Horizon		
		A0 + A1	A1h + A21	Σ
VQi	29	24	32	57
	28	3	6	9
	27	60	92	152
	26	22	3	26
	25	49	31	80
	24	2	19	21
	23	26	2	28
	22	35	11	46
VQt	21	12	18	30
	20	9	7	16
	19	10	3	13
	18	10	2	12
	17	11	2	13
	16	15	1	16
	15	13	6	20
	14	20	1	21
	13	39	7	46
	12	12	2	15
QB	11	7	6	13
	10	18	3	21
	9	10	10	20
	8	20	0.7	20
	7	9	2	12
	6	31	11	42
	5	26	21	47
	4	7	3	10
DQ	3	9	0.5	9
	2	11	0.1	11
	1	23	0.9	24
VQi		28	25	52
VQt		15	5	21
QB		16	7	23
DQ		14	0.5	14

2.3.4 Ionic composition of soil

To estimate exchangeable ions, 6 g of soil was shaken with 40 ml of ammonium acetate buffer,1 N, pH 7.0, washed successively with 16, 12, and 12 ml of the buffer over a Schleicher & Schüll No 589 blackband filter, filtered through a Sartorius 0.8-μm membrane filter, and filled with the buffer to 100 ml. These solutions were used, usually undiluted, occasionally once diluted, to estimate Na^+ and K^+ by flame emission spectrometer. To estimate Mg^{2+} and Ca^{2+} in a Perkin-Elmer atomic absorption spectrometer, 1 ml of extract of A0 soil or 5 ml of extract of A21 soil was diluted into

5 ml of aqueous solution of $La(NO_3)_3$ (containing La at exactly 10 g/l) and made up with water to 50 ml. Exchangeable ions were expressed as mass fraction in soil (mg/kg) and as mass concentration in soil (g/m^3).

Available ions are often expressed as a mass fraction (mg of ions per 100 g of soil), though roots of plants and mycelia of fungi occupy and exploit a certain volume of soil. It would therefore be an improvement to express them as a mass concentration (mg of ions per cubic metre of soil).

In the A0 horizon, the concentration of Na^+ and K^+ was slightly more under Violo-Quercetum ilicetosum than under other associations. Concentrations of Ca^{2+} and Mg^{2+} were about the same under all (sub)associations.

In the A21 horizon, concentration of Na^+ was more, and of K^+, Mg^{2+}, and Ca^{2+} was less than in the A0 horizon. In general, the variation in concentrations was high, giving considerable overlap between soils under different (sub)associations. Nevertheless some differences existed. Concentration of Na^+ was more under Violo-Quercetum ilicetosum then under the other associations. Concentration of K^+ decreased in the order Violo-Quercetum ilicetosum, Querco-Betuletum, Violo-Quercetum typicum, Dicrano-Quercetum, and of Mg^{2+} in the order Violo-Quercetum ilicetosum, Querco-Betuletum, Violo-Quercetum typicum, Dicrano-Quercetum where it was distinctly less than under the other associations. Concentration of Ca^{2+} was most under Violo-Quercetum ilicetosum, less under Violo-Quercetum typicum and Querco-Betuletum and least under Dicrano-Quercetum.

There was a linear correlation with high correlation coefficients between mass fraction of cations and mass fraction of carbon. The correlation for concentrations was also linear, but the correlation coefficients were slightly lower. It is therefore possible to use organic matter to predict content or concentration of cations.

2.3.5 Organic matter and nitrogen in soil

To estimate organic matter, some soil was dried at 105 °C. A portion of some grams was weighed and the loss on ignition was measured after heating to 800 °C for 2.5 h. Carbon was calculated as 58 % of the weight loss (Van Bemmelen factor). Data was expressed as mass fraction and mass concentration of carbon in soil.

To estimate total nitrogen, some soil was dried again at 105 °C. Soil of A0 (0.2 g) and of A21 (0.5 g or 1 g exactly weighed) was heated in an acid mixture of 6 g of salicylic acid in 110 ml of dilute sulphuric acid (90 ml of water on 500 ml of H_2SO_4, volumic mass 1840 kg/m^3) at 400° C for 1 h. The solution was chilled and diluted with 75 ml of water. In a Tecator Kjeltec System 1002 distiller 50 ml of NaOH (40 g/l) was added. This solution was distilled into 25 ml of boric acid (40 g/l) with mixed indicators, and titrated with $KH(IO_3)_2$ 10 mmol/l). Nitrogen was expressed as mass fraction and mass concentration in soil.

In the A0 horizon, contents and concentrations of carbon and nitrogen decreased in the order Violo-Quercetum ilicetosum, Violo-Quercetum typicum, Querco-Betuletum, Dicrano-Quercetum, but the differences were rather small. The mass ratio of C to N differed very little, increasing slightly in the same order.

In the A21 horizon, the difference between the associations was more distinct. Concentrations of carbon and nitrogen were both most under Violo-Quercetum ilicetosum, less under Violo-Quercetum typicum and Querco-Betuletum, and least under Dicrano-Quercetum. The mass ratio was higher under Dicrano-Quercetum and Querco-Betuletum than under Violo-Quercetum ilicetosum. There is a strong linear correlation between nitrogen and organic matter in both layers, comparable to the correlation for cations and organic matter.

3 Associations of higher plants

3.1 METHODS

The plots of at least 150 m^2 were selected in vegetation that looked uniform. Except for some plots of Violo-Quercetum ilicetosum, all plots were, however, larger, ca. 1000 m^2 (Table 1). An area of 1000 m^2 was necessary to describe the fungal vegetation; for green vegetation, 300 m^2 would suffice. The whole of each plot (1000 m^2) was described and not only a representative part of the plot. Plots of 150 or 100 m^2 and the moss layer of all plots (except 2 and 3), were recorded as one relevé; those of 875, 1000, or 1050 m^2 and of the moss layer of Plot 2 and 3 were split into subrelevés of 25 m^2, using the same subplots as for the fungal vegetation. Subrelevés were later integrated into a 'total' relevé, using the values given below for mean real cover.

3.1.1 Recording methods

Vegetation was described with Braun-Blanquet relevés (Appendix Table C1-4). Cover was recorded with Braun-Blanquet symbols, modified according to Barkman et al. (1964), as follows (with geometric mean in parenthesis):

r	rare, 1-2 specimens (0.1%)	cover always < 5%
+	few, 3-10 specimens (0.5%)	
1	numerous, 10-100 specimens (1%)	
2m	very numerous, > 100 specimens (3%)	
2a	cover 5 - 12.5% (8%)	
2b	cover 12.5- 25 % (18%)	
3	cover 25 - 50 % (35%)	
4	cover 50 - 75 % (60%)	
5	cover 75 -100 % (86%)	

In some plots, a rather large area was covered by dead half-rotten stumps, stubs, trunks and fallen logs, often with a remarkably high moss cover. For records for green vegetation, this non-soil synusia is usually omitted, but in this study, it was essential, since some fungi only occurred there. Records for stumps were therefore made in addition to the vegetational relevé with an estimate of how much of the plot area was covered by dead stumps and logs, and a separate relevé of this microhabitat. The cover of moss and of each moss species was estimated as an area fraction. These relevés were made for a whole plot.

The records of green vegetation were made in the summer of 1977 and 1978. Barkman and I made those of moss layer on ground and on dead stumps and logs in May 1979. The relevé of Plot 1 was taken from Vreugdenhil & Barkman (1974).

Synoptical characteristics presence, P, and total cover value, TCV, were calculated (Table 2). Presence represents the proportion of plots where a species was found. Total cover value represents the mean cover of a species (calculated with the geometric mean of the cover values).

3.1.2 Calculation of affinity and difference between communities

In this paper, Barkman's methods (1974b) of calculating affinity between two associations were used (Table 3). A_C is an affinity based on the number of common and uncommon species:

$$A_C = (c + 1)/[(ab)^{\frac{1}{2}} + 1] \tag{1}$$

where c is the number of species common to both associations, a is the number of species occurring in only one, b the number occurring only in the other. Only absence and presence of species are thus used to calculate A_C.

The affinity A_P is based on presence, P:

$$A_P = \Sigma C_P/(\Sigma A_P \cdot \Sigma B_P)^{\frac{1}{2}} \tag{2}$$

where C_P is presence in common, i.e. the lower for the two associations, A_P is presence of a species reduced by C_P in favour of the one association, B_P the same for the other association.

The affinity A_T is based on the cover of the species, TCV:

$$A_T = \Sigma C_T/(\Sigma A_T \cdot \Sigma B_T)^{\frac{1}{2}} \tag{3}$$

where C_T is TCV in common, i.e. the lower for the two associations, A_T is the TCV of a species reducd by C_T in favour of the one association, B_T the same in favour of the other association. It thus employs both presence and cover.

The differences between the associations $D_C = 10/A_C$, $D_P = 10/A_P$, and $D_T = 10/A_T$ were also calculated (Fig. 1).

Table 2. Synoptical vegetation table of the four vegetation types. Presence, P on a scale I-X; total cover value, TCV = 100 × (mean cover in %). Dicrano-Quercetum based on 42 records (Vreugdenhill & Barkman, 1974); other associations based on Appendix C. Unless otherwise stated, mosses listed were terricolous. For further details see Appendix C. Not mentioned are species with Presence 1: for Dicrano-Quercetum, *Orthodicranum montanum* (Hedw.) Loesk. (TCV 5), *Dicranum fuscescens* Turn. (1), *Dicranum majus* Sm. (7); for Violo-Quercetum ilicetosum, *Fagus sylvatica* L. in shrub layer (1).

	Dicrano-Quercetum	Querco-Betuleteum	Violo-Quercetum typicum	Violo-Quercetum ilicetosum
Number of relevés	42	8	10	8
Tree layer				
av. height (m)	3-10(-15)	(0.5-)9-18	(5-)9-18	(3-)10-20(-24)
av. cover crown (%)	87	89	93	86
av. cover canopy (%)	80	63	74	60
av. number of species	1.4	3.4	3.5	2.9
Shrub layer				
av. height (m)	(0.1-)1-2	0.5-4(-7)	0.5-3(-8)	0.5-5(-10)
av. cover (%)	2.6	6	9	26
av. number of species	0.4	3.9	4.0	3.9
Herb layer				
av. height (m)	0-0.2	0-0.4(-1.5)	0-0.6(-1.5)	0-0.4(-0.7)
av. cover (%)	4.3	60	54	7
av. number of species	2.2	20.1	19.3	14.9
Moss layer				
av. cover (%)	68	3.4	0.3	1.7
av. number of species	21.0	13.0	7.0	6.4
Dead stumps and logs				
av. cover (%)	0.07	1.5	1.6	1.0
av. area fraction of moss cover (%)	3.3	50	48.5	19.4
av. number of species	3.7	15.1	13.9	8.3
av. aggregate number of species	25.0	41.3	35.8	27.4

Table 2. Continued.

	Dicrano-Quercetum		Querco-Betuletum		Violo-Quercetum typicum		Violo-Quercetum ilicetosum	
	P	TCV	P	TCV	P	TCV	P	TCV
1. Differential species of Dicrano-Quercetum								
m *Dicranum scoparium* Hedw.	X	5231	IX	46	V	23		
m *Pohlia nutans* (Hedw.) Lindb.	X	535	VII	27	III	12	III	7
m *Lophocolea heterophylla* (Schr.) Dum.	X	302	IV	20	V	22	IV	20
m *Lecidea granulosa* (Hoffm.) Ach.	X	41						
m *Campylopus fragilis* (Brid.) B.S.G.	IX	354	IV	40	V	5	III	19
m *Cladonia pyxidata* (L.) Hoffm.	IX	215						
m *Aulacomnium androgynum* (Hedw.)Schwaegr.	IX	97	IV	15	II	6		
m *Parmelia physodes* (L.) Arch.	IX	87						
m *Cladonia glauca* Flörke	IX	72						
m *Dicranum polysetum* Swartz	VII	267	III	12				
m *Pleurozium schreberi* (Brid.) Mitt.	VIII	198	III	106				
m *Cephaloziella divaricata* (Franc) Schiffner	VIII	147						
m *Cladonia impexa* Harm.	VII	114						
h *Calluna vulgaris* (L.) Hull	V	47	II	100				
m *Cephalozia bicuspidata* L.	V	52						
m *Cladonia furcata* (Huds.) Schrad.	V	36						
m *Cladonia macilenta* Hoffm.	IV	41						
m *Dicranoweisia cirrhata* (Hedw.) Lindb.	IV	20	III	2				
h *Festuca ovina* L.	III	38						
h *Empetrum nigrum* L.	III	30						
m *Cladonia uncialis* (L.) Wigg.	III	16						
2. Differential species of Querco-Betuletum								
h *Vaccinium myrtillus* L.	I	1	X	3800	VII	126	VII	47
h *Vaccinium vitis-idaea* L.	I	17	IX	254	I	1		
h *Melampyrum pratense* L.			VII	75	I	1		
3. Differential species of Violo-Quercetum								
h *Oxalis acetosella* L.			III	39	V	100	V	41
s *Hedera helix* L.					IV	12	IV	4
h *Convallaria majalis* L.			II	1	III	615	II	8
s *Corylus avellana* L.					II	11	IV	14

Table 2. Continued.

	Dicrano-Quercetum		Querco-Betuletum		Violo-Quercetum typicum		Violo-Quercetum ilicetosum	
	P	TCV	P	TCV	P	TCV	P	TCV
4. Differential species of Violo-Quercetum typicum								
h *Maianthemum bifolium* (L.) Schm.			V	37	X	475	VII	70
h *Trientalis europaea* L.			IV	9	VI	550	II	37
h *Stellaria holostea* L.			IV	19	VI	435	II	6
h *Pteridium aquilinum* (L.) Kunh.			II	37	VI	1640	V	37
5. Differential species of Violo-Quercetum ilicetosum								
t *Ilex aquifolium* L.							VII	2812
s *Ilex aquifolium* L.					I	80	X	2587
6. Differential species of Dicrano-Quercetum and Querco-Betuletum								
m *Leucobryum glaucum* (Hedw.) B.S.G.	VII	152	X	84	I	1		
m *Campylopus flexuosus* (Hedw.) Brid.	IX	360	IV	45				
7. Differential species of Querco-Betuletum and Violo-Quercetum typicum								
h *Molinia caerulea* (L.) Moench			IX	225	VII	82		
h *Rubus idaeus* L.			III	8	III	20		
8. Differential species of Dicrano-Quercetum, Querco-Betuletum and Violo-Quercetum typicum								
h *Deschampsia flexuosa* (L.) Trin.	IV	273	IX	1437	VI	480	II	6

Table 2. Continued.

	Dicrano-Quercetum		Querco-Betuletum		Violo-Quercetum typicum		Violo-Quercetum ilicetosum	
	P	TCV	P	TCV	P	TCV	P	TCV
9. Differential species of Quercion robori-petraeae.								
h *Rubus fruticosus* L.			IX	146	X	430	X	165
h *Ilex aquifolium* L.			IX	25	VIII	28	X	281
h *Polygonatum multiflorum* (L.) All.			VII	16	X	380	IX	30
h *Corydalis claviculata* (L.) DC.	I	1	IX	264	IX	600	VIII	51
s *Sorbus aucuparia* L.			IX	151	VIII	416	VIII	283
t *Betula pubescens* Ehrh.			IX	1137	X	1556	V	775
t *Lonicera periclymenum* L.			II	1	II	6	II	1
s *Lonicera periclymenum* L.			V	10	VI	37	III	7
h *Lonicera periclymenum* L.	I	8	IX	269	IX	292	V	10
h *Hedera helix* L.			V	21	IX	326	V	109
h *Dryopteris dilatata* (Hoffm.) A. Gray			VII	16	IV	8	VII	51
h *Stellaria media* (L.) Vill.	I	21	V	21	V	5	VIII	121
m *Atrichum undulatum* (Hedw.) Beauv.			IV	3	I	10	IV	3
m *Plagiothecium curvifolium* Schlieph.			III	7	IV	26	II	1
h *Chamaenerion angustifolium* (L.) Scop.			III	12	II	6	IV	4
h *Galeopsis tetrahit* L.			V	10	III	7	VII	11
h *Dryopteris carthusiana* (Vill.) Fuchs			III	2	IV	12	III	12
h *Luzula pilosa* (L.) Willd.			II	1	I	5	IV	4
m *Brachythecium rutabulum* (Hedw.) B.S.G.			III	2	I	5	III	8
h *Milium effusum* L.			II	1	I	10	III	8
10. Accompanying species								
t *Quercus robur* L.	IX	6512	X	5075	X	5090	X	2713
s *Quercus robur* L.	III	206	V	25	III	11	III	2
h *Quercus robur* L.	I	2	X	62	IX	37	VIII	39
m *Mnium hornum* Hedw.	VI	44	IX	171	VIII	81	IX	156
m *Dicranella heteromalla* (Hedw.) Schimp.	IX	201	IX	84	VII	57	X	140
m *Hypnum cupressiforme* Hedw.	X	875	IX	76	VII	57	VII	11
m *Plagiothecium laetum* B.S.G.	VI	46	VIII	85	V	47	IX	71
s *Betula pubescens* Ehrh.	II	40	IX	346	III	16	III	12
h *Betula pubescens* Ehrh.	I	1	X	36	VII	15	V	21
t *Frangula alnus* Mill.	I	8	III	14	III	36	II	1
s *Frangula alnus* Mill.			VIII	96	VIII	307	III	7
h *Frangula alnus* Mill.	X	23	VIII	39	IX	58	II	2
m *Polytrichum formosum* Hedw.	IX	120	VIII	157	IV	41	IV	31

Table 2. Continued.

	Dicrano-Quercetum		Querco-Betuletum		Violo-Quercetum typicum		Violo-Quercetum ilicetosum	
	P	TCV	P	TCV	P	TCV	P	TCV
t *Sorbus aucuparia* L.	I	102	V	56	VI	256	III	14
h *Sorbus aucuparia* L.	I	2	X	62	X	86	X	170
m *Tetraphis pellucida* Hedw.	III	20	IV	26	II	10	II	1
m *Orthodontium lineare* Schwaegr.	VII	77	V	10	I	1	I	1
m *Isopterygium elegans* (Hook.) Lindb.	II	10	V	46			III	12
m *Calypogeia muelleriana* (Schiffn.) K.N.	I	1	V	41			III	8
m *Ptilidium ciliare* (L.) Hampe	II	23						
m *Polytrichum marginatum* Web. & Mohr	I	3	III	2				
m *Lecidea uliginosa* (Schrad.) Ach.	I	1	II	1				
m *Lophocolea bidentata* (L.) Dum.	III	15	III	8				
m *Lepidozia reptans* (L.) Dum.	I	1	II	1	I	3		
h *Galium hercynicum* Weig.	I	1	II	6	I	30		
t *Quercus rubra* L.	II	1371	II	6				
h *Quercus rubra* L.			II	6	I	1		
h *Carex pilulifera* L.	III	11	IV	9			II	1
m *Eurhynchium praelongum* (Hedw.) B.S.G.	I	1			III	3		
t *Amelanchier lamarckii* Schroed.					III	90		
s *Amelanchier lamarckii* Schroed.			III	2	I	1		
h *Amelanchier lamarckii* Schroed.	I	1	V	15	III	7		
t *Prunus serotina* Ehrh.			II	12	I	30		
s *Prunus serotina* Ehrh.			II	6	II	85		
h *Prunus serotina* Ehrh.	I	1	III	12	IV	17		
m *Pseudoscleropodium purum* (Hedw.) Fleisch.			III	12	I	5		
t *Populus tremula* L.			III	8				
h *Populus tremula* L.			III	8				
h *Luzula multiflora* (Retz.) Lej.			II	1	I	1		
h *Agrostis tenuis* Sibth.			II	1	I	1		
t *Fagus sylvatica* L.			II	6			II	225
h *Holcus lanatus* L.					IV	20	II	1
m *Plagiothecium sylvaticum* (Brid.) B.S.G.					II	2	II	1
h *Galium aparine* L.					I	1	III	2
s *Sambucus nigra* L.					II	2	II	1
m *Isothecium myosuroides* Brid.					I	5	II	1

Table 2. Continued.

	Dicrano-Quercetum		Querco-Betuletum		Violo-Quercetum typicum		Violo-Quercetum ilicetosum	
	P	TCV	P	TCV	P	TCV	P	TCV
Moss on dead stumps and logs								
3. Differential species of Violo-Quercetum								
Dicranella heteromalla (Hedw.) Schimp.					VI	19	IV	20
Eurhynchium praelongum (Hedw.) B.S.G.			II	6	IV	12	V	21
Plagiothecium latebricola B.S.G.			II	1	II	6	V	10
4. Differential species of Violo-Quercetum typicum								
Campylopus fragilis (Brid.) B.S.G.			III	14	VI	10		
7. Differential species of Querco-Betuletum and Violo-Quercetum typicum								
Mnium hornum Hedw.			IX	494	X	2010	IX	52
Dicranum scoparium Hedw.	1	33	VIII	456	VIII	216		
Tetraphis pellucida Hedw.			VIII	557	VI	123	III	39
Orthodontium lineare Schwaegr.	I	3	V	244	VII	108	II	6
Cladonia glauca Flörke	I	16	V	21	VI	32	II	1
Cladonia digitata (L.) Hoffm.			VII	29	IV	13	II	1
Polytrichum formosum Hedw.			VII	490	II	181		
Plagiothecium curvifolium Schlieph.			IV	25	III	186		
Campylopus flexuosus (Hedw.) Brid.			V	229	III	3		
8. Differential species of Dicrano-Quercetum, Querco-Betuletum and Violo-Quercetum typicum								
Leucobryum glaucum (Hedw.) B.S.G.	I	16	VII	127	IV	8		
Cladonia pyxidata (L.) Hoffm.	I	3	IV	4	III	7		

Table 2. Continued.

	Dicrano-Quercetum		Querco-Betuletum		Violo-Quercetum typicum		Violo-Quercetum ilicetosum	
	P	TCV	P	TCV	P	TCV	P	TCV
9. Differential species of Quercion robori-petraeae.								
Brachythecium rutabulum (Hedw.) B.S.G.			VII	70	V	13	V	244
Isothecium myosuroides Brid.			III	101	V	235	VII	27
Lepidozia reptans (L.) Dum			IV	14	III	32	II	6
Isopterygium seligeri (Brid.) Dix.			III	200	II	11	IV	51
10. Accompanying species								
Hypnum cupressiforme Hedw.	I	100	X	1637	X	1050	X	544
Lophocolea heterophylla (Schrad.) Dum.	I	100	X	437	X	550	X	1862
Plagiothecium laetum B.S.G.	I	3	IX	239	IX	351	VII	137
Aulacomnium androgynum (Hedw.) Schwaegr.	I	100	VIII	282	VII	53	III	39
Dicranoweisia cirrhata (Hedw.) Lindb.	I	3	V	234	V	84	III	12
Pohlia nutans (Hedw.) Lindb.	I	33	V	26	V	9	II	1
Calypogeia muelleriana (Schiffn.) K.N.			IV	4			II	6
Brachythecium velutinum (Hedw.) B.S.G.			II	1	I	5	II	1
Lecidea uliginosa (Schrad.) Ach.	I	3	II	1				
Cladonia polydactyla (Flörke) Spreng.			II	6	I	5		
Lophocolea bidentata (L.) Dum.			III	7				
Ptilidium pulcherrimum (Web.) Hampe			III	2				
Orthodicranum montanum (Hedw.) Loesk.			III	2				

3.2 DESCRIPTIONS OF THE ASSOCIATIONS

3.2.1 Querco-Betuletum

Querco roboris-Betuletum Tx. 1930.
Type relevé Tüxen 1930, p. 7-8, relevé 2, as Querceto-Betuletum. To satisfy the Code of Nomenclature (Barkman et al., 1976), the name must be modified.
Synonyms:
Molinio-Quercetum roboris Scam. & Pass. 1959.
Vaccinio-Quercetum loniceretosum Doing 1962.
Melampyro-Quercetum roboris Pass. & Hofm. 1968.

Westhoff & Den Held (1969), who reviewed the Querco-Betuletum including the Dicrano-Quercetum (Section 3.2.4) listed the following of differential taxa in relation to the Violo-Quercetum: *Pinus sylvestris, Polypodium vulgare, Vaccinium vitis-idaea, Calluna vulgaris, Festuca tenuifolia, Juniperus communis, Empetrum nigrum, Cladonia* Sect. *Cladina, Dicranum scoparium, Aulacomnium androgynum, Buxbaumia aphylla, Pleurozium schreberi, Leucobryum glaucum, Ptilidium ciliare, Campylopus flexuosus, Polytrichum juniperinum* and *Rhytidiadelphus squarrosus. Cornus suecica* is considered to be the only character species in the Netherlands. Oberdorfer et al. (1967) described Querco roboris-Betuletum as indistinct and poor in character species ("Rumpf-Association"). They did not name any differential species. Passarge & Hofmann (1968) did not name character or differential species, but did give a synoptic table. Doing (1962) and Bakker (1969) listed characteristic groups of species.

Tüxen (1937) divided the Querco roboris-Betuletum into 2 subassociations: molinietosum and typicum. My plots all fall into the subassociation typicum.

My survey indicated the following as differential species (Table 2 and Appendix Table C2, group 2, 6 and 7) in relation to Dicrano-Quercetum and Violo-Quercetum: *Vaccinium myrtillus, V. vitis-idaea,* and *Melampyrum pratense*; for Querco-Betuletum and Violo-Quercetum in relation to Dicrano-Quercetum: *Molinia caerulea* and *Rubus idaeus*; for Querco-Betuletum and Dicrano-Quercetum in relation to Violo-Quercetum: *Leucobryum glaucum* and *Campylopus flexuosus*. Some species called differential by Westhoff & Den Held are in my opinion differential for Dicrano-Quercetum in relation to Querco-Betuletum and Violo-Quercetum, and not for Querco-Betuletum in relation to Violo-Quercetum: *Calluna vulgaris, Festuca tenuifolia (=F. ovina* var. *tenuifolia), Empetrum nigrum, Cladonia* sect. *Cladina, Dicranum scoparium, Aulacomnium androgynum, Pleurozium schreberi, Ptilidium ciliare*, and *Campylopus flexuosus*. The other species they mentioned cannot be treated as differential or character species: *Pinus sylvestris, Juniperus communis, Polypodium vulgare, Buxbaumia aphylla, Polytrichum juniperinum, Rhytidiadelphus squarrosus*, and *Cornus suecica*. I found *Pinus sylvestris* only very rarely in Dicrano-Quer-

A Querco-Betuletum vegetation, plot 11, Noordlagerbos.

Vaccinium myrtillus (left) , differential species of the Querco-Betuletum, and Molinia caerulea, differential species of the Querco-Betuletum and the Violo-Quercetum typicum.

cetum, and never in Querco-Betuletum. Neither this species nor *Juniperus communis* grow spontaneously in a wood. *Polypodium vulgare* and *Buxbaumia aphylla* were observed only once in Querco-Betuletum and Dicrano-Quercetum, respectively, and so cannot be treated as differential. *Polytrichum juniperinum*, *Rhytidiadelphus squarrosus*, and *Cornus suecica* were not observed in any of the plots. *Rhytidiadelphus squarrosus* did not occur in Dicrano-Quercetum nor Querco-Betuletum; other *Rhytidiadelphus* species were not observed either. *Cornus suecica*, a very rare species and therefore only locally a character species, is typical of north-facing edges of woods, and is more likely in association with open woods than with a closed Querco-Betuletum.

Of mosses on dead stumps and logs, no species were differential for Querco-Betuletum in relation to the other associations. There were 8 species (Group 7) differential for Querco-Betuletum and Violo-Quercetum typicum in relation to Dicrano-Quercetum: *Mnium hornum*, *Dicranum scoparium*, *Tetraphis pellucida*, *Orthodontium lineare*, *Cladonia glauca*, *C. digitata*, *Polytrichum formosum*, *Plagiothecium curvifolium*, and *Campylopus flexuosus*. Differential species for Querco-Betuletum, and Violo-Quercetum typicum et ilicetosum in relation to Dicrano-Quercetum are *Brachythecium rutabulum*, *Isothecium myosuroides*, *Lepidozia reptans*, and *Isopterygium seligeri*.

The plots were scrubby woods, coppices, high woods, or former coppices transformed into high woods. In scrubby woods and coppices, the tree layer was not very high, and the shrub layer was poor or undeveloped. Usually the shrub layer could not be distinguished as a separate layer. In high woods, the tree layer was higher and more distinctly separated from the shrub layer, which was better developed. The herb layer was nearly always well developed, being predominated by *Deschampsia flexuosa*, *Molinia caerulea*, *Corydalis claviculata* and *Vaccinium myrtillus*, the last of which sometimes covered up to 65 %.

3.2.2 Violo-Quercetum

Violo-Quercetum Oberd. 1957.
Synonyms:
Querceto sessiliflorae-Betuletum violetosum rivinianae Tx. et Diem. in Tx. 1937. This name is not validly published according to the Code of Nomenclature (Barkman et al., 1976).
Fago-Quercetum petraeae (Tx. 1937) Tx. 1955 p.p.
Maianthemo-Quercetum Bakker 1969.

This association can be considered as a variant of Fago-Quercetum petraeae in the low-lying plains, dominated by *Quercus robur*, and not *Q. petraea* (Van den Broek & Diemont, 1966). Here I consider this community as an association, the correct name is Violo-Quercetum. Tüxen (1937), however,

A Violo-Quercetum typicum vegetation, plot 20, Mantingerbos.

Oxalis acetosella, differential species of the Violo-Quercetum typicum.

considered it as a subassociation; the name according to the Code is then Fago-Quercetum petraeae violetosum rivinianae (Tx. & Diem. in Tx. 1937) comb. nov.

In the Netherlands Doing (1962) distinguished at least 3 vicarious associations, Solidagino-Quercetum (= Fago-Quercetum petraeae (Tx. 1937) Tx. 1955 p.p.) on acid undisturbed loam soils, in the south of the Netherlands; Violo-Quercetum roboris on acid but not very poor sandy soils; Convallario-Quercetum roboris on sandy soils in the inner area of the coastal dunes; and possibly a fourth association of woods with *Corydalis claviculata* and *Ilex aquifolium* on soils with a loamy subsoil in the north-east of the Netherlands. The woods I investigated belong to this association. Because of the slight differences, Bakker (1969) combined these 3 associations as Maianthemo-Quercetum and distinguished 2 subassociations, anemonetosum et typicum. The woods I investigated belong to the subassociation typicum.

I found only a few of the character and differential species mentioned in literature (e.g. Tüxen, 1937; Oberdorfer, 1957; Oberdorfer et al., 1967; Westhoff & Den Held, 1969). Westhoff & Den Held mentioned *Quercus petraea*, *Hieracium sabaudum*, *Luzula luzuloides*, and *L. sylvatica*, but they do not occur in the Drenthian District; *Rubus saxatilis* occurred only near Ter Apel; *Solidago virgaurea* did not occur in the woods I investigated. *Lathyrus montanus* was found mainly on the Hondsrug and the Havelterberg. *Malus sylvestris* was found in the wood Mantingerbos. *Populus tremula* is abundant in the wood Thijnsbos, where also *Polygonatum verticillatum* used to occur, but recently disappeared. These 3 species did not occur in my plots. I did find *Populus tremula*, though it was rare, in 2 plots of Querco-Betuletum. *Hieracium lachenalii* did not occur. *Ilex aquifolium* is a character species of the tree and shrub layer; in the herb layer this species occurred as often in Violo-Quercetum typicum as in Querco-Betuletum.

Westhoff & Den Held listed many differential species for Violo-Quercetum in relation to Querco-Betuletum. Some did not occur or only rarely in Violo-Quercetum and then only in aberrant disturbed plots: *Scrophularia nodosa*, *Narcissus pseudonarcissus*, *Sambucus racemosa*, and *Selinum carvifolium*. *Mespilus germanica* and *Hypericum pulchrum* were found mainly in Solidagino-Quercetum in the south of the Province of Limburg. *Stellaria nemorum* ssp. *glochidisperma* occurs in Drenthe only in the wood Norgerholt, mainly in Stellario-Carpinetum. All these species and *Viola riviniana* were not found in the plots. The other species Westhoff & Den Held mentioned were: *Anthoxantum odoratum*, *Polygonatum multiflorum*, *Luzula pilosa*, *Atrichum undulatum*, *Hedera helix*, *Oxalis acetosella*, *Convallaria majalis*, *Stellaria holostea*, *Corylus avellana* and *Prunus serotina*. In my survey, *Anthoxantum odoratum* occurred only once, in a Querco-Betuletum at a slightly disturbed site; so it cannot be considered differential. *Oxalis acetosella*, *Hedera helix*, *Convallaria majalis* and *Corylus avellana* were distinctly differential for Violo-Quercetum typicum et ilicetosum in relation to Querco-Betuletum and

Dicrano-Quercetum. *Stellaria holostea* is differential for Violo-Quercetum typicum in relation to Querco-Betuletum, Dicrano-Quercetum and Violo-Quercetum ilicetosum, together with *Trientalis europaea*, *Maianthemum bifolium* (character species for Quercion robori-petraeae, according to Westhoff & Den Held), and *Pteridium aquilinum*. *Luzula pilosa*, *Atrichum undulatum* and *Polygonatum multiflorum* proved not differential for Violo-Quercetum in relation to Querco-Betuletum. These species and some others (Table 2 and Appendix Table C3, Group 9) were differential for Violo-Quercetum typicum et ilicetosum and Querco-Betuletum in relation to Dicrano-Quercetum. *Prunus serotina* was at most weakly differential for Violo-Quercetum typicum and Querco-Betuletum in relation to Dicrano-Quercetum and Violo-Quercetum ilicetosum.

Of the mosses growing on dead wood, *Campylopus fragilis* was differential for Violo-Quercetum typicum in relation to other (sub)associations. *Dicranella heteromalla*, *Eurhynchium praelongum*, and *Plagiothecium latebricola* were differential for Violo-Quercetum typicum et ilicetosum in relation to Dicrano-Quercetum and Querco-Betuletum. Eight species were differential for Violo-Quercetum typicum and Querco-Betuletum: *Mnium hornum*, *Dicranum scoparium*, *Tetraphis pellucida*, *Orthodontium lineare*, *Cladonia glauca*, *C. digitata*, *Polytrichum formosum*, *Plagiothecium curvifolium*, and *Campylopus flexuosus*. Differential for Violo-Quercetum typicum et ilicetosum and Querco-Betuletum in relation to Dicrano-Quercetum were *Brachythecium rutabulum*, *Isothecium myosuroides*, *Lepidozia reptans* and *Isopterygium seligeri*.

In this association, there were coppices and high woods, as in Querco-Betuletum. In the coppices, the shrub layer was absent or very scanty. In the high woods, the shrub layer was more developed (cover 15-20 %) than in the high woods of Querco-Betuletum. The tree layer of Violo-Quercetum typicum did not differ greatly from that of Querco-Betuletum. The composition of the herb layer differed most from that of Querco-Betuletum. Herbs that determined appearance in Querco-Betuletum occurred in Violo-Quercetum too, but only in sparse cover. The appearance of the herb layer in Violo-Quercetum typicum was determined by *Pteridium aquilinum*, *Maianthemum bifolium*, *Trientalis europaea*, *Oxalis acetosella*, terrestrial *Hedera helix*, *Stellaria holostea* and *Convallaria majalis*.

3.2.3 Violo-Quercetum ilicetosum

Violo-Quercetum ilicetosum subass. nov.
type: Relevé 23 (Table 1), Norgerholt, Norg, Province of Drenthe, Netherlands.
non Querceto-Ilicetum Tx. 1930.

Querceto-Ilicetum Tx. 1930 is a completely different association. Besides *Maianthemum bifolium* and *Ilex aquifolium* as character and differential spe-

A Violo-Quercetum ilicetosum vegetation, plot 24, Mantingerbos.

Ilex aquifolium, differential species of the Violo-Quercetum ilicetosum.

cies, it has *Teucrium scorodonium, Thelypteris dryopteris, Luzula luzuloides* and *Solidago virgaurea*. Herb and shrub layers are much more developed than those of Violo-Quercetum ilicetosum, and contain species such as *Carpinus betulus, Crataegus* spec., *Prunus spinosa, Athyrium filix-femina, Circaea lutetiana*.

The only differential species for Violo-Quercetum ilicetosum in relation to Violo-Quercetum typicum was *Ilex aquifolium* in the tree and shrub layer. Spontaneous growth of young Ilex shrub was observed in some Violo-Quercetum typicum, apparently not leading to dominance in tree or shrub layer. *Isopterygium seligeri* in Violo-Quercetum ilicetosum was called characteristic by Westhoff & Den Held (1969), but did not differ from that in Violo-Quercetum typicum and Querco-Betuletum either on the ground or on dead stumps. Violo-Quercetum ilicetosum and Violo-Quercetum typicum had 9 differential species in relation to Querco-Betuletum: *Oxalis acetosella, Hedera helix, Convallaria majalis, Corylus avellana, Maianthemum bifolium, Trientalis europaea, Stellaria holostea, Pteridium aquilinum, and Ilex aquifolium.* There were no differential species for Violo-Quercetum ilicetosum and Querco-Betuletum in relation to Violo-Quercetum typicum.

Ilex aquifolium occurred as a nearly closed low-tree layer or high-shrub layer. A herb layer was almost absent; the mean cover was 7.5 % (in Violo-Quercetum typicum 50 %). In open spaces and at the edge of woods, the herb layer was similar to that of Violo-Quercetum typicum. This reason and the numbers of differential species merit classification as a Violo-Quercetum, ranking as a subassociation.

The almost complete absence of a herb layer was probably due to the dense shade from the evergreen *Ilex* trees. The *Ilex* community probably originated from Violo-Quercetum typicum by spontaneous growth.

Violo-Quercetum ilicetosum is perhaps restricted to the Drenthian District (Barkman & Westhoff, 1969) and is rather rare even there.

The plots were all high woods with large old oak trees.

3.2.4 Dicrano-Quercetum

Dicrano-Quercetum Pass. 1962 emend. Barkm. nom. non rite publ.
Synonyms:
Querco-Betuletum Tx. 1930 p.p.
Vaccinio-Quercetum cladonietosum Doing 1962.
Classification:
According to Barkman (1974a) and Vreugdenhil & Barkman (1974), Dicrano-Quercetum in the Netherlands can be divided into two subassociations: plagiothecietosum Barkm. 1974 (with two variants) and polypodietosum Barkm. 1974. Dicrano-Quercetum Pass. is so poor in species that it cannot be allocated to either of these subassociations.

In a study on Dicrano-Quercetum, Vreugdenhil & Barkman surveyed 42 plots

A Dicrano-Quercetum vegetation, plot 1, Dwingeloo.

Leucobryum glaucum, differential species of the Dicrano-Quercetum and the Querco-Betuletum, plot 1.

in the Province of Drenthe, and 11 in the inner coastal dunes near Alkmaar (Province of North Holland). These 53 plots were compared with related associations, mostly rather poor Querco-Betuletum that had been described in the literature. They found many differential species, mostly mosses, for Dicrano-Quercetum in relation to Querco-Betuletum. I compared Vreugdenhil & Barkman's 42 relevés from Drenthe with my relevés of Querco-Betuletum and Violo-Quercetum typicum et ilicetosum (Table 2). There were 14 distinctly differential species for Dicrano-Quercetum in relation to Querco-Betuletum: *Dicranum scoparium, Pohlia nutans, Lecidea granulosa, Cladonia pyxidata, Parmelia physodes, Cladonia glauca, Dicranum polysetum, Pleurozium schreberi, Cephaloziella divaricata, Cladonia impexa, Calluna vulgaris, Cephalozia bicuspidata, Cladonia furcata, Cladonia macilenta*. There were also 14 weakly differential species: *Lophocolea heterophylla, Campylopus fragilis, Aulacomnium androgynum, Dicranoweisia cirrhata, Festuca ovina, Empetrum nigrum, Cladonia uncialis, Orthodicranum montaum, Agrostis canina, Dicranum fuscescens, Ptilidium ciliare, Cornicularia aculeata, Cladonia floerkeana* and *Cetraria glauca*. All these mosses and lichens were terricolous. Some occur sometimes in Querco-Betuletum and Violo-Quercetum, but then always on bark or dead wood. In relevés of mosses on dead wood, no species were differential for Dicrano-Quercetum in relation to the other associations.

I studied only 3 plots of Dicrano-Quercetum. The synoptic table of Dicrano-Quercetum was not based on these 3 relevés, but on the 42 made in Drenthe by Vreugdenhil & Barkman. My 3 relevés belong to subassociation plagiothecietosum; Relevés 1 and 2 fall under the variant of *Cetraria glauca*, Relevé 3 under the variant of *Tetraphis pellucida*.

The vegetation was scrubby wood or sometimes coppice. The tree layer was always very low, 0.5-8(-15) m high, without a shrub layer. The herb layer was always sparse, cover 1-12 % consisting of *Calluna vulgaris, Festuca ovina, Deschampsia flexuosa* and less often of *Empetrum nigrum* and *Carex pilulifera*. So this herb layer lacks species characteristic of Querco-Betuletum and Violo-Quercetum, and some species occur that are typical of very dry heaths and inland drift sands. The moss layer was characteristic of the Dicrano-Quercetum. It occurred in patches with a mean cover of 70 %. In Drenthe, *Dicranum scoparium* dominated in moss layer.

3.3 AFFINITIES OF THE ASSOCIATIONS

Affinities (Table 3) and differences (Fig. 1) show that Querco-Betuletum is closest related to Violo-Quercetum typicum. Next follows Violo-Quercetum typicum with Violo-Quercetum ilicetosum. The affinity of Querco-Betuletum with Violo-Quercetum ilicetosum was third highest.

The highest affinity could have been expected between the two subassociations of Violo-Quercetum. By affinity only, Violo-Quercetum ilicetosum should be regarded as an association and not as a subassociation. However,

Table 3. Affinities of associations, A_C, A_P and A_T (defined in Section 3.1.2), based on higher plants, mosses and lichens.

	A_C	A_P	A_T
DQ -QB	0.89	0.62	0.52
DQ -VQt	0.67	0.71	0.46
DQ -VQi	0.52	0.32	0.25
QB -VQt	3.11	3.29	1.29
QB -VQi	1.78	1.71	0.55
VQt-VQi	2.71	2.01	0.62

Violo-Quercetum had only one differential species, and the calculations were based on few records and a small area. So I consider it as a subassociation. Querco-Betuletum and Violo-Quercetum typicum had the highest affinity but also many differential species. So I consider them as independent but closely related associations.

The affinities with Dicrano-Quercetum were much lower as expected, since there are many differential species between Dicrano-Quercetum and the other associations. Querco-Betuletum and Violo-Quercetum (with its two subassociations) can be allocated by affinity to one alliance. The low affinity of Dicrano-Quercetum with Quercion robori-petraeae strongly support the proposal of Barkman (1974) to exclude Dicrano-Quercetum from Quercion robori-petraeae.

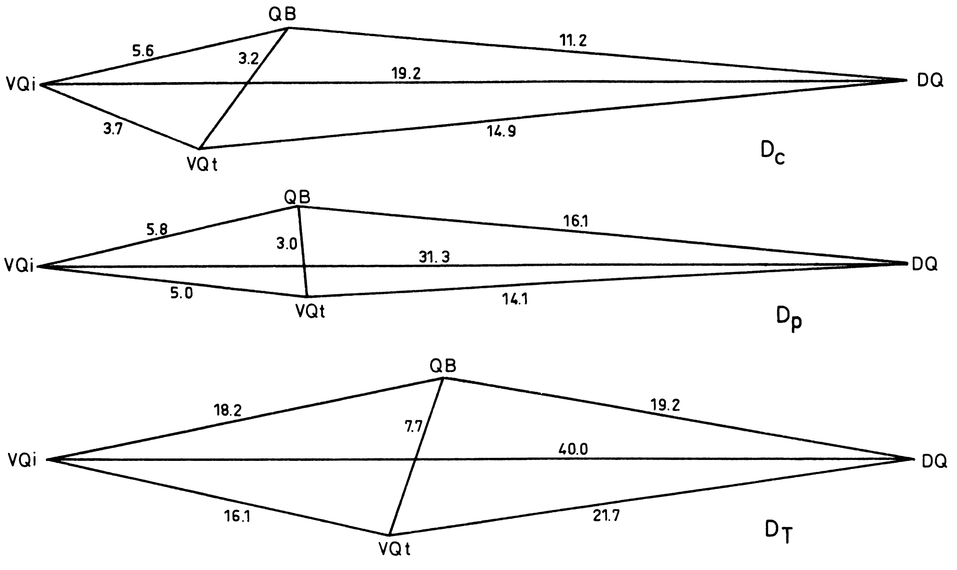

Figure 1. Differences between the vegetation types, $\underline{D}_c$, $\underline{D}_p$, and $\underline{D}_T$ (defined in Section 3.1.2), based on higher plants, mosses and lichens. The lines represent values of $\underline{D}$.

3.4 ASSIGNMENT TO HIGHER SYNTAXA

Generally the Querco-Betuletum and the Violo-Quercetum have been grouped in the alliance Quercion robori-petraeae (Malcuit 1929) Br.-Bl. 1932, in the order Quercetalia robori-petraeae Tx. 1931, and the class Quercetea robori-petraeae Br.-Bl. & Tx. 1934.

Scamoni & Passarge (1959), Doing (1962; 1963) and Passarge & Hofmann (1968) did not agree with this classification. Doing considered that the Quercetalia robori-petraeae belonged to the class Querco-Piceetea Doing 1962, together with Betulo-Vaccinietalia uliginosi and Vaccinio-Piceetalia. Passarge & Hofmann used their own classification, considering Molinio-Quercion Scam. & Pass. 1959, Agrostido-Quercion Scam. & Pass. 1959, and Melampyro-Quercion Pass. & Hofm. 1968 together as synonymous with Quercion robori-petraeae. They classed Molinio-Quercion in the order Molinio-Quercetalia Pass. & Hofm. 1968; both other alliances were classed in the order Melampyro-Quercetalia robori-petraeae Pass. & Hofm. 1968. The 2 orders were combined into the class Deschampsio-Quercetea robori-petraeae Br.-Bl. & Tx. 1943 em. Pass. & Hofm. 1968, together with Dicrano-Quercetalia robori-petraeae Pass. & Hofm. 1968.

Dicrano-Quercetum was assigned by Passarge & Hofmann to the alliance Dicrano-Quercion Pass. 1963 in the order Dicrano-Quercetalia robori-petraeae, and class Deschampsio-Quercetea robori-petraeae. Barkman (1974a) proposed to combine Dicrano-Quercetum with Dicrano-Juniperetum and Leucobryo-Pinetum in alliance Dicrano-Pinion.

The status of Dicrano-Pinion (Libbert 1933) Matuszkiewicz 1962 is rather uncertain. Scamoni & Passarge (1959), Doing Kraft & Westhoff (1959), and Doing (1962) assigned Vaccinio-Piceetalia, the order to which the Dicrano-Pinion should belong, and Quercetalia robori-petraeae to the class Betulo-Pinetea Prsg. & Knapp 1942, or to the class Querco-Piceetea Doing Kraft & Westhoff 1959. This was rejected by Matuszkiewisz (1962) and Westhoff & Den Held (1969). Tüxen (1955) and Oberdorfer et al. (1967) did not recognize Dicrano-Pinion.

In this study, many species were found to differentiate Dicrano-Quercetum from Querco-Betuletum and Violo-Quercetum: 28 for Dicrano-Quercetum with respect to Querco-Betuletum and Violo-Quercetum, and 30 for Querco-Betuletum and Violo-Quercetum in relation to Dicrano-Quercetum. These numbers of differential species justify separation from Quercion robori-petraeae. The species of Group 9 (Table 2 and Appendix Table C) are differential species of Quercion robori-petraeae in relation to Dicrano-Quercetum.

4 Fungal associations

4.1 INTRODUCTION

Fungal species are much more seasonal than green plants. Those to be seen in late summer differ from those of early autumn and even more from those of late autumn. Fructification also differs from year to year. These differences within and between years depend on weather, especially rain, humidity, and temperature of air and soil (Barkman, 1976; Thoen, 1976), on the weather of preceding periods, and possibly on other, unknown factors.

4.2 METHODS

4.2.1 Records and tables

To describe the fungus vegetation of a plot, one must make several records each year for several years. It was planned to make 2 or 3 records for each fructification season (late summer and autumn) in each plot for 4 years. This aim was not always achieved, partly because the frequency records and sometimes the identification of fungi were time-consuming, partly because of fluctuations in fructification. For instance in 1976, fructification did not start until the beginning of October.

I did not visit the plots much at other times. In winter, spring, and early summer, there were few fungi to be seen, mostly old specimens from the preceding autumn. However, these observations on fungi were noted for the tables.

In a record, density (abundance per 1000 m^2) was based on a count or estimate of the number of fruiting bodies of each fungus (abundance relevé). Counting is more accurate but more time-consuming. So a combination was used. For plots of 1000 m^2, abundance was noted in the following scale (according to Barkman (1976), slightly modified), with geometric mean number of fruiting bodies of that class, i.e. $(x_1 \cdot x_2)^{\frac{1}{2}}$, in which x_1 and x_2 are the minimum and the maximum values of that class, in parenthesis.

r (rare)	1 or 2	(1.4)
o (occasional)	3 - 9	(5)
f (frequent)	10 - 29	(17)
vf (very frequent)	30 - 99	(54)
a (abundant)	100 - 500	(223)
va (very abundant)	> 500	

In plots that were larger or smaller than 1000 m^2, values were adjusted.

Species with numerous small fruiting bodies growing in clusters were not counted individually. The number of clusters was then noted instead. This never applied to Agaricales, only to fungi growing clustered on wood or an other limited substrate, such as the genera *Hymenoscyphus*, *Cudoniella*, *Sphaerobolus*, *Onygena* and *Ciboria*, and to fungi growing on wood without separate fruiting bodies such as *Stereum*, *Phlebia*, *Merulius* and *Exidia*.

An abundance table was made of each plot where the species and the abundance were given of each record (i.e. observation date). Data were also included of earlier records from the plots by J.J. Barkman and by P. Ypelaar. From these tables, it was easy to read off a maximum abundance of carpophores (MAC) of a species for a year, and an aggregate maximum abundance of carpophores (AMAC), the highest value for that species (Barkman, 1976). It was also easy to read off the number of years in which a species was found and so to calculate an annual frequency (a frequency in time) (AF) (Barkman, 1976). (Appendix Table D). The separate tables for each plot and each observation date are available in a report from the Biological Station, Wijster, NL (Jansen, 1981).

In 17 plots, occurrence or spatial frequency (SF) was calculated. These composite plots were divided into 35-42 subplots of 25 m^2, according to size of the plots (875-1050 m^2). Spatial frequency was calculated as the proportion (number fraction) of subplots where the species was found at one time.

The 17 composite plots were spread over the associations: 2 in Dicrano-Quercetum, 5 in Querco-Betuletum, 7 in Violo-Quercetum typicum and 3 in Violo-Quercetum ilicetosum. The records of such plots were time-consuming; in total, there were 6 in Dicrano-Quercetum (i.e. 3 per plot), 19 in Querco-Betuletum (3.8 per plot), 23 in Violo-Quercetum typicum (3.3 per plot), and 10 in Violo-Quercetum ilicetosum (3.3 per plot), in late summer or autumn of 1976 (12), of 1977 (28), and of 1978 (18).

As the subplots were fixed (with pegs) and numbered, all records of a composite plot could be combined into one cumulative frequency record. Cumulative spatial frequency of a species (CSF) could thus be expressed as proportion (number fraction) of subplots in which the species was found during the 3 years (Appendix Table D).

In a frequency record, the number of fruiting bodies was counted (if 1-3) or estimated (if more) in each subplot. So the abundance of the species was estimated too, and included in the abundance table of that plot.

Some characteristics were calculated for each (sub)association (Table 4): the presence, P; the mean aggregate maximum abundance of carpophores, GAMAC (Barkman, 1976); the mean annual frequency, MAF (Barkman, 1976); and the mean cumulative spatial frequency, MCSF.

To calculate a mean, the aggregate maximum abundance and the frequency in time were calculated over all plots and the cumulative spatial frequency over all composite plots, including the plots where the species were not found.

Presence was calculated as for higher plants, representing the number fraction of plots where a species was found, and was expressed in a scale of Roman numerals I - X. In calculating mean aggregate maximum abundance, GAMAC, the AMAC values were reconverted into number of fruiting bodies using the geometric mean of the abundance classes. GAMAC represents the average maximum density of fruiting bodies.

For Dicrano-Quercetum, the general data were based on 11 plots: Plots 1, 2 and 3 of this survey and 8 plots investigated by P. Ypelaar. For the other (sub)associations, the data were based on my plots, including earlier observations by J.J. Barkman on presence of the species.

The values of P, GAMAC, and MCSF (Table 4) were used to assess the ecological and sociological optimum of species. Species with one optimum or several optima were faithful (character) species and differential species, respectively. Deciding whether a species had an optimum in one association (or alliance etc.) only, was only possible if all plant communities of a region were investigated. For fungi, we are still far from this state of knowledge in any region. This study only permits distinction of differential species for a certain subassociation, association, or alliance within the group of acid oakwoods. This does not exclude the possibility, however, that some of the differential species may turn out later to be character species.

A species was considered presumably differential if it was differential in one characteristic, and was considered differential if it was differential in two characteristics and the other characteristic does not contradict it. The main differential characteristic was the P value. A species was considered differential if P was IV, V, or VI and at least 4 classes lower in every other vegetation, if P was VII, VIII, or IX and at least 5 classes lower in every other vegetation, or if P was X and at least 6 classes lower in every other vegetation.

The second differential characteristic was GAMAC. A species was considered differential if GAMAC was at least 2 classes lower in every other vegetation. The classification of abundance values (Section 4.2.1) was used; 0.1-0.9 was added as a separate class.

The third differential characteristic was MCSF, which was less distinctive than P or GAMAC, because it was based on only a few plots and was not measured in all species. A species was considered differential if MCSF was at least 2 classes lower in every other association. The following classification was used: 0.1-0.9, 1-9, 10-25, 26-60, 61-100.

The presence of the differential species in other associations was also studied in the literature, to ascertain the ecological range. Literature was studied on acid oak and beech woods (Quercion robori-petraeae), on richer oak and beech woods (Querco-Carpinetum, Luzulo-Fagetum, Melico-Fagetum) and on poor acid coniferous woods or scrubs (Vaccinio-Piceetalia).

Table 4. Synoptical table of fungi. The first column gives Presence, the proportion of plots where the species was found, on a scale of Roman numerals I-X. The second column gives mean aggregate maximum abundance, the mean maximum number of fruiting bodies in a plot (adjusted to 1000 m^2). The third column gives mean annual frequency, the frequency in time in mean proportion of years. The fourth column gives mean cumulative spatial frequency, the mean proportion of the plot area where fruiting bodies were observed. Species found only once are listed separately in Notes to Appendix D. The species of Quercion robori-petraeae are grouped by preference for the different associations (a-g).

		Dicrano-Quercetum				Querco-Betuletum				Violo-Quercetum typicum				Violo-Quercetum ilicetosum			
Total number of records		34				72				99				68			
Total number of frequency records		6				19				23				10			
Total number of plots		11				8				10				8			
Number of frequency plots		2				5				7				3			
Total number of taxa		179				187				175				136			
Mean number of taxa per plot		106.3				76.5				66.9				54.4			
		P	GAMAC	MAF	MCSF	P	GAMAC	MAF	MCSF	P	GAMAC	MAF	MCSF	P	GAMAC	MAF	MCSF
Column No.		1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
1. Species of Dicrano-Quercetum																	
cDQ	*Cordyceps ophioglossoides*	X	190	83	22	II	0.4	6	0.6								
DQ	*Russula fragilis*	X	94	91	29	III	2	13	7								
DQ	*Amanita fulva*	X	79	92	47	III	5	19	10								
cDQ	*Cantharellus cibarius*	X	6	61	8												
DQ	*Cortinarius paleaceus*	IX	22	50	13	II	0.1	6	1								
DQ	*Marasminus androsaceus*	IX	186	89	37	V	9	32	17	IV	2	17	1				
DQ	*Lactarius chrysorheus*	VIII	72	65	27	III	2	13	7								
DQ	*Inocybe ovatocystis*	VIII	13	57	10												
cDQ	*Cordyceps canadensis*	VIII	6	61	8	II	1	3	0.6								
DQ	*Cortinarius obtusus*	VII	8	53	2												
DQ	*Cortinarius fusisporus*	VII	4	52	6	II	0.2	3	0.2								
DQ	*Leotia lubrica*	VII	4	39	2												
DQ	*Dermocybe cinnamomeolutea*	VII	2	50	2												
DQ	*Thelephora terrestris*	VI	1	42	7												
DQ	*Boletus erythropus*	VI	1	29													
DQ	*Cortinarius glandicolor*	V	1	39	0.5												
cDQ	*Psathyrella fulvesc.var.dicrani*	IV	2	24	6												
DQ	*Tricholoma portentosum*	IV	1	14													
DQ	*Inocybe napipes*	VI	8	50	13	IV	0.8	18	1	III	0.4	10	1				
DQ	*Russula adusta*	IV	0.7	17	0.5												
DQ	*Entoloma turbidum*	IV	0.7	12	0.5												

Table 4. Continued.

		Dicrano-Quercetum				Querco-Betuletum				Violo-Quercetum typicum				Violo-Quercetum ilicetosum			
DQ	*Cortinarius bolaris*	IV	0.7	17													
cDQ	*Hydnellum scrobiculatum*	IV	0.5	14													
cDQ	*Inocybe sambucina*	IV	0.4	17	1												
DQ	*Boletus edulis*	IV	0.5	14													
DQ	*Cortinarius alboviolaceus*	III	4	17													
DQ	*Cortinarius* cf. *stemmatus*	II	2	9	15												
cDQ	*Sarcodon scabrosus*	III	0.6	15													
cDQ	*Hydnellum spongiosipes*	III	0.3	15	0.5												
pDQ	*Russula cyanoxantha*	IV	1	27	1	II	0.1	3									
pDQ	*Inocybe xanthomelas*	III	2	12	8	II	0.1	3	0.2								
pDQ	*Hebeloma pumilum*	III	1	8	2	II	0.1	6	0.6								
pDQ	*Tricholoma columbetta*	III	0.6	15	1												
pDQ	*Tricholoma virgatum*	III	0.6	12													
	Russula vesca	IV	0.7	26		II											
	Psathyrella cernua	II	0.3	14	3												
	Tricholoma saponaceum	II	0.5	4													
	Sarcodon joeides	II	0.2	3													
	Amanita muscaria	II	0.2	6													
	Inocybe boltonii	II	0.2	6													
	Hydnellum concrescens	II	0.2	6													
	Phellodon melaleucus	II	0.2	6													
	Clitocybe inornata	I	0.5	3													
	Cortinarius albofimbriatus	I	0.1	3													
	Cortinarius decipiens s.Lge	I	0.4	3													
	Cortinarius porphyropus	I	0.1	3													
	Cortinarius mucifluus	I	0.1	3													
	Inocybe lacera	I	0.1	6	1												
	Entoloma cetratum	I	0.2	3	3												
2. Species of Quercion robori-petraeae																	
a. with a preference for Querco-Betuletum																	
Qrp	*Polyporus brumalis*	I	0.1	1		X	4	49	8	V	1	17	2	V	2	20	
Qrp	*Stereum hirsutum*	II	0.2	14		IX	5	50	21	IX	2	50	8	VIII	2	45	7
Qrp	*Tephrocybe tylicolor*	III	2	8	5	IX	26	46	9	VIII	10	24	2	III	3	9	1
Qrp	*Chondrostereum purpureum*	I				VII	2	26	6	III	0.6	8	1	V	1	17	2
Qrp	*Psathyrella hydrophila*	III	0.6	15	0.5	VII	53	35	6	VI	14	22	2	III	14	16	1
pQ	*Clitocybe diatreta*	I	2	1		VII	4	26	4	III	3	13	3				
pQ	*Mycena mucor*					III	9	6	2	I	6	3	2	II			
pQ	*Galerina sahleri*					II	6	3	6	I	0.6	3	0.4				
b. with a preference for Violo-Quercetum																	
Qrp	*Mycena sepia*					V	2	18	3	VIII	5	35	8	VIII	10	29	14

Table 4. Continued.

		Dicrano-Quercetum				Querco-Betuletum				Violo-Quercetum typicum				Violo-Quercetum ilicetosum			
Qrp	*Cudoniella acicularis*	I	0.6	1	9	V	3	39	16	VIII	4	53	18	X	6	53	35
c. with a preference for Violo-Quercetum typicum																	
Qrp	*Oudemansiella platyphylla*	IV	0.5	24	1	X	16	77	19	X	34	88	42	X	22	80	26
Qrp	*Mycena stylobates*					VIII	22	49	24	IX	35	42	28	II	0.3	6	1
Qrp	*Collybia cookei*	II	2	5	3	IX	69	44	16	VII	160	40	26	III	16	9	6
Qrp	*Marasmiellus ramealis*					V	22	31	10	VI	37	36	15	II	3	6	1
Qrp	*Psilocybe crobula*					III	0.3	5	1	V	4	17	4	IV	1	16	2
d. with a preference for Violo-Quercetum ilicetosum																	
Qrp	*Mycena haematopus*					VII	21	34	19	IV	13	20	10	VII	46	35	34
Qrp	*Mycena vitilis*	IV	4	17	32	X	56	94	75	X	56	80	67	X	130	83	80
Qrp	*Kuehneromyces mutabilis*					III	19	13	2	II	10	10	1	IV	45	19	1
Qrp	*Hohenbuehelia atrocaerulea*					III	11	9	2	II	2	8	1	IV	21	13	1
pQ	*Clitopilus hobsonii*					II	0.8	3		I	2	3	0.4	III	8	6	1
pQ	*Piptoporus betulinus*					III	0.5	13	0.8	II	1	13	1	IV	9	25	2
pQ	*Pleurotus ostreatus*					II	0.4	4	1	II	0.2	3	0.4	V	1	9	1
e. with a preference for Querco-Betuletum and Violo-Quercetum ilicetosum																	
Qrp	*Xylaria hypoxylon*					X	3	64	11	IV	0.6	12	1	X	7	53	19
Qrp	*Bjerkandera adusta*	I	0.1	9		VII	5	40	7	II	0.6	7	0.4	X	3	28	2
Qrp	*Panellus serotinus*	II	0.2	3		V	57	21	11	III	9	12	2	IX	37	42	7
	Xylaria polymorpha					III	1	7						II	1	4	
	Gymnopilus spectabilis					II	1	4						II	2	6	
	Crepidotus haustellaris					II	0.2	3	0.6					II	0.1	3	1
	Coprinus tuberosus					II	0.2	3	0.4					II	0.8	3	1
	Clavulina cristata					II								II	0.1	3	0.3
	Calocera viscosa					II								II	0.1	8	
f. with a preference for Querco-Betuletum and Violo-Quercetum typicum																	
pQ	*Rickenella fibula*					IV	4	21	5	V	3	15	3				
Qrp	*Clitocybe metachroa*	II	23	5	25	X	83	75	44	X	62	58	51	V	8	20	17
pQ	*Mycena pura*					V	2	20	2	IV	3	23	3				
pQ	*Galerina hypnorum*	I	0.1	2	1	V	2	14	3	III	7	9	8				
	Clitocybe phyllophila	I	0.2	1	1	IV	4	17	2	IV	8	18	5				
	Coprinus pellucidus					II	4	6	0.6	I	1	2	0.4				
	Mycena capillaris					III	1	6	2	I	1	2	1				
	Cortinarius cf. *punctatus*					III	2	6	0.4	I	1	3					
	Bulgaria inquinans					II	1	3		I	0.1	2	1				
	Marasmiellus vaillantii					II	0.1	3		I	0.5	3	0.4				

Table 4. Continued.

		Dicrano-Quercetum				Querco-Betuletum				Violo-Quercetum typicum				Violo-Quercetum ilicetosum			
	Steccherinum cf. *hydneum*					II	0.1	3	0.6	I	0.1	3					
	Pholiota tuberculosa					II	0.1	3	0.6	I	0.3	5	0.6				
	Mycena smithiana					II	0.5	3	0.6	I	0.6	2					
g. Indifferent species																	
Qrp	*Nectria sp.*	I	0.1	3	1	X	12	76	46	X	15	85	49	X	14	68	47
Qrp	*Rutstroemia firma*	I	0.1	1		VIII	4	27	7	IV	2	17	4	VII	12	24	8
Qrp	*Stereum rugosum*	I	0.2	1	3	V	2	24	9	VII	3	20	8	IX	4	42	13
Qrp	*Phallus impudicus*	I	1	6	10	V	14	34	25	X	5	71	7	IX	4	58	6
Qrp	*Galerina cinctula*	I	0.1	1	1	IV	2	9	4	VI	3	15	2	IV	1	13	4
Qrp	*Clitocybe fragrans*					VII	2	16	1	IV	4	9	7	II	6	3	2
Qrp	*Mycena epipterygia*					V	5	26	3	IV	1	13	3	III	2	9	1
pQ	*Hypholoma sublateritium*	IV	1	26		VII	15	44	12	VII	11	37	5	V	10	20	2
Qrp	*Pluteus salicinus*					IV	0.4	10	1	IV	0.6	12	2	IV	0.5	13	2
Qrp	*Tyromyces chioneus*					VII	2	16	3	II	2	4	0.7	V	1	30	2
Qrp	*Hapalopilus rutilans*					V	0.8	20	3	III	0.6	13	1	IV	1	16	2
pQ	*Merulius tremellosus*					V	0.4	24	2	II	0.5	4	0.7	III	1	9	2
pQ	*Crepidotus pubescens*					III	17	9	1	III	8	13	3	III	0.6	3	
pQ	*Inonotus radiatus*					III	3	9	0.6	II	0.4	5	0.4	IV	0.5	7	1
	Xerocomus chrysenteron					III	0.1	5		II	0.6	8	0.3	III	0.1	3	1
	Xerocomus subtomentosus					III	2	13	2	I	0.1	3	0.1	II	0.1	3	0.3
	Clitocybe umbilicata					II	2	6	2	I	0.3	3	1	II	0.4	3	1
	Tubaria furfuracea					II	0.8	3	0.2	II	0.7	6	1	II			
pQ	*Laccaria laccata*	I	1	1	1	IV	3	15	5	III	1	13	1	III	1	14	1
3. Species of Querco-Betuletum																	
QB	*Mycena rorida*	III	1	9	3	X	39	66	40	VI	2	25	6	IV	0.4	13	2
QB	*Hymenoscyphus epiphyllus*					V	2	16	4								
pQB	*Panellus stipticus*	II	1	11	1	V	35	26	3	II	8	5	1	III	3	7	
pQB	*Clitocybe brumalis*					III	3	7	1								
	Galerina triscopa					II	3	13	4								
	Cortinarius orellanoides					II	0.2	6	1								
	Galerina heterocystis					II	0.1	6	0.6								
4. Species of Violo-Quercetum																	
VQ	*Mycena inclinata*					II	6	9	0.6	V	42	26	8	VII	51	31	8
VQ	*Collybia fusipes*									IV	7	20	4	II	7	9	6
VQ	*Tyromyces caesius*	I	0.1	1		II	0.5	8		VI	4	28	3	VII	2	29	4
pVQ	*Galerina ampullaceocystis*	II	0.2	5	1	III	0.4	9	2	VII	2	23	6	IV	3	13	3
pVQ	*Stropharia aeruginosa*					III	0.5	13	1	V	2	19	1	V	2	23	1
	Entoloma euchrous									II	0.7	8	0.6	II	3	3	1
	Russula parazurea									II	0.4	5	0.4	II	0.3	3	1
	Inonotus dryadeus									I	0.1	3	0.1	III	0.3	7	0.3

Table 4. Continued.

		Dicrano-Quercetum				Querco-Betuletum				Violo-Quercetum typicum				Violo-Quercetum ilicetosum			
5. Species of Violo-Quercetum typicum																	
Vt	*Collybia peronata*	I	0.1	1	1	IV	3	18	3	IX	36	76	13	V	4	31	2
Vt	*Marasmius splachnoides*					II	18	9	4	VII	24	41	18	II	0.1	6	
Vt	*Marasmius epiphylloides*									III	74	20	12				
pVt	*Clitocybe flaccida*	I	0.1	1						III	6	20	3				
pVT	*Scleroderma verrucosum*									III	2	6	0.6				
	Resupinatus applicatus									II	3	5	0.4				
	Xerocomus parasiticus									II	2	5	1				
	Mycena pearsoniana									II	0.3	5	1				
	Laetiporus sulphureus									II	0.2	5	1				
6. Species of Violo-Quercetum ilicetosum																	
Vi	*Coprinus* section *Micacei*									I	0.1	2	0.4	VII	35	17	0.3
Vi	*Psathyrella frustulenta*													IV	7	22	2
Vi	*Ciboria batschiana*					IV	2	15	4	IV	4	11	7	VII	35	24	43
Vi	*Typhula erythropus*									I	0.8	2	1	III	61	16	28
Vi	*Typhula phacorrhiza*									I	0.7	2	0.7	III	65	9	15
Vi	*Polyporus varius*					II	0.3	6	0.6	I	0.4	5	0.1	V	3	26	2
pVi	*Mutinus caninus*					III	0.5	10		II	0.7	13	1	V	7	28	2
pVi	*Cortinarius tabularis*													III	1	7	0.3
	Phellinus ferreus	I		4										III	0.8	15	1
7. Species of Dicrano-Quercetum and Querco-Betuletum																	
a. with a preference for Dicrano-Quercetum																	
pDQ, QB	*Laccaria amethystina*	X	37	86	29	V	9	31	14	I	0.1	6	0.1	II	0.5	6	1
DQ, QB	*Galerina calyptrata*	VIII	73	76	38	V	2	15	3	I	0.1	6	0.4				
pDQ, QB	*Lactarius camphoratus*	VII	102	58	29	VII	6	35	4	I	0.2	3	0.4	II			
	Clitocybe clavipes	VI	3	41	1	III	4	19	9	I	0.2	3	0.3				
pDQ, pQB	*Amanita citrina*	III	3	26	20	IV	4	20	0.2	II	0.2	5	0.1				
	Laccaria proxima	X	21	83	29	VIII	6	46	12	VI	3	19	5	IV	1	13	7
	Entoloma rhodocylix	IV	1	23	4	III	0.2	9	2	I	0.3	3	0.4				
b. Indifferent species																	
	Cortinarius elatior	IV	0.4	18	1	III	0.3	6	0.6								
	Hebeloma longicaudum	IV	3	18	1	III	2	13	0.6								
	Clitocybe gilva	I	3	6		II	0.5	6	1								
	Clitocybe ditopa	III	0.5	6	4	II	1	3	1								
	Inocybe longicystis	II	0.5	6	0.5	II	0.4	9	0.4								
	Heterobasidion annosus	I	0.1	9		III	0.5	7	0.4								
	Collybia tuberosa	II	0.6	3	5	II	1	9	2								
	Lentinellus cochleatus	I	0.4	9		II	0.1	6									

Table 4. Continued.

	Dicrano-Quercetum				Querco-Betuletum				Violo-Quercetum typicum				Violo-Quercetum ilicetosum			
Galerina mniophila	I	0.1	1		II	1	6	1								
Tricholomopsis rutilans	I	0.4	1		II	0.1	4									
Polyporus ciliatus	I	0.5	9		II	0.1	3	0.4								
Hebeloma calyptrosporum	II	2	5	4	II	0.2	3	0.6								
8. Species of Dicrano-Quercetum, Querco-Betuletum and Violo-Quercetum typicum																
a. with a preference for Dicrano-Quercetum																
Russula emetica	VIII	46	62	22	V	1	17	4	V	1	14	2	II	0.1	3	
Cystoderma amianthinum	X	10	79	6	VII	2	24	2	IV	2	18	2	II	0.8	3	
b. with a preference for Dicrano-Quercetum and Querco-Betuletum																
Collybia cirrhata	IV	17	23	24	VII	19	18	9	V	2	19	3				
Xerocomus badius	VIII	8	76	27	V	9	21	3	IV	2	17	2				
Galerina atkinsoniana	VI	7	35	26	VII	3	24	9	III	0.5	18	1				
c. with a preference for Querco-Betuletum and Violo-Quercetum typicum																
Collybia butyracea	V	6	32	7	IX	18	52	17	X	31	69	31	III	0.4	9	3
Clitocybe candicans	III	1	12		VIII	4	33	4	IV	8	17	8				
d. with a preference for Dicrano-Quercetum and Violo-Quercetum typicum																
Lycoperdon foetidum	IV	1	15	2	II	1	9	6	III	1	8	0.5				
Lactarius turpis	III	0.3	18						III	2	15	2				
Collybia maculata	II	0.5	11	1					I	0.6	5					
Russula atropurpurea	I	0.1	1	0.5					II	0.2	2	0.1				
Pholiota alnicola	I	0.2	3	1					I	1	2					
e. Indifferent species																
Amanita rubescens	IX	4	73	13	VIII	2	35	3	VII	2	41	2	III	0.3	9	1
Scleroderma citrinum	X	190	95	21	X	58	78	26	VIII	33	41	18	III	0.8	7	1
Collybia dryophila	X	11	77	13	X	12	69	9	IX	6	43	7	III	0.3	6	2
Mycena cinerella	VII	15	36	5	IX	38	43	16	VIII	12	24	19	II	0.1	3	1
Cortinarius decipiens s.Henry	IV	3	24	0.5	VII	20	34	8	IV	5	15	2				
Crepidotus variabilis	I	0.1	1	0.5	III	3	13	2	III	2	17	2	II			
Tylopilus felleus	I	0.1	5	0.5	III	7	13	0.6	I	0.1	5	0.4				
Galerina pumila	I	0.2	1	3	II	1	9	2	I	0.1	3	0.4				
Pholiota lenta	II	0.5	12	1	III	1	17	0.2	II	0.4	10	0.7				
Fistulina hepatica	II	0.2	8	1	III	0.5	6	0.8	II	0.3	10	1	II			
Stropharia semiglobata	II	0.2	1		III	0.3	6	1	I	0.1	3	0.4				

Table 4. Continued.

	Dicrano-Quercetum				Querco-Betuletum				Violo-Quercetum typicum				Violo-Quercetum ilicetosum			
9. Accompanying species																
Hymenoscyphus fructigenus	IV	7	18	33	X	11	45	27	V	6	23	13	V	15	19	27
Coryne sarcoides	II	0.2	1		IV	1	20	8	IV	1	17	4	IX	2	30	7
Gymnopilus hybridus	VII	3	53	4	IX	8	54	3	V	7	30	4	IV	1	13	2
Coriolus versicolor	IV	0.5	17	1	IX	30	68	14	IV	6	19	2	IV	12	22	1
Mycena sanguinolenta	VII	18	47	19	X	129	79	80	X	52	77	47	VIII	7	42	39
Schizopora paradoxa	IV	0.7	18	6	VII	2	37	8	IX	6	42	13	X	6	53	38
Sphaerobolus stellatus	II	4	3	3	II	1	2	0.6	IV	7	9	2	V	40	28	13
Tyromyces lacteus	I	0.1	3	1	III	0.2	6	0.8	IV	1	12	1	III	0.3	7	1
Lactarius quietus	X	140	91	79	X	73	96	57	X	74	82	67	X	47	72	57
Paxillus involutus	X	70	94	78	X	20	61	24	X	29	57	15	X	5	47	7
Lactarius theiogalus	IX	158	85	62	IX	56	59	39	X	75	70	32	VIII	7	29	4
Clitocybe vibecina	IX	46	73	34	X	100	71	44	X	176	61	57	VII	25	29	16
Psathyrella squamosa	IV	5	31	26	X	10	72	14	IX	7	57	9	VII	4	28	10
Armillariella mellea	V	24	26	4	IX	50	44	24	VII	202	44	35	VII	8	25	12
Galerina decipiens	VII	37	52	67	X	28	75	57	IX	31	63	42	IX	5	43	8
Mycena polygramma	VI	2	39	4	IX	13	53	6	VIII	14	38	8	IV	0.4	13	3
Mycena galericulata	X	20	89	44	X	247	100	81	X	240	98	91	X	212	96	87
Mycena galopus	X	33	79	34	X	265	97	86	X	265	96	80	X	290	86	97
Hypholoma fasciculare	IX	42	81	44	X	142	92	46	IX	185	88	36	X	170	86	22
Pluteus cervinus	V	0.5	27	6	X	3	55	8	X	4	79	13	IX	1	49	5
Calocera cornea	VII	2	57	28	VIII	3	37	14	IX	2	47	11	X	3	46	17
Psathyrella fulvescens	IV	0.5	15	4	VIII	4	21	4	VIII	3	43	5	VII	3	31	5
Russula ochroleuca	VI	5	56	3	IX	6	66	5	VIII	5	46	8	VII	4	33	9
Exidia glandulosa	IV	0.5	24	3	VIII	3	27	8	VI	13	20	3	IV	0.6	9	3
Galerina allospora	III	1	9	9	V	2	18	6	VI	1	22	3	III	1	9	4
Coprinus velox	II	2	5	6	VIII	115	28	5	VI	20	20	3	V	4	10	1
Phlebia radiata	II	0.2	5		IV	0.4	18	2	VI	2	14	5	VII	2	19	5
Tephrocybe ambusta	III	0.6	15		IV	1	13	2	III	0.5	8	1	III	0.5	6	3
Lepista nuda	I	0.2	1		II	0.1	3		II	0.2	7		IV	2	13	5
Mycena speirea	II	0.2	6	1	III	1	5	3	III	1	7	2	II	0.1	3	0.3
Psathyrella spadiceogrisea	I	1	3	6	II	0.2	3	1	II	0.6	4	0.5	III	0.4	7	0.3
Mycena iodiolens	I	0.1	5		II	0.6	3	1	II	1	5	0.5	IV	4	9	2
Ganoderma applanatum	I	0.1	1	1	III	0.2	7						II	0.3	8	
Onygena corvina	I	0.1	1	1	III	0.2	6	0.4					II	0.1	3	0.3
Tremella mesenterica	II	0.2	12		II	0.1	3	0.4					III	0.3	3	
Russula nigricans	I	2	6	0.5	II				I	0.1	2					
Russula amoenolens	I	0.1	1	0.5									II	0.3	4	
Inocybe cookei	I	0.1	1	0.5									II	0.3	3	0.3

4.2.2 Increment to number of species with duration of study

Not all fungi were found every year, and each year new fungi were observed.

For each plot, the number of species after 1, 2 and 3 years was calculated as a fraction of the number of species observed in 4 years. The values were also calculated for each association (Fig. 2). Data from earlier research and the incomplete data from Plots 6, 7, 27 and 29 were omitted. In Dicrano-Quercetum, the increment was also calculated, using also the observations made by Ypelaar in 1972 and 1973.

With every year, the increment in the number of species became less, except in a year very rich in species. The increment in the fourth year ranged from 7 to 10 %, and was much less than in the third year of 10 to 24 %. In Dicrano-Quercetum, the increase continued to decrease in the fifth and sixth year, to 4 % in the fifth and 6 % in the sixth year. The sixth year was apparently a year rich in species in Dicrano-Quercetum. Barkman (1980) found an average increase of 13 % in the fourth year on plots in Dicrano-Juniperetum studied for 13 years. I found a smaller increase in the fourth year, average 8.5 %, probably because I visited the plots several times a year.

After 4 years, Barkman had found only 54 % of the species in Dicrano-Juniperetum after 13 years research. So a survey lasting only 4 years is not enough to find all the fungi in an association. It is probably comparable with the 80 % found by Barkman in the Dicrano-Juniperetum in the year in which the increase in the number of species was 9 %.

If we extrapolate the curves of Fig. 2 to an asymptotic end value this also yields about 80 % of the end value after the fourth year. It is therefore probable that the tables represent about 80 % of the total mycoflora of the plots investigated.

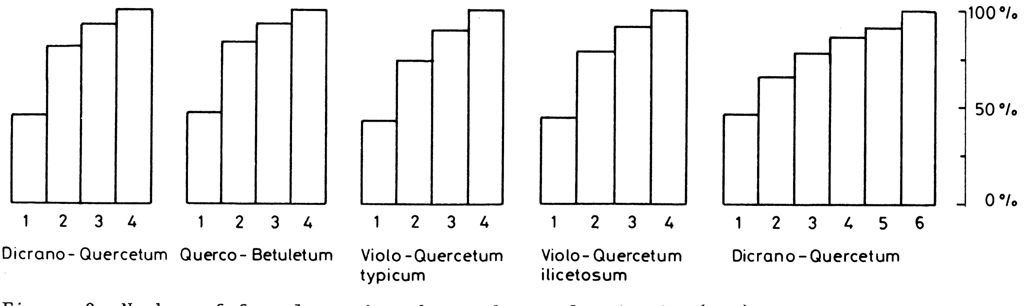

Figure 2. Number of fungal species observed per plot in the (sub)associations after 1, 2, 3 and 4 years as a fraction of the number of species observed in 4 years. Years 1976-1979, except for Dicrano-Quercetum at right, 1972-1973 and 1976-1979.

Table 5. Number of fungus species per (sub)association

	DQ	QB	VQt	VQi
Mean per plot	106.3	76.5	66.9	54.5
Mean per frequency plot	115.5	81.6	74.7	74.6
Total	179	187	175	136
Found in all 4 types	67	67	67	67
Found in only 3 types	20	20	20	
	3	3		3
		30	30	30
Found in only 2 types	24	24		
	5		5	
	3			3
		11	11	
		6		6
			7	7
Found in only one type	57	26	35	20

4.3 RESULTS

4.3.1 Number of species

In the 4 (sub)associations all together, 313 fungi (species, subspecies or varieties) were observed. The total number of fungi was remarkably low in Violo-Quercetum ilicetosum (Table 5), as was also the mean number of fungi per plot. These low numbers were most likely due to the small unrepresentative plots in Violo-Quercetum ilicetosum. The mean number in frequency plots of this subassociation, which were larger, so more representative, and more intensively investigated, did not differ from that of Violo-Quercetum typicum. Violo-Quercetum typicum had slightly fewer species, total and mean per plot, than Querco-Betuletum. In Dicrano-Quercetum, the total number did not differ much from that in Querco-Betuletum and Violo-Quercetum typicum. The mean number per plot and per frequency plot was markedly higher in Dicrano-Quercetum than in the other vegetation types: in other words, the Dicrano-Quercetum plots were very rich in species.

4.3.2 Differential species

4.3.2.1 Dicrano-Quercetum

Many of the species of Dicrano-Quercetum (Table 4 and Appendix Table D, Group 1) were differential or presumably differential species. Fourteen species with a low presence were not differential by the above criteria (Section 4.2.1) but were not found in any other association; they were added to Group 1.

There are 30 differential species: *Amanita fulva*, *Boletus edulis*, *B. erythropus*, *Cantharellus cibarius*, *Cordyceps canadensis*, *C. ophioglossoides*, *Cortinarius alboviolaceus*, *C. bolaris*, *C. fusisporus*, *C. glandicolor*, *C. obtusus*, *C. paleaceus*, *C.* cf. *stemmatus*, *Dermocybe cinnamomeolutea*, *Entoloma turbidum*, *Hydnellum scrobiculatum*, *H. spongiosipes*, *Inocybe napipes*, *I. ovatocystys*, *I. sambucina*, *Lactarius chrysorrheus*, *Leotia lubrica*, *Marasmius androsaceus*, *Psathyrella fulvescens* var. *dicrani*, *Russula adusta*, *R. fragilis*, *Sarcodon scabrosus*, *Thelephora terrestris*, and *Tricholoma portentosum*. *Galerina calyptrata* was also differential for Dicrano-Quercetum, but was listed in Group 7 because it was also differential for Querco-Betuletum in relation to Violo-Quercetum. Presumably differential were the following 9 species: *Hebeloma pumilum*, *Inocybe xanthomelas*, *Russula cyanoxantha*, *R. vesca*, *Tricholoma columbetta*, *T. virgatum* (Group 1), and *Amanita citrina*, *Laccaria amethystina*, and *Lactarius camphoratus* (listed in Group 7a because they were also differential or presumably differential for Querco-Betuletum in relation to Violo-Quercetum).

No literature was available on fungi of Dicrano-Quercetum. Many of the 'species of Dicrano-Quercetum' were also reported from other associations, sometimes on richer soil, and often both from deciduous and coniferous woods. For instance, *Russula fragilis* was reported from Querco-Betuletum typicum (Runge, 1960; this study), from Genisto tinctoriae-Quercetum petraeae subcarpaticum dicranetosum (Bohus & Babos, 1967), Querco-Carpinetum (Einhellinger, 1964; Šmarda, 1972), Luzulo-Fagetum leucobryetosum (Jahn et al., 1967; they found it a differential species for this subassociation), Melico-Fagetum (Lange, 1978), and also from associations with coniferous trees, Melampyro-Abietetum variant with Leucobryum glaucum (Krieglsteiner, 1977), Querco-Piceetum (Nespiak, 1959), and Pino-Quercetum serratuletosum (Nespiak, 1959).

All differential species were species of acid, sandy soils, poor in humus. Many of them have a wider coenological range than Dicrano-Quercetum, but when growing in richer woods, they were perhaps restricted to poorer, more acid patches. The real optimum for some of these species was probably in coniferous woods or scrubs, or on poor heathlands, such as *Marasmius androsaceus* and *Inocybe lacera*. Within the oak woods on sandy soils in Drenthe, however, they had an optimum in Dicrano-Quercetum and could be taken as differential.

A few species were possibly character species: *Cantharellus cibarius*, *Cordyceps canadensis*, *C. ophioglossoides*, *Hydnellum scrobiculatum*, *H. spongiosipes*, *Inocybe sambucina*, *Psathyrella fulvescens* var. *dicrani*, *Sarcodon scabrosus* and *S. underwoodii*. *Cantharellus cibarius* and the two *Cordyceps* species were sometimes found outside Dicrano-Quercetum, but the ecological range was narrow enough to consider them as character species. *Inocybe sambucina* and the *Hydnellum* and *Sarcodon* species were rare, and in Drenthe found only in Dicrano-Quercetum (Ypelaar, 1974). *Sarcodon underwoodii* was noted only once (Appendix Table D, notes), but was found also in another Dicrano-Quercetum in Drenthe (Ypelaar, 1974); it has not been reported from other localities in this province. *Psathyrella fulvescens* var. *dicrani* was found often in Dicrano-Quercetum, and has not yet been reported from other habitats.

Many of the species of Group 1 were mycorrhizal: 40 (= 82 %). Only 6 species (12 %) were saprophytes of humus, 2 species were parasitic, 1 species grew on fallen leaves. No species in this group grew on wood.

4.3.2.2 Quercion robori-petraeae

Quercion robori-petraeae had many differential species and presumably differential species (Table 4 and Appendix D, Group 2). Some species that were not differential but preferred Quercion were added to this group; they were absent from Dicrano-Quercetum or had much lower P or GAMAC values there.

On that basis, there were 29 differential species: *Bjerkandera adusta, Chondrostereum purpureum, Clitocybe fragrans, C. metachroa, Collybia cookei, Cudoniella acicularis, Galerina cinctula, Hapalopilus rutilans, Hohenbuehelia atrocaerulea, Kuehneromyces mutabilis, Marasmiellus ramealis, Mycena epipterygia, M. haematopus, M. sepia, M. stylobates, M. vitilis, Oudemansiella platyphylla, Panellus serotinus, Phallus impudicus, Pluteus salicinus, Polyporus brumalis, Psathyrella hydrophilla, Psilocybe crobula, Stereum hirsutum, S. rugosum, Tephrocybe tylicolor, Tyromyces chioneus* and *Xylaria hypoxylon*. The following 14 species were presumably differential: *Clitocybe diatreta, Clitopilus hobsonii, Crepidotus pubescens, Galerina hypnorum, G. sahleri, Hypholoma sublateritium, Inonotus radiatus, Laccaria laccata, Merulius tremellosus, Mucena mucor, M. pura, Piptoporus betulinus, Pleurotus ostreatus*, and *Rickenella fibula*. The other species of this group were species with a low presence, which preferred Quercion but were not differential.

Quercion was well distinguished from Dicrano-Quercetum and the numbers of differential species indicated the small affinity between Quercion and Dicrano-Quercetum. The differential species were, generally, species of deciduous woods on nutrient and humus-richer soil. Many of the species (e.g. *Bjerkandera adusta, Clitocybe fragrans, Mycena haematopus, Xylaria hypoxylon*) were recorded in the literature from associations such as Querco-Carpinetum, Mercuriali-Fagetum, Melico-Fagetum. Some were recorded from coniferous woods too (e.g. *Collybia cookei, Mycena epipterygia, Laccaria laccata*) and one species (*Clitocybe diatreta*) was recorded from coniferous or mixed woods only and not from the richer deciduous woods.

There were 63 species in Group 2, of which 4 (= 6 %) were mycorrhizal, 11 species (17 %) saprophytes of humus, 32 species (51 %) growing on wood and branches, 15 species (24 %) growing on fallen leaves, fruits or mosses, and 1 species growing on dung. This spectrum is completely different from that of Group 1 (species of Dicrano-Quercetum).

The associations of Quercion had markedly fewer differential species. Querco-Betuletum (Group 3 and part of Group 7) had only 2 differential species, *Mycena rorida* and *Hymenoscyphus epiphyllus*, and 2 presumably differential species, *Panellus stipticus* and *Clitocybe brumalis*. Some species that occurred in both Dicrano-Quercetum and Querco-Betuletum (Group 7) were also differential for Querco-Betuletum (*Laccaria amethystina*, *Galerina calyptrata* and *Lactarius camphoratus*) or presumably differential (*Amanita citrina*). *Cortinarius orellanoides*, *Galerina heterocystys*, and *G. triscopa* were not differential by the criteria (Section 4.2.1), and were added to Group 3 because of their absence from the other associations.

Runge (1960) and Birken (1976) both gave a list of species found in Querco-Betuletum. Of these species, Runge mentioned only *Laccaria amethystina*; Birken mentioned only *L. amethystina* and *Panellus stipticus*, so the resemblance with my study was low. Of the (presumably) differential species of Group 3, *Mycena rorida* was recorded in the literature from Querco-Carpinetum (Runge 1963), from 'acidophilous oak-beech woods' (Lisiewska, 1974), and also from coniferous woods or scrubs or mixed woods, Pino-Vaccinietum myrtilli, Pino-Vaccinietum uliginosi, and Querco-Piceetum (Nespiak, 1959), Melampyro-Abietetum, and Asperula-Abieti-Fagetum (Krieglsteiner, 1977) and Dicrano-Juniperetum (Barkman, pers. commun.). *Clitocybe brumalis* was probably more a species of coniferous woods; Krieglsteiner found it characteristic for Melampyro-Abietetum variant of *Leucobryum glaucum*. Nespiak recorded it from Pino-Quercetum serratuletosum and Pino-Vaccinitum myrtilli. It was common in Dicrano-Juniperetum (Barkman, pers. commun.), and it was not recorded in the literature studied for other types of deciduous woods. I did not find mention of *Galerina calyptrata* and *Hymenoscyphus epiphyllus*, which were probably lacking there. However, they could be overlooked by their small size or mistaken for other species. Of the 7 species of Group 3, there was one mycorrhizal species, one saprophyte of humus, and 5 species growing on decaying wood, leaves and twigs.

Violo-Quercetum had 3 differential species (*Collybia fusipes*, *Mycena inclinata* and *Tyromyces caesius*) and 2 presumably differential species, (*Galerina ampullaceocystis* and *Stropharia aeruginosa*) (Group 4). *Mycena inclinata* had a slight preference for subassociation ilicetosum, the other 3 species for subassociation typicum. For *Collybia fusipes*, P was higher in V.-Q. typicum than in V.-Q. ilicetosum, but the values for GAMAC and MCSF were nearly the same. *Entoloma euchrous*, *Inonotus dryadeus*, and *Russula parazurea* were added to Group 4, because they were not found in any other association.

I did not find mention of *Galerina ampullaceocystis* in the literature studied. The other (presumably) differential species were all recorded from Querco-Carpinetum (Nespiak, 1959; Einhellinger, 1974; Lisiewska, 1965), and also from associations on richer soil, such as Melico-Fagetum (Lisiewska, 1974; Lange, 1978) and Fagetum typicum (Smarda, 1972). They were not recorded from the more humus-poor association, Querco-Betuletum, and could (apart from *Tyromyces caesius*) be regarded as species of deciduous woods on soil not too poor in nutrients and humus, but it was not known what association they might be optimum in. *Tyromyces caesius* certainly reached its optimum in coniferous woods. It usually grew on wood of conifers, and was recorded from Pinus-Robinia woods (Winterhoff, 1976), from Melampyro-Abietetum and Asperulo-Abieti-Fagetum (Krieglsteiner, 1977), from Dicrano-Juniperetum (Barkman, pers. commun.), Querco-Carpinetum and Melico-Fagetum. Coniferous trees were not present in Violo-Quercetum plots, but logs of conifers were sometimes present, from forestry operations. *Tyromyces caesius* growing on wood of deciduous trees, however, was also observed.

Of the 8 species of Group 4, 1 was mycorrhizal, 1 saprophytic on humus, and 6 grew on wood or branches.

The subassociations were both well characterized by differential species. The subassociation typicum had 3 differential species (*Collybia peronata*, *Marasmius splachnoides*, *M. epiphylloides*) and 2 presumably differential species (*Clitocybe flaccida* and *Scleroderma verrucosum*) (Group 5). *Laetiporus sulphureus*, *Mycena pearsoniana*, *Resupinatus applicatus*, and *Xerocomus parasiticus* were added to this group, because they were found only in Violo-Quercetum typicum.

Collybia peronata attained the highest values of P, GAMAC and MCSF here, but was also frequent in the other subassociation. It has also been recorded from other associations, such as Querco-Carpinetum (Lisiewska, 1965; Runge, 1963; Einhellinger, 1964), Mercuriali-Fagetum (Lisiewska, 1974), Melico-Fagetum (Lisiewska, 1974; Lange, 1978), Melampyro-Abietetum (Krieglsteiner, 1977) and Dicrano-Juniperetum (Barkman, pers. commun.). Jahn et al. (1967) called it an accompanying species in the *Fagus* woods they investigated. *Marasmius splachnoides* has about the same value for GAMAC here as in Querco-Betuletum, but much higher values for P and MCSF. It was also recorded from Querco-Carpinetum (Lisiewska, 1965), Mercuriali-Fagetum, and Melico-Fagetum (Lisiewska, 1974). Also from my experience, it occurred in richer oak woods such as Querco-Carpinetum, where it possibly reached its optimum. *Marasmius epiphylloides* was confined to terrestrial *Hedera helix*, and was therefore restricted to Violo-Quercetum. It could be a character species in the Netherlands. In the literature, it was recorded only from Querco-Carpinetum (Lisiewska, 1965). I did not find any data in the literature on the distribution of *Clitocybe flaccida*. The related taxa *C. gilva* and *C. inversa* were recorded from Querco-Betuletum (Birken, 1976), Querco-Carpinetum (Runge, 1963; Einhellinger, 1964) and Luzulo-Fagetum leucobryetosum (Jahn et al., 1967). *Scleroderma verrucosum* has been recorded from Querco-Carpinetum (Lisiewska, 1965) and Melico-Fagetum (Lange, 1978). The species of this group all occurred in richer oak woods, often also in beech woods. Their absence from Violo-Quercetum ilicetosum is probably associated with unfavourable litter, the large proportion of *Ilex* leaves, or by unfavourable microclimate.

Of the 9 species of this group, 1 was mycorrhizal, 1 parasitical and 7 species grew on humus, litter or wood.

The subassociation ilicetosum had 6 differential taxa, *Ciboria batschiana*, *Coprinus* section *Micacei*, *Polyporus varius*, *Psathyrella frustulenta*, *Typhula erythropus*, and *T. phacorrhiza*, and 2 presumably differential species, *Cortinarius tabularis* and *Mutinus caninus* (Group 6). *Phellinus ferreus* was also placed in this group, because it was found only once in one of the other associations (without data on abundance or exact habitat). Four species of *Coprinus* section *Micacei* were found, *C. domesticus*, *C. micaceus*, *C. radians*, and *C. xanthothrix*, which all preferred Violo-Quercetum ilicetosum, but P was low. The section as a whole, however, was differential. The species also occurred in other associations. *C. micaceus* has been recorded from Querco-Betuletum (Runge, 1960), Querco-Carpinetum (several authors), a *Pinus-Robinia* wood (Winterhoff, 1977), Melico-Fagetum (Lange, 1978; Jahn et al., 1967, who called it a presumably differential species for Melico-Fagetum). *Coprinus xanthothrix* has been listed for Querco-Carpinetum (several authors), and *Pinus-Robinia* and *Teucrium-Quercus-Pinus* woods (Winterhoff, 1977), *C. domesticus* from a *Pinus-Robinia* wood (Winterhoff, 1977). In view of their habitat (rotten wood and twigs of deciduous trees), I expect that they have rather wide ranges within wood associations. Both *Typhula* species were found to occur only in thick layers of *Ilex* leaves (see Section 7.3). They are also known from litter of other deciduous trees, but usually in a fairly moist habitat. *Polyporus varius* was recorded from Melico-Fagetum (Lange, 1978), *Mutinus caninus* from Melico-Fagetum (Lange, 1978) and Querco-Carpinetum (Lisiewska, 1965). I did not find data in the literature on the distribution in other associations of the other (presumably) differential species. The number of differential fungi of Violo-Quercetum ilicetosum was larger than of higher plants (only one differential species). It is therefore possible, based on fungi, to consider Violo-Quercetum ilicetosum as an independent association and not as a subassociation.

Of the 12 species of Group 6, 1 was mycorrhizal, 2 were saprophytes of humus, 3 species grew on fallen leaves and fruits, and 6 grew on wood or branches.

There were 19 species with a preference for Dicrano-Quercetum and Querco-Betuletum (Group 7). I listed species differential for both associations in relation to Violo-Quercetum, and species with a low presence in Dicrano-Quercetum and Querco-Betuletum, and absent in Violo-Quercetum. Seven species preferred Dicrano-Quercetum (Subgroup a), 4 of them were (presumably) differential for Dicrano-Quercetum or Querco-Betuletum. Twelve species occurred almost equally in the 2 associations, with low presence and abundance, and were listed as 'indifferent species' (Subgroup b). These species were all absent in Violo-Quercetum. There were no species of this group that preferred Querco-Betuletum. Apparently these species can be considered as species of (oak woods on) acid, sandy soils poor in humus. For instance both *Laccaria* species, when occurring in Violo-Quercetum, preferred sites with a sandy layer at shallow depth.

There were 23 species in Dicrano-Quercetum, Querco-Betuletum, and Violo-Quercetum typicum, and absent or present with much lower P and GAMAC in Violo-Quercetum ilicetosum (Group 8). They were listed in subgroups according to preference for Dicrano-Quercetum (Subgroup a), Dicrano-Quercetum and Querco-Betuletum (b), Querco-Betuletum and Violo-Quercetum typicum (c), Dicrano-Quercetum and Violo-Quercetum typicum (d), and without preference (e). The species with a preference for Dicrano-Quercetum, or Dicrano-Quercetum and Querco-Betuletum, resembled the species of Group 7, but had a wider range: *Russula emetica*, *Cystoderma amianthinum*, *Collybia cirrhata*, *Xerocomus badius*, and *Galerina atkinsoniana*. *Collybia butyracea* and *Clitocybe candicans* preferred Querco-Betuletum and Violo-Quercetum typicum. There were 5 species listed in Subgroup d, but the preference for Dicrano-Quercetum and Violo-Quercetum was only weak, because P, GAMAC and MCSF were very low. The other 11 species in Group 8 were more or less equally distributed in the 3 vegetations. The absence of these species from Violo-Quercetum ilicetosum was a characteristic they had in common with the species of Group 2f. Probably the forest floor in Violo-Quercetum ilicetosum was unfavourable for these fungi because of the large proportion of dry, brittle, and badly decomposing *Ilex* leaves and by the absence of mycorrhiza in *Ilex*. The differences in microclimate, caused by the dense shade throughout the year, or by the absence of herb layer, might also be a factor.

Accompanying species (Group 9, 38 species) were by definition fairly uniformly distributed. The group included the very common species, with high values for P, GAMAC and MCSF, but also the rare species with low values for P, GAMAC and MCSF. Some species were most abundant in Dicrano-Quercetum, e.g. *Lactarius quietus*, *L. theiogalus*, *Paxillus involutus*, in Querco-Betuletum, e.g. *Mycena sanguinolenta*, or in Violo-Quercetum typicum, e.g. *Clitocybe vibecina* and *Armillariella mellea*. The common species sometimes had GAMAC, MCSF or P differential according to the criteria. But because values were high in every vegetation, these species were not really differential. Most species of this group had a wide range, occurring also frequently in other associations.

4.3.3 Mathematical affinities

The values for A_C, A_P, and A_T (Table 6) and D_C, D_P, and D_T (Fig. 3) show that the affinities of the fungal vegetation was more or less the same as for phanerogams, mosses and lichens. There was a great affinity between Violo-Quercetum typicum and Querco-Betuletum, even greater than between both the subassociations of Violo-Quercetum. The affinity of Dicrano-Quercetum with the other vegetations was very low, especially with Violo-Quer-

Table 6. Affinities of fungal vegetation, A_c, A_p and A_T (defined in Sections 3.1.2 and 4.2.1)

	A_c	A_p	A_T
DQ - QB	1.61	1.14	0.40
DQ - VQt	1.08	0.90	0.33
DQ - VQi	0.89	0.62	0.16
QB - VQt	2.50	3.15	2.36
QB - VQi	2.18	2.01	1.25
VQt - VQi	2.27	2.33	1.33

cetum ilicetosum. The same relations were shown as in the affinities for higher plants.

Violo-Quercetum ilicetosum may thus be considered an independent association and not a subassociation. The relatively large number of differential species supports this view. Nevertheless, I retained Violo-Quercetum ilicetosum as a subassociation and not as an association because of the limited number of relevés in a limited area, because of the green vegetation, and because plant communities are classified by green vegetation.

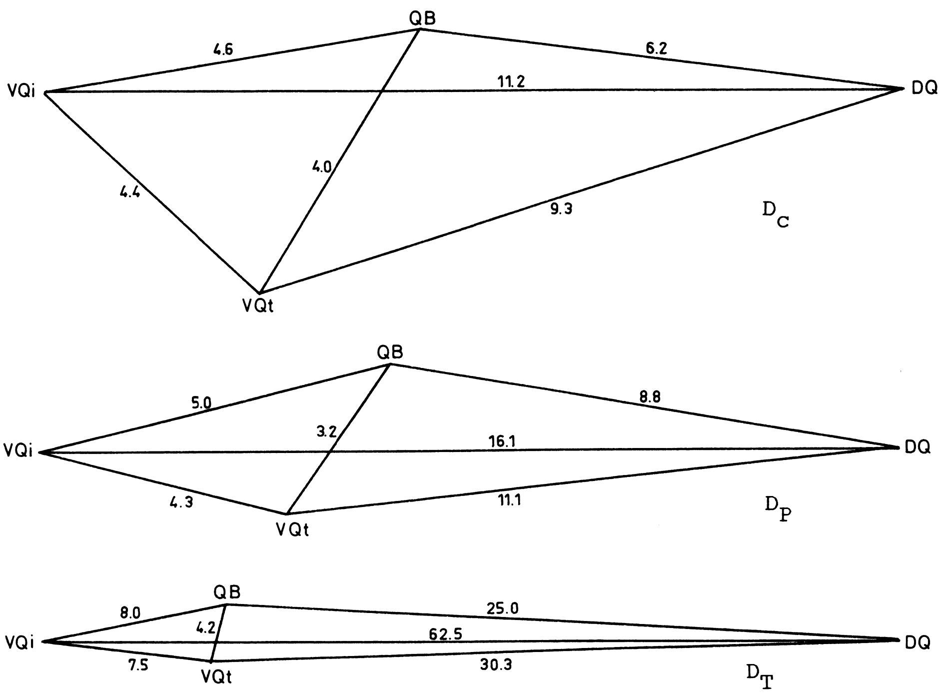

Figure 3. Differences between fungal vegetations, $\underline{D}_c$, $\underline{D}_p$ and $\underline{D}_T$ (defined in Sections 3.1.2 and 4.2.1). The lines represent values of $\underline{D}$.

4.3.4 Representative plot size

The relation between the number of species in a plot and the size of that plot (Fig. 4) was studied in order to determine the 'minimum' area or the representative plot size. These are discussed for each (sub)association separately.

In Querco-Betuletum, only plots of 1500 and 2000 m^2 were investigated. The 1500 m^2 plots had 101, 59, 75 and 65 (mean 75) species, the 2000 m^2 plots had 85, 69, 75 and 83 (mean 78) species. In the frequency plots of 1000 or 1050 m^2 (part of a 1500 or 2000 m^2 plot, not indicated in Fig. 4), only 69, 73, 64, 54 and 69 (mean 66) species were found. Therefore 1500 m^2 can be considered as representative area size for fungi in Querco-Betuletum.

The Violo-Quercetum typicum plots of 500, 700, 800 and 1200 m^2 had, respectively, 40, 51, 55 and 74 species. The 1500 m^2 plots had 68, 50, 88, 90 and 85 (mean 76) species. Only one plot of 2000 m^2 was investigated, and had 68 species. The frequency plots of 1000 or 1050 m^2 (part of the 1500 or 2000 m^2 plots, not indicated in Fig. 4) only had 56, 33, 74, 68, 62 and 63 (mean 58) species. Therefore 1500 m^2 can be considered as representative area for fungi in Violo-Quercetum typicum too.

The Violo-Quercetum ilicetosum plots of 300, 500 (twice), 800 and 1000 m^2 had, respectively, 35, 35, 44, 37 and 60 species. The plots of 1900 and 2000 m^2 both had 71 species; the plot of 3000 m^2 had 82 species. The frequency plots of 875 or 1000 m^2 (part of the plots of 1900, 2000 or 3000 m^2, not indicated in Fig. 4) had 57, 52 and 47 (mean 52) species. Here 2000 m^2

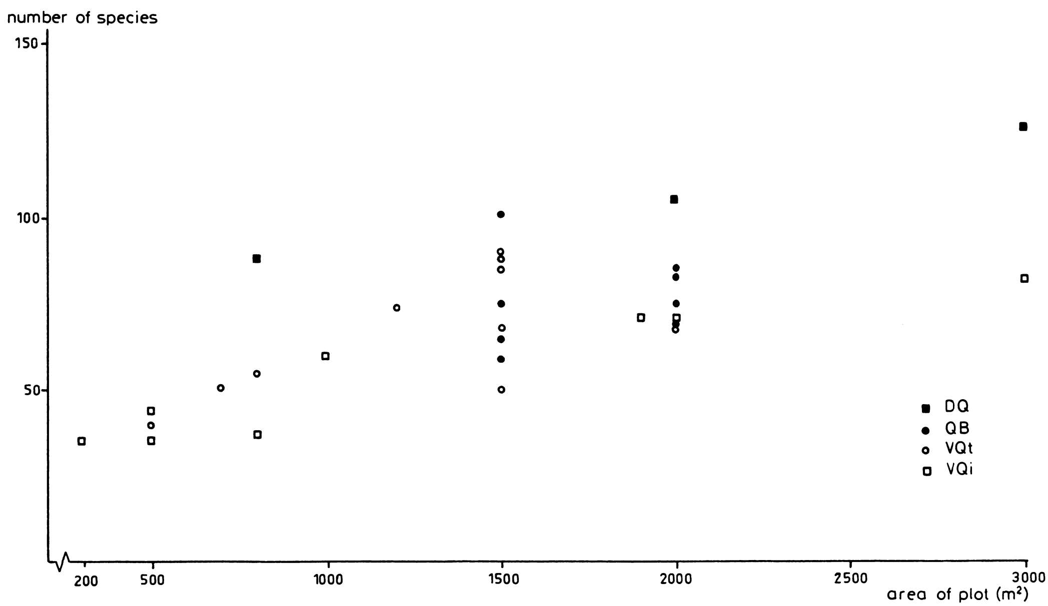

Figure 4. Relation between area and number of fungal species encountered.

cannot be considered representative area for fungi, since it had only 86 % of the number of species of the plot of 3000 m². A plot of 3000 m² was probably representative, but as no larger plots were studied, that could not be ascertained.

In Dicrano-Quercetum, only 3 plots were studied, too few to draw conclusions on the representative plot size. An advantage was that the plots were investigated for 6 years, thus the records were thought to be more complete. The plot of 800 m² had 88 species, that of 2000 m² had 100, and that of 3000 m² had 126 species. In the frequency plots of 1000 m² (part of the plots of 2000 or 3000 m², not indicated in Fig. 4), 63 and 65 species were found. There too, 2000 m² cannot be considered representative, since the plot of 2000 m² had only 83 % of the species of the plot of 3000 m². A plot of 3000 m² was probably representative.

4.4 CONCLUSIONS

Many more fungi were found than higher plants. Violo-Quercetum ilicetosum proved relatively poor, Dicrano-Quercetum relatively rich in fungi.

Some fungi were differential, as were some higher plants. There were more differential fungi than higher plants, especially in associations with only a few higher plants: Dicrano-Quercetum and Violo-Quercetum ilicetosum.

Dicrano-Quercetum and Quercion robori-petraeae had many differential fungal species from each other. This supports the idea that Dicrano-Quercetum does not belong to Quercion robori-petraeae. The Quercion associations had fewer differential fungal species, but were also well characterized. By differential fungal species, one could rank Violo-Quercetum ilicetosum as an association.

The affinities for fungal vegetations of the (sub)associations resembled the affinities for higher plants.

The representative area proved to be rather large, about 1500 m² for Querco-Betuletum and Violo-Quercetum typicum, and at least 3000 m² for Violo-Quercetum ilicetosum and Dicrano-Quercetum.

5 Annual frequency of fungal species

The survey lasted 4 years, so I could calculate the number of species found in one, two, three, and four years, and distinguish 4 annual frequency classes. In each plot, the number of species in each frequency class was calculated as a proportion of the cumulative number of species in the plot, and the frequency was averaged for each (sub)association. Data from earlier research and incomplete data from Plots 6, 7, 27, and 29 (visited only in 3 years) were omitted.

The pattern did not differ greatly between associations (Fig. 5). Class 1 was the largest and tended to increase slightly from Dicrano-Quercetum to Querco-Betuletum to Violo-Quercetum typicum to Violo-Quercetum ilicetosum. Classes 3 and 4 tended to decrease in this series. These were relatively large in Dicrano-Quercetum and in Querco-Betuletum: in other words, Dicrano-Quercetum and Querco-Betuletum had a relatively constant mycoflora.

Appendix Table D gives annual frequency data for each fungus based also on earlier research by Ypelaar and Barkman. Table 4 gives mean frequency for the associations.

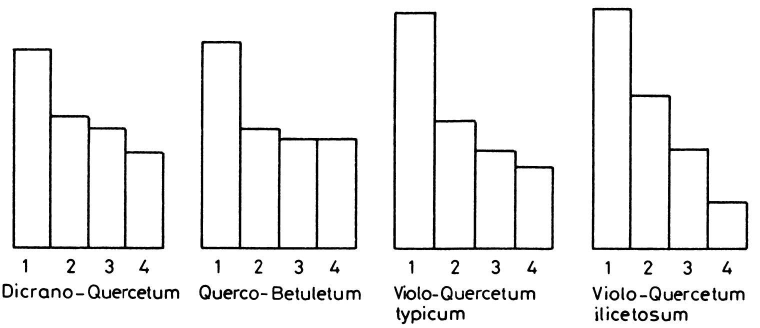

Figure 5. Annual frequency of fungal species in each (sub)association as proportion (averaged between plots) of the cumulative number of species encountered.

6 Spatial frequency of fungal species

6.1 INTRODUCTION

The real abundance of a species is not the abundance of carpophores, but the abundance of mycelia, which is, however, difficult to determine. Darimont (1973) counted the abundance of 'stations'. A 'station' is a group of carpophores that is separated from other groups, and therefore marks the area where the individual, the mycelium, grows. The following difficulties may occur in working with 'stations'. 'Stations' are not sharply separated; not all mycelia form carpophores at the same time; a 'station' can consist of several mycelia; or several 'stations' can in fact be one mycelium. Because of these difficulties, I propose cumulative spatial frequency (CSF) as an indicator of abundance of mycelia. Spatial frequency (SF) of a species is the fraction of the plot area where carpophores were observed in a record (Section 4.2.1). Cumulative spatial frequency of a species is the fraction of the plot area where carpophores were observed during the research.

The spatial frequency of a species depends on the size of the subrecords, and on the size, the number, and the spatial distribution of the individuals. The area covered by mycelia of many macrofungi (parasites and fungi on dung are excluded here) was probably 1-20 m^2, as judged by the area covered by groups of carpophores. To get accurate values for SF the subplots must be not smaller than the area covered by mycelia. Only if all subplots were the same size could we compare the spatial frequency. In this study, the area was 25 m^2, slightly more than the presumed area of most mycelia.

The way mycelium grows and the spatial distribution of a species greatly influences the SF. Because of this it was not possible to convert abundance of carpophores into spatial frequency. Because of the size chosen for the subplots, it was expected that the SF would be a more exact indicator of abundance of mycelia than abundance of carpophores would be.

6.2 METHODS

To record spatial frequencies, 17 plots (DQ 2 plots, QB 5 plots, VQt 7 plots, and VQi 3 plots) were divided into 35, 40 or 42 subplots, depending on the area of the composite plot. A clear picture of the SF can be obtained from these subplots. A larger number of subplots would become unworkable. Once or twice in 1976, 1977 and 1978, frequency was recorded in each composite plot, consisting of 35, 40, or 42 subrecords. Presence of species was noted in each subplot. The records were aggregated for each plot, into one cumulative frequency record with indication of the subplots where the species had been found. The cumulative spatial frequency was the proportion of the plot area in which the species was observed during the research.

For each association the mean of the values for CSF, the mean cumulative spatial frequency (MCSF), was calculated for each species.

To assess uniformity of the plots, five classes of cumulative spatial frequency were assessed: 1-20 % of subplots (Class I), 21-40 % (Class II), 41-60 % (Class III), 61-80 % (Class IV) and 81-100 % (Class V). In each composite plot, the fraction of species for the five classes was calculated and the mean values per (sub)association.

Heterogeneity was assessed with an index H, where

$$H = \delta(\mathrm{I}) + \delta(\mathrm{II})/\delta(\mathrm{IV}) + \delta(\mathrm{V}) \tag{4}$$

where δ is the number fraction (proportion) in the respective class.

6.3 RESULTS

6.3.1 Introduction

As the frequency surveys were mainly in September, October and the first half of November, and only occasionally in June, July and August, the CSF could be too low for species with optima before September or after the middle of November. This would be true only for a few species, such as *Oudemansiella platyphylla*, *Mycena cinerella* and *Clitocybe vibecina*. Some other rarer species were found in a composite plot but not during a frequency relevé, so their spatial frequency was not measured. The CSF was likely to be more accurate for species with a high frequency in time. In general, CSF should be considered as minimum.

6.3.2 Distribution of frequency classes as an indicator of uniformity

Raunkiaer (1918) found that frequency classes fall in the order $\mathrm{I}>\mathrm{II}>\mathrm{III}\gtrless\mathrm{IV}<\mathrm{V}$. If Class V is larger than Class IV, the vegetation of the plot is uniform on this scale. This principle of constant species was formulated for higher plants. Raunkiaer considered that the area of subplots had to be about 0.1 m^2. Class I became very large if the subplots were too small; all frequencies fell in Class V if the area of subplots roughly equalled the 'minimum area'. My subplots had an area of 25 m^2, thus distinctly larger than the size recommended by Raunkiaer.

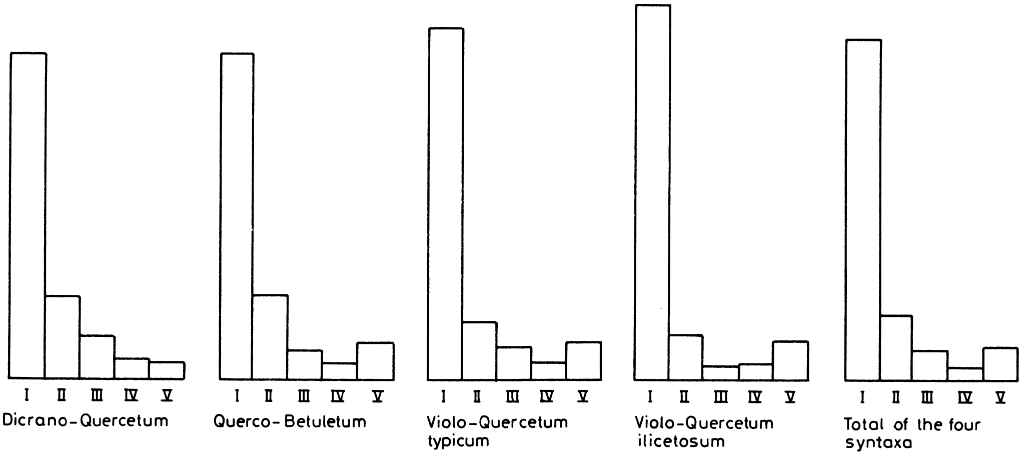

Figure 6. Frequency histograms for each of the four (sub)associations and for the combined associations, averaged for all species. Classes for spatial frequency: I, 1-20 % of subplots; II, 21-40 %; III, 41-60 %; IV, 61-80 % and V, 81-100 % of subplots.

The frequency histograms for the associations and for all four together (Fig. 6) did not differ much. Class I was large, much larger than the other classes. Class V was about twice as large as Class IV in Querco-Betuletum, Violo-Quercetum typicum and Violo-Quercetum ilicetosum, indicating uniformity of the fungal vegetation on this scale. The principle of constant species apparently also applies to the fungi of these associations.

In Dicrano-Quercetum, Class V was smaller than Class IV, indicating its fungal vegetation was not uniform on this scale. This irregularity was also indicated by the index *H* (Equation 4): 14.3 for Dicrano-Quercetum, 9.3 for Querco-Betuletum, 8.5 for Violo-Quercetum typicum, and 9.3 for Violo-Quercetum ilicetosum. There may be several reasons why Raunkiaer's principle

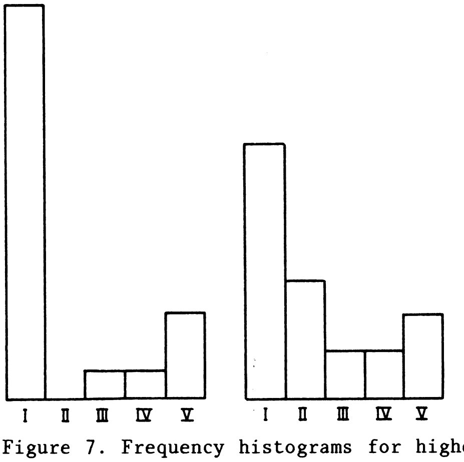

Figure 7. Frequency histograms for higher plants (left) and mosses (right) in Dicrano-Quercetum.

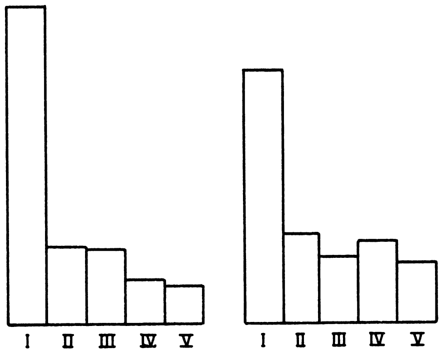

Figure 8. Frequency histograms of fungi for subplots of area 50 m^2 (left) and 100 m^2 (right) in Dicrano-Quercetum.

does not apply to the fungal vegetation of Dicrano-Quercetum.

The records might be incomplete because they were not made in the proper season or because the number of visits was too few.

The number of frequency records and the number of fungi in these records was neither extremely low nor high compared with the other associations. The annual frequency of fungi in Dicrano-Quercetum was relatively high, so it is unlikely that the relevés are incomplete.

The green vegetation of these plots might not be uniform on the scale considered and therefore associated fungal vegetation would not be either.

As fungal vegetation cannot easily be seen to be uniform, the plots were chosen for uniformity of green vegetation. Frequency histograms of higher plants and mosses of the Dicrano-Quercetum (Fig. 7) did not indicate irregularities. So it is unlikely that this was the cause of the irregular fungal vegetation. However, the mosses in the plots showed some irregularity (Section 7.3). The growth of mosses in patches is intrinsic to Dicrano-Quercetum.

The subplots might be too small to reflect the spatial pattern (in other words, the stations of the fungal vegetation of the Dicrano-Quercetum were much coarser than in the other associations). If the subplots were too small, we could combine them into subplots of 50 and 100 m^2. By doing so (Fig. 8), Classes IV and V increased somewhat, and the index of heterogeneity (*H*) decreased from 14.3 to 5.9 to 3.1. However, Raunkiaer's principle still did not fit. Perhaps the subplots should be increased to the area of the moss patches.

In conclusion, the distribution of fungi between subplots within plots of Dicrano-Quercetum was irregular for inexplicable reasons, presumably because their spatial pattern was coarser than that of green vegetation.

6.3.3 Relation between spatial frequency and abundance of carpophores

The relation between CSF and number of carpophores (highest abundance of carpophores measured in the frequency relevés was used) was for the species

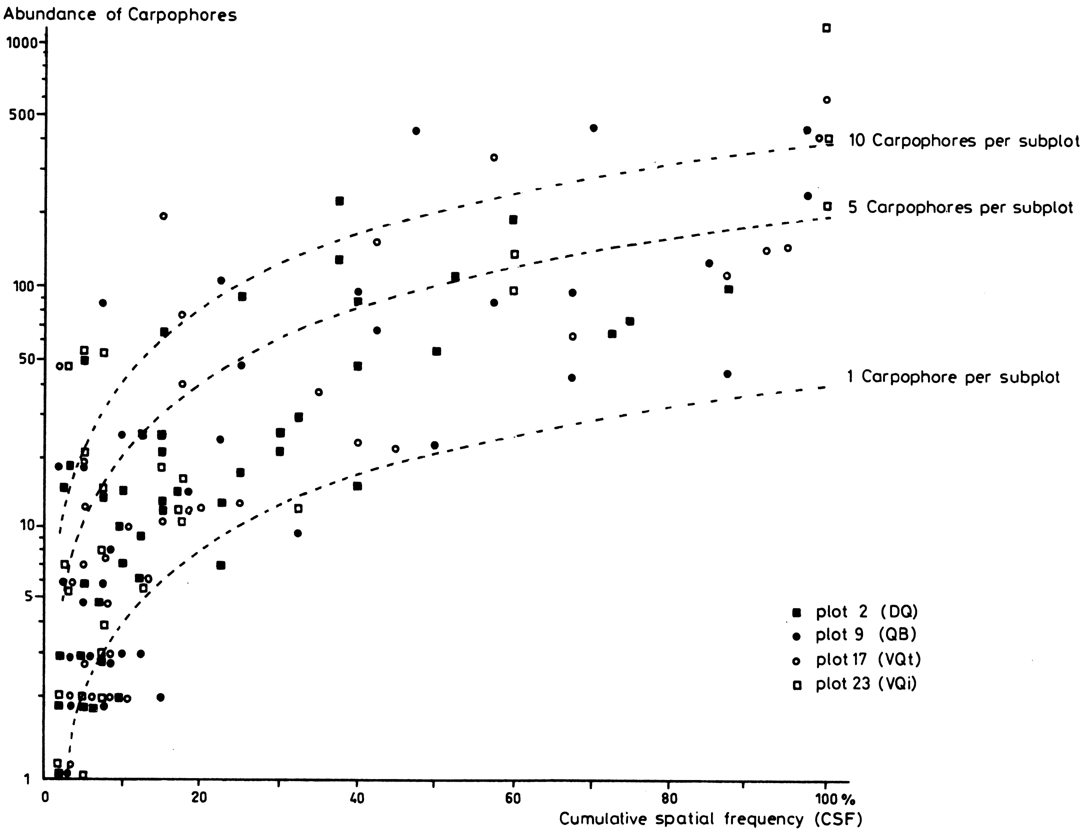

Figure 9. Relation between cumulative spatial frequency and the abundance (highest abundance of carpophores measured in frequency records) in four plots. The dotted lines of 1, 5 and 10 carpophores per subplot are lines of characteristic abundance: mean abundance of carpophores in the subplots where the species was found. Thus subplots where a species was not found, where its abundance was 0, were not included in this calculation.

of four plots similar between vegetation types (Fig. 9). Of the fungi in Figure 9, 62 % had a characteristic abundance of 1-5 carpophores per subplot. Of these fungi 85 % had a CSF of 50 % or less; 13 % had a characteristic abundance of 6-10 per subplot; 16 % had an abundance of 11 or more, and 9 % had less than 1. The last mentioned were species that were always low in abundance and spatial frequency, but reached a higher cumulative spatial frequency because they grew in different subplots every year.

Species with 10 or less carpophores in a composite plot had a CSF of 1-22(-32) %, those with abundance of 11-50 had a CSF of 1-68(-88) %, and those with 100 and more had values of 15-100 %. So one cannot convert an abundance of carpophores into a spatial frequency, or a spatial frequency into an abundance. Only rough predictions are possible.

For species of almost the same abundance per subplot, one can estimate a fairly characteristic relation of CSF with abundance. Four examples are given in Figure 10. *Pluteus cervinus* had a characteristic abundance of

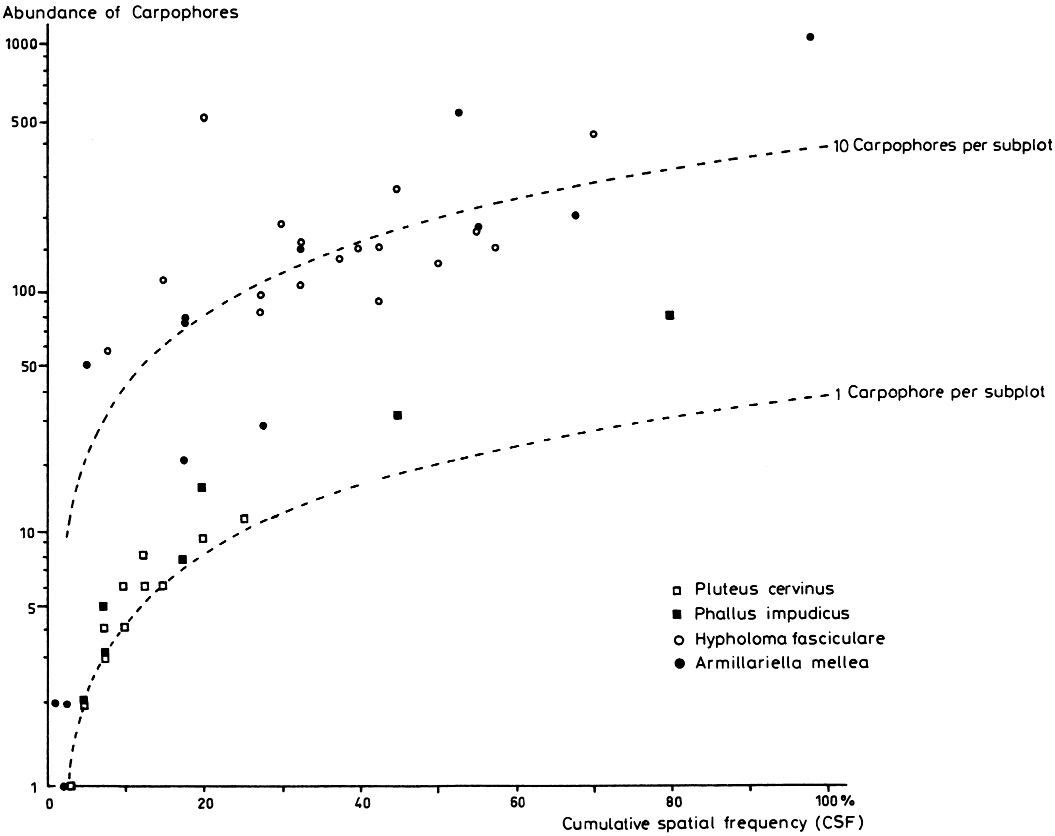

Figure 10. Relation between cumulative spatial frequency and abundance (highest abundance of carpophores measured in frequency records) for four species.

1-1.3 specimens per subplot, and CSF of 25 % or less. *Phallus impudicus* had a characteristic abundance of 1-1.6 if CSF was low, <15 %, and up to nearly 3 if CSF was higher. For *Hypholoma fasciculare*, this relation is less stable. The values were grouped around 10 per subplot, but a value of even 60 occurred. For *Armillariella mellea*, abundance was from 1 to more than 25 per subplot, showing that a characteristic relation between CSF and abundance did not exist.

Species whose carpophores grew alone would have only 1 carpophore in a subplot, so lie on line 1 carpophore per subplot. Species with more carpophores per subplot lie between this line and lines of 5 or 10 carpophores per subplot, or even higher. Species growing each year in other subplots had a rather high cumulative spatial frequency (CSF, total for 3 years). If their highest abundance of carpophores was relatively low, these species could have a characteristic abundance of less than 1 specimen per subplot and so are found in the figure below the line of 1 specimen per subplot. The characteristic abundance indicates whether carpophores grew isolated or in clusters, but does not indicate mycelial pattern.

6.4 CONCLUSIONS

In assessing cumulative spatial frequency, one can use histograms, which reflect the uniformity or irregularity of the fungal vegetation between subplots. The fungal vegetations of Quercion associations seemed uniform. The fungal vegetation of Dicrano-Quercetum seemed irregular with subplots of 25-100 m^2. Probably the fungal vegetation of Dicrano-Quercetum had a much coarser pattern than the green vegetation.

The cumulative spatial frequency over the whole period of survey had some correlation with highest abundance of carpophores, but the two indices were not interconvertible. Only for some species of constant abundance in the subplots was there a characteristic relation between the two indices.

7 Distribution patterns

7.1 INTRODUCTION AND METHODS

The frequency records of each species were 'mapped' for easy recognition of spatial patterns in each plot. The absolute maximum abundance of carpophores was indicated in each subplot: 1, 2 or 3 carpophores were counted, 4 or more specimens were divided into classes of 4-10, 11-29, 30-79, 80-189, and 190 or more specimens (Van der Maarel, 1971).

The distribution of fungal species in a plot could be random, uniform or clustered. Pielou (1969; p. 107) gives a statistical method for discriminating random from uniform and clustered in a grid for each cumulative spatial frequency. On the maps, the number of joins were counted. The distribution was called uniform if there were less joins ($P<0.05$) than expected from the null hypothesis of random occurrence of subplots with or without the species. The distribution was called clustered if there were more joins ($P<0.05$) than expected.

The maps were also used to recognize correlation of distribution patterns between fungi, or of fungi with mosses or higher plants.

Correlation between species is expressed by the coefficient V, where

$$V = (ad - bc)/(mnrs)^{\frac{1}{2}} \qquad (5)$$

where a is the number of subplots where both species were present, b and c the number of subplots where only one species was present, d the number of subplots where both species were absent, $m = a + b$, $n = c + d$, $r = a + c$, $r = b + d$. V can reach values between -1 and +1. It was tested by Pielou's method (1969; p. 163) whether the values of V were significant. If $P<0.05$, an asterisk was placed after the value of V. The coefficient was meaningless for species with a very low CSF, <5 %, or a very high CSF, >90 %.

Correlation was expected for fungi that depended on other species of fungi, mosses or higher plants. In general, a plot is heterogeneous for a dependent fungus because of biotic heterogeneity.

7.2 DISTRIBUTION PATTERNS

Three patterns are possible, random (actually: not significantly different from random), significantly clustered, and significantly uniform. Significantly uniform patterns were not found at all. Uniformity seems scarce

Legend to the distribution patterns (Fig. 11-29).

Abundance of fungi is indicated as follows:

absent
present, number of specimens not counted
one specimen per partial plot
2 specimens per partial plot
3 specimens per partial plot
4-10 specimens per partial plot
11-29 specimens per partial plot
30-89 specimens per partial plot
90-189 specimens per partial plot
>190 specimens per partial plot

not only in higher plants but also in fungi. Significant clustering did not often occur. Of 680 distribution patterns, the pattern was random in 537 and clustered in 143. Most species (109) were random in all or in all but one of the plots in which they were found. Only 35 species were clustered in 2 or more plots, of which only 10 species were clustered rather than randomly distributed: *Amanita rubescens* (random once, clustered twice), *Clitocybe flaccida* (r 0, c 2) (Fig. 11), *Galerina calyptrata* (r 1, c 2), *Hapalopilus rutilans* (r 1, c 2), *Inocybe napipes* (r 1, c 2), *Lactarius chrysorrheus* (r 0, c 2), *Marasmius epiphylloides* (r 0, c 3), *Scleroderma citrinum* (r 4, c 7) (Fig. 12), *Typhula phacorrhiza* (r 0, c 2), and *Tyromyces chioneus* (r 1, c 3). Six species were as often clustered as random: *Collybia peronata (r 3, c 3) (Fig. 13)*, *Gymnopilus hybridus* (r 3, c 3), *Laccaria amethystina* (r 2, c 2), *Lactarius camphoratus* (r 2, c 2), *Polyporus brumalis* (r 2, c 2), and *Psilocybe crobula* (r 2, c 2). The other 19 species were more often random than clustered: *Armillariella mellea* (r 7, c 2), *Calocera cornea* (r 12, c 3), *Collybia butyracea* (r 10, c 3), *Collybia cirrhata* (r 4, c 3), *Cudoniella acicularis* (r 10, c 2), *Hypholoma fasciculare* (r 14, c 3), *Hypholoma sublateritium* (r 4, c 2), *Lactarius quietus* (r 9, c 5), *Lactarius theiogalus* (r 10, c 3), *Marasmius androsaceus* (r 3, c 2), *Mycena cinerella* (r 6, c 2), *Mycena rorida* (r 5, c 2), *Mycena sanguinolenta* (r 10, c 2), *Mycena stylobates* (r 5, c 2), *Nectria sp.* (r 11,

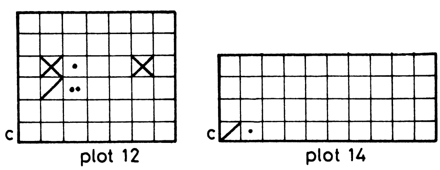

Figure 11. Distribution and abundance of Clitocybe flaccida.

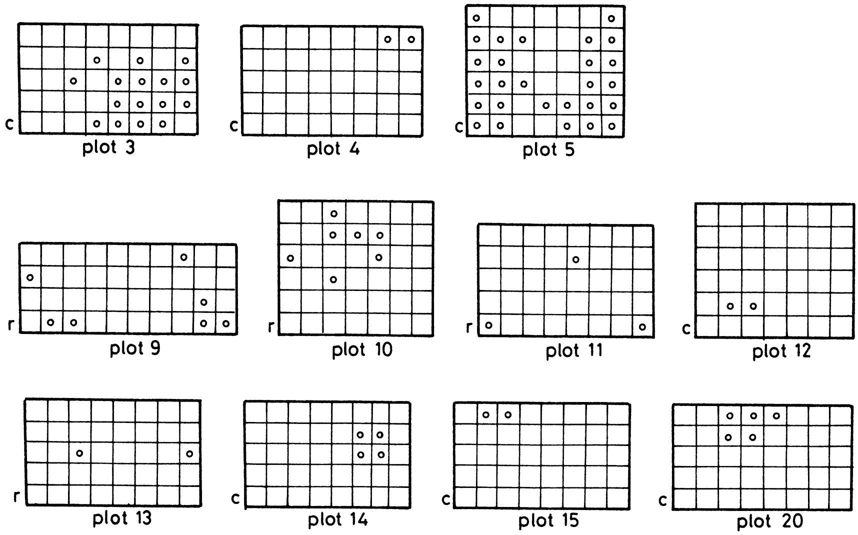

Figure 12. Distribution of Scleroderma citrinum.

c 3), *Oudemansiella platyphylla* (r 9, c 4), *Paxillus involutus* (r 10, c 3), *Phallus impudicus* (r 7, c 3), and *Psathyrella squamosa* (r 10, c 4).

Generally the fungi were clustered in only a few plots. Only *Scleroderma citrinum, Lactarius quietus,* and *Psathyrella squamosa* formed patches in 4 or more plots. Patches formed if either the mycelium was so extended that it spread over 2 or more subplots, or if mycelia were clustered.

Mycelium may spread over several subplots. It could be observed as a cluster of carpophores at the border of a subplot spreading over 2 or more adjacent subplots. This was often observed in fungi growing on prostrate decaying stems, such as *Hapalopilus rutilans, Tyromyces chioneus, Polyporus brumalis* and *Gymnopilus hybridus* (Fig. 14-17). A small patch probably represents only one mycelium. It was not possible to determine whether extensive patches represented one extensive mycelium, or several small mycelia growing together, e.g. the clusters of *Clitocybe flaccida* in Plot 12 (Fig.

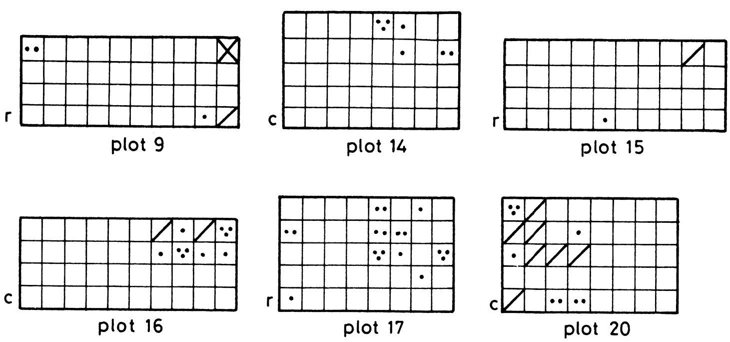

Figure 13. Distribution and abundance of Collybia peronata.

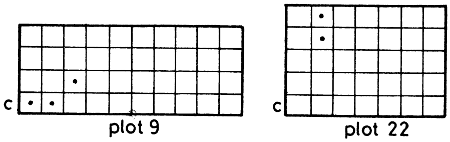

Figure 14. Distribution and abundance of Hapalopilus rutilans.

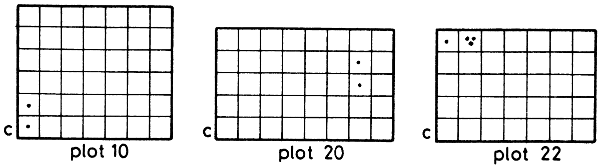

Figure 15. Distribution and abundance of Tyromyces chioneus.

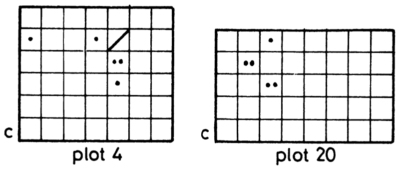

Figure 16. Distribution and abundance of Polyporus brumalis.

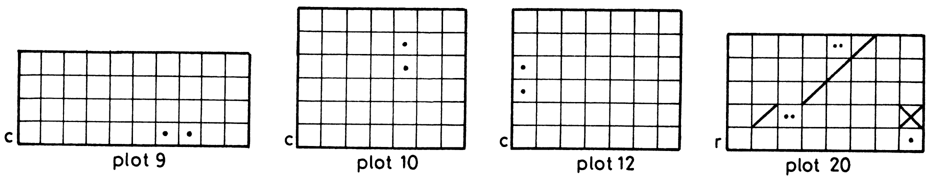

Figure 17. Distribution and abundance of Gymnopilus hybridus.

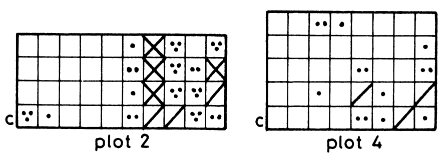

Figure 18. Distribution and abundance of Lactarius chrysorheus.

11), *Scleroderma citrinum* in Plots 14 and 20 (Fig. 12), and *Collybia peronata* in Plot 16 (Fig. 13).

Mycelia could be clustered by intrinsic growth characteristics of the species. One would then expect them to cluster in all plots where they were observed, at least within one vegetation type. Three species showed this feature, *Lactarius chrysorheus* (Fig. 18), *Marasmius epiphylloides* (Fig. 24), and *Typhula phacorrhiza* (Fig. 25). The clustering of *M. epiphylloides* and of

T. phacorrhiza is partly caused by unevenness of the plots for these species (Section 7.3). It was not possible to decide whether the plots were heterogeneous for *L. chrysorheus*, nor whether it was one very extended mycelium (250-500 m^2) per plot, or several smaller mycelia, growing clustered. Biotic unevenness could not explain this clustering because the species with which *L. chrysorheus* was associated, *Quercus robur*, was evenly distributed.

7.3 CORRELATED DISTRIBUTIONS

In Dicrano-Quercetum, Plots 2 and 3, close correlation was found of large number of fungal species in a subplot (that is more species than the mean number of species in the subplots of a composite plot) and high cover of terrestrial moss (cover >5 %) (0.48*, 0.77*). Values in parenthesis are are *V*, first of Plot 2, second of Plot 3. A dash means no observation because the species did not occur in that plot or in less than 3 subplots.

Three species showed a significant correlation with high moss cover in both plots: *Marasmius androsaceus* (0.59*, 0.67*), *Galerina decipiens* (0.61*, 0.34*), and *Inocybe napipes* (0.35*, 0.49*). Several other species had a significant correlation in one plot (Fig. 19 and 20): *Inocybe xanthomelas* (0.51*, -), *I. ovatocystis* (0.41*, 0.28), *Psathyrella fulvescens* (0.36*, -), *Collybia butyracea* (0.35*, -0.17), *Cordyceps ophioglossoides* (0.32*, -), *Galerina calyptrata* (0.31, 0.46*), *G. atkinsoniana* (-, 0.52*), *Mycena galo-*

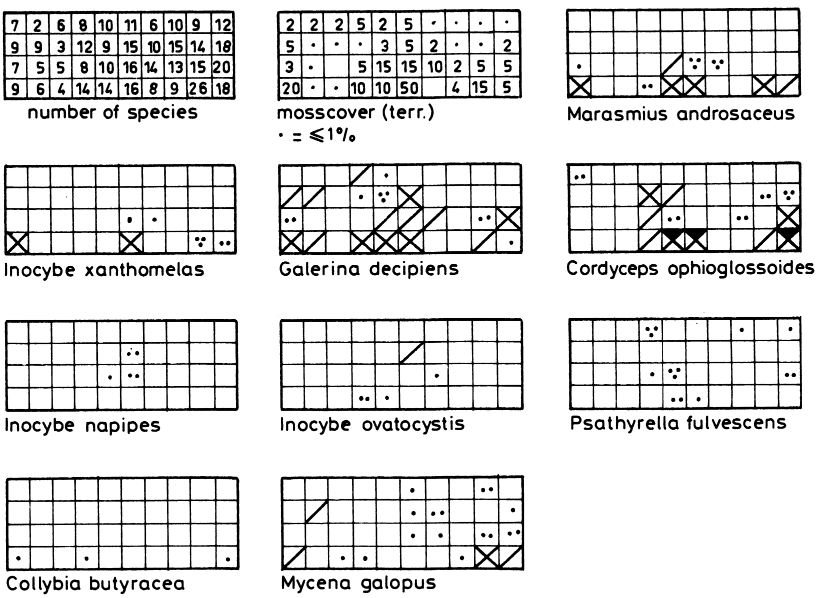

Figure 19. Distribution of number of species of fungi, of moss cover (area fraction of subplots), and distribution and abundance of some fungi in Plot 2.

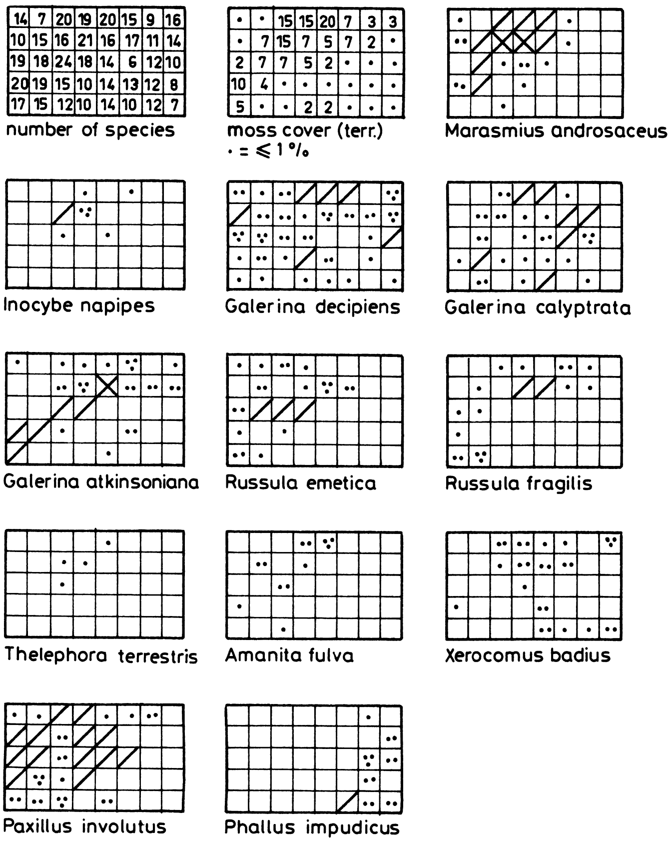

Figure 20. Distribution of number of species of fungi, of moss cover (area fraction of subplots), and distribution and abundance of some fungi in Plot 3.

pus (0.38*, 0.02), *Russula emetica* (-0.12, 0.58*), *R. fragilis* (0.08, 0.56*), *Thelephora terrestris* (-0.12, 0.45*), *Paxillus involutus* (0.00, 0.40*), *Xerocomus badius* (0.15, 0.43*), and *Amanita fulva* (0.24, 0.49*).

Only very few species have a slight preference for growing in the spots with little moss. Few negative correlations of fungi with the moss patches were found, but only once was it significant: *Phallus impudicus* (-, -0.37*).

The moss patches can be considered as a microhabitat with its own fungi. The moss-rich patches were rather large, 25 to 300 m^2: 16 subplots (40 %) in Plot 2 had a moss cover of >5 % and 14 (35 %) in Plot 3. The moss-rich patches indicate the abiotic heterogeneity (rate of litter accumulation) and probably cause, perhaps in combination with tickness of the litter layer, the differences in fungal vegetation.

Subplots with a large number of fungi (more species than the mean number for subplots in that plot) correlated significantly with subplots with a low cover of the herb layer (<10 %) in Plot 14 (V = 0.32*; Fig. 22). Sub-

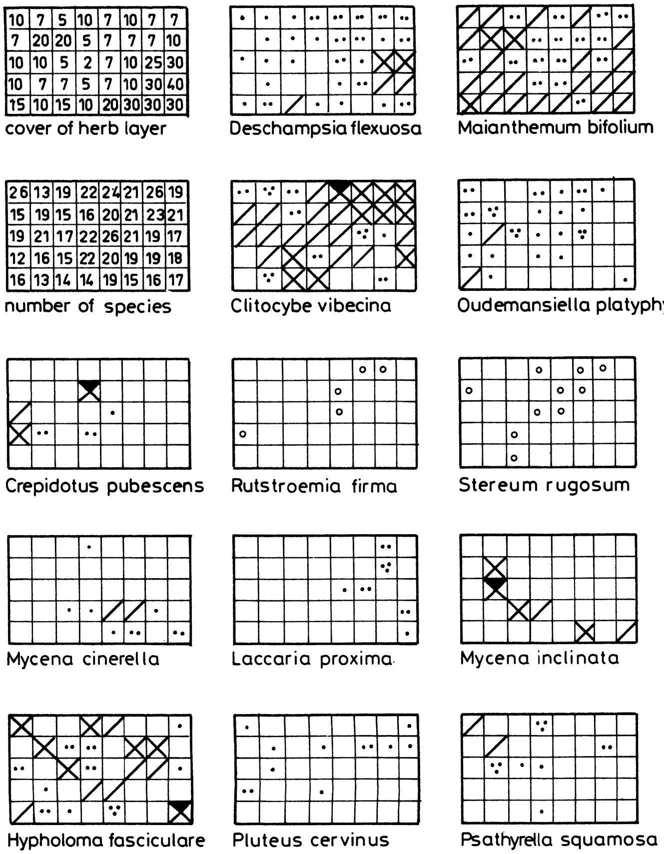

Figure 21. Distribution of the herb cover (area fraction of subplots), of number of species of fungi, and distribution and abundance of some higher plants and fungi in Plot 14.

plots with a low cover of the herb layer were significantly clustered, as were subplots with many species of fungus. I do not know whether the fungi were the cause or a result of absence of herbs, nor which factors cause the clustering. Lange (1923), Wilkins et al. (1938), Leischner-Siska (1939), Friedrich (1940), Krieglsteiner (1977) also reported that the richest fungal flora was found where the phanerogam flora was poor. Few species correlated with a low cover of the herb layer (Fig. 21): *Clitocybe vibecina* (V = 0.49*) and *Oudemansiella platyphylla* (V = 0.43*). For some other species, V had a lower value and was not significant, for instance *Calocera cornea*, *Stereum rugosum*, *Pluteus cervinus*, *Rutstroemia firma*, *Marasmiellus ramealis*, *Phlebia radiata*, *Crepidotus pubescens*, *Collybia peronata*. These are all species growing on litter (fallen leaves or twigs) or on fallen, or standing dead wood.

High density of the herb layer in Plot 14 was caused by high densities of *Maianthemum bifolium*, *Deschampsia flexuosa*, and *Hedera helix*, singly or in combination, and never exceeded 40 % of a subplot. *Marasmius epiphyl-*

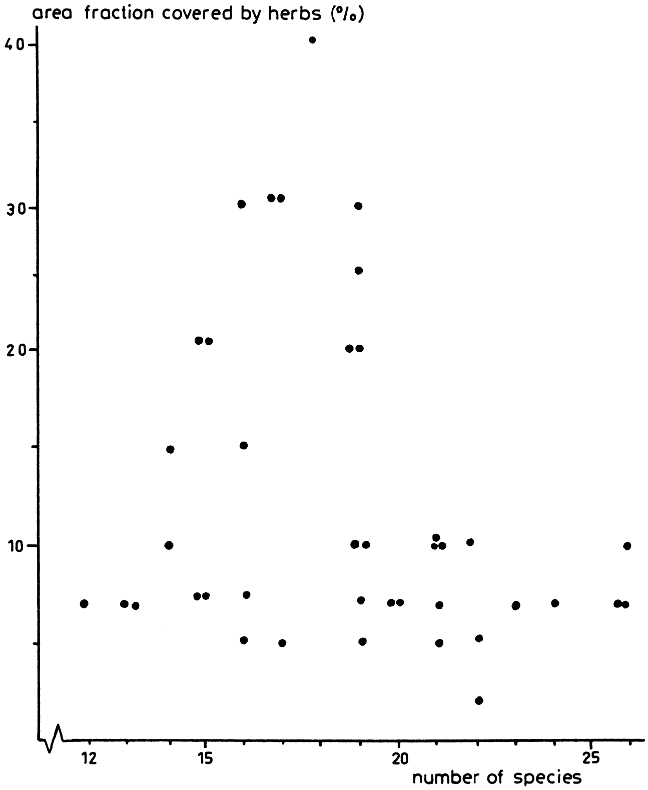

Figure 22. Relation between number of species of fungi and herb cover (area fraction) in subplots of Plot 14.

loides (V = 0.91*; Fig. 24) and *Mycena cinerella* (V = 0.63*) correlated with *Hedera helix*. No other fungi appeared to correlate with a high density of the herb layer or with a specific herb.

In Plot 24, *Quercus robur*, *Betula pubescens* and *Vaccinium myrtillus* were not evenly distributed but grew together in only a small part of the plot (Fig. 23). The density of *Ilex aquifolium* in this part was slightly less than in the rest of the plot (Fig. 25). Shrub and herb layers were almost absent in the whole plot. Several fungi were associated with *Quercus robur*, *Betula pubescens* and *Vaccinium myrtillus*. Correlations were as follows (with values for V):

	with *Q. robur*	*B. pubescens*	*V. myrtillus*
Lactarius quietus	0.73*	0.60*	0.65*
Paxillus involutus	0.26*	0.48*	0.22
Mycena vitilis	0.51*	0.24	0.43*
M. vitilis >4 specimens	0.91*	0.49*	0.83*
Panellus serotinus	0.22	0.40*	0.20
Pluteus cervinus	0.38*	0.28	0.35*
Collybia butyracea	0.38*	0.28	0.35*
C. peronata	0.38*	0.28	0.35*
Mycena cinerella	0.38*	0.28	0.35*

Correlation between the fungi themselves was very low and not significant. These fungi probably depended on one or more species of higher plants. *Paxillus involutus* and *Panellus serotinus* depended on *Betula pubescens*, *Lactarius quietus*, *Mycena vitilis*, *Pluteus cervinus*, *Collybia peronata*, and *Mycena cinerella* depended on *Quercus robur*. None of these fungi depended on *Vaccinium myrtillus*. The influence of higher plants was not very great. The number of fungal species in this part was not larger than elsewhere in the plot.

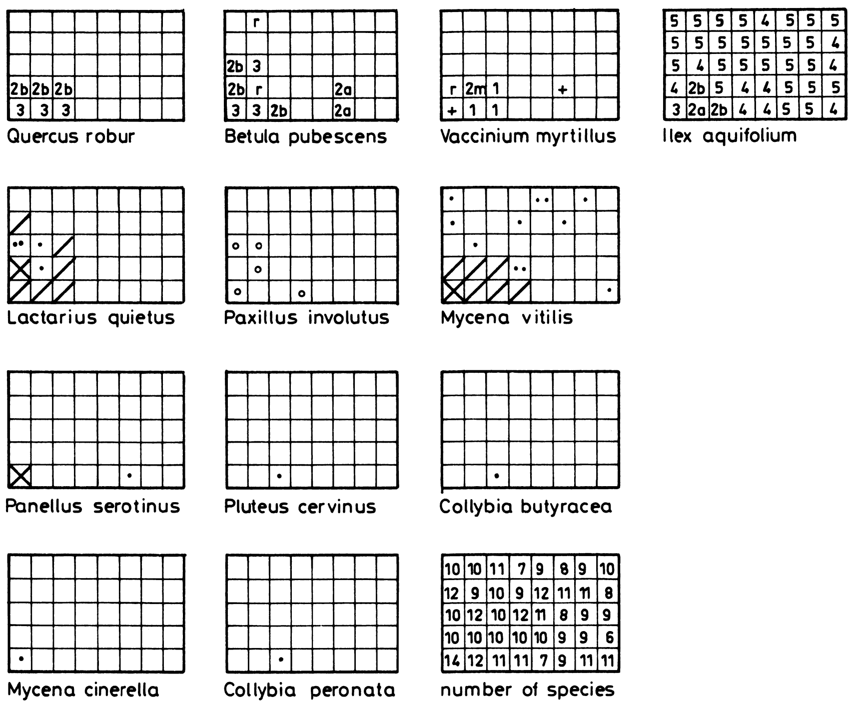

Figure 23. Distribution and abundance of some higher plants and fungi, and distribution of number of species of fungi in Plot 24.

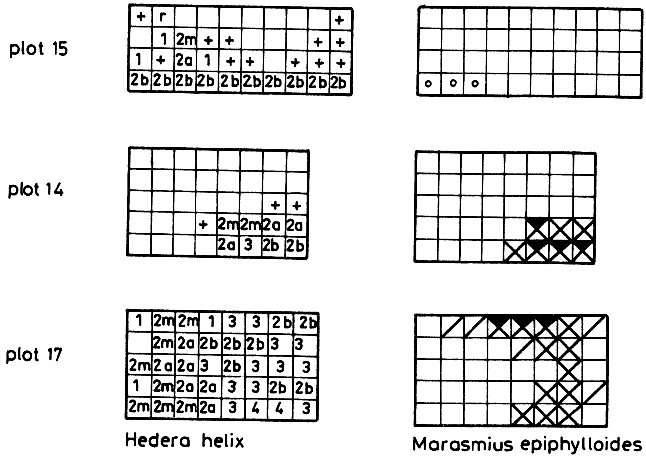

Figure 24. Distribution and abundance of Hedera helix as a ground plant and of Marasmius epiphylloides.

The 2 other Violo-Quercetum ilicetosum plots were more uniform; *Q. robur*, in particular, was uniformly distributed over the whole plot (SF 100 %), so no correlations with fungi could be calculated. Nor were correlations found of these fungi with *B. pubescens* nor with *V. myrtillus* in these plots.

Unevenness of a plot was also found for fungi depending on a special substrate, such as (litter of) a specific plant or another fungus. These substrates were often not quite uniform throughout the plot, so the plot is not uniform for those fungi. Some examples are discussed below.

The substrate for *Marasmius epiphylloides* is dead leaves of *Hedera helix*. The fungus was found in 3 plots and had a correlation with *H. helix* growing on the ground, cover >5 % of 0.91* in Plot 14, of 0.46* in Plot 15, and of 0.43* in Plot 17 (Fig. 24). *Hedera helix* had a clustered distribution in these 3 plots, so the plots were uneven for *M. epiphylloides*. As a result the distribution of *M. epiphylloides* was also clustered. It is not known which agents prevented *M. epiphylloides* from growing in all subplots with a 5 % or more cover of *H. helix* growing on the ground.

The leaves of *Ilex aquifolium* are the substrate for *Typhula erythropus* and *T. phacorrhiza*. These fungi were only found in Plots 20 and 24, where they correlated with *I. aquifolium* in the tree layer cover >75 % (Fig. 25). Values of *V* were for *T. erythropus* 0.56* in Plot 20 and 0.63* in Plot 24, for *T. phacorrhiza* 0.70* in Plot 20 and 0.45* in Plot 24. Apparently the *Ilex* litter was only suitable for the *Typhula* species if the cover of *Ilex* trees was high. The fungi were not found in other plots with high *Ilex* densities. Apparently other factors prevented the fungi from growing there.

Psilocybe crobula grew on the petioles of leaves of *Pteridium aquilinum* in Plot 20 (Fig. 26). Correlation was 0.52*. Correlation with *P. aquilinum* cover >50 % was much higher, 0.90*. Apparently *P. crobula* prefers high

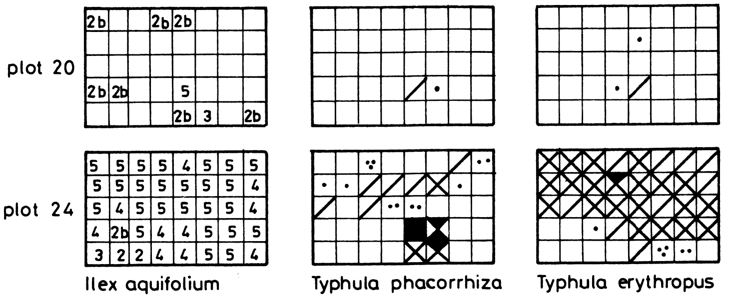

Figure 25. Distribution and abundance of Ilex aquifolium (tree layer), Typhula phacorrhiza, and T. erythropus.

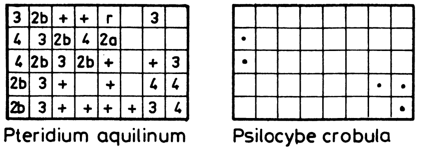

Figure 26. Distribution and abundance of Pteridium aquilinum and of Psilocybe crobula in Plot 20.

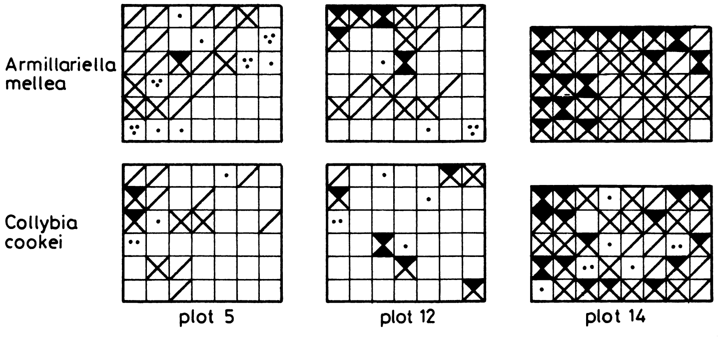

Figure 27. Distribution and abundance of Armillariella mellea and Collybia cookei.

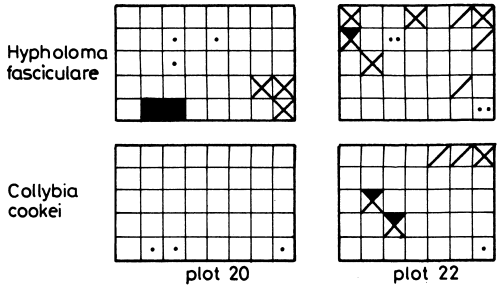

Figure 28. Distribution and abundance of Hypholoma fasciculare and Collybia cookei.

cover of *P. aquilinum*. The species also grew together in two other plots, but there *P. crobula* grew on another substrate and no correlation was found: -0.08 in Plot 15, and 0.07 in Plot 17.

Collybia cookei grows on 'rotten' fleshy fungi. In fact, the substrate was not 'rotten', but was a kind of sclerotium. In several plots, *C. cookei* grew on *Armillariella mellea* (Fig. 27). In the plots where both species grew together, in at least 2, and at the most all but 5 subplots, the following values for *V* were found: Plot 5 0.55*, Plot 10 0.25, Plot 11 -0.17, Plot 12 0.35*, Plot 16 0.22, Plot 17 0.18, and Plot 22 0.05. In Plots 5 and 12, the distribution of *C. cookei* depended, at least partly, on the distribution of *A. mellea*. In Plot 14, the CSF of both species was very high, 98 %, so a calculated correlation was meaningless; the substrate for *C. cookei* was distributed homogeneously as also was *C. cookei*. In that plot too, the distribution of *C. cookei* depended very much on that of *A. mellea*. Other species on which *C. cookei* could depend, like *Paxillus involutus*, *Russula* or *Boletus* species, did not explain the distribution of *C. cookei* in Plots 5, 12, and 14. In Plots 10, 11, 16, 17 and 22, the distribution of *C. cookei* was not explained by the distribution of *A. mellea*.

In Plots 20 and 22, the distribution of *C. cookei* was correlated with the distribution of *Hypholoma fasciculare* (*V* = 0.57* and 0.38*; Fig. 28). In other plots where these species grew together, no significant correlation was found.

Paxillus involutus is a mycorrhizal symbiont. In several plots, a strong correlation with *Betula pubescens* cover >12.5 % or cover >25 % was found (Fig. 29). The following values for *V* were found (only calculated in plots were *P. involutus* had a CSF of at least 5 % and *B. pubescens* at the most a spatial frequency of 90 %):

Plot No.	Correlation(*V*) of *Paxillus involutus* with *Betula pubescens* cover >12.5 %	>25 %	Spatial frequency of *Betula pubescens* cover >12.5 %	>25 %	Cumulative spatial frequency of *Paxillus involutus*
5	0.41*	-	12	0	29
9	0.19	0.35*	88	50	33
10	0.17	0.26	71	35	38
11	-	0.13	93	43	33
13	0.25	0.41*	80	38	75
14	0.43*	0.31	35	32	70
15	0.13	0.14	80	50	28
16	0.14	0.09	53	8	43
24	0.46*	0.48*	20	8	25

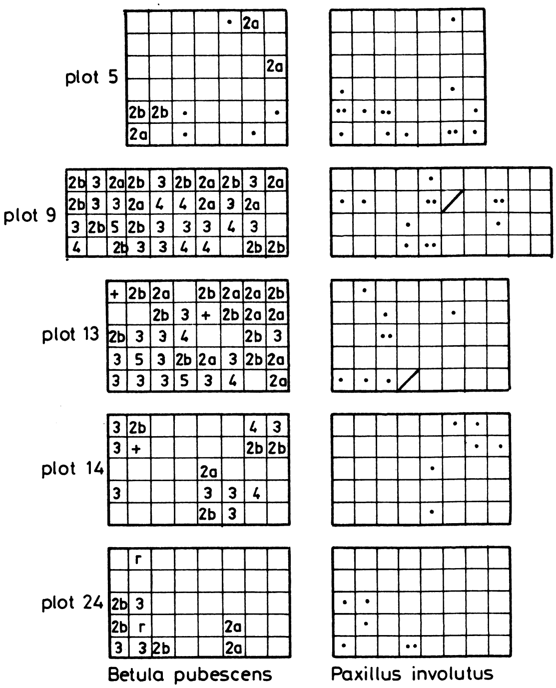

Figure 29. Distribution and abundance of Betula pubescens in tree layer and of Paxillus involutus.

The species were significantly correlated in the 3 plots with the lowest frequency of *B. pubescens*. In 2 of the 4 plots with a high spatial frequency (>80 %) of *B. pubescens*, there was a correlation with *B. pubescens* cover >25 %. No (significant) correlation was found in 4 plots. *P. involutus* also formed mycorrhiza with *Quercus robur*, as apparently happened in Plots 2, 3 and 4, where *B. pubescens* did not occur. No correlation was found with other host plants, such as *Populus tremula* or *Fagus sylvatica*.

Between *Paxillus involutus* and *Phallus impudicus*, a negative correlation was found in several plots. The following values for *V* were found (only calculated in plots where both species occurred at least in 2 subplots): Plot 3 -0.59*, Plot 5 -0.02, Plot 11 -0.21, Plot 13 -0.14, Plot 15 -0.05, Plot 16 -0.14. In plot 3, the only one where the correlation was significant, *P. involutus* grew in the moss patches and *P. impudicus* outside the moss patches in the bare litter (Fig. 20).

7.4 CONCLUSION

The distribution patterns of most of the species were random in the scale used. Significantly uniform patterns were not found. Significantly clustered patterns were scarce and it is not known for certain whether only the carpophores were clustered or whether the mycelia were clustered. Clustering of some fungi could depend on a special substrate, e.g. dead wood, other species of fungi or plants. The distribution of some fungi in Dicrano-Quercetum depended on the distribution of moss patches. In one plot, the distribution of some fungi was negatively correlated with a high cover of plants. The distribution of *Marasmius epiphylloides*, *Typhula erythropus* and *T. phacorrhiza*, *Psilocybe crobula*, *Collybia cookei* and *Paxillus involutus* was (partly) explained by the respective distribution of *Hedera helix*, *Ilex aquifolium*, *Pteridium aquilinum*, *Armillariella mellea* and *Hypholoma fasciculare*, and *Betula pubescens*. But for some fungi (e.g. *Lactarius chrysorheus*) no cause for the clustering could be traced.

8 Composition of ecological groups

Within the fungus flora of these oak woods, 6 ecological groups were distinguished: mycorrhizal species; saprophytes on humus; saprophytes on decaying wood and branches; saprophytes on fallen leaves, fruits, dead herbs and mosses (litter saprophytes); parasites; and fungi on dung and bird pellets. Every species was classed into one of those groups. Some species were difficult to class, e.g. it was not always known whether a species was mycorrhizal. For genera such as *Cortinarius* and *Lactarius*, this question is beyond doubt, but opinions varied about genera such as *Inocybe* and *Tricholoma*. Fungi can also be facultative mycorrhizal, as are *Laccaria* species. Following the literature (mainly Trappe, 1962) I took as mycorrhizal the species of the genera *Amanita*, *Boletus*, *Cantharellus*, *Cortinarius*, *Dermocybe*, *Hebeloma*, *Hydnellum*, *Inocybe*, *Lactarius*, *Leccinum*, *Paxillus*, *Phallus*, *Phellodon*, *Phylloporus*, *Russula*, *Sarcodon*, *Scleroderma*, *Tricholoma*, *Tylopilus*, *Xerocomus* (except *X. parasiticus*), and *Lepista nuda*.

Saprophytes growing on decaying wood of stumps, trunks, logs, and branches were generally easy to distinguish, as this way of growth is usually a clear characteristic. Classed as wood saprophytes were species of the Polyporaceae, of the genera *Bulgaria*, *Calocera*, *Coryne*, *Chondrostereum*, *Exidia*, *Gymnopilus*, *Hohenbuehelia*, *Hypholoma*, *Kuehneromyces*, *Lentinellus*, *Marasmiellus*, *Nectria*, *Oudemansiella*, *Panellus*, *Pleurotus*, *Pluteus*, *Rutstroemia*, *Sphaerobolus*, *Steccherinum*, *Tremella*, *Tricholomopsis*, *Xylaria*, and *Collybia fusipes*, *Coprinus* Sect. *Micacei*, *Crepidotus haustellaris*, *Entoloma euchrous*, *Galerina cinctula*, *G. ampullaceocystis*, *G. triscopa*, *Mycena galericulata*, *M. haematopus*, *M. inclinata*, *M. polygramma*, *Pholiota alnicola*, *P. tuberculosa*, *Psathyrella hydrophila*.

It was not always easy to distinguish the humus saprophytes from the litter saprophytes. It was difficult determine whether some species grew on humus or on fallen leaves. I took as humus saprophytes species of the genera *Clavulina*, *Clitocybe*, *Cystoderma*, *Entoloma* (except *E. euchrous*), *Helvella*, *Laccaria*, *Lepiota*, *Psathyrella* (except *P. hydrophila*), *Tephrocybe*, *Tubaria*, and some of the species of *Collybia*, *Mycena*, *Stropharia*.

For litter saprophytes it was sometimes difficult to distinguish between saprophytes and parasites. Especially in some species growing on herbs, as did *Mycena rorida* and *Crepidotus pubescens*, it was not clear whether they grew on dead or on still living herbs. I considered them as saprophytes like *Collybia cirrhata*, *C. cookei* and *C. tuberosa*. Species (only a few) growing on or between mosses were also added to this ecological group. I considered as litter saprophytes species of the genera *Ciboria*, *Clavariadelphus*, *Collybia* (except *C. fusipes*), *Crepidotus* (except *C. haustellaris*), *Marasmius*, *Psilocybe*, *Rickenella*, *Typhula*, and some species of *Galerina*, *Mycena*.

The group parasites included only a few species. The difference between parasites and saprophytes was not always well defined. Two species were included that were sometimes parasites and sometimes saprophytes: *Armillariella mellea* and *Heterobasidion annosum*. Parasites on insects and other fungi were also included here (*Cordyceps* spp.). The group of fungi on dung and bird pellets was also very small: some *Coprinus* species, *Onygena corvina*, *Panaeolus fimicola* and *Stropharia semiglobata*.

The number of species in each ecological group were counted for each association and for all associations together (Table 7). The group mycorrhizal species was especially important in Dicrano-Quercetum. Many of the mycorrhizal species found in this study were present there, and 44 % of the species in Dicrano-Quercetum were mycorrhizal. The number and proportion of mycorrhizal species was much lower in Querco-Betuletum, and lower still in Violo-Quercetum.

The group of humus saprophytes was almost equally important in all associations. The number in Violo-Quercetum ilicetosum was slightly lower, but the proportion equalled that in the other associations.

The group of saprophytes on wood was especially large in Violo-Quercetum ilicetosum, where 62 species were present. In this subassociation, 46 % of the species were wood saprophytes. About the same number of species was present in Violo-Quercetum typicum and Querco-Betuletum, but the proportion was smaller. A much smaller number (and proportion) was present in Dicrano-Quercetum. The small number in Dicrano-Quercetum was probably caused by the sparse covering in the microhabitat of 'dead stumps and logs', 0.07 % (Table 2). This microhabitat was more common in Quercion robori-petraeae, covering 1.5 % in Querco-Betuletum, 1.6 % in Violo-Quercetum typicum, and 1.0 % in Violo-Quercetum ilicetosum.

Table 7. Ecological groups of fungi. Number of species in the 6 groups for each association (proportion (%) of total number of species in an association in parenthesis) and in all the vegetation types together.
M, mycorrhizal species; H, humus saprophytes; W, saprophytes on decaying wood; L, saprophytes on litter, branches, fallen twigs, leaves, fruits, dead herbaceous plants and mosses; P, parasites; D, fungi on dung or bird pellets.

	M	H	W	L	P	D
Dicrano-Quercetum	78(44)	34(19)	36(20)	23(13)	4(2)	4(2)
Querco-Betuletum	40(21)	41(22)	56(30)	41(22)	5(3)	4(2)
Violo-Quercetum typicum	28(16)	40(23)	60(34)	39(22)	3(2)	5(3)
Violo-Quercetum illicetosum	19(14)	25(18)	62(46)	27(20)	1(1)	2(1)
Total	102(33)	64(20)	81(26)	52(17)	7(2)	7(2)

The group saprophytes on litter was largest in Querco-Betuletum and Violo-Quercetum typicum. Fewer were present in Violo-Quercetum ilicetosum, but the proportion equalled that in Querco-Betuletum and Violo-Quercetum typicum. In Dicrano-Quercetum the number (and proportion) was slightly lower than in the associations of Quercion robori-petraeae.

The groups parasites and saprophytes on dung represented only a very small proportion of the mycoflora, and did not differ much between the 4 (sub)associaions.

Querco-Betuletum had about the same share of saprophytes, but slightly more mycorrhizal species than Violo-Quercetum typicum. The low number of species in Violo-Quercetum ilicetosum was due to the very low number of mycorrhizal species, and the slightly lower number of humus and litter saprophytes. Dicrano-Quercetum had less saprophytes, but many more mycorrhizal species than the associations of Quercion robori-petraeae.

9 Annotations on identification and taxonomy of some fungi

Nomenclature was based on Moser (1978) for Agaricales and Boletales (except for some recently monographed genera); Donk (1974) for Polyporaceae; Dennis (1978) for Ascomycetes; Maas Geesteranus (1975) for hydnaceous fungi; Corner (1967) for Clavarioid fungi; Dumoulin (1968) for Gasteromycetes; Eriksson & Ryvarden (1973-1979) for Corticiaceae; Bourdot & Galzin (1927) for Heterobasidiomycetes. Many other books and articles were used for the identification.

Material of many species was conserved (exsiccata) at the herbarium of the Biological Station, Wijster, not indicated or indicated with (Wag-W). Some collections from the Rijksherbarium, Leyden, were studied, as indicated with (L). Collections were cited by the name of the collector (my own collections indicated by AEJ) followed by collection number.

Colours are often indicated in colour codes: Munsell or M refers to the Munsell Soil Colour Charts (1954), Expo to the Code Expolaire (Cailleux & Taylor, 1958), and Methuen to the Methuen handbook of colour (Kornerup & Wanscher, 1978).

The number of gills is given: the number of entire lamellae (L) and the number of lamellulae (l) between two entire lamellae.

The ratio of length to width (Q) of spores is given. Q = 1.3-1.6-1.8 means: length to width ratio varied from 1.3 to 1.8, mean value 1.6.

Amanita porphyria. Det. C. Bas. Spores spherical.

Armillariella mellea. The small species into which *A. mellea* has been split were not distinguished here.

Clitocybe. Many of the specimens of the hygrophanous species of this genus were identified by T.W. Kuyper.

C. candicans. Often a small membranaceous white *Clitocybe* sp. was found. It had crowded thin gills, almost without smell or taste and clearly belonged to the group Candicantes. It grew on leaves; spores were small, ellipsoid, (4.5-)5-6(-6.8) × 2.9-3.9 μm. It was difficult to decide whether it was *C. candicans* with longer spores or *C. tenuissima* Romagn. growing on leaves. I decided to follow Harmaja (1969) and to consider it as one species, *C. candicans*. The name *C. tenuissima* is regarded as a more recent synonym.

C. metachroa. I considered *C. dicolor* (Pers.) Lge and *C. metachroa* conspecific, and united them under the name *C. metachroa*.

C. vibecina. *C. langei* Sing. ex Hora is included, as I consider them conspecific.

Collybia. Nomenclature according to Jansen & Noordeloos (1980).

Collybia dryophila. Both forma *funicularis* Fr. and f. *dryophila* were found. The latter was very variable: the colour of the cap varied from very light to very dark brown, the form of the cheilocystidia varied from more or less cylindrical with coralloid branches, to clavate with thin branches, and to capitate or almost spheropedunculate. They were both found growing on the ground and on oak trunks.

C. cf. *kuehneriana*. Only one specimen was found. It was too old to identify with certainty.

Coprinus domesticus, *C. micaceus*, *C. radians* and *C. xanthothrix* are listed under *Coprinus* Section *Micacei* in Table 4 and Appendix Table D.

C. tuberosus and *C. velox*. See Kits van Waveren (1968).

Cordyceps sp. Sent to Dr R.A. Samson for determination; publication in preparation.

Cortinarius albofimbriatus. Det. P. Ypelaar.

C. alboviolaceus. Det. P. Ypelaar.

C. bolaris. Det. P. Ypelaar.

C. decipiens sens. Lge. Det. P. Ypelaar.

C. decipiens sens. Henry. Very often, I found a rather small brown *Telamonia* with distinct conical papilla, on a rather long and slender stem. I considered it as *C. decipiens* sens. Henry. As there are very few publications on this fungus, a description of the specimens studied follows.

Cap 15-35 mm wide, first convex to pulvinate, then plano-convex to flat, sometimes with undulate to ascending margin, always with distinct conical papilla with rounded top, dark brown, dark red-brown, Munsell 2.5YR 2/4-3/6, 5YR 2/2, 3/2-4, 4/3, 7.5YR 3-4/2-4, often lighter in marginal zone to 7.5YR 5-6/4, hygrophanous, when drying turning to brown or pale brown, M 7.5YR 3/2, 4-6/4, 10YR 7-8/4. When young, it has very fine whitish velar fibres; when older, these are only present on the margin or it is glabrous. Gills (L 21-28, 1 3-7) slightly emarginate, (3-)4-5(-7) mm high, distant, about 8-12 per centimetre half-way between margin and cap centre, yellowish-ochre, 7.5YR 4/4, 5/6-8, 10YR 5/8, 6/6, edge entire or crenate, when young whiter than the sides, when old almost the same colour as the sides. Stipe (30-)45-75(-90) × 2-5 mm, cylindrical, base sometimes slightly broader up to 6 mm, occasionaly bent, and sometimes rooting slightly, with fine longitudinal white silk-like shiny fibrils, when very wet colour of stipe flesh shines through; sometimes the stipe has an indistinct band of white velar fibres half-way, foot with white, occasionally slightly pink tomentum, which sticks the substrate together. Flesh in cap thin, ± 1 mm, in the papilla thicker, same colour as surface; in stipe, thin, slightly lighter than the surface, 5YR 4/3, 5/4, 7.5YR 4-5/4. Smell raphanoid when cut, seldom odourless. Taste sometimes slightly raphanoid, usually insignificant. Spores (9.5-)10.2-12.7 (-13.9) × (5.4-)6.1-6.8(-8.0) µm (about 200 measurements in 11 collections), Q 1.7-1.8-1.9, ellipsoid to oblong, often with one big drop of oil, distinctly rough, the top often with some bigger warts; above the apiculus, a small smooth plage. Basidia 30-40 × (6-)7-10 µm, clavate, 4-spored. Pleurocystida absent. Cheilocystidia (15-)20-31 × 7.8-10.2 (-15.5) µm, clavate to broad clavate, not very distinct from young basidia, with a thin smooth colourless wall, often multicellular, top cell sometimes nearly spherical, in clusters, in old specimens often indistinct; edge usually partly sterile. Habitat.-- In rather nutrient-poor but humus-rich oak woods on sandy soils, on and between half-rotten litter, clustered together. Collections examined.-- Netherlands: Prov. Drenthe, Amshoffsbos, AEJ 252, AEJ 559 and 560; Tonckensbos, AEJ 402, AEJ 587; Schoonloër strubben, AEJ 492, AEJ 586, AEJ 471; Schoonloër strubben, AEJ 366; Heuvingerzand, AEJ 220; Prov. Overijssel, De Eese, AEJ 491, AEJ 233, AEJ 400, AEJ 464, AEJ 529. (All Wag-W).

The large spores and the cheilocystidia are characteristic. Both characteristics fit *C. decipiens* sens. Henry mentioned by Kühner & Romagnesi (1953). Moser (1978) did not mention this fungus. Unfortunately I could not consult Henry's original description. In the Winkelbos (Plot 18), I found some specimens (AEJ 566) very similar to *C. decipiens* described above, but the papilla was absent, the colours were darker red (M 5YR 3/1-2 when fresh), and the spores were somewhat smaller: (7.8-)8.3-10.0(-10.8) × (4.9-)5.4-5.9 µm, Q 1.6-1.9. I am not sure whether it was the same or some other species. Appendix Table D lists it under *C. decipiens* sens. Hy, but it should be read as cf. *decipiens*.

C. cf. *fasciatus*. In Amshoffsbos (Plot 5), I found a fungus (AEJ 592) with the following characteristics. Cap 22 mm wide, with rather sharp papilla and ascending margin, hygrophanous, bleached to very pale brown, Munsell 10YR 8/4, papilla brown 10YR 5/3. Gills 4 mm high, rather distant, yellow, 10YR 7/6. Stipe 75 × 3 mm, honey-coloured, the upper half shining and glabrous, the lower half with some white velar fibres. Spores 7.6-8.8(-9.3) × 4.9-5.6 µm (14 measurements, 1 collection), Q 1.5-1.6-1.9, ellipsoid, seldom ovoid, distinctly rough.

According to Lange (1938) and Kühner & Romagnesi (1953), it can easily be identified as *C. fasciatus*. It also fits a description by Kühner (1961). The specimens were rather old and dried when they were found, so I could not describe the fresh colours. As this makes the identification uncertain, I called this fungus *Cortinarius* cf. *fasciatus*.

C. fusisporus. A very rare fungus, described by Kühner in 1955 and not mentioned since in the literature. Even Moser (1978) did not know this species. I found it 5 times on 3 different plots, so it is certainly not a very rare species in this type of vegetation. Description was as follows. Cap 9-29(-45) mm wide, first conical with broad involute margin, later becoming hemispherical to convex to flat, when old sometimes with ascending margin, sometimes with small flat umbo, dark brown, brown-yellow, yellow-brown, Munsell 5YR 4/6, 7.5YR 4-7/4, 10YR 6/4, finely radially fibrillose, at first entire, later only at margin covered with whitish or yellowish velar fibres. Gills up to 5 mm high, adnate, reddish-brown, strong brown, M 5YR 5/4-6, 7.5YR 5/6, 10YR 5/8, edge entire to finely crenate, same colour as sides. Stipe 17-40(-70) × 2-4(-6) mm, more or less cylindrical, slightly shining brown-yellow, M 7.5YR 7/6, 10YR 6-7/6, 8/4, a third to half-way down from top with small yellow annulus, the lower half with some whitish velar fibres, the foot with little, whitish felt. Flesh in cap and stem watery yellow, about the same colour as the surface. Smell insignificant, when cut sometimes slightly raphanoid. Spores (8.0-)8.8-10.7 (-12.7) × (4.2-)4.4-4.9(-5.4) µm (42 measurements in 5 collections), mean Q 2.2, distinctly rough, top with bigger warts. Basidia clavate, e.g. 24 × 7.8 µm, 28 × 8.3 µm, 4-spored. Gill trama regular, hyphae with brown walls with brown incrusted pigment. Habitat.-- In nutrient-poor, humus-poor oakwoods on sandy soils; growing on sand. Collections examined.-- Netherlands, Prov. Drenthe, Dwingeloo, AEJ 373; Zuid Hijkerzand, AEJ 240, AEJ 342 and 343; Schoonloër strubben, AEJ 581 (All Wag-W).

C. hinnuleus. As I found it difficult to find the right name for this species, I described the specimens studied. Cap 18-56 mm wide, first more or less hemispherical, later broadly conical to convex, with flat umbo and broad, inflexed margin, dark brown, Expo F-H 52, near margin Expo F 62, yellowish brown when dried, Expo C 63, Munsell 10YR 7-8/6, margin sometimes slightly grayer, indistinctly radially fibrillous, later almost entirely fine-scaly, sometimes radial cleft, margin not stiate, with some velar fibres. Gills (L 27-32, 1 3) 5-9 mm high, adnexed, rather distant, almost the same colour as the cap, yellowish-brown, M 10YR 5-6/4. Stipe 40-50 × 5-9 mm, cylindrical or broadening towards the base to 5-11 mm, at first white fibrillous with about half-way a distinct white, persistent velar belt and further down many white velar flocks, later browner, foot white-felted, sometimes with a little lilac. Smell indistinct to slightly nasty-sweetish. Taste slightly raphanoid, sharp. Spores (6.3-)7.8-9.0(-9.8) × 4.9-5.9(-6.3) µm, Q 1.3-1.5-1.8, ellipsoid sometimes oblong, distinctly rough, with one big drop of oil. Habitat.-- In nutrient-poor and humus-poor oak woods on sandy soils; on sand. Collections examined.-- Netherlands, Prov. Drenthe, Zuid Hijkerzand, AEJ 591 and B.W.L. de Vries 3364. The specimens studied correspond to those described by Henry (1936).

C. mucifluus. Det. P. Ypelaar.

C. obtusus. It was difficult to find the right name for this species too. Although the spores were slightly too big and a different habitat was stated, the collections agreed with those described by Kühner (1961). The following is a description of specimens from the Province of Overijssel. Cap 10-30 mm wide, first hemispherical or broadly conical with a rounded top, later conico-convex to convex or plano-convex with a broad rounded umbo, or even flat or with slightly ascending margin, dark red brown, Munsell 2.5YR 3/4, orange brown to yellowish near margin, 5YR 5-6/8, 7.5YR 5/6-6/8, hygrophanous, margin when wet striate, with white velar fibres. Gills up to 3 mm high, slightly anastomosing, first light brown, later darker, yellow-brown, ochre-brown, Munsell 7.5YR 5-6/8, 5YR 5/8, towards edge slightly lighter, 7.5YR 7/8. Stipe 35-45 × 2-5 mm, more or less cylindric or slightly attenuate towards base, young completely white and fibrillose, when older white fibrillose with light brown top, later strong brown, 7.5YR 5/6, with some white fibres and a red-brown top, 2.5YR 4/4. Flesh in cap thin, dark red-brown, like the surface, in stipe top orange-brown, 5YR 5/8, towards base lighter to 7.5YR 6/8 in foot. Smell indistinct. Spores (6.6-)7.3-8.3(-9.3) × 4.4-5.6 µm, ellipsoid, sometimes slightly ovoid, indistinctly rough, light yellowish to brownish-yellow under the microscope. Gill trama yellowish to brownish-yellow in KOH, hymenium with some inconspicuous yellow necropigment. Habitat.-- In oak woods on nutrient-poor and humus-poor sandy soils. Collections examined.-- Netherland, Prov. Overijssel, De Eese, AEJ 594 and 595, AEJ 379.

C. orellanoides. A beautiful and interesting fungus, that I found only in one plot in 2 successive years at exactly the same site. Cap 26-32 mm wide, broadly conical, with a rather acute top and slightly involute margin, later convex with distinctly flat umbo and inflexed margin, orange-brown, yellowish-red, Munsell 5YR 5/6, 7.5.YR 5/6, Methuen 6D8, 7E7, not hygrophanous, completely covered by fine scaly fibrils in the same colour. Gills (L c. 35, 1 (0-)1 (-3)) up to 7 mm high, narrowing near stem and decurrent by a small tooth (uncinate), rather distant, c. 12 per centimetre half-way between margin and cap centre, the same colour as the cap or slightly lighter, Methuen 6D6; margin entire, the same colour as sides. Stipe 50-70 × 6.5-8 mm, toward base gradually thickening to 8-12 mm at foot, nearly the same colour as the cap or slightly lighter, Munsell 5YR 5/8, 7.5YR 6/6-7/8, longitudinally slightly fibrillose, in lower half with 2 light yellow velum belts, 10YR 8/6, foot entirely covered with light yellow velum, 10YR 6-8/6, 2.5Y 7/6, the tip of the foot slightly white-tomentose. Flesh in cap and stem light yellow, 10YR 8/4, turning dark brown with KOH. Spores (8.3-)9.3-10.7(-12.7) × (6.3-)6.8-8.3 µm (34 measurements, 2 collections), Q 1.2-1.4-1.6, ovoid, broad ovoid, ellipsoid or broad ellipsoid, top sometimes slightly acute, distinctly rough, with one big drop of oil. Basidia (34-)38.5-41.5(-47.3) × 8.8-10.7(-12.2) μm (11 measurements), slenderly clavate, 4-spored, light brown when old. Gill trama consisting of cylindrical to weakly or distinctly inflated hyphae, 5-10(-20) μm wide, with a thin smooth, light yellow-brown wall and some scattered darker spots. Habitat.-- In oak-birch woods on nutrient-poor sandy soils (Querco-Betuletum), between litter and *Polytrichum formosum*. Collections examined.-- Netherlands, Prov. Drenthe, Amshoffsbos, AEJ 359, AEJ 561.

C. paleaceus sens. lat. Here I have included *C. paleaceus* Fr. and *C. flexipes* Fr. as mentioned by Lange (1938), *C. paleaceus* Fr. ex Weinm. and forma *flexipes* Fr. as mentioned by Kühner & Romagnesi (1953), and *C. paleaceus* Fr. and *C. paleiferus* Svrček as mentioned by Moser (1978). Lange noted that *C. paleaceus*, *C. flexipes* and *C. hemitrichus* were intimately related, especially *C. paleaceus* and *C. hemitrichus*. *C. flexipes* should be more easily distinguishable because of the dark gills. Kühner & Romagnesi do not refer to Lange's plates; they distinguish the var. *flexipes* from the more usual form by the dark gills. Moser considers *C. paleaceus* and *C. flexipes* sens. Lange synonymous. *C. paleiferus* is distinguished from *C. paleaceus* by the violaceous gills, and so seems to me to be synonymous with *C. paleaceus* var. *flexipes* sens. Kühner & Romagn.

For a time, I thought the specimens I had found could be divided clearly into *C. paleaceus* and *C. paleiferus*. A fungus with violaceously tomentose stipe base, violaceous gills, and a conico-convex cap with acute papilla and many velar flocks was *C. paleiferus*. A more slender fungus with a flatter cap, smaller papilla, more fugacious velum, and without violaceous colours was *C. paleaceus*. The size of the spores of these taxa was almost the same. While studying the collections, other forms came to light: one similar to *C. paleiferus*, 2 others similar to *C. paleaceus*.

	Form of cap	Velum on cap	Colour of		
			gills	top of stipe	tomentum on foot
paleiferus e.g. AEJ 515	conico-convex big papilla	very much persistent	viol	viol	viol
cf. *paleiferus* e.g. AEJ 500	conico-convex small papilla	fugacious	lbrown	viol	viol
cf. *paleaceus* e.g. AEJ 496	convex small papilla	fugacious	brown	brown	±viol
cf. *paleaceus* e.g. AEJ 572	convex small papilla	fugacious	brown	brown	white or none foot brown
paleaceus e.g. AEJ 562	convex small papilla	much ±fugacious	brown	brown	white (rare)

(viol=violaceous; lbrown=light brown)

The material studied varied so much that more combinations probably exist. As yet, I cannot say whether these specimens belong to 1, 2 or more species. In field studies, *C. paleaceus* was often recorded without details being noted, for instance about colours, so it was impossible to distinguish the 5 forms later. I have therefore grouped them all under the name *C. paleaceus* sens. lat.

C. pluvius. Kühner (1959) described *C. pluvialis* as a new name for *C. pluvius* sens. Orton. Kühner's fungus, however, was slightly more robust and had bigger spores than AEJ 521; the colours were similar. Orton's description (1955) was rather concise, so, without studying the collections, I do not know whether they are separate species. I have called this collection *C. pluvius* sens. Orton. Descriptionis as follows. Cap 11 mm wide, broadly conical with a rounded top, later almost flat, cream in centre Methuen 4A2, margin pure white, surface viscous, slightly peeling, without scales, fibrils or velum. Gills (L c. 30, l 1-3) 2 mm high, adnate to subdecurrent, rather distant, c. 12 per centimetre half-way between margin and cap centre, at first yellow-ochre, Methuen 4A6, later browner, 5C6. Stipe 15-20 × 2 mm, toward base broadening to 3.5 mm, subradicating, white, whitish, a bit brownish 4A3 translucent, solid. Flesh in cap and stipe white, in cap with KOH brownish-violaceous. Smell nasty (like *Inocybe*). Taste very bitter. Spores (5.4-)5.9-7.0(-7.3) × 4.4-5.4 μm (13 measurements), ellipsoid or slightly ovoid, distinctly fine rough. Basidia e.g. 25 × 7 μm, 29 × 6.8 μm, 27 × 6.3 μm, slenderly clavate, 4-spored. Cystidia not seen. Cuticle consisting of radial hyphae, crowded together, on septa 5-10 μm wide, inflating to 15 μm wide, with thin, hyaline walls, clamp connections present but usually indistinct. Habitat.-- In oak woods on nutrient-poor and humus-poor sandy soil (Dicrano-Quercetum), between mosses, especially *Dicranum scoparium*. Collection examined.-- Netherlands, Prov. Overijssel, De Eese, AEJ 521.

C. porphyropus. Det. P. Ypelaar.

C. pseudosalor. Det. P. Ypelaar.

C. cf. *punctatus* (Fig. 30). I could not get a clear picture of *C. punctatus* from the literature. Especially as the authors did not agree on the differences between the 3 related species *C. punctatus*, *C. glandicolor* and *C. brunneus*. The collected specimens were very similar to *C. punctatus* sens. Lge and *C. glandicolor* sens. Rick. Moser (1978) stated *C. glandicolor* to be a species of coniferous woods. So I named the specimens *C.* cf. *punctatus*. Description was as follows. Cap 20-35 (-50) mm wide, first conico-convex, later convex with reflexed to slightly ascending undulate margin, with a large acute to rounded umbo, very dark brown, nearly black, Munsell 5YR 3/1-3, 10YR 2/1-2, margin with radial velar fibres, lighter, grayish brown, 7.5YR 5/4, 10YR 5/3, hygrophanous, drying to reddish-brown, 5YR 5/4 or 7.5YR 5-6/4,

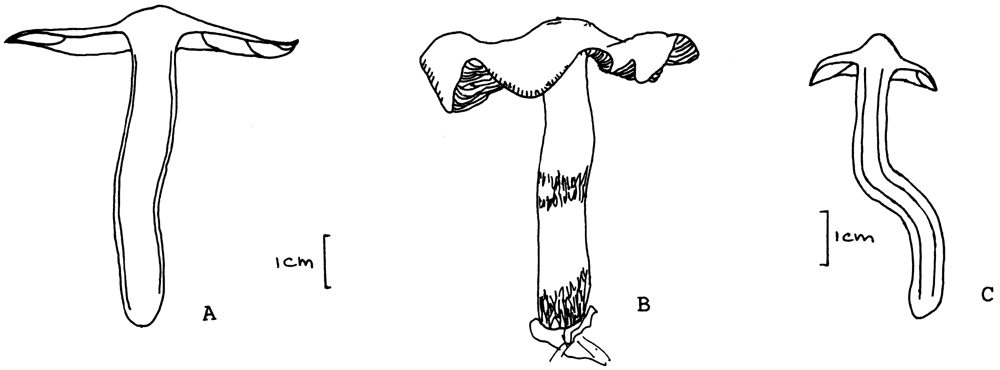

Figure 30. Cortinarius cf. punctatus. Habit sketch and longitudinal sections. A, B from A.E. Jansen 475; C from A.E. Jansen 545.

old specimens sometimes radially cleft. Gills (L 24-32, l 3-5 (-15)) 2-4(-7) mm high, sometimes veined, adnate or slightly subdecurrent, distant, 8-10 per centimetre half-way from margin to centre, rather dark brown, greenish-brown, Munsell 5YR 4/2-4, 7.5YR 4-5/4, 5/6, 10YR 4/4-3/3, 2.5Y 4/4, toward edge sometimes lighter to 10YR 6/4, edge entire or slightly eroded. Stipe 30-50(-70) × (3-)4-6(-9) mm, cylindrical or slightly attenuate upward, at first finely fibrillose, white, whitish-cream, light brown, 2.5Y 8/2, 10YR 8/2, later dark brown, 2.5YR 2/4, 5YR 2/4, in or above the middle with indistinct, light yellow velar remnants, foot white tomentose with violaceous tint, not rooting, solid or narrow fistulose. Smell weakly raphanoid. Taste indistinct, or weakly mustard or weakly nutty. Flesh in cap very thin except in umbo, as dark as the cap surface; in stipe cortex (c. 1 mm) as dark as the cap surface, downward sometimes lighter to yellow-brown, in inner parts a looser tissue, shining yellowish to light brown. Spores (6.8-)7.8-10.3(-11.2) × (4.4-)4.9-5.9 μm (c. 65 measurements, 5 collections), ellipsoid or weakly ovoid, distinctly rough, with 1 large drop of oil. Basidia (29-)32-35(-39) × 6.8-7.8(-8.2) μm, slenderly clavate, sometimes constricted below the top, c. 7-12 μm protruding above the hymenium, mostly 4-spored with 2.9-3.9 μm long sterigmata, old basidia light yellow-brown. Cheilocystidia inconspicuous, clavate, (13.6-)16-20(-23) × (4.9-)5.9-7.8(-8.3) μm, with thin hyaline wall, sometimes multicellular or branched and then longer, e.g. 26 × 9.8 μm, procumbent or ascending, along the sterile edge. Habitat.-- In oak woods on nutrient-poor sandy soils (Querco-Betuletum, Violo-Quercetum), in patches together, under *Betula*. Collections examined.-- Netherlands, Prov. Drenthe, Thijnsbosje, AEJ 475, AEJ 539, AEJ 545; Noordlagerbos, AEJ 405; Amshoffsbos, AEJ 361.

C. cf. *stemmatus* (Fig. 31). Often a small brown *Telamonia* was found, that was similar to *C. stemmatus* sens. Henry. Henry's fungus, however, was

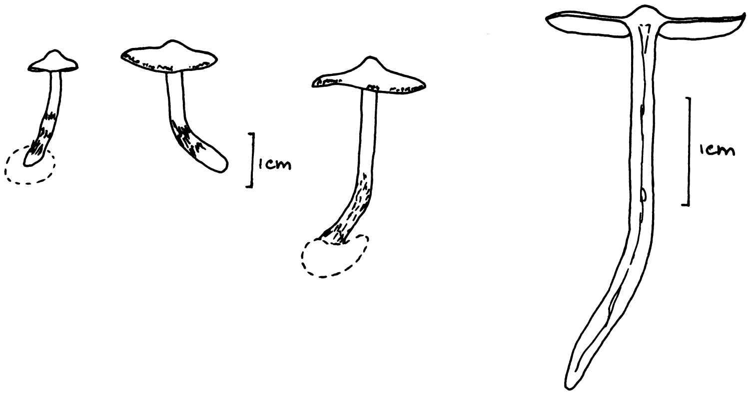

Figure 31. Cortinarius cf. stemmatus. Habit sketch and longitudinal section. From A.E. Jansen 495.

somewhat bigger, had broader gills, more velum on the stem and less variation in the size of spores. Therfore there is some doubt whether this really was *C. stemmatus*. Description was as follows. Cap (6-)12-22(-35) mm wide, at first hemispherical, conical, or broad conical with involute margin, later convex, plano-convex to flat or with ascending margin, with a large rounded or sometimes acute umbo, dark brown, dark red-brown, Munsell 5YR 3/4, 4/8, 4/2, 7.5YR 4/2-6; when old, slightly yellower, 10YR 4/3, 5/4, hygrophanous, drying to 7.5YR 5/6, 6-7/8, 10YR 8/4-6, at first entire, later covered at margin with white or very pale brown velar fibres, old glabrous. Gills (L c. 26, l 1-3(-7)) 2 mm high, adnate to uncinate, distant, 10-12 per centimetre half-way from margin to cap centre, yellow-brown to brown, 7.5YR 4/4, 5-6/6, 10YR 5/8, edge the same colour as the sides. Stipe (10-) 20-50 × 2-4(-6) mm, cylindrical or broadening slightly towards the base, to 6.5 mm, whitish, light brown, yellowish-brown, Munsell 10YR 8-6/4, 7-6/6, fine longitudinally fibrillous, in middle with small white velar ring, lower down sometimes some scattered velar flocks, foot slightly rooting, with small white or sometimes bluish-pink tomentum, which adhers the substrate together. Flesh in cap very thin, brown, dark brown, 7.5YR 4/2, in stem lighter, 7.5YR 4/4, 10YR 6/6-8/4; with KOH purplish-black. Smell inconspicuous or weakly pelargonium-like when cut. Taste slight. Spores (6.6-)7.3-9.3(-10.2) × (4.4-) 4.9-5.6(-6.3) µm (c. 80 measurements in 8 collections), Q 1.3-1.6-1.8, ellipsoid, sometimes ovoid or oblong, sometimes with one or two drops of oil. Basidia 26-31 × 6.3-7.8 µm, slenderly clavate, 4-spored, old basidia light to very dark brown. Cystidia were not seen. Gill trama consisting of thin cylindrical to inflated hyphae, 3-15 µm wide, with brown-yellow to dark brown, finely to coarsely incrusted walls. Habitat.-- In oak woods on nutrient-poor and humus-poor sandy soils (Dicrano-Quercetum), in small to big patches together, on sand between mosses (especially *Dicranum scoparium*). Collections examined.-- Netherlands, Prov. Drenthe, Zuidhijkerzand, AEJ 242 and B.W.L. de Vries 3496, AEJ 344 and 345, AEJ 354, AEJ 495 and 501, AEJ 571 and 573.

C. tabularis. The specimens correspond to Cooke, Plates 766/783, and Lange, Plate 94B.

Cystoderma longisporum. In Table 4 and Appendix Table D, this species is combined with *C. amianthinum* because they were not easy to distinguish macroscopically and were not always studied microscopically.

Entoloma. Nomenclature according to Noordeloos (1981).

Galerina cf. *cerina*. Found only once; the specimens were too old to be identified with certainty.

G. heimansii. This species was only found once: 3 carpophores on a rotten twig, under *Ilex aquifolium* in a Violo-Quercetum ilicetosum, Mantingerbos (Plot 24), AEJ 393. The specimens were exactly the same as those described by Reijnders (1959). Habitat and fructification time, however, were strikingly different.

G. cf. *incurvata*. Nom. prov., see Barkman (1969). Found only once, the specimens were too old to be determined with certainty.

G. inversa. Nom. provis. (Barkman, 1969).

G. triscopa (Fig. 32). This species was new for the Netherlands. A description of AEJ 271 is as follows. Cap 4-7 mm wide, at first conical, later convex, with distinct papilla, brownish-yellow, Munsell 10YR 6/6, translucently striate when wet, hygrophanous, drying to yellow, 2Y 8/6, cuticle not peeling, margin slightly longer than gills. Gills adnate to subdecurrent, yellowish brown, M 7.5YR 5/8, 10YR 5/8, edge granular, white. Stipe 15-20 × 0.7-1 mm, yellowish-brown, M 7.5YR 5-6/8, sometimes reddish-yellow near base, M 5YR 5/8, the upper half with scattered hairs, the lower half with white velum. Spores (7.0-)7.8-9.8 × 4.4-5.4 μm (7 measurements), Q 1.5-1.7-1.9, ovoid, amygdaloid, distinctly rough, not calyptrate, plage smooth, top of spore often smooth with small, indistinct apical pore, rather dark in KOH, ± 7.5YR 6/6. Basidia 4-spored. Pleurocystidia absent. Cheilocystidia 32-44 × 5.4-8.3 (ventricose base) × (2.0-)2.9-3.9(-4.6)(neck) × (2.9-)3.4-6.1(apex) μm, lageniform, ventricose, with rather long neck, narrowing towards the top, which usually bears a distinct spherical capitulum, but is sometimes only rounded; abundant, edge sterile. Caulocystidia slightly smaller, almost the same form as the cheilocystidia. Habitat.-- On rotten wood in oak-birch wood on nutrient-poor sandy soils (Querco-Betuletum). Collection examined.-- Netherlands, Prov. Drenthe, Noordlagerbos, 1977-40-25, AEJ 271. Found at same site on 1976-09-27, AEJ 162, and 1978-10-11, AEJ 377.

When these specimens were compared with descriptions in the literature (e.g. Kuhner, 1935; Smith & Singer, 1964) and another collection

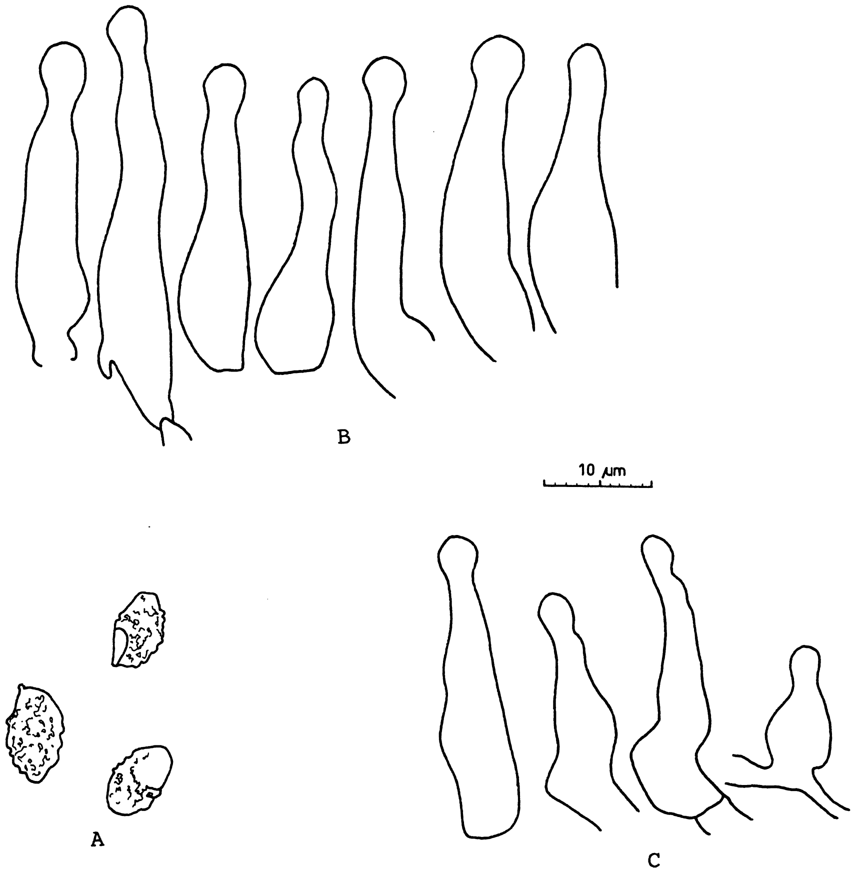

Figure 32. Galerina triscopa. A. Spores. B. Cheilocystidia. C. Caulocystidia. From A.E. Jansen 271.

of *G. triscopa* (BRD, Eifel, Gerolstein, C. Bas 5718 (L)), they were smaller and somewhat lighter, more yellowish. Microscopic features were the same as those in the literature and in the collection CB 5718.

Hebeloma cf. *vaccinum*. Found only once: on Plot 15, Drenthe, Uffelte, 1979-09-27, AEJ 553, 2 specimens. The specimens were similar to *H. vaccinum*, but differed slightly: the cap was umbonate; the stipe was bulbous (in 1 specimen only); the gill-edge bore some drops on it, and the basidia and cheilocystidia were slightly shorter. Nevertheless, *H. vaccinum* seems to be the correct name.

Inocybe longicystis. Cheilocystidia and pleurocystidia broadly fusiform, 65-73 × 15-22 μm.

I. ovatocystis. Cheilocystidia and pleurocystidia 21-43 × 13-21 μm.

I. sambucina. The specimens corresponded with the description and plate of Bruylants (1957).

Inocybe xanthomelas (Fig. 33). Cap 14-30 mm wide, first conical, later

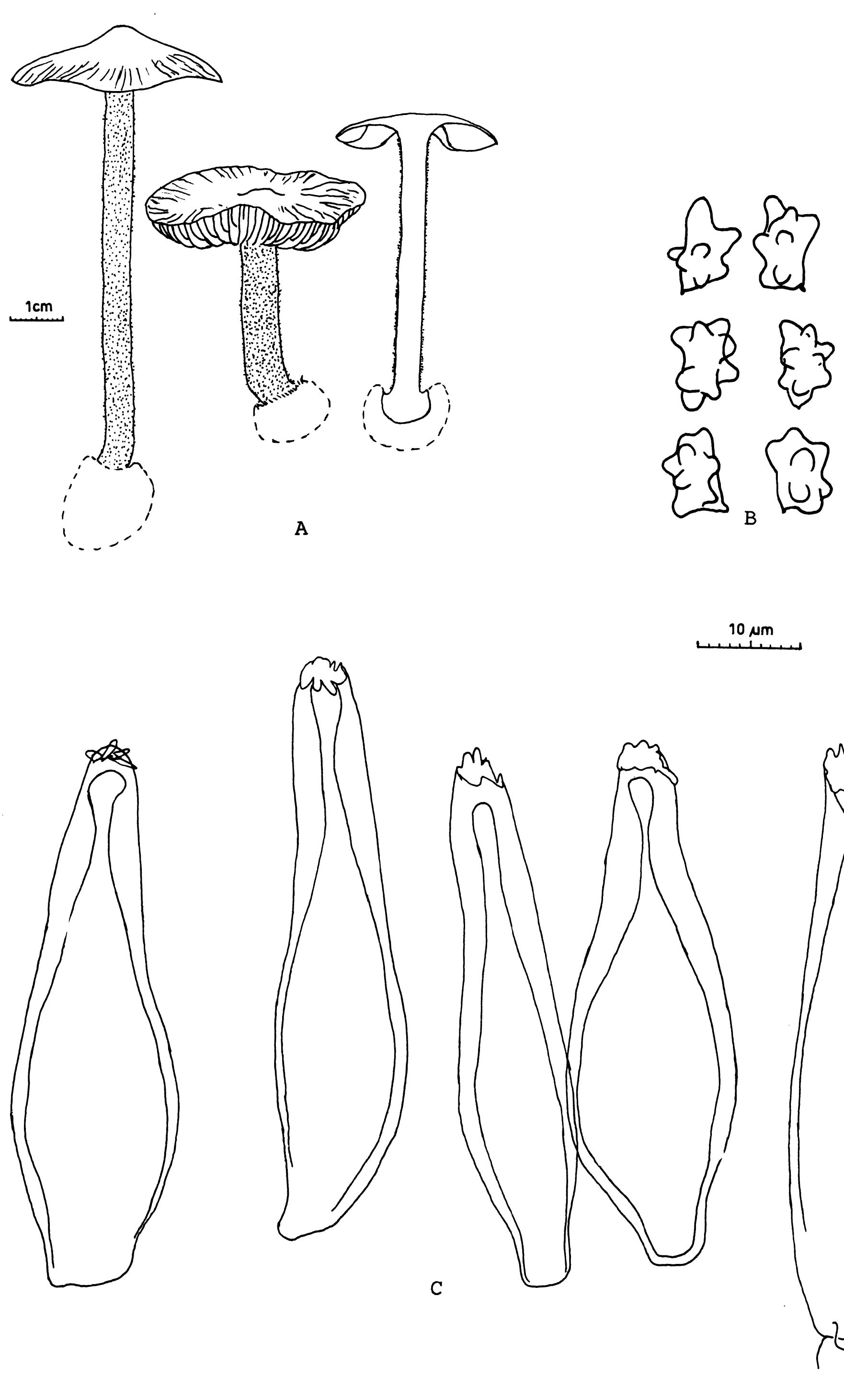

Figure 33. Inocybe xanthomelas. A. Habit sketch and longitudinal section. B. Spores. C. Pleuro- and cheilocystidia. A from A.E. Jansen 499, B and C from A.E. Jansen 189.

broadly conical to convex or flat with slightly undulating margin, with distinct umbo, when old sometimes with a radial cleft margin, light yellow-brown, yellow-brown to brown, Munsell 2.5YR 7/6, 10YR 6/4-6, 7.5YR 6/6, 5/4-8, 4/4, rather coarse radial fibrillose. Gills c. 2.5 mm high, adnexed, rather crowded, whitish to light yellowish-gray, M 2.5Y 7/2, later browner, 10YR 6-7/4-6. Stipe 15-40 × 2.5-4 mm, cylindrical or slightly broadening towards the base, the foot with a small to rather robust, marginate bulb, first nearly white, becoming light yellow, M 5Y 8/4, 2.5Y 8/2-6, later browner, 2.5Y 7/4-6, 10YR 5/3, 6/3-4, fine fibrillose, the whole length pruinose; solid. Flesh in cap white, in stipe very light yellow, in bulb white. Smell and taste indistinct. Spores (7.8-)8.8-10.7(-11.2) × (5.9-)6.3-7.8(-8.3) μm (41 measurements, 5 collections), Q 1.2-1.4-1.6, with (7-)8-12(-15) prominent nodules. Basidia 26-36 × 8.2-12.2 μm, clavate, 4-spored with sterigmata up to 6 μm long. Pleurocystidia 51-92 × 11-20(-25) μm, lageniform, seldom clavate to spheropedunculate, with a smooth 2.5-3.4 (-4.4) μm thick and in KOH yellow wall, the top often with some crystals. Cheilocystidia about same in form and size. Caulocystidia lageniform, (52-)70-100(-112) × 12-24 μm, with a thick wall, in KOH yellow, even thicker at the neck, between less striking clavate cells. Habitat.-- In oak woods on nutrient-poor and humus-poor sandy soils, in small patches on bare sand or between mosses such as *Dicranum scoparium, Pohlia nutans*. Collections examined.-- Netherlands, Prov. Drenthe, Zuid Hijkerzand, AEJ 284, AEJ 189, AEJ 304, AEJ 499, AEJ 570; Schoonloër strubben, AEJ 579; Prov. Overijssel, De Eese, AEJ 513. Observations.-- The specimens studied were largely from one plot, where they were found in each of the 4 years, at exactly the same site; there were probably 3 mycelia in that sample plot of area 1000 m^2.

There was some variation in microscopic features. Collections 304 and 570 had small spores, 7.8-9.3 × 6.3-6.8 μm resp. 8.8-9.3 × 5.9-6.8 (-7.8) μm, whereas 189 has 9.3-11.2 × 6.2-8.3 μm. Collection 570 had both short and thick, and long and thin pleurocystidia (Q 2.0-7.3, mean 4.0) whereas other collections have long and thin pleurocystidia with less variation (e.g. Q 3.1-4.8, mean 3.9 or 4.1-5.2, mean 4.6).

Distinction between *I. xanthomelas* and *I. mixtilis* (Britz.) Sacc. was not easy. *I. xanthomelas* should have a stipe blackening with age, larger spores with more prominent nodules and more slender pleurocystidia and cheilocystidia, than *I. mixtilis*. In the collections studied, I never observed blackening of the stem during drying, but aged specimens in the field had brownish stems. Spores were mostly of the shape and size appropriate to *I. xanthomelas*, but in some collections the size was more like that of *I. mixtilis*. Shape and size of the pleurocystidia and cheilocystidia were, in spite of the variation, more like those of *I. xanthomelas*, but the thickening of the wall was more like

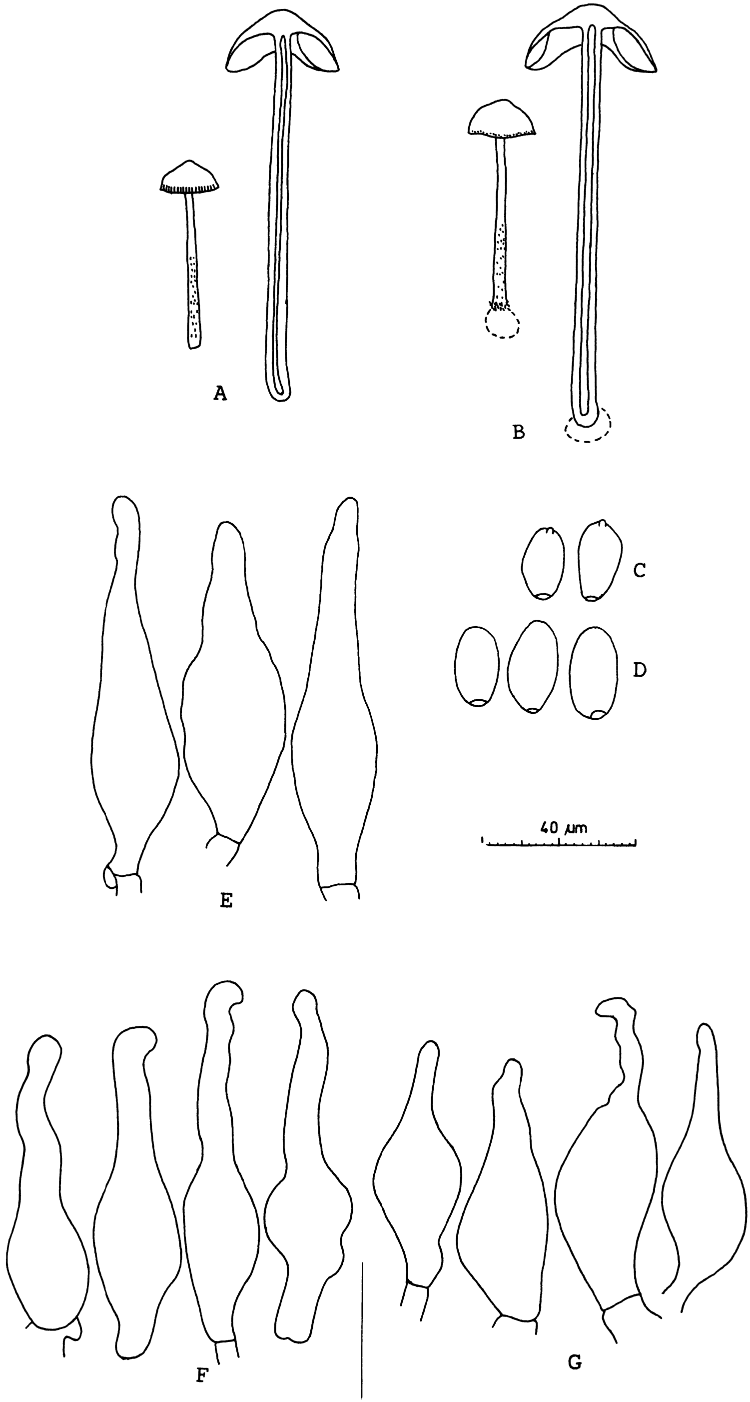

Figure 34. Psathyrella fulvescens var. dicrani. A and B. Habit sketch (×0.7) and longitudinal sections (×1.4). C and D. Spores. E. Pleurocystidia. F and G. Cheilocystidia. A from A.E. Jansen 494, B from A.E. Jansen 569, C and F from A.E. Jansen 170, D, E and G from A.E. Jansen 303.

that of *I. mixtilis* (Stangl, 1977; 1980). The specimens studied most likely belonged to *I. xanthomelas*, but there were some differences.

Marasmiellus. Nomenclature according to Jansen & Noordeloos (1980).

Psathyrella. Many of the specimens were identified by Dr E. Kits van Waveren.

P. fulvescens var. *dicrani* (Fig. 34). A small *Psathyrella* was often found in Dicrano-Quercetum. It had a hygrophanous cap, turning warm orange-brown on drying, with fugacious white velum and a slender, non-rooting stem. At first, I thought it was a form of *P. prona*. But according to Dr E. Kits van Waveren, who kindly studied some of the specimens, it is a form of *P. fulvescens*. *Psathyrella fulvescens* is a very variable species and new varieties or forms are at present difficult to describe. Nevertheless it seemed to me that this form had some constant differences from the typical form. It has larger spores, striking cheilocystidia, often with bent tops, and was found only in Dicrano-Quercetum, never in the more humus-rich oak woods. Therefore I propose to give it taxonomic status. As it is not yet clear whether intermediates occur, I have ranked it only as variety.

Psathyrella fulvescens var. *dicrani* A.E. Jansen, var. nov. (Fig. 34). A varietate typica differet sporibus majoribus, (8.3-)9.3-11.4(-12.2) μm longis, (4.9-)5.5-6.1(-6.8) μm latis, cheilocystibus collo paulum graciliore apiceque saepe curvato.

Typus: A.E. Jansen 303, 1978-07-26, Netherlands, Prov. of Drenthe, Zuid Hijkerzand, (Wag-W).

Description:

Cap (10-)18-30(-40) mm wide, conico-convex to convex with a small to rather stout rounded umbo, rather dark red-brown at centre, Munsell 5YR 4/3-8, 7.5YR 4/4, lighter near margin, 5YR 5/3, 7.5YR 5/4-6, hygrophanous, quickly becoming lighter in colour, warm orange-brown, 7.5YR 5-7/6, 5/8, 10YR 7-8/6 in centre, near margin lighter, brownish-yellow, often with some pink, 10YR 7/3, 6-8/4, 6-7/6, 6/8, 2.5Y 8/4, first with distinct white fugacious velum at the margin sometimes with fine flocks covering half of the cap, when older with only some flocks near margin or glabrous. Gills (L 20-35, l 1-3) 3-5.5 mm broad, adnate, very thin and therefore rather distant, c. 16/cm half-way margin and cap centre, first yellow-brown, Munsell 10YR 7/6, later with spores grayish-brown, light gray, brown-gray to dark chocolate-brown, 2.5YR 5-6/2, 10YR 6/1-3, 4/2, 3/3, edge white but near cap margin often the same colour as the sides. Stipe 30-60 × 2-4(-5) mm, cylindrical, sometimes slightly thickened near base to 3-7(-9) mm, white, seldom yellow-white or light brownish-white, top pruinous, in lower half fine fibrillose and with some velar fibres, when old glabrous, foot rounded, not rooting, fistulose. Flesh in cap thin, dark yellow-brown to light brown or cream, 10YR 4-8/4; in stipe white or creamy white at the top, light yellow-brown 10YR 8/6 round the hollow centre, yellow-brown 10YR 5/6 at the foot; in gill hyaline to light yellow-brown. Smell and taste inconspicuous. Spores (8.3-)9.3-11.4(-12.2) × (4.9-)5.5-6.1(-6.8) µm (c. 50 measurements, 9 collections), Q 1.4-1.7-1.9, ellipsoid, with small pore, dark brown-gray in KOH under microscope. Basidia c. 20-27 × 10 µm, broad clavate to almost spheropedunculate, 4-spored. Pleurocystidia 36-60 × 10-14 (ventricose base) µm, fusiform-ventricose or lageniform-pedicellate with long, tapering neck with subacute top, with a thin wall light yellow (in KOH). Cheilocystidia of almost the same shape and size, but neck often more slender and more distinctly separated from ventricose base, top often bent, intermixed with fusiform and spheropedunculate cells, forming a sterile edge. Habitat.-- Solitary or in small groups, on litter or on sand between mosses such as *Dicranum scoparium*, *Pohlia nutans*, *Campylopus flexuosus*, in oak woods on nutrient-poor and humus-poor sandy soils (Dicrano-Quercetum). Collections examined.-- Netherlands, Prov. Drenthe, Zuid Hijkerzand, P. Ypelaar 72, AEJ 455, AEJ 170, AEJ 456, B.W.L. de Vries 109-1, AEJ 303, AEJ 316, AEJ 346, 348 and 349, AEJ 494, AEJ 569; Boswachterij Dwingeloo, A.K. Masselink 6543, P. Ypelaar 4, AEJ 168, AEJ 372; Boswachterij Smilde, P. Ypelaar 96; Prov. Overijssel, De Eese, AEJ 157.

Russula emetica. The varieties *sylvestris* Sing., *betularum* (Hora) Romagn. (=*R. betularum* Hora), and *emetica* were found. I have not studied all specimens microscopically, which is necessary in order to name the varieties correctly, so I consider them here as *R. emetica* sens. lat.

Steccherinum cf. *hydneum*. Specimens differed from *S. laeticolor* (Berk. & Curt.) Bank. (=*S. robustius* Eriks. & Lundell) in the more ochraceous carpophore and in the subglobose spores: 4-4.6(-5.0) × 3-4 µm. Det. N. Deodatus and B.W.L. de Vries.

Stropharia aeruginosa was taken to include *S. caerulea* Kreisel (=*S. cyanea* (Bolt. ex.Fr.) Tuomikoski).

Summary

Higher plants, mosses, lichens, soil horizons and chemical composition, and fungi were described for the associations Dicrano-Quercetum, Querco-Betuletum, Violo-Quercetum typicum, and Violo-Quercetum ilicetosum in the Province of Drenthe (Netherlands).

Higher plants, mosses and lichens were recorded by the Braun-Blanquet method as modified by Barkman et al. (1964). The moss flora on dead trunks, stumps and logs was separately described, since it was the substrate for some fungi. The syntaxa and their status were assessed with reference to the literature. Character and differential species mentioned in the literature were discussed. Querco-Betuletum and Violo-Quercetum proved to be closely related associations, belonging to the alliance Quercion robori-petraeae. Violo-Quercetum ilicetosum was described as a new sub-association. Barkman's opinion that Dicrano-Quercetum was an independent association was confirmed by its many differential species, which were almost all mosses and lichens. The affinity with Quercion robori-petraeae was low, and it was not included in that alliance.

The plots of Quercion associations were all situated on sandy soils, often with a subsoil of loam or loamy sand. One plot had a 'broek' earth soil; the others had distinct humus podzols. The Violo-Quercetum ilicetosum plots had relatively deep profiles, often with a thick A1h horizon. Under Violo-Quercetum typicum and Querco-Betuletum, the soils were shallower, and an A1h horizon was usually absent. The topsoil of the Querco-Betuletum was mostly disturbed. Dicrano-Quercetum plots were situated on soils of young drift sands, in which a profile was only weakly developed (dune vague soil with a micropodzol).

Samples of the A0 and the A21 horizons were analysed chemically. Most of the mycelia were present in these horizons. The soils were very acid, pH 2.9-3.5 in the A21 horizon, 3.3-4.7 in the A0 horizon. In the A0 horizon, Na^{+}, K^{+}, Mg^{2+} and Ca^{2+} were present in almost the same amounts under all the different types of vegetation. In the A21 horizon the concentrations were highest under Violo-Quercetum ilicetosum, and lowest under Dicrano-Quercetum. The 'total ion supply' was highest under Violo-Quercetum ilicetosum, was much lower under Violo-Quercetum typicum and Querco-Betuletum, and lowest under Dicrano-Quercetum. The ratio of carbon to nitrogen, however, increased in this order.

Description of the fungus vegetation was based upon records of permanent sample plots studied for four successive years. The number of fungal spe-

cies (314) far exceeded that of higher plants and ferns (72), and mosses and lichens (67).

In relation to each other, Dicrano-Quercetum and Quercion robori-petraeae had many differential species. This supports the idea that Dicrano-Quercetum does not belong to Quercion robori-petraeae. Querco-Betuletum and Violo-Quercetum had fewer differential species, but were well characterized. Dicrano-Quercetum and Violo-Quercetum ilicetosum, both very poor in vascular plants, proved with the fungal species to be better characterized. This holds true especially for Violo-Quercetum ilicetosum, which was very poor in mosses and lichens growing on the ground.

The 'minimum area', the plot size representative for a vegetation, was 1500 m^2 in Querco-Betuletum and Violo-Quercetum typicum, and at least 3000 m^2 in Violo-Quercetum ilicetosum and Dicrano-Quercetum.

A new parameter, cumulative spatial frequency, gave an indication of the real abundance of fungal mycelia: the proportion of the subplots of a permanent plot in which carpophores of a given species were ever observed during the survey. Aggregate maximum abundance had some correlation with spatial frequency, but the two parameters were not interconvertible.

Cumulative spatial frequency also yielded results on some other aspects. Raunkiaer's law (1918) of constant species also applied to fungi of Quercion robori-petraeae, but not to fungi of Dicrano-Quercetum (in contrast to the vegetation of green plants of Dicrano-Quercetum). Dicrano-Quercetum was characteristically variegated, more so than stands of other associations, probably because of the large moss patches. Distribution patterns of species within the plots were also studied. The distribution was mostly random, and never uniform. Only 35 fungus species were clustered in two or more plots. This may be attributable either to extensive mycelium spread over two or more subplots, or to clustered mycelia, e.g. because of unevenness in the plot for environmental factors affecting the given species. Some examples are considered of correlated distributions between fungi, or of fungi with vascular plants or mosses. Incidence of several fungi (e.g. *Marasmius androsaceus, Galerina decipiens, Inocybe napipes*) coincided with moss cover in both Dicrano-Quercetum plots. In a Violo-Quercetum typicum plot, large numbers of fungal species in subplots correlated with a low cover of herbs. *Marasmius epiphylloides* correlated with ground-growing *Hedera helix*, but as *M. epiphylloides* did not occur in all subplots with a high cover of *H. helix* its distribution is not entirely explained by this biotic variation. *Collybia cookei* correlated with *Armillariella mellea* in some plots.

The fungi were classed into ecological groups: mycorrhizal species; saprophytes on humus; saprophytes on wood and branches; and saprophytes on leaves, fruits, herbs, and mosses. The contribution of each group to the fungal vegetation was estimated. Dicrano-Quercetum had very many, Violo-Quercetum ilicetosum very few mycorrhizal species. Dicrano-Quercetum had the fewest, Violo-Quercetum ilicetosum the most saprophytes on wood. The proportion of humus saprophytes was almost equal in all associations. The number of humus saprophytes in Violo-Quercetum ilicetosum was least. The number of saprophytes on leaves was highest in Querco-Betuletum and Violo-Quercetum typicum.

Notes, or descriptions are given of fungi raising difficulties in identification. A new fungus was described: *Psathyrella fulvescens* var. *dicrani*.

Samenvatting

In deze publikatie wordt de paddestoelenvegetatie, de vegetatie van hogere planten, mossen en korstmossen, en de bodem (profielen en chemische analyses) beschreven van de associaties Dicrano-Quercetum, Querco-Betuletum en Violo-Quercetum en van diens subassociatie ilicetosum in Drenthe.

Hogere planten, mossen en korstmossen werden beschreven met opnames volgens de Braun-Blanquet methode, gewijzigd volgens Barkman et al. (1964). De mossen op rottende stronken, stobben en stammen zijn apart beschreven, omdat het het substraat is voor sommige paddestoelsoorten. De juiste naam van de vegetatietypen is bepaald met behulp van de literatuur, evenals de synsystematische plaats. De in de literatuur genoemde ken- en differentiërende soorten zijn besproken. Het Querco-Betuletum en het Violo-Quercetum bleken nauw verwante associaties te zijn. Ze behoren tot het verbond Quercion robori-petraeae. Het Violo-Quercetum ilicetosum werd als nieuwe subassociatie beschreven. De mening van Barkman, dat het Dicrano-Quercetum een zelfstandige associatie is, werd bevestigd. Deze associatie heeft veel differentierende soorten (vrijwel uitsluitend mossen en korstmossen), zodat de verwantschap met het Quercion robori-petraeae gering is. Het wordt daarom niet tot dit verbond gerekend.

De onderzochte proefvlakken van het Quercion robori-petraeae hadden alle een zandige boden, vaak met een ondergrond van leem of lemig zand. In één proefvlak was een broekeerdgrond aanwezig, de andere proefvlakken hadden alle duidelijke humuspodzolprofielen. De proefvlakken in het Violo-Quercetum ilicetosum hadden relatief diepe profielen waarin vaak een dikke A1h-horizont aanwezig was. In het Violo-Quercetum typicum en het Querco-Betuletum was het profiel korter en was een A1h-horizont gewoonlijk niet aanwezig. De bovenste horizont van de Querco-Betuletum-proefvlakken was over het algemeen gestoord. De proefvlakken van het Dicrano-Quercetum bleken te liggen op tamelijk recent stuifzand waarin slechts een uiterst kort profiel was ontwikkeld (duinvaaggrond met een micropodzol).

De chemische analyses werden gedaan in monsters van de A0- en de A21-horizont. In deze horizonten is het meeste mycelium aanwezig. De bodems bleken alle zeer zuur te zijn, pH 2,9-3,5 in de A21-horizont en 3,3-4,7 in de A0-horizont. In de A0-horizont waren de Na-, K-, Mg- en Ca-ionen (uitgedrukt in massafractie en massaconcentratie) in elk van de vegetatietypen in nagenoeg gelijke hoeveelheden aanwezig, in de A21-horizont werden de hoogste concentraties gevonden in het Violo-Quercetum ilicetosum en de laagste in het Dicrano-Quercetum. De 'totale ionenvoorraad' was het hoogst in het

Violo-Quercetum ilicetosum, veel lager in het Violo-Quercetum typicum en het Querco-Betuletum, en nog weer lager in het Dicrano-Quercetum. De koolstof/stikstof verhouding gedroeg zich omgekeerd en nam toe in deze volgorde.

De paddestoelenvegetatie is beschreven met behulp van opnamen van proefvlakken die gedurende 4 achtereenvolgende jaren onderzocht zijn. Er werden veel meer soorten paddestoelen (314) dan groene planten (72) of mossen en lichenen (67) gevonden.

Het Dicrano-Quercetum en het Quercion robori-petraeae hebben ten opzichte van elkaar veel differentiërende soorten. Dit ondersteunt het idee dat het Dicrano-Quercetum niet tot het Quercion robori-petraeae behoort. Het Querco-Betuletum en het Violo-Quercetum hebben ten opzichte van elkaar minder differntiërende soorten, maar zijn wel duidelijk gescheiden. Zowel het Dicrano-Quercetum als het Violo-Quercetum ilicetosum, beide vegetaties met zeer weinig vaatplanten, bleken met behulp van de paddestoelenvegetatie beter te karakteriseren. Dit geldt met name voor het Violo-Quercetum ilicetosum, dat ook zeer arm is aan (terrestrische) mossen en korstmossen.

Het 'minimumareaal', of eigenlijk de representatieve proefvlakgrootte bleek in het Querco-Betuletum en het Violo-Quercetum typicum 1500 m^2 te zijn, en in het Violo-Quercetum ilicetosum en in het Dicrano-Quercetum minstens 3000 m^2.

Om de werkelijke abundantie van fungi, dus de abundantie van de mycelia, te bepalen werd een nieuwe grootheid ingevoerd, de Totale Ruimtelijke Frequentie (Cumulative spatial frequency, CSF): het deel (percentage) van het aantal deelproefvlakken van een proefvlak waarin in enig jaar vruchtlichamen van die soort zijn waargenomen. De absolute maximale abundantie (AMAC) van de vruchtlichamen vertoont wel een bepaald verband met de CSF, maar het is gewoonlijk niet mogelijk de ene eenheid in de andere om te rekenen.

De bepaling van de CSF gaf ook een aantal andere resultaten. Zo kon worden vastgesteld dat de derde wet van Raunkiaer (1918) ook opgaat voor de fungi van het Quercion robori-petraeae, maar niet voor de fungi van het Dicrano-Quercetum, dit in tegenstelling tot de groene planten van het Dicrano-Quercetum. De fytocoenose van het Dicrano-Quercetum bleek door het voorkomen van uitgestrekte mostapijten een karakteristieke heterogeniteit te bezitten, die groter is dan bij de andere syntaxa. Ook konden verspreidingspatronen van soorten binnen de proefvlakken bestudeerd worden: veruit de meeste soorten bleken normaal verspreid te zijn en er waren geen soorten die regelmatig verspreid (uniform) waren. Slechts 35 soorten kwamen geclusterd voor in 2 of meer proefvlakken. Clustering kan worden veroorzaakt doordat de mycelia zo groot zijn dat zij over verscheidene deelproefvlakken verspreid zijn, of doordat de mycelia geclusterd groeien, bijvoorbeeld doordat het proefvlak niet homogeen is, althans voor dié soort.

Ook konden dankzij deze methode correlaties tussen verspreidingen, zowel van fungi onderling als van fungi met vaatplanten of mossen worden bestudeerd. In beide Dicrano-Quercetum proefvlakken bleek een correlatie te bestaan tussen verscheidene paddestoelsoorten (bv. *Marasmius androsaceus*, *Galerina decipiens*, *Inocybe napipes*) en de mostapijten. In een Violo-Quercetum typicum proefvlak bestond een correlatie tussen een hoog aantal paddestoelsoorten en een lage bedekking van de kruidlaag. *Marasmius epiphylloides* correleerde met terrestrisch groeiende klimop, maar kwam niet voor in alle deelproefvlakken met een hoge bedekking van de klimop. *Collybia cookei* correleerde in een aantal proefvlakken met *Armillariella mellea*.

De paddestoelen werden ingedeeld naar oecologische groepen (waarvan de mycorrhizasoorten, de humussaprofyten, de saprofyten op hout en takken en de saprofyten op blad, vruchten, planten en mossen de belangrijkste bleken te zijn) en het aandeel van elk van de groepen in de paddestoelenflora werd bepaald. In het Dicrano-Quercetum bleken zeer veel, in het Violo-Quercetum ilicetosum weinig mycorrhizasoorten voor te komen. Het Dicrano-Quercetum had weinig saprofyten op hout, het Violo-Quercetum ilicetosum weinig humussaprofyten. De saprofyten op blad e.d. waren het talrijkst in het Querco-Betuletum en het Violo-Quercetum typicum.

Van een aantal paddestoelsoorten, namelijk die waar de determinatie moeilijkheden gaf, door de aard van het materiaal of doordat er taxonomische problemen waren, zijn korte tot lange aantekeningen of beschrijvingen opgenomen. *Psathyrella fulvescens* var. *dicrani* werd als nieuwe variëteit beschreven.

Appendices

Appendix A. Soils under the studied plots. B, red boulder clay with manganese lenses; L, gray loam; LS, loamy sand; SL, sandy loam (in horizons C and D). Watertable classes as described in Section 2.2.1. Disturbance by human activity (probably in distant past) indicated by ×. Soil types: B, Broek earth; D, micropodzol in Dune vague soil; H, Haar podzol; M, Moorland podzol; V, Field podzol.

Table A1. Soils under Dicrano-Quercetum.

Plot No		Total	1	2	3
A00	cover (%)	32	15	90	80
Q. robur		30	15	90	80
A00	thickness (cm)	3	0- 5	0-8	0-4
A0	thickness (cm)	2	2- 5	1	1-4
A1	thickness (cm)	2	2- 3	3	1
A21	thickness (cm)	2	2- 5	1	2
A22	thickness (cm)	3	2- 3	3	3
B2	thickness (cm)	6	3- 4	11	5
C1	depth (cm)	13	9-15	18	11
	character	S	S	S	S
Watertable		VII	VII	VII	VII
Soil type		D	D	D	D

Table A2. Soils under Querco-Betuletum.

Plot No		Total	4	5	6	7	8	9	10	11
A00 cover (%)		84	80	98	100	80	95	80	60	80
Q. robur		82	80	98	100	80	95	70	50	80
A00	thickness (cm)	2	0-8	2-5	2-3	0-3	1-4	0-2	0-2	0-2
A0	thickness (cm)	5	1	6	6	3	7	6	4	4
A1	thickness (cm)	3	2	6	5	1	2	4	6	1
A21	thickness (cm)	9	10			5	3	22	7	24
A22	thickness (cm)	8	20			4	10	21	8	
Ap	thickness (cm)	7		29	20				10	
B2	thickness (cm)	6	5	11			3	25	8	
B3	thickness (cm)	7						52		
BC	thickness (cm)	1	8							
C1	depth (cm)		45	46		10		124	39	
	character		S	LS		S		SL	S	
C2	depth (cm)			64					110	
	character			SL					LS	
A21b	thickness (cm)	7			25	8				23
A22b	thickness (cm)	5				12	5			28
B2b	thickness (cm)	6			13	10	12			12
B3b	thickness (cm)	9				15	10			42
BCb	thickness (cm)	1			7					
C1b	depth (cm)	70			70	60	45			130
	character	S-SL			LS	S	S			L
C2b	depth (cm)	83			85					
	character	LS-L			L					
Watertable		V-VII	VII	VI	V	VI	VI	V	VI	VI
Disturbance		×		×	×	×	×	×	×	×
Soil type		V-H-M	H	V	V	V	V	M	V	V

Table A3. Soils under Violo-Quercetum typicum.

Plot No		Total	12	13	14	15	16	17	18	19	20	21
AOO	cover (%)	84	80	95	90	50	70	100	80	80	95	100
Q. robur		84	80	95	90	50	70	100	80	80	95	100
AOO	thickness (cm)	2	0-5	2-4	0-5	0-5	0-3	1-3	0-2	0-3	1-2	1-3
AO	thickness (cm)	4	3	3	3	5	6	5	3	3	4	4
A1	thickness (cm)	3	2	12	4	3	2	2	1	1	3	5
A1h	thickness (cm)	4				7		5			8	20
A21	thickness (cm)	10	10	23	5	26	5	2	5	13	9	
A22	thickness (cm)	14	15	5	10	14	12	15	10	11	20	32
B2	thickness (cm)	23	30	7	8	10	25	26	15	40	55	18
B3	thickness (cm)	16		23		15	26	25	8		28	30
BC	thickness (cm)	5			10	15	10		17			
C1	depth (cm)	75	57	70	37	90	80	75	56	65	123	105
	character	S-SL	S	LS	S	LS	LS	S	LS	LS	LS	S
C2	depth (cm)	81		85		100			80		133	
	character	SL/B		SL		B			SL		SL	
Watertable		V-VII	VI	V	VII	VI	VI	VII	VII	VI	V	V
Soil type		V-H-M	V	V	H	V	V	V	V	V	M	M

Table A4. Soils under Violo-Quercetum ilicetosum.

Plot No		Total	22	23	24	25	26	27	28	29
AOO	cover	88	90	90	90	90	100	100	60	80
Q. robur		55	80	55	20	55	90	50	20	70
I. aquifolium		31	10	10	70	45	10	40	40	10
AOO	thickness (cm)	1	0-2	0-2	0-2	1-2	1	2	0-1	1-2
AO	thickness (cm)	4	5-7	5-8	1	4	3	5	1	5
A1	thickness (cm)	5	5	4		9	4	13		8
A1h	thickness (cm)	14	7		27	10		32	12	22
A21	thickness (cm)	9	7	8	3	10	9		22	10
A22	thickness (cm)	21	20	24	6	41	29	5	26	15
B2	thickness (cm)	18	18	10	39	10	35	15	15	
B3	thickness (cm)	16	15	15	35		15	20	30	
BC	thickness (cm)	1				5				
C1	depth (cm)	82	72	61	110	85	85	85	105	55
	character	S-SL	S	S	LS	SL	SL	LS	S	LS
C2	depth (cm)	83								60
	character	SL								SL
Watertable		III-VII	VI	VII	V	III	III	VII	V	III
Soil type		V-M-B	V	V	M	M	V	M	V	B

Notes

Plot 1. At 85->110 cm depth: an older profile, buried under driftsand.
Plot 2. At 110->125 cm depth: an older A1 horizon, buried under driftsand.
Plot 3. At 50- 100 cm depth: an older profile, buried under driftsand.
Plot 5. The Ap horizon had cavities and mixed colours.
Plot 6. The Ap horizon was a mixture of former A, B and C horizons and had been turned up when the drains were dug.
Plot 7. The upper 14 cm showed evidence of human activity (digging) and only a small profile has developed over the years. The C1 horizon was 5 cm thick.
Plot 8. The upper 16 cm showed evidence of human activity and only a small profile has developed. The A22b and the B2b horizons had no clear characteristics.
Plot 9. The cover of the A00 contains in addition 8 % *Betula pubescens*. There was also some disturbance on this plot as a result of drain digging. The disturbed horizon is, however, very thin. So it is given as an undisturbed profile.
Plot 10. The Ap horizon had mixed colours. Probably the whole site was dug out at the time that the drains were laid. In the upper 15 cm a new, small profile has developed.
Plot 11. The upper 24 cm was turned up when the drains were dug. It has a clear A1 character.
Plot 12. The A21 horizon can be divided into a 4 cm A211 horizon, a 1 cm driftsand horizon and a 5 cm A212 horizon.
Plot 23. The cover of the A00 contains in addition 25 % *Fagus sylvatica*. There is some variation in thickness of the A1 (± 2 cm), the A21 (± 2 cm) and the A22 (± 4 cm) horizon.
Plot 29. The B horizon is lacking. The C2 horizon has iron spots and gleysymptomes.

Appendix B. Chemical and physical properties of soils. ρ, volumic mass of dry intact bulked soil; σ, electrical conductivity.

Table B1. Chemical and physical properties of AO horizon on mass basis.

	Plot No	$pH-H_2O$	pH-KCl	σ (mS/m)	ρ (kg/m^3)	Substance content					
						Na^+ (mg/100 g)	K^+ (mg/100 g)	Mg^{2+} (mg/100 g)	Ca^{2+} (mg/100 g)	N (g/100 g)	C (g/100 g)
VQi	29	3.6	2.8	18.8	150	12.8	45.3	31.7	148	2.06	48.4
	28	3.6	2.8	27.7	200	10.1	50.4	32.5	139	2.67	50.4
	27	3.8	3.0	33.5	200	10.2	54.2	37.2	104	2.27	47.1
	26	3.8	2.9	31.7	170	15.6	60.1	46.9	156	2.34	48.3
	25	4.0	3.2	37.5	180	13.3	51.4	39.4	150	2.22	44.9
	24	3.7	2.8	21.2	230	9.7	49.8	23.1	77	2.23	47.7
	23	3.8	2.9	24.8	150	14.9	62.7	51.1	135	2.26	53.0
	22	3.9	3.0	31.9	160	13.1	72.5	53.9	168	2.30	52.0
VQt	21	3.5	2.6	12.9	200	10.4	36.4	29.7	128	2.43	50.5
	20	3.5	2.6	13.4	170	9.7	38.7	37.8	129	2.20	51.6
	19	3.8	2.9	24.5	160	12.4	57.7	38.1	156	2.10	47.7
	18	3.9	3.0	24.3	180	12.4	56.7	40.3	192	2.32	48.3
	17	3.7	2.7	15.1	160	9.2	38.7	36.9	144	2.07	45.1
	16	3.8	2.8	18.8	160	11.9	44.0	43.9	70	1.97	47.3
	15	3.8	2.9	16.7	210	10.9	35.8	33.9	158	1.87	39.3
	14	4.0	3.2	28.2	140	11.1	62.4	47.8	229	2.21	52.0
	13	3.8	2.9	26.0	140	9.6	54.8	54.4	141	2.35	54.9
	12	4.0	3.1	24.8	150	11.3	48.8	41.1	196	2.25	49.8
QB	11	3.5	2.6	14.3	160	7.8	28.6	41.4	134	2.35	50.3
	10	4.1	3.0	18.0	160	12.9	53.4	57.8	153	2.00	46.3
	9	3.5	2.6	10.1	170	8.1	40.5	35.6	120	2.38	53.1
	8	4.1	3.2	21.8	150	10.7	62.6	47.8	206	2.04	48.8
	7	4.0	3.0	23.4	160	15.2	54.3	51.7	153	2.23	48.6
	6	3.9	3.1	25.6	160	11.2	50.9	55.8	180	2.32	50.2
	5	3.8	2.9	21.4	140	11.6	50.1	59.4	95	2.36	54.4
	4	4.1	3.1	22.8	200	10.4	54.2	37.5	99	1.71	39.6
DQ	3	3.8	2.9	24.8	130	15.6	68.8	55.0	163	2.15	52.8
	2	4.0	3.2	26.6	130	13.0	73.8	65.0	231	2.13	52.7
	1	3.9	3.2	34.9	130	15.7	60.1	60.0	208	2.14	51.4
VQi		3.8 (3.5-4.1)	2.9 (2.7-3.3)	28.4 (20.9-42.9)	180 (150-230)	12.5 (9.7-15.6)	55.8 (45.3-72.5)	39.5 (23.1-53.9)	135 (77-168)	2.29 (1.54-2.68)	49.0 (41.6-53.9)
VQt		3.8 (3.5-4.2)	2.9 (2.6-3.3)	20.5 (11.5-30.3)	170 (140-210)	10.9 (9.2-12.4)	47.4 (35.8-62.4)	40.4 (29.7-54.4)	154 (70-229)	2.18 (1.32-2.59)	48.6 (27.1-55.1)
QB		3.9 (3.5-4.2)	2.9 (2.5-3.3)	20.1 (8.1-34.5)	160 (140-200)	11.0 (7.8-15.2)	49.3 (28.6-62.6)	48.4 (35.6-59.4)	142 (95-206)	2.17 (0.93-2.45)	48.9 (20.1-54.6)
DQ		3.9 (3.8-4.1)	3.1 (2.9-3.3)	28.8 (21.5-40.2)	130 (130)	14.8 (13.0-15.6)	67.6 (60.1-73.8)	60.0 (55.0-65.0)	201 (163-231)	2.14 (2.05-2.21)	52.3 (50.5-55.5)

Table B2. Chemical properties of AO horizon on volume basis and C/N ratio.

	Plot No	Substance concentration						
		Na^{+} (mg/l)	K^{+} (mg/l)	Mg^{2+} (mg/l)	Ca^{2+} (mg/l)	N (g/l)	C (g/l)	C/N
VQi	29	19.6	69.5	48.7	227	0.32	7.45	23.5
	28	20.5	103	66.0	282	0.54	10.2	18.9
	27	20.0	107	73.1	204	0.45	9.27	20.8
	26	25.8	100	78.2	260	0.39	8.06	20.7
	25	23.5	90.7	70.9	266	0.39	7.80	20.2
	24	21.9	112	52.8	176	0.50	10.8	22.2
	23	22.0	93.6	76.8	203	0.34	7.93	23.4
	22	20.5	113	83.4	260	0.36	8.13	24.2
VQt	21	20.5	71.2	58.2	251	0.48	9.89	20.8
	20	16.1	64.5	62.8	217	0.37	8.59	23.5
	19	20.6	95.8	63.1	258	0.35	7.91	22.8
	18	22.3	99.1	85.5	340	0.42	8.91	21.4
	17	14.2	59.5	57.0	224	0.32	6.90	21.8
	16	19.8	72.4	72.8	116	0.32	7.69	24.1
	15	21.0	69.1	65.4	302	0.36	7.66	21.0
	14	15.2	85.0	65.0	313	0.30	7.10	23.6
	13	13.1	74.9	74.4	194	0.32	7.50	23.3
	12	16.9	73.1	61.3	293	0.34	7.44	22.2
QB	11	12.4	45.9	66.3	214	0.38	8.04	21.4
	10	20.7	84.2	91.9	244	0.32	7.41	23.2
	9	13.7	69.1	60.3	203	0.40	9.02	22.4
	8	16.0	94.2	71.7	309	0.31	7.31	24.0
	7	23.9	58.9	79.7	239	0.35	7.57	21.8
	6	18.3	82.8	88.7	293	0.38	8.17	21.6
	5	16.2	70.2	83.2	133	0.33	7.61	23.0
	4	19.3	101	67.6	180	0.31	7.08	23.0
DQ	3	19.4	85.5	69.6	206	0.27	6.66	24.6
	2	16.1	90.5	80.5	286	0.26	6.49	24.7
	1	20.4	78.1	78.0	271	0.28	6.68	24.0
VQi		21.7	98.5	68.7	235	0.41	8.70	21.7
		(19.6-25.8)	(69.5-113)	(48.7-83.4)	(176-282)	(0.29-0.60)	(6.44-11.7)	(18.8-27.0)
VQt		18.0	76.5	66.5	251	0.36	7.96	22.4
		(13.1-22.3)	(59.5-99.1)	(57.0-85.5)	(116-340)	(0.20-0.51)	(6.54-10.2)	(20.2-25.9)
QB		17.6	79.2	76.2	220	0.35	7.78	22.6
		(12.4-23.9)	(45.9-101)	(60.3-91.9)	(133-309)	(0.26-0.44)	(5.64-9.54)	(21.1-25.6)
DQ		18.6	84.7	76.0	254	0.27	6.61	24.4
		(16.1-20.4)	(85.5-90.5)	(69.6-80.5)	(206-286)	(0.24-0.30)	(6.11-7.13)	(23.6-25.2)

Table B3. Chemical and physical properties of A21 horizon on mass basis.

	Plot No	$pH\text{-}H_2O$	pH-KCl	σ (mS/m)	ρ (kg/m^3)	Substance content: Na^+ (mg/100 g)	K^+ (mg/100 g)	Mg^{2+} (mg/100 g)	Ca^{2+} (mg/100 g)	N (g/100 g)	C (g/100 g)
VQi	29	3.6	2.7	10.8	340	10.1	14.0	8.1	24.7	1.46	34.2
	28	3.9	2.8	5.1	710	3.4	6.8	5.2	29.1	0.47	10.9
	27	3.7	2.6	20.4	320	14.3	45.9	18.8	58.4	1.51	47.7
	26	3.8	2.8	8.6	540	6.2	12.3	9.2	20.5	0.56	14.7
	25	3.6	2.5	16.6	340	11.9	23.1	15.1	42.4	1.41	34.8
	24	3.6	2.5	6.9	410	6.2	12.1	6.9	35.6	1.00	28.4
	23	3.9	2.9	5.0	710	3.8	9.1	6.2	14.8	0.46	9.22
	22	3.7	2.7	9.2	440	5.8	19.2	11.2	27.9	0.75	18.0
VQt	21	3.6	2.5	9.1	370	8.7	20.2	17.7	54.1	1.26	34.2
	20	3.6	2.6	3.9	570	4.0	9.5	8.4	33.9	0.82	21.7
	19	3.8	3.0	2.4	1040	2.5	6.2	2.2	6.3	0.21	5.34
	18	3.8	2.9	3.7	840	3.8	6.0	3.9	15.1	0.30	7.26
	17	3.8	2.8	3.6	650	2.8	8.1	5.0	16.5	0.44	9.99
	16	3.8	3.0	2.4	870	2.7	4.2	2.9	4.1	0.22	4.93
	15	3.8	2.9	1.9	830	3.4	5.8	3.4	14.3	0.29	6.31
	14	3.9	3.0	2.6	860	2.6	5.7	3.5	12.4	0.26	6.09
	13	3.9	3.0	3.1	910	2.4	4.6	2.4	5.5	0.24	6.14
	12	3.9	3.3	2.3	980	2.3	4.7	2.1	4.3	0.14	4.26
QB	11	3.8	2.8	2.4	860	2.6	4.3	4.1	13.0	0.23	7.49
	10	3.9	3.0	4.5	630	4.0	9.4	7.9	16.2	0.34	9.11
	9	3.7	2.6	4.6	550	3.8	11.2	8.9	29.7	0.64	18.6
	8	4.1	3.4	2.5	950	2.4	4.4	2.1	5.3	0.14	3.96
	7	3.9	3.0	4.7	730	3.8	9.1	6.1	15.9	0.30	8.82
	6	3.8	3.1	5.3	930	2.9	8.7	3.6	14.2	0.19	5.48
	5	3.7	2.6	7.4	290	7.7	24.5	29.6	28.7	1.03	29.5
	4	4.3	3.1	3.4	1080	2.7	7.2	2.7	5.5	0.19	6.13
DQ	3	4.0	3.0	2.3	800	3.1	5.5	3.1	3.0	0.20	6.17
	2	4.3	3.4	1.4	1270	2.1	2.8	1.3	3.4	0.06	1.69
	1	4.0	3.3	2.5	1060	2.4	3.4	1.7	6.2	0.09	2.38
VQi		3.7 (3.5-4.0)	2.7 (2.5-2.9)	10.3 (3.2-21.7)	480 (340-710)	7.7 (3.4-14.3)	17.8 (6.8-45.9)	10.1 (5.2-18.8)	31.7 (14.8-58.4)	0.95 (0.26-2.15)	24.7 (6.5-49.2)
VQt		3.8 (3.5-4.0)	3.0 (2.4-3.4)	3.5 (1.4-12.0)	790 (370-1040)	3.5 (2.3-8.7)	7.5 (4.2-20.2)	5.2 (2.1-17.7)	16.7 (4.1-54.1)	0.42 (0.12-1.98)	10.6 (3.0-47.7)
QB		3.9 (3.5-4.4)	3.0 (2.6-3.5)	4.4 (1.7-9.9)	750 (550-1080)	3.7 (2.4-7.7)	9.9 (4.3-24.5)	8.1 (2.1-29.6)	16.1 (5.3-29.7)	0.38 (0.13-1-04)	11.1 (2.7-36.8)
DQ		4.1 (3.9-4.3)	3.2 (2.9-3.5)	2.1 (1.3-2.9)	1040 (800-1060)	2.5 (2.1-3.1)	3.9 (2.8-5.5)	2.0 (1.3-3.1)	4.2 (3.0-6.2)	0.12 (0.06-0.25)	3.41 (1.51-8.46

Table B4. Chemical properties of A21 horizon on volume basis and C/N ratio.

	Plot No	Substance concentration						
		Na^+ (mg/l)	K^+ (mg/l)	Mg^{2+} (mg/l)	Ca^{2+} (mg/l)	N (g/l)	C (g/l)	C/N
VQi	29	31.0	44.7	25.1	79.1	0.47	11.0	23.8
	28	23.0	45.8	35.3	193	0.31	7.23	23.7
	27	45.2	146	59.5	185	0.48	18.2	31.5
	26	33.0	64.4	47.8	106	0.29	7.71	26.1
	25	40.8	77.8	50.8	144	0.48	11.8	24.9
	24	24.0	46.8	26.3	138	0.38	11.0	29.9
	23	26.5	64.4	42.9	102	0.31	6.32	20.2
	22	25.8	73.0	49.3	123	0.33	7.96	24.1
VQt	21	29.1	71.2	55.7	178	0.39	11.1	28.2
	20	21.0	49.4	42.6	178	0.44	10.6	25.4
	19	25.4	52.7	22.7	65.6	0.22	5.48	25.2
	18	32.2	50.4	32.8	127	0.25	6.08	24.5
	17	17.9	51.9	31.9	106	0.27	6.24	23.1
	16	23.0	34.3	24.3	33.8	0.19	4.12	22.0
	15	27.8	47.5	27.8	122	0.23	5.14	22.0
	14	22.2	48.4	29.1	104	0.22	5.10	23.3
	13	21.8	41.0	20.8	47.4	0.22	5.49	24.9
	12	22.1	45.2	20.2	40.8	0.14	4.08	29.5
QB	11	22.0	36.9	34.5	110	0.20	6.36	32.1
	10	25.0	59.0	50.1	102	0.21	5.68	27.2
	9	19.2	54.1	42.2	140	0.30	8.91	29.9
	8	22.5	42.4	19.3	48.3	0.14	3.69	27.0
	7	27.1	63.2	42.2	84.4	0.22	6.30	29.2
	6	25.7	75.9	30.6	119	0.16	4.62	29.8
	5	21.6	68.8	83.2	81.3	0.29	8.38	29.1
	4	28.0	75.4	27.8	56.3	0.20	6.46	32.3
DQ	3	24.3	43.3	23.8	23.8	0.15	4.72	30.6
	2	26.2	35.9	16.1	43.2	0.08	2.14	28.3
	1	25.4	36.0	18.1	64.9	0.09	2.48	29.0
VQi		31.2 (23.0-45.2)	70.3 (44.7-146)	42.1 (25.1-59.5)	134 (79.1-193)	0.38 (0.29-0.48)	10.1 (5.58-25.6)	25.5 (18.6-34.9)
VQt		24.3 (17.9-32.2)	49.2 (34.3-71.2)	30.8 (20.2-55.7)	100 (33.8-178)	0.26 (0.14-0.44)	6.34 (3.02-13.0)	24.5 (14.4-31.9)
QB		23.9 (19.2-28.0)	59.5 (36.9-75.9)	41.2 (19.3-83.2)	92.7 (48.3-140)	0.21 (0.14-0.30)	6.30 (3.21-10.1)	29.6 (24.9-33.9)
DQ		25.3 (24.3-26.2)	38.4 (35.9-43.3)	19.3 (16.1-23.8)	44.0 (23.8-64.9)	0.11 (0.08-0.15)	3.11 (1.89-6.34)	29.3 (26.1-33.8)

Appendix C. Vegetation table for all plots recorded by modified Braun-Blanquet method (Section 3.1). t, tree layer; s, shrub layer; m, moss layer.

Table C1. Vegetation table Dicrano-Quercetum.

Plot number	1	2	3
Sample plot area (m^2)	150	1000	1000
Tree layer			
Height above ground (m)	1-15	0.5-8 (-10)	0.5-8 (-10)
Cover, crown (%)	85	96	96
canopy (%)	25	80	70
Number of species	1	3	3
Shrub layer			
Height (m)	1-5		
Cover (%)	1		
Number of species	1		
Herb layer			
Height (m)	0-0.2	0-0.1	0-0.1 (-0.5)
Cover (%)	<1	<1	12
Number of species	14	7	8
Moss layer			
Cover (%)	<1	7	4
Number of species	25	31	30
Dead stumps and logs			
Cover (%)	0.2	<0.01	<0.01
Area fraction of moss cover on stumps etc. (%)	10		
Number of species	11		
Total number of species	35	40	40
1. Differential species of Dicrano-Quercetum			
m *Dicranum scoparium*	3	2m	2m
m *Pohlia nutans*	1	2m	1
m *Lophocolea heterophylla*	1	1	1
m *Lecidea granulosa*	+		r
m *Campylopus fragilis*	+	+	+
m *Cladonia pyxidata*	+	r	+
m *Aulacomnium androgynum*	2m	r	+
m *Parmelia physodes*	+		+
m *Cladonia glauca*	1	r	+
m *Dicranum polysetum*	1		r
m *Pleurozium schreberi*	2a	r	r
m *Cephaloziella divaricata*		1	r
m *Cladonia impexa*	+	1	r
h *Calluna vulgaris*	+	+	
m *Cephalozia bicuspidata*	+	+	r
m *Cladonia furcata*		+	r
m *Dicranoweisia cirrhata*	+	+	+
h *Festuca ovina*	+	+	+
h *Empetrum nigrum*	+	r	
m *Cladonia uncialis*		1	
m *Orthodicranum montanum*		r	r
h *Agrostis canina*	r	r	r
m *Dicranum fuscescens*	+	r	

Table C1. Continued.

Plot number	1	2	3
2. Differential species of Querco-Betuletum			
h *Vaccinium myrtillus*			+
6. Differential species of Dicrano-Quercetum and Querco-Betuletum			
m *Leucobryum glaucum*	+	2m	+
m *Campylopus flexuosus*	1	2m	1
8. Differential species of Dicrano-Quercetum, Querco-Betuletum and Violo-Quercetum typicum			
h *Deschampsia flexuosa*	r		2b
9. Differential species of Quercion robori-petraeae			
h *Corydalis claviculata*	+		
h *Galeopsis tetrahit*			r
10. Accompanying species			
t *Quercus robur*	2b	5	4
s *Quercus robur*	+		
h *Quercus robur*	+	+	
m *Mnium hornum*	r	r	1
m *Dicranella heteromalla*	+	+	r
m *Hypnum cupressiforme*	3	2m	1
m *Plagiothecium laetum*	+	r	r
h *Betula pubescens*	+		
t *Frangula alnus*		+	2m
h *Frangula alnus*	r	r	+
m *Polytrichum formosum*	2a	+	r
t *Sorbus aucuparia*			+
h *Sorbus aucuparia*	r	r	+
m *Tetraphis pellucida*			1
m *Orthodontium lineare*			+
m *Isopterygium elegans*		r	
m *Lecidea uliginosa*	2m	+	r
m *Lophocolea bidentata*			r
m *Lepidozia reptans*			r
h *Galium hercynicum*			r
h *Carex pilulifera*			r
m *Eurhynchium praelongum*		r	
h *Amelanchier lamarckii*	+k		
h *Prunus serotina*	+k		
Moss on dead stumps and logs			
7. Differential species of Querco-Betuletum and Violo-Quercetum typicum			
Dicranum scoparium	1		
Orthodontium lineare	r		
Cladonia glauca	+		
8. Differential species of Dicrano-Quercetum, Querco-Betuletum and Violo-Quercetum typicum			
Leucobryum glaucum	+		
Cladonia pyxidata	r		

Table C1. Continued.

Plot number	1	2	3
10. Accompanying species			
Hypnum cupressiforme	2m		
Lophocolea heterophylla	2m		
Plagiothecium laetum	r		
Aulacomnium androgynum	2m		
Dicranoweisia cirrhata	1		
Pohlia nutans	1		
Lecidea uliginosa			r

Table C2. Vegetation table Querco-Betuletum.

Plot number	4	5	6	7	8	9	10	11
Sample plot area (m^2)	1000	1050	1050	150	200	1000	1050	1000
Tree layer								
Height above ground (m)	0.5-9	14	(10-) 18	16-18	16	(7-) 10-16	4-10	4-12
Cover, crown (%)	85	91	93	95	90	96	71	94
canopy (%)	60	68	78	65	40	80	44	72
Number of species	6	2	2	4	1	6	3	3
Shrub layer								
Height (m)		0.5-2	1-4 (-6)	3.5-7	0.5-4 (-6)	1-5	0.5-4	0.5-3 (-4)
Cover (%)		<0.7	10	17	10	6	2	5.5
Number of species		5	4	3	4	6	4	5
Herb layer								
Height (m)	0-0.4	0-0.3	0-0.5	0-0.4 (-1.5)	0-0.4 (-0.5)	0-0.4	0-0.5	0-0.4 (-1)
Cover (%)	56	9	75	80	80	58	44	77
Number of species	17	16	19	23	22	20	23	21
Moss layer								
Cover (%)	10	2	5	<1	<0.1	1.5	0.1	8
Number of species	21	12	13	11	7	11	13	16
Dead stumps and logs								
Cover (%)	0.4	4	0.1	0.1	1	3	2	1
Area fraction of moss cover on stumps etc. (%)	50	90	80	20	70	30	20	40
Number of species	16	17	9	15	9	20	18	17
Total number of species	42	34	37	43	36	45	49	44
1. Differential species of Dicrano-Quercetum								
m *Dicranum scoparium*	1	1	r	r	+	+		+
m *Pohlia nutans*	1	+	+	r			r	
m *Lophocolea heterophylla*	1	r						+
m *Campylopus fragilis*	r					r		2m
m *Aulacomnium androgynum*	1	r						r
m *Dicranum polysetum*	+	+						
m *Pleurozium schreberi*	2a						+	
h *Calluna vulgaris*	2a							
m *Dicranoweisia cirrhata*					r	r		
2. Differential species of Querco-Betuletum								
h *Vaccinium myrtillus*	3	2a	4	2b	4	4	2m	4
h *Vaccinium vitis-idaea*	2b	+	r	r	1		+	r
h *Melampyrum pratense*	+	1		+	2m		1	
3. Differential species of Violo-Quercetum								
h *Oxalis acetosella*					2m		r	
h *Convallaria majalis*	r							
4. Differential species of Violo-Quercetum typicum								
h *Maianthemum bifolium*	+			1			1	+
h *Trientalis europaea*	+		r			r		
h *Stellaria holostea*						+	+	+
h *Pteridium aquilinum*								2m

Table C2. Continued.

Plot number	4	5	6	7	8	9	10	11
6. Differential species of Dicrano-Quercetum and Querco-Betuletum								
m *Leucobryum glaucum*	+	1	r	+	r	1	+	2m
m *Campylopus flexuosus*	+	2m	r					
7. Differential species of Querco-Betuletum and Violo-Quercetum typicum								
h *Molinia caerulea*	1	1	1	2a		1	2m	2m
h *Rubus idaeus*			r	+				
8. Differential species of Dicrano-Quercetum, Querco-Betuletum and Violo-Quercetum typicum								
h *Deschampsia flexuosa*	2a		2m	4	2a	+	3	+
9. Differential species of Quercion robori-petraeae								
h *Rubus fruticosus*		r	2a	1	+	1	r	1
h *Ilex aquifolium*		r	r	+	r	1	r	r
h *Polygonatum multiflorum*	r		r			+	+	r
h *Corydalis claviculata*		r	2a	1	+	+	2m	2a
s *Sorbus aucuparia*		r	1	+	2a	1	1	+
t *Betula pubescens*	+	1	1	+		3	2b	3
t *Lonicera periclymenum*	r							
s *Lonicera periclymenum*				+		r	r	r
h *Lonicera periclymenum*	+	1		2a	2a	+	2m	+
h *Hedera helix*					1	+	r	r
h *Dryopteris dilatata*		r	r	+		+		r
h *Stellaria media*				r	1	r	+	
m *Atrichum undulatum*			r	r			r	
m *Plagiothecium curvifolium*				+		r		
h *Chamaenerion angustifolium*		+	+					
h *Galeopsis tetrahit*			r		+	r	r	
h *Dryopteris carthusiana*		r						r
h *Luzula pilosa*							r	
m *Brachythecium rutabulum*	r						r	
h *Milium effusum*						r		
10. Accompanying species								
t *Quercus robur*	4	4	5	4	3	3	3	3
s *Quercus robur*		+			+	+		+
h *Quercus robur*	+	+	+	1	1	+	+	+
m *Mnium hornum*	r	+	2m	1		1	r	2a
m *Dicranella heteromalla*	1		2m	1	+	r	r	1
m *Hypnum cupressiforme*	2m	+	1	+	+		r	+
m *Plagiothecium laetum*	r		2m	r	r	+		2m
s *Betula pubescens*		r	2a	2b	+	+	r	+
h *Betula pubescens*	r	r	r	+	1	+	r	+
t *Frangula alnus*	1					r		
s *Frangula alnus*		r	+		+	2m	+	2m
h *Frangula alnus*	+	r		1		+	+	+
m *Polytrichum formosum*	r	2m	2m			2m	+	2m
t *Sorbus aucuparia*	+					2m	+	+
h *Sorbus aucuparia*	+	+	+	+	1	+	1	+
m *Tetraphis pellucida*		r	1					1
m *Orthodontium lineare*		r		+		r		r
m *Isopterygium elegans*	r		2m	r			r	
m *Calypogeia muelleriana*	r		r				r	2m

Table C2. Continued.

Plot number	4	5	6	7	8	9	10	11
m *Polytrichum marginatum*					r			r
m *Lecidea uliginosa*	r							
m *Lophocolea bidentata*	+						r	
m *Lepidozia reptans*	r							
h *Galium hercynicum*					+			
t *Quercus rubra*				+				
h *Quercus rubra*				+k				
h *Carex pilulifera*	+		r				r	
s *Amelanchier lamarckii*		r	r					
h *Amelanchier lamarckii*		r	+		+			r
t *Prunus serotina*						1		
s *Prunus serotina*						+		
h *Prunus serotina*		+		+				
m *Pseudoscleropodium purum*	+						+	
t *Populus tremula*	+					r		
h *Populus tremula*				r		+		
h *Luzula multiflora*							r	
h *Agrostis tenuis*			r					
t *Fagus sylvatica*				+				
Moss on dead stumps and logs								
3. Differential species of Violo-Quercetum								
Eurhynchium praelongum								+
Plagiothecium latebricola						r		
4. Differential species of Violo-Quercetum typicum								
Campylopus fragilis		1		r				
7. Differential species of Querco-Betuletum and Violo-Quercetum typicum								
Mnium hornum	+	2a		1	1	2a	2m	2b
Dicranum scoparium	2a	2b			2a	1	1	+
Tetraphis pellucida		2m	3	r		2m	+	2m
Orthodontium lineare		+		2b		+	+	
Cladonia glauca		+			1	r	r	
Cladonia digitata		r	r			1	1	r
Polytrichum formosum	r	3			r	2m		1
Plagiothecium curvifolium				+	+			1
Campylopus flexuosus	+	2b	r					r
8. Differential species of Dicrano-Quercetum, Querco-Betuletum and Violo-Quercetum typicum								
Leucobryum glaucum	r	2a				1	r	1
Cladonia pyxidata	r			r			r	
9. Differential species of Quercion robori-petraeae								
Brachythecium rutabulum	+		+	1		r	+	2m
Isothecium myosuroides						r	2a	
Lepidozia reptans			+			+		r
Isopterygium seligeri						2a		2a

Table C2. Continued.

Plot number	4	5	6	7	8	9	10	11
10. Accompanying species								
Hypnum cupressiforme	2b	2b	2b	2a	3	2a	2a	2b
Lophocolea heterophylla	1	2m	2b	1	2m	2m	2m	2m
Plagiothecium laetum	1	+	1	+		2a	r	2a
Aulacomnium androgynum	2b	2m		r		+	+	+
Dicranoweisia cirrhata	r			r	2b		+	
Pohlia nutans	+	1		+		r		
Calypogeia muelleriana	r	r		r				
Brachythecium velutinum								r
Lecidea uliginosa							r	
Cladonia polydactyla			+					
Lophocolea bidentata				+			r	
Ptilidium pulcherrimum						r	r	
Orthodicranum montanum	r	r						

Table C3. Vegetation table Violo-Quercetum typicum.

Plot number	12	13	14	15	16	17	18	19	20	21
Sample plot area (m^2)	1050	1000	1000	1000	1000	1000	150	150	1000	150
Tree layer										
Height above ground (m)	(5-) 10-15	4-7	8-12	6-10	4-12	9-12	10-15	9-12	16-18	10-14
Cover, crown (%)	96	99	97	96	88	98	90	90	97	80
canopy (%)	71	96	82	83	40	75	70	70	84	70
Number of species	3	7	5	3	6	2	2	2	2	3
Shrub layer										
Height (m)	1-3 (-5)		0.5-2 (-3)	0.5-4	1-4	1-4 (-6)	0.3-3	1-4 (-8)	0.5-1.5 (-6)	
Cover (%)	5		15	1	5	15	10	15	20	
Number of species	3		8	5	4	6	4	3	7	
Herb layer										
Height (m)	0-0.5 (-1)	0-0.4	0-0.3 (0.5)	0-0.4 (-0.8)	0-0.7	0-1 (-1.5)	0-0.5	0-0.5 (-0.7)	0-0.3 (-1)	0-1.5
Cover (%)	44	7	13	66	26	90	80	70	63	80
Number of species	25	16	19	22	19	23	21	11	21	16
Moss layer										
Cover (%)	<0.01	<1	0.2	0.3	0.2	<0.1	1	<0.1		<0.1
Number of species	3	11	11	11	9	8	10	5		2
Dead stumps and logs										
Cover (%)	0.5	5	2	2	1	1	2	1	1	1
Area fraction of moss cover on stumps etc. (%)	25	100	100	40	100	50	15	30	10	15
Number of species	11	15	23	15	12	16	9	8	18	12
Total number of species	38	36	45	38	33	43	36	21	39	29
1. Differential species of Dicrano-Quercetum										
m *Dicranum scoparium*		1		r	1	r	r			
m *Pohlia nutans*			r	r			1			
m *Lophocolea heterophylla*		r	r	+	+		1			
m *Campylopus fragilis*				r	r		r	r		r
m *Aulacomnium androgynum*			r		+					

Table C3. Continued.

Plot number	12	13	14	15	16	17	18	19	20	21
2. Differential species of Querco-Betuletum										
h *Vaccinium myrtillus*		+	1	+	+	1		r	2a	1
h *Vaccinium vitis-idaea*			r							
h *Melampyrum pratense*	r									
3. Differential species of Violo-Quercetum										
h *Oxalis acetosella*			+	+		2m	2m		2m	
s *Hedera helix*			+	r		+			r	
h *Convallaria majalis*					1	+	4			
s *Corylus avellana*					r	1				
4. Differential species of Violo-Quercetum typicum										
h *Maianthemum bifolium*	2a	+	2a	2a	2a	2a	2m	2m	+	+
h *Trientalis europaea*		2a	2m				2m	2m	2m	3
h *Stellaria holostea*				2a	+	2m	1		2b	2b
h *Pteridium aquilinum*				2a	2a	4		3	2b	3
5. Differential species of Violo-Quercetum ilicetosum										
s *Ilex aquifolium*									2a	
6. Differential species of Dicrano-Quercetum and Querco-Betuletum										
m *Leucobryum glaucum*		r								
7. Differential species of Querco-Betuletum and Violo-Quercetum typicum										
h *Molinia caerulea*	+	1		r	r	2m			+	2m
h *Rubus idaeus*	+					+			1	
8. Differential species of Dicrano-Quercetum, Querco-Betuletum and Violo-Quercetum typicum										
h *Deschampsia flexuosa*	2b	2m	2m	2a	2a	2a				

Table C3. Continued.

Plot number	12	13	14	15	16	17	18	19	20	21
9. Differential species of Quercion robori-petraeae										
h *Rubus fruticosus*	r	r	r	2m	r	r	+	3	2m	1
h *Ilex aquifolium*	r	r	r	+	r	r			1	1
h *Polygonatum multiflorum*	r	r	+	+	+	+	r	+	+	+
h *Corydalis claviculata*	2m	1	+	3	+	2a	2m		1	2a
s *Sorbus aucuparia*	+		2a	r	2m	2m	2a	2b	1	
t *Betula pubescens*	r	2b	2a	3	2a	2a	3	+	2a	3
t *Lonicera periclymenum*		r			+					
s *Lonicera periclymenum*	r		1	+	1	1			r	
h *Lonicera periclymenum*	2b	r	+	+	+	2a	r		1	+
h *Hedera helix*		+	2m	2a	+	2b	1	r	1	+
h *Dryopteris dilatata*			r	r			+		r	
h *Stellaria media*	r				r		r	r	r	
m *Atrichum undulatum*							1			
m *Plagiothecium curvifolium*	r	1					1	+		
h *Chamaenerion angustifolium*	r						+			
h *Galeopsis tetrahit*	+			r			r			
h *Dryopteris carthusiana*		+	r			r	+			
h *Luzula pilosa*								+		
m *Brachythecium rutabulum*		+								
h *Milium effusum*									1	
10. Accompanying species										
t *Quercus robur*	4	3	4	4	3	4	3	4	5	2b
s *Quercus robur*			+			+			r	
h *Quercus robur*	+		+	+	+	+	r	+	+	r
m *Mnium hornum*		1	1	1	2m	+	1	+		r
m *Dicranella heteromalla*	r	r	+	+		+	2m	1		
m *Hypnum cupressiforme*	r	+	r	2m	+		1	+		
m *Plagiothecium laetum*		+	1	2m	r	r				
s *Betula pubescens*			r					+	1	
h *Betula pubescens*		r	r	r	r	r			+	+
t *Frangula alnus*		2m	r		+					
s *Frangula alnus*	2m		2a	r	2m	2a	r	+	2a	
h *Frangula alnus*	2m	r	r	+	+	+	+		r	+
m *Polytrichum formosum*		2m	+			r	+			
t *Sorbus aucuparia*	2m	2b	+	1	2m					r
h *Sorbus aucuparia*	1	r	+	+	1	+	1	2m	+	+
m *Tetraphis pellucida*			+		+					
m *Orthodontium lineare*					r					

Table C3. Continued.

Plot number	12	13	14	15	16	17	18	19	20	21
m *Lepidozia reptans*						r				
h *Galium hercynicum*	2m									
h *Quercus rubra*						r				
m *Eurhynchium praelongum*			r	r		r				
t *Amelanchier lamarckii*		2a	+		+					
s *Amelanchier lamarckii*			r							
h *Amelanchier lamarckii*	r		+	r						
t *Prunus serotina*		2m								
s *Prunus serotina*			+				2a			
h *Prunus serotina*	r	r		+			1			
m *Pseudoscleropodium purum*		+								
h *Luzula multiflora*	r									
h *Agrostis tenuis*	r									
h *Holcus lanatus*				+	+	+	+			
m *Plagiothecium sylvaticum*			r			r				
h *Galium aparine*							r			
s *Sambucus nigra*				r			r			
m *Isothecium myosuroides*				+						
Moss on dead stumps and logs										
3. Differential species of Violo-Quercetum										
Dicranella heteromalla	r			r			+	1	r	r
Eurhynchium praelongum			+	r		r				+
Plagiothecium latebricola				+					r	
4. Differential species of Violo-Quercetum typicum										
Campylopus fragilis		r		+	r		r	r	r	
7. Differential species of Querco-Betuletum and Violo-Quercetum typicum										
Mnium hornum	+	4	3	2a	4	2b	2a	2a	+	2m
Dicranum scoparium	+	2a	1	r	2a	+	2m		+	
Tetraphis pellucida		2m	r		2a	1			r	r
Orthodontium lineare		2a	r	1	+		r		1	r
Cladonia glauca		1	r		+	+	1		r	
Cladonia digitata			r	r		1				r
Polytrichum formosum		2b	r							
Plagiothecium curvifolium		+				r		2b		
Campylopus flexuosus			r						r	r

Table C3. Continued.

Plot number	12	13	14	15	16	17	18	19	20	21
8. Differential species of Dicrano-Quercetum, Querco-Betuletum and Violo-Quercetum typicum										
Leucobryum glaucum		+	r		r				r	
Cladonia pyxidata	+		r	r						
9. Differential species of Quercion robori-petraeae										
Brachythecium rutabulum	+		r			r			r	+
Isothecium myosuroides	1		2b	1		+	2m			
Lepidozia reptans		r	2m			r				
Isopterygium seligeri						r			1	
10. Accompanying species										
Hypnum cupressiforme	2b	2m	2b	2b	2a	2b	2m	2a	2m	2a
Lophocolea heterophylla	2a	2m	2a	2m	2a	2a	2m	2m	2a	2m
Plagiothecium laetum	r	2m	2b	2a	+	2m		1	1	+
Aulacomnium androgynum		r	2m	+	1	r		r	+	
Dicranoweisia cirrhata	2a		r			r			r	r
Pohlia nutans	r		r	+	r				r	
Brachythecium velutinum			+							
Cladonia polydactyla			+							

Table C4. Vegetation table Violo-Quercetum ilicetosum.

Plot number	22	23	24	25	26	27	28	29
Sample plot area (m^2)	875	1000	1000	150	150	150	150	150
Tree layer								
Height above ground (m)	7-15	(6-) 14-20	(8-) 10-14	3-14	20	16-24	3-12	(10)- 18-24
Cover, crown (%)	93	94	97	90	80	60	95	80
canopy (%)	66	67	78	70	40	30	70	60
Number of species	6	3	5	3	1	2	2	1
Shrub layer								
Height (m)	0.5-4	0.5-3	0.3-3	0.5-2	0.5-7	0.5-10	0.5-3	0.5-1
Cover (%)	20	11	1.4	5	20	80	7	70
Number of species	8	5	5	2	3	3	1	4
Herb layer								
Height (m)	0-0.3 (-0.5)	0-0.5	0-0.3 (-0.7)	0-0.5	0-0.5 (-0.7)	0-0.5	0-0.5	0-0.3 (-0.5)
Cover (%)	14	4	1.3	10	9	<1	<1	20
Number of species	21	12	14	17	13	11	13	18
Moss layer								
Cover (%)	<0.1	0.1	0.2	12	0.2	1	<0.1	<1
Number of species	3	7	6	8	9	6	5	7
Dead stumps and logs								
Cover (%)	2	0.2	0.3	1	1	2	1	0.5
Area fraction of moss cover on stumps etc. (%)	15	10	50	10	20	10	30	10
Number of species	10	4	11	5	11	10	9	6
Total number of species	34	22	27	26	30	26	24	30
1. Differential species of Dicrano-Quercetum								
m *Pohlia nutans*					r	+		
m *Lophocolea heterophylla*				+		1	r	
m *Campylopus fragilis*				+		1		
2. Differential species of Querco-Betuletum								
h *Vaccinium myrtillus*	2m		+	r			r	r
3. Differential species of Violo-Quercetum								
h *Oxalis acetosella*	2m		r			r		r
s *Hedera helix*	r	r	r					
h *Convallaria majalis*	r	+						
s *Corylus avellana*	r	+						+
4. Differential species of Violo-Quercetum typicum								
h *Maianthemum bifolium*	1	+			2m	+	r	+
h *Trientalis europaea*	2m							
h *Stellaria holostea*	+							
h *Pteridium aquilinum*			+	+	1		1	
5. Differential species of Violo-Quercetum ilicetosum								
t *Ilex aquifolium*	3	3	4	3			4	
s *Ilex aquifolium*	2b	2a	1	2a	2b	5	2a	4

Table C4. Continued.

Plot number	22	23	24	25	26	27	28	29
8. Differential species of Dicrano-Quercetum, Querco-Betuletum and Violo-Quercetum typicum								
h *Deschampsia flexuosa*	+							
9. Differential species of Quercion robori-petraeae								
h *Rubus fruticosus*	+	2m	r	+	2a	+	+	r
h *Ilex aquifolium*	2m	2m	2m	1	1	+	2m	2a
h *Polygonatum multiflorum*	+	r	+		1	r	r	r
h *Corydalis claviculata*	1	+	r	1	+		1	
s *Sorbus aucuparia*	2m	+	+		+	r		2b
t *Betula pubescens*	2a		1	3		2b		
t *Lonicera periclymenum*	r							
s *Lonicera periclymenum*	+				r			
h *Lonicera periclymenum*	+		r		r			r
h *Hedera helix*	+	r	r					2a
h *Dryopteris dilatata*	1	r	1	+		+		
h *Stellaria media*	r		+	2a	+	r	+	
m *Atrichum undulatum*		r			r			r
m *Plagiothecium curvifolium*					r			
h *Chamaenerion angustifolium*				r	r	r		
h *Galeopsis tetrahit*	+		r	r			r	r
h *Dryopteris carthusiana*	+			+				
h *Luzula pilosa*		r			r			r
m *Brachythecium rutabulum*					+			r
h *Milium effusum*				+				r
10. Accompanying species								
t *Quercus robur*	3	3	1	3	3	2a	2a	4
s *Quercus robur*	r		r					
h *Quercus robur*	+	+	+	r			+	1
m *Mnium hornum*	+	+	1	2a	1		+	1
m *Dicranella heteromalla*	r	+	+	1	2m	2m	r	2m
m *Hypnum cupressiforme*		r	r	+		r	r	
m *Plagiothecium laetum*	r	1	+	2m	+	+		r
s *Betula pubescens*	+			+				
h *Betula pubescens*	r			1	+			r
t *Frangula alnus*			r					
s *Frangula alnus*	+	r						
h *Frangula alnus*	r							r
m *Polytrichum formosum*				1	1			+
t *Sorbus aucuparia*	r		1					
h *Sorbus aucuparia*	r	+	2m	2m	+	+	2m	2m
m *Tetraphis pellucida*			r					
m *Orthodontium lineare*							r	
m *Isopterygium elegans*		+				+		
m *Calypogeia muelleriana*			r					+
h *Carex pilulifera*					r			
t *Fagus sylvatica*		2b						
h *Holcus lanatus*		r						
m *Plagiothecium sylvaticum*				r				
h *Galium aparine*						r	r	
s *Sambucus nigra*						r		
m *Isothecium myosuroides*		r						

Table C4. Continued.

Plot number	22	23	24	25	26	27	28	29
Moss on dead stumps and logs								
3. Differential species of Violo-Quercetum								
Dicranella heteromalla			r		+	1		
Eurhynchium praelongum			r	r		+	1	
Plagiothecium latebricola			r			+	r	r
7. Differential species of Querco-Betuletum and Violo-Quercetum typicum								
Mnium hornum	1	r	1		1	r	+	+
Tetraphis pellucida	2m				r			
Orthodontium lineare	+							
Cladonia glauca	r							
Cladonia digitata	r							
9. Differential species of Quercion robori-petraeae								
Brachythecium rutabulum					+	+	2b	+
Isothecium myosuroides	+	1	r		+			r
Lepidozia reptans			+					
Isopterygium seligeri	r		2m				1	
10. Accompanying species								
Hypnum cupressiforme	2a	2a	2a	2m	2a	2a	+	2m
Lophocolea heterophylla	2a	2m	2b	2a	2m	2m	2a	2a
Plagiothecium laetum	1		2a	+		1	+	
Aulacomnium androgynum				r	2m			
Dicranoweisia cirrhata					+	+		
Pohlia nutans							r	
Calypogeia muelleriana			+					
Brachythecium velutinum					r			

Notes

Rare species not mentioned in either table of Appendix C nor in Table 2.
Plot 1: *Rumex acetosella* L. r(I-1), *Nardus stricta* L. r(I-1), *Diplophyllum albicans* (L.) Dum. +(I-1), *Buxbaumia aphylla* Hedw. +(I-1), *Calypogeia trichomanis* (L.) Corda +(I-1), *Ceratodon purpereus* (Hedw.) Brid. +(I-1), *Cetraria glauca* (L.) Ach. r(II-4).
Plot 2: *Juncus squarrosus* L. r(I-1), *Polytrichum piliferum* Hedw. r(I-4), *Cladonia gracilis* (L.) Willd. +(I-1), *Cladonia destricta* (Nyl.) Sandst. +(I-1), *Cladonia floerkeana* (Fr.) Sommerf. r(II-2), *Cornicularia aculeata* (Schreb.) Ach. +(II-5), *Pinus sylvestris* L. tree layer 1(I-2).
Plot 3: *Campylopus introflexus* Brid. +(I-4).
Plot 4: *Polypodium vulgare* L. r(I-1), *Pleurozium schreberi* (Brid.) Mitt. on dead stumps 2b(I-225).
Plot 7: *Lolium perenne* L. r(I-1), *Chenopodium album* L. r(I-1).
Plot 8: *Anthoxanthum odoratum* L. 2m(I-37), *Poa trivialis* L. 1(I-12), *Luzula* cf. *campestris* (L.) DC. +(I-6), *Potentilla erecta* (L.) Räuschel r(I-1), *Prunus* spec. herblayer +(I-6), *Cladonia squamosa* (Scop.) Hoffm. on dead stumps r(I-1).
Plot 9: *Isopterygium seligeri* (Brid) Dix. 1(I-12), *Isopterygium elegans* (Hook) Lindb. on dead stumps r(I-1).
Plot 11: *Plagiothecium undulatum* (Hedw.) B.S.G. +(I-6).
Plot 12: *Moehringia trinervia* (L.) Clairv. 1(I-10), *Senecio sylvaticus* L. +(I-5), *Poa pratensis* L. r(I-1), *Veronica officinalis* L. +(I-5).
Plot 13: *Dicranum majus* Sm. on dead stumps r(I-1).
Plot 14: *Dicranum fuscescens* Turn. on dead stumps r(I-1).
Plot 15: *Plagiothecium latebricola* B.S.G. +(I-5).
Plot 17: *Holcus mollis* L. +(I-5).
Plot 22: *Hedera helix* L. in tree layer r(I-1).
Plot 25: *Dactylis glomerata* L. r(I-1), *Poa annua* L. r(I-1), *Polygonum aviculare* L. +(I-6).
Plot 26: *Polytrichum marginatum* Web. & Mohr. on dead stumps r(I-1).
Plot 27: *Sambucus nigra* L. herb layer +(I-6), *Bryum capillare* Hedw. on dead stumps r(I-1).
Plot 28: *Polygonum* cf *convolvulus* L. r(I-1).
Plot 29: *Acer pseudoplatanus* L. shrub layer r(I-1), *Anemone nemorosa* L. r(I-1), *Corylus avellana* L. herb layer r(I-1), *Taxus baccata* L. (seedling) r(I-1).

Appendix D. Abundance, annual frequency and spatial frequency of fungi. Two or three items of data are given for each species in a plot: aggregate maximum abundance of fruiting bodies (r, rare; o, occasional; f, freqent; vf, very frequent; a, abundant; va, very abundant; x, present but abundance not estimated); annual frequency; cumulative spatial frequency (%), only for some plots. Records by Barkman are marked 'B'.

Table D1. Abundance, annual frequency and spatial frequency of fungi in Dicrano-Quercetum.

Plot number	1		2			3		
Plot area (m²)	800		1000 -2000			1000 -3000		
Number of records	10		12			12		
Number of frequency records			3			3		
Time (years)	6		6			6		
Number of species	88		105			126		
Number of species in frequency records			63			65		
1. Species of Dicrano-Quercetum								
Cordyceps ophioglossoides	f	33	a	100	38	o	83	5
Russula fragilis	f	100	f	100	23	o	100	35
Amanita fulva	f	100	vf	83	75	f	83	18
Cantharellus cibarius	a	83	a	83	30	f	83	1
Cortinarius paleaceus	o	50	vf	83	15	vf	67	10
Marasminus androsaceus	o	100	vf	100	25	vf	83	48
Lactarius chrysorheus	a	100	a	83	53	f	83	1
Inocybe ovatocystis	o	33	f	67	10	f	83	10
Cordyceps canadensis	o	33	f	67	13	r	67	3
Cortinarius obtusus	f	33	f	33	1	o	17	3
Cortinarius fusisporus	o	50	f	100	10	r	17	1
Leotia lubrica	o	50	f	17	3	o	17	1
Dermocybe cinnamomeolutea	o	17	o	33	3	r	50	1
Thelephora terrestris	r	33	r	100	3	o	83	10
Boletus erythropus	r	50				r	17	
Cortinarius glandicolor			r	33	1			
Psathyrella fulvescens var. *dicrani*	o	67	f	83	8	o	17	3
Tricholoma portentosum	o	33	o	17				
Inocybe napipes	r	17	o	67	8	f	67	18
Russula adusta			r	33				
Entoloma turbidum	r	17	r	17	1			
Cortinarius bolaris						o	33	
Hydnellum scrobiculatum	r	17	r	17		r	17	
Inocybe sambucina			r	17	1	r	17	1
Boletus edulis	r	17	r	17		r	17	
Cortinarius alboviolaceus			o	33				
Cortinarius cf. *stemmatus*			f	67	25	o	33	5
Sarcodon scabrosus						r	17	
Hydnellum spongiosipes	r	17				r	50	1
Russula cyanoxantha			r	17		o	83	1
Inocybe xanthomelas			r	67	15	o	17	1
Hebeloma pumilum			o	17	1	o	17	3
Tricholoma columbetta	r	50	o	67	3			
Tricholoma virgatum			o	33				
Russula vesca	r	33						
Psathyrella cernua						r	50	5
Tricholoma saponaceum	o	33				r	17	
Sarcodon joeides			r	17		r	17	
Amanita muscaria			r	17				
Inocybe boltonii			r	17				
Hydnellum concrescens						r	17	
Phellodon melaleucus						r	17	
Clitocybe inornata						o	33	
Cortinarius albofimbriatus			o	33				
Cortinarius decipiens s.Lge			o	33				

Table D1. Continued.

Plot number	1	2	3
Cortinarius porphyropus		r 33	
Cortinarius mucifluus		r 33	
Inocybe lacera		r 67 3	
Entoloma cetratum			r 33 5
2. Species of Quercion robori-petraeae			
a. with a preference for Querco-Betuletum			
Polyporus brumalis	r 17		
Stereum hirsutum			r 50 3
Tephrocybe tylicolor	r 17	o 50 5	f 17 5
Chondrostereum purpureum	B		
Psathyrella hydrophila		r 17 1	
Clitocybe diatreta	vf 17		
b. with a preference for Violo-Quercetum			
Cudoniella acicularis			o 17 18
c. with a preference for Violo-Quercetum typicum			
Oudemansiella platyphylla	r 50		r 17 3
Collybia cookei		f 17 3	o 33 3
d. with a preference for Violo-Quercetum ilicetosum			
Mycena vitilis	f 50	r 33 10	vf 50 53
e. with a preference for Querco-Betuletum and Violo-Quercetum ilicetosum			
Panellus serotinus	r 17		r 17
f. with a preference for Querco-Betuletum and Violo-Quercetum typicum			
Clitocybe metachroa	a 17		a 33 50
Galerina hypnorum	B	r 17 3	
Clitocybe phyllophila		r 17 3	
g. Indifferent species			
Nectria sp.			r 33 3
Rutstroemia firma	r 17		
Stereum rugosum			r 17 5
Phallus impudicus			f 67 20
Galerina cinctula			r 17 3
Hypholoma sublateritium	r 17		o 17
Laccaria laccata		r 17 3	
3. Species of Querco-Betuletum			
Mycena rorida	o 33	o 50 3	o 17 3
Panellus stipticus			f 17 3
4. Species of Violo-Quercetum			
Tyromyces caesius	r 17		
Galerina ampullaceocystis	r 17		r 33 3

Table D1. Continued.

Plot number	1		2			3		
5. Species of Violo-Quercetum typicum								
Collybia peronata			r	17	3			
Clitocybe flaccida	r	17						
7. Species of Dicrano-Quercetum and Querco-Betuletum								
a. with a preference for Dicrano-Quercetum								
Laccaria amethystina	f	67	f	83	30	a	100	28
Galerina calyptrata	vf	67	o	100	13	vf	67	63
Lactarius camphoratus	vf	100	f	50	10	a	83	48
Clitocybe clavipes	f	50				o	50	3
Amanita citrina						f	83	40
Laccaria proxima	o	83	vf	100	33	f	67	25
Entoloma rhodocylix	o	17	o	50	5	o	33	3
b. Indifferent species								
Cortinarius elatior			r	17	1	r	33	1
Hebeloma longicaudum			f	33	1	o	17	1
Clitocybe gilva	vf	67						
Clitocybe ditopa	r	33	o	17	5	r	17	3
Inocybe longicystis						r	17	1
Collybia tuberosa			o	17	8	r	17	1
Galerina mniophila	r	17						
Tricholomopsis rutilans	o	17						
Hebeloma calyptrosporum			f	17	3	r	33	5
8. Species of Dicrano-Quercetum, Querco-Betuletum and Violo-Quercetum typicum								
a. with a preference for Dicrano-Quercetum								
Russula emetica	r	33	r	67	3	vf	83	40
Cystoderma amianthinum	o	67	o	67	15	f	83	8
b. with a preference for Dicrano-Quercetum and Querco-Betuletum								
Collybia cirrhata			vf	17	15	a	33	33
Xerocomus badius	f	83	o	67	10	vf	83	43
Galerina atkinsoniana	o	50	r	33		vf	50	50
c. with a preference for Querco-Betuletum and Violo-Quercetum typicum								
Collybia butyracea	f	50	o	17	8	o	33	5
Clitocybe candicans	r	33						
d. with a preference for Dicrano-Quercetum and Violo-Quercetum typicum								
Lycoperdon foetidum	o	50	o	33		r	33	3
Collybia maculata			o	67	3			
Russula atropurpurea						r	17	1
Pholiota alnicola						r	33	3

Table D1. Continued.

Plot number	1		2			3		
e. Indifferent species								
Amanita rubescens	o	33	o	100	23	r	67	3
Scleroderma citrinum	a	100	o	67	1	a	83	40
Collybia dryophila	f	50	f	67	15	vf	83	10
Mycena cinerella			o	17	1	vf	33	8
Cortinarius decipiens s.Henry						r	17	1
Crepidotus variabilis						r	17	1
Tylopilus felleus						r	50	1
Galerina pumila			r	17	5			
Pholiota lenta	o	33						
Fistulina hepatica						r	33	3
Stropharia semiglobata	r	17				r	17	3
9. Accompanying species								
Hymenoscyphus fructigenus			o	50	18	f	50	48
Coryne sarcoides			x	17				
Gymnopilus hybridus	f	83	r	33	3	r	67	5
Coriolus versicolor	x	17	r	33	1	r	33	1
Mycena sanguinolenta	a	67	o	50	13	f	50	25
Schizopora paradoxa	x	33	r	33	3	o	33	8
Sphaerobolus stellatus			r	17	3	vf	17	3
Tyromyces lacteus						r	33	3
Lactarius quietus	vf	100	a	100	73	a	100	85
Paxillus involutus	vf	83	vf	100	88	vf	100	68
Lactarius theiogalus	vf	100	vf	100	40	va	83	83
Clitocybe vibecina	a	50	a	83	60	a	67	8
Psathyrella squamosa	f	50	f	50	18	f	83	33
Armillariella mellea	a	67	vf	33	5	r	33	3
Galerina decipiens	a	83	vf	67	50	vf	67	83
Mycena polygramma	r	33	o	67	5	o	33	3
Mycena galericulata	vf	100	f	83	15	vf	100	73
Mycena galopus	f	83	vf	100	40	f	83	28
Hypholoma fasciculare	a	85	a	100	38	a	100	50
Pluteus cervinus	r	67	r	33	3	r	50	8
Calocera cornea	r	83	f	83	40	o	67	15
Psathyrella fulvescens	r	33	o	17	5	r	17	3
Russula ochroleuca	vf	83				r	83	5
Exidia glandulosa	r	50	r	50	5	x	17	1
Galerina allospora	r	17	r	33	5	o	50	13
Coprinus velox			o	17	3	f	33	8
Phlebia radiata	x	33	x	17				
Tephrocybe ambusta	r	17						
Lepista nuda	r	17						
Mycena speirea			r	17	3			
Psathyrella spadiceogrisea						f	33	12
Ganoderma applanatum			r	17	3			
Onygena corvina			r	17	3			
Tremella mesenterica	x	33						
Russula nigricans						f	67	1
Russula amoenolens						r	17	1
Inocybe cookei			r	17	1			

Table D2. Abundance, annual frequency and spatial frequency of fungi in Querco-Betuletum.

Plot number	4	5	6	7	8	9	10	11
Plot area (m^2)	1000 -1500	1050 -2000	1500	2000	2000	1000 -1500	1000 -1500	1000 -2000
Number of records	10	8	7	7	11	8	11	10
Number of frequency records	5	3				4	3	4
Time (years)	4	4	4	3	4	6	4	4
Number of species	101	85	59	69	75	75	65	83
Number of species in frequency records	69	73				64	54	69
1. Species of Dicrano-Quercetum								
Cordyceps ophioglossoides	o 50 3							
Russula fragilis	f 75 35				r 25			
Amanita fulva	vf 75 50				r 75			
Cortinarius paleaceus		r 50 5						
Marasminus androsaceus	vf100 63		o 25			o 83 13		0 50 8
Lactarius chrysorheus	f 75 33				r 25			
Cordyceps canadensis	f 25 3							
Cortinarius fusisporus	r 25 1							
Inocybe napipes		o 75 5	r 17				r 50 2	
Russula cyanoxantha			r 25					
Inocybe xanthomelas	r 25 1							
Hebeloma pumilum	r 50 3							
Russula vesca								B
2. Species of Quercion robori-petraeae								
a. with a preference for Querco-Betuletum								
Polyporus brumalis	f 75 13	o 50 17	r 25	r 100	r 25	r 17 3	0 75 2	3 25 5
Stereum hirsutum	r 25 3	f 100 36		r 100	r 25	r 50 5	f 100 36	0 75 23
Tephrocybe tylicolor	vf100 23	o 50 7		vf100	o 25	f 17 3	0 25 2	vf 50 10
Chondrostereum purpureum		r 25 5	r 25			r 33 8	o 50 2	0 75 13
Psathyrella hydrophila		a 100 2	o 25	vf 33	r 25		a 100 29	
Clitocybe diatreta	f 75 10	o 75 7		r 33	o 50			r 25 3
Mycena mucor	vf 25 10				r 25			
Galerina sahleri		vf 25 29						
b. with a preference for Violo-Quercetum								
Mycena sepia			o 25	r 33		o 33 8	r 50 5	
Cudoniella acicularis		r 75 10	r 75			o 83 28		r 75 43

Table D2. Continued.

Plot number	4	5	6	7	8	9	10	11
c. with a preference for Violo-Quercetum typicum								
Oudemansiella platyphylla	o 25 3	vf100 38	o 100	o 66	o 50	f 100 15	r 75 5	vf100 35
Mycena stylobates	f 75 20	o 25 2			vf 50	vf 67 50	o 75 5	vf100 45
Collybia cookei	o 25 3	a 75 40	r 25	vf 66		o 33 3	a 50 22	vf 75 13
Marasmiellus ramealis		vf 75 17		B		a 100 23		o 75 8
Psilocybe crobula						r 17 3		r 25 3
d. with a preference for Violo-Quercetum ilicetosum								
Mycena haematopus		f 25 7	f 25		f 25	vf100 68		vf100 18
Mycena vitilis	o 100 20	vf100 83	f 100	vf100	f 100	vf 50 88	a 100 90	a 100 95
Kuehneromyces mutabilis						vf 50 5		a 50 3
Hohenbuehelia atrocaerulea						vf 50 8		r 25 3
Clitopilus hobsonii			o 25					
Piptoporus betulinus						r 50 3		r 50 3
Pleurotus ostreatus						o 33 5		
e. with a preference for Querco-Betuletum and Violo-Quercetum ilicetosum								
Xylaria hypoxylon	o 100 8	r 25 2	r 50	o 100	r 50	r 33 8	o 50 10	o 100 28
Bjerkandera adusta				o 100	o 50	o 17 3	o 75 24	f 75 28
Panellus serotinus				o 33		a 33 48	o 50 2	f 50 5
Xylaria polymorpha			o 25	r 33				
Gymnopilus spectabilis				o 33				
Crepidotus haustellaris	r 25 3							
Coprinus tuberosus							r 25 2	
Clavulina cristata				B				
Calocera viscosa			B					
f. with a preference for Querco-Betuletum and Violo-Quercetum typicum								
Rickenella fibula						o 67 8	r 25 2	f 75 15
Clitocybe metachroa	a 75 53	a 75 86	a 75	f 100	vf 50	o 50 13	vf100 26	vf 75 40
Mycena pura	r 25 3	o 50 5		r 33	o 50			
Galerina hypnorum	o 25 8	o 25 2		o 33			r 25 3	
Clitocybe phyllophila	f 25 8	f 75 3		r 33				
Coprinus pellucidus								vf 50 3
Mycena capillaris					r 25			o 25 10
Cortinarius cf. *punctatus*		f 25 2						r 25 3
Bulgaria inquinans					f 25			
Marasmiellus vaillantii					r 25			
Steccherinum cf. *hydneum*								r 25 3
Pholiota tuberculosa								r 25 3
Mycena smithiana	o 25 3							

Table D2. Continued.

Plot number	4	5	6	7	8	9	10	11
g. Indifferent species								
Nectria spec.	r 25 3	o 100 14	o 100	o 66	o 50	vf 67 95	o 100 26	f 100 90
Rutstroemia firma	r 25 1	o 50 26		o 66	r 25		f 25 3	r 25 5
Stereum rugosum		r 50 2		r 33		o 33 28		o 75 15
Phallus impudicus	r 25 1	vf100 76				r 50 3		vf100 45
Galerina cinctula		o 25 14	r 25					o 25 8
Clitocybe fragrans		o 25 2	r 25		o 25		r 25 2	r 25 3
Mycena epipterygia				f 100	f 25	o 50 10	0 25 3	
Hypholoma sublateritium	o 25 3	f 75 26	o 50	f 100				vf100 30
Pluteus salicinus			r 25			r 33 3		r 25 3
Tyromyces chioneus	o 25 8	o 25 1		r 33		o 17 3	r 28 5	
Hapalopilus rutilans	r 25 3				r 25	o 83 8	r 25 3	
Merulius tremellosus	r 50 3	r 25 1				r 67 5		r 50 3
Crepidotus pubescens					f 25			a 50 5
Inonotus radiatus			f 50					o 25 3
Xerocomus chrysenteron			o 17		r 25			
Xerocomus subtomentosus	f 75 8				r 25			
Clitocybe umbilicata		f 50 10						
Tubaria furfuracea	o 25 1							
Laccaria laccata	f 75 13				o 25	r 17 3		
3. Species of Querco-Betuletum								
Mycena rorida	vf100 58	f 50 26	o 50	r 33	o 100	f 67 23	r 25 2	a 100 90
Hymenoscyphus epiphyllus	o 50 8	o 25 10			r 25		r 25 2	
Panellus stipticus		a 100 14		f 66	o 25	o 17 1		
Clitocybe brumalis	f 25 5			r 33				
Galerina triscopa								f 100 18
Cortinarius orellanoides		r 50 5						
Galerina heterocystis	r 50 3							
4. Species of Violo-Quercetum								
Mycena inclinata								vf 75 3
Tyromyces caesius				o 66				
Galerina ampullaceocystis						r 50 5		r 25 3
Stropharia aeruginosa				r 33		o 67 5		
5. Species of Violo-Quercetum typicum								
Collybia peronata	r 25 1					f 67 10		r 50 3
Marasmius splachnoides	a 75 18							
6. Species of Violo-Quercetum ilicetosum								
Ciboria batschiana		o 50 10	o 50			o 17 8		
Polyporus varius						r 50 3		
Mutinus caninus			r 50	o 33				

Table D2. Continued.

Plot number	4	5	6	7	8	9	10	11
7. Species of Dicrano-Quercetum and Querco-Betuletum								
a. with a preference for Dicrano-Quercetum								
Laccaria amethystina	vf100 63	r 50 1			f 75		o 25 7	
Galerina calyptrata	r 25 3	o 25 7				r 17 1		o 50 3
Lactarius camphoratus	f 100 15	f 75 5	r 25	r 33	o 50			
Clitocybe clavipes	f 100 45				o 50			
Amanita citrina	r 50 1			r 33	f 75			
Laccaria proxima	f 75 30	o 75 14	B	o 66			f 75 12	o 75 3
Entoloma rhodocylix	r 25 3	r 50 5						
b. Indifferent species								
Cortinarius elatior	r 25 3				r 25			
Hebeloma longicaudum	o 50 3				o 50			
Clitocybe gilva		o 50 7						
Clitocybe ditopa		o 25 7						
Inocybe longicystis		o 75 2		B				
Heterobasidion annosus		o 25 2		r 33				
Collybia tuberosa	f 75 10							
Lentinellus cochleatus					r 50			
Galerina mniophila	o 50 5							
Tricholomopsis rutilans				r 33				
Polyporus ciliatus		r 25 2						
Hebeloma calyptrosporum	r 25 3							
8. Species of Dicrano-Quercetum, Querco-Betuletum and Violo-Quercetum typicum								
a. with a preference for Dicrano-Quercetum								
Russula emetica	o 50 15	r 25 1			r 25	o 33 3		
Cystoderma amianthinum	o 50 1	r 25 5			o 75	r 17 3	o 25 2	
b. with a preference for Dicrano-Quercetum and Querco-Betuletum								
Collybia cirrhata	a 50 28	f 25 7				r 17 3	r 25 1	o 25 8
Xerocomus badius		o 50 7		B	vf 75		o 50 7	
Galerina atkinsoniana	f 75 30	o 25 7				o 17 3	r 50 3	r 25 3
c. with a preference for Querco-Betuletum and Violo-Quercetum typicum								
Collybia butyracea		o 50 7	o 25	o 33	o 75	vf 83 43	f 75 17	vf 75 18
Clitocybe candicans	o 25 3	f 100 14	o 25	r 33		r 33 1		o 50 3

Table D2. Continued.

Plot number	4	5	6	7	8	9	10	11
d. with a preference for Dicrano-Quercetum and Violo-Quercetum typicum								
Lycoperdon foetidum	o 75 30							
e. Indifferent species								
Amanita rubescens	r 50 10	r 25 4	r 75	o 33	r 75		r 25 2	
Scleroderma citrinum	f 75 25	a 100 64	r 50	vf100	r 50	f 100 18	f 75 17	f 75 8
Collybia dryophila	vf100 60	o 75 1	o 25	o 33	f 75	o 67 5	o 75 2	o 100 5
Mycena cinerella	f 50 3	a 50 10		r 33	f 75	vf 33 38	f 50 19	f 50 8
Cortinarius decipiens s.Henry	vf 75 20	f 75 12			vf 75		o 25 5	r 25 3
Crepidotus variabilis	f 50 8							o 50 3
Tylopilus felleus	r 25 3				vf 75			
Galerina pumila	f 75 8							
Pholiota lenta				o 100		r 33 1		
Fistulina hepatica	r 25 1						r 25 3	
Stropharia semiglobata	r 25 5			r 25				
9. Accompanying species								
Hymenoscyphus fructigenus	f 50 53	f 50 52	f 75	f 66	f 50	o 17 5	o 25 22	r 25 3
Coryne sarcoides						o 33 18	o 50 7	o 75 13
Gymnopilus hybridus		r 50 2	f 25	f 100	o 50	r 33 5	o 75 5	o 100 5
Coriolus versicolor	vf 75 13	vf100 24	f 50	o 66	vf 75		f 75 7	f 100 25
Mycena sanguinolenta	a 100 95	a 75 100	f 75	vf100	f 75	a 83 85	f 25 26	a 100 95
Schizopora paradoxa		r 25 2	o 50	r 100		o 67 30		o 50 8
Sphaerobolus stellatus						f 17 3		
Tyromyces lacteus	r 25 1							r 25 3
Lactarius quietus	a 100 100	a 100 83	o 100	o 66	vf100	vf100 33	vf100 38	vf100 33
Paxillus involutus	vf 75 38	f 100 29	B	r 33	vf100	vf 83 25	f 25 24	o 75 5
Lactarius theiogalus	a 100 65	a 100 90		r 33	a 75	vf 67 13	o 75 19	o 25 8
Clitocybe vibecina	vf100 30	vf 50 30	a 50	a 66	a 75	vf 50 58	a 75 57	vf100 43
Psathyrella squamosa	o 50 15	f 100 24	B	f 100	o 100	r 50 3	f 100 19	o 75 8
Armillariella mellea		a 75 67	o 50	o 33	r 50	r 17 3	a 50 33	vf 75 18
Galerina decipiens	f 75 18	vf100 90	o 75	r 33	r 50	vf 67 68	f 100 29	vf100 78
Mycena polygramma	f 100 8	r 100 5		o 33	o 25	r 17 3	vf100 10	o 50 5
Mycena galericulata	f 100 23	va100 100	vf100	f 100	vf100	a 100 98	a 100 83	va100 100
Mycena galopus	vf100 50	va100 100	vf100	a 100	vf100	a 100 98	a 100 86	a 75 95
Hypholoma fasciculare	vf100 28	vf100 43	f 75	vf100	o 75	a 83 70	a 100 33	a 100 55
Pluteus cervinus	o 75 13	o 100 12	r 50	r 66	r 25	o 50 8	o 50 2	r 25 3
Calocera cornea	o 50 28	o 50 19		r 66		o 33 10	o 50 2	o 50 10
Psathyrella fulvescens	o 25 3	r 25 2			o 25	o 17 8	r 50 2	f 25 5
Russula ochroleuca	r 25 1	f 100 14	f 75	r 100	o 100		r 50 5	o 75 5
Exidia glandulosa	r 25 3		r 50		r 25	r 17 5	f 75 31	o 25 1
Galerina allospora		f 75 24	B			r 17 3		r 50 5
Coprinus velox		vf 25 1	o 25		f 25	vf 17 3	f 25 2	va100 20
Phlebia radiata	r 50 3					r 17 3	r 25 5	

Table D2. Continued.

Plot number	4	5	6	7	8	9	10	11
Tephrocybe ambusta	o 50 3	o 25 3				r 25 3		r 25 3
Lepista nuda					r 25			
Mycena speirea	o 25 10					o 17 3		
Psathyrella spadiceogrisea	r 25 5							
Mycena iodiolens		o 25 7						
Ganoderma applanatum			r 25	r 33				
Onygena corvina		r 25 2	r 25					
Russula nigricans				B				

Table D3. Abundance, annual frequency and spatial frequency of fungi in Violo-Quercetum typicum.

Plot number	12	13	14	15	16	17	18	19	20	21
Plot area (m²)	1050 -1500	1000 -1500	1000 -1500	1000 -2000	1000 -1500	1000 -1200	700	800	1000 -1500	500
Number of records	12	8	10	8	11	9	10	8	13	10
Number of frequency records	3	2	4	3	4	3			4	
Time (years)	4	4	4	4	4	4	5	4	6	4
Number of species	68	50	88	68	90	74	51	55	85	40
Number of species in frequency records	56	33	74	47	68	62			63	
1. Species of Dicrano-Quercetum										
Marasminus androsaceus				r 50 3	o 75 3		o 20	r 25		
Inocybe napipes		r 50 3			r 25 3			r 25		
2. Species of Quercion robori-petraeae										
a. with a preference for Querco-Betuletum										
Polyporus brumalis	r 25 2				r 25 3	r 25 3			o 17 8	o 75
Stereum hirsutum	r 75 7	o 50 5	o 75 15	r 100 5	o 50 8	r 25 3	o 20		o 33 10	o 75
Tephrocybe tylicolor		f 25 3	r 50 3	r 25 3	r 50 3		f 20	o 25	o 17 3	vf 25
Chondrostereum purpureum				r 25 1				r 25	r 33 8	
Psathyrella hydrophila	f 50 2		f 50 3	vf 25 3	o 50 3				r 17 3	vf 25
Clitocybe diatreta	f 50 10				f 50 8	r 25 3				
Mycena mucor			vf 25 13							
Galerina sahleri						o 25 3				
b. with a preference for Violo-Quercetum										
Mycena sepia	f 50 26	o 25 3	r 50 5		o 75 5	r 50 8	f 20	r 50	o 33 8	
Cudoniella acicularis		f 100 50	o 75 25	r 50 3	o 75 10	o 75 10		r 50	f 83 30	r 25
c. with a preference for Violo-Quercetum typicum										
Oudemansiella platyphylla	vf100 57	f 100 18	vf 75 58	vf 75 70	f 100 20	vf 75 40	f 100	vf100	f 100 33	o 50
Mycena stylobates	a 100 29		vf 25 38	vf 25 48	f 25 3	vf 50 35	f 20	r 50	f 50 45	f 75
Collybia cookei	a 75 26	vf 50 3	va100 98	o 25 3	a 50 28	a 50 15			f 50 8	
Marasmiellus ramealis		o 50 1	vf 75 20	vf 50 8	vf100 13		a 60			r 25
Psilocybe crobula				o 25 5	r 25 3	f 25 5			o 67 13	o 25

Table D3. Continued.

Plot number	12			13			14			15			16			17			18		19		20			21	
d. with a preference for Violo-Quercetum ilicetosum																											
Mycena haematopus							o	25	8				r	25	3	o	50	3					a	100	53		
Mycena vitilis	vf	100	69	f	100	50	a	75	90	o	75	23	f	100	55	a	100	88	vf	60	f	50	vf	67	95	vf	75
Kuehneromyces mutabilis				f	50	3							vf	50	3												
Hohenbuehelia atrocaerulea										o	25	5	o	50	3												
Clitopilus hobsonii													f	25	3												
Piptoporus betulinus																							o	50	8	o	75
Pleurotus ostreatus							r	25	3																		
e. with a preference for Querco-Betuletum and Violo-Quercetum ilicetosum																											
Xylaria hypoxylon							r	50	3												r	25	r	17	3	o	25
Bjerkandera adusta																					o	50	r	17	3		
Panellus serotinus										o	25	3	f	50	8	vf	25	3					o	17	3		
f. with a preference for Querco-Betuletum and Violo-Quercetum typicum																											
Rickenella fibula				r	50	3	f	25	10	r	25	3	r	25	3				o	20							
Clitocybe metachroa	a	100	95	f	25	3	a	100	83	f	50	23	vf	100	53	a	50	95	f	20	o	50	r	33	3	f	50
Mycena pura	f	100	9				r	50	8	r	50	5									o	25					
Galerina hypnorum							vf	50	55				r	25	3								r	17	1		
Clitocybe phyllophila	vf	25	22				f	75	5	f	25	1				o	50	5									
Coprinus pellucidus																							f	17	3		
Mycena capillaris																							f	17	10		
Cortinarius cf. *punctatus*																										f	25
Bulgaria inquinans																							f	17	1		
Marasmiellus vaillantii				o	25	3																					
Steccherinum cf. *hydneum*																					r	25					
Pholiota tuberculosa													o	50	4												
Mycena smithiana																			o	20							
g. Indifferent species																											
Nectra sp.	f	75	29	f	75	58	f	100	85	f	100	35	o	100	40	o	100	28	f	60	f	75	f	67	65	o	100
Rutstroemia firma	o	25	5				o	75	13							r	50	8					o	17	3		
Stereum rugosum							o	50	25				o	25	10	r	75	8	r	20	r	25	r	50	13	o	50
Phallus impudicus	r	50	1	o	100	8	r	25	1	o	75	18	o	100	5	r	50	8	f	60	r	50	o	100	8	o	100
Galerina cinctula				r	25	1	f	25	3							o	25	8	r	20	r	25	r	33	3		
Clitocybe fragrans	o	25	1				f	25	28							f	25	18					r	17	3		
Mycena epipterygia							o	25	5	o	25	3	r	50	3	o	25	8									
Hypholoma sublateritium	vf	50	2	f	75	10	o	75	5	o	25	3				f	75	10	o	40			f	33	5		
Pluteus salicinus	r	25	2										r	25	1	r	50	3					r	17	5		
Tyromyces ,chioneus																							f	17	5	f	25
Hapalopilus rutilans										o	75	5	r	25	1	r	25	3									

Table D3. Continued.

Plot number	12	13	14	15	16	17	18	19	20	21
Merulius tremellosus					o 25 3				r 17 1	
Crepidotus pubescens		o 25 1	vf 75 15		r 25 3					
Inonotus radiatus			r 25 3							o 25
Xerocomus chrysenteron				o 50 1	r 25 1					
Xerocomus subtomentosus					r 25 1					
Clitocybe umbilicata			o 25 8							
Tubaria furfuracea				r 25 1					o 33 5	
Laccaria laccata			r 25 1			o 75 5		o 25		
3. Species of Querco-Betuletum										
Mycena rorida	o 50 5		o 50 18		r 25 3	o 25 8		o 50	o 50 10	
Panellus stipticus			vf 25 3			vf 25 3				
4. Species of Violo-Quercetum										
Mycena inclinata			vf 75 15		a 100 35	vf 50 3	o 20		f 17 3	
Collybia fusipes				vf 75 25	r 25 1	r 25 3		vf 75		
Tyromyces caesius	o 50 2		r 25 3		f 50 5			r 25	o 100 8	f 25
Galerina ampullaceocystis		r 25 3	r 25 3	r 25 3	o 50 18	o 50 3	o 20		o 33 10	
Stropharia aeruginosa		r 25 1		o 75 3		o 25 5		f 50	r 17 1	
Entoloma euchrous		o 25 1			f 50 3					
Russula parazurea				r 25 3			o 20			
Innotus dryadeus			r 25 1							
5. Species of Violo-Quercetum typicum										
Collybia peronata	f 75 1		o 75 10	f 50 5	f 100 20	f 100 25	vf 80	a 100	vf 83 30	vf100
Marasmius splachnoides	f 100 31		vf 50 1	a 75 70	r 25 3	f 75 20	o 60	f 25		
Marasmius epiphylloides			a 75 18	a 25 8		a 100 58				
Clitocybe flaccida	vf 75 12		r 25 3	o 100 5						
Scleroderma verrucosum				o 25 3			f 20		r 17 1	
Resupinatus applicatus			o 25 3							f 25
Xerocomus parasiticus			f 25 1		f 25 8					
Mycena pearsoniana				r 25 3		r 25 3				
Laetiporus sulphureus		r 25 3	r 25 3							
6. Species of Violo-Quercetum ilicetosum										
Coprinus Sect. *Micacei*									r 17 3	
Ciboria batschiana	o 25 5		o 25 5			f 25 20			f 33 18	
Typhula erythropus									o 17 8	
Typhula phacorrhiza									o 17 .5	
Polyporus varius									o 50 1	
Mutinus caninus						o 75 8				o 50

Table D3. Continued.

Plot number	12			13			14			15			16			17			18		19		20			21	
7. Species of Dicrano-Quercetum and Querco-Betuletum																											
a. with a preference for Dicrano-Quercetum																											
Laccaria amethystina													r	50	1												
Galerina calyptrata													r	50	3												
Lactarius camphoratus													o	25	3												
Clitocybe clavipes													r	25	1												
Amanita citrina													r	25	1						r	25					
Laccaria proxima	r	25	2	r	25	1	f	50	15				o	50	13						o	25	r	17	1		
Entoloma rhodocylix													o	25	3												
8. Species of Dicrano-Quercetum, Querco-Betuletum and Violo-Quercetum typicum																											
a. with a preference for Dicrano-Quercetum																											
Russula emetica				r	25	5				r	25	3	r	50	3								r	17	1	o	25
Cystoderma amianthinum	f	75	2				r	25	3				r	50	8	r	25	3									
b. with a preference for Dicrano-Quercetum and Querco-Betuletum																											
Collybia cirrhata	o	75	5	f	50	3				r	25	3	o	25	5								r	17	3		
Xerocomus badius	r	50	1				f	50	8														o	67	5		
Galerina atkinsoniana	r	25	2				o	75	5				r	75	1												
c. with a preference for Querco-Betuletum and Violo-Quercetum typicum																											
Collybia butyracea	a	100	69	o	50	5	f	100	40	vf	100	25	vf	100	48	r	50	3	o	20	vf	50	f	67	25	o	50
Clitocybe candicans	vf	75	50													o	50	8			o	25	o	17	1		
d. with a preference for Dicrano-Quercetum and Violo-Quercetum typicum																											
Lycoperdon foetidum	o	25	2										r	25	1				o	20							
Lactarius turpis	o	50	2	o	50	5							o	50	8												
Collybia maculata				o	50																						
Russula atropurpurea							r	25	1																		
Pholiota alnicola																					f	25					

Table D3. Continued.

Plot number	12	13	14	15	16	17	18	19	20	21
e. Indifferent species										
Amanita rubescens	o 75 2		r 25 3	r 75 3	r 25 1	o 75 5	r 60	o 75		
Scleroderma citrinum	o 50 5	f 100 5	f 50 10		a 75 90	f 50 5			f 83 13	
Collybia dryophila	o 50 1	r 50 3	o 50 5	f 75 25	f 75 8	r 25 3	o 40	o 50	r 17 1	
Mycena cinerella	r 25 2		f 50 23	o 25 3	vf 50 68	f 25 5		r 25	f 17 33	r 25
Cortinarius decipiens s. Henry	r 25 1		r 25 3		f 75 13		f 20			
Crepidotus variabilis	o 75 5		o 50 8				o 40			
Tylopilus felleus					r 50 3					
Galerina pumila		r 25 3								
Pholiota lenta	o 75 5						r 20			
Fistulina hepatica			r 75 3		r 25 3					
Stropharia semiglobata					r 25 3					
9. Accompanying species										
Hymenoscyphus fructigenus	o 50 14		f 50 40		f 50 3	f 50 13			o 33 20	
Coryne sarcoides			r 50 5	r 25 3	o 25 18				r 67 3	
Gymnopilus hybridus	o 75 5				o 50 3	r 25 3		o 50	vf100 20	
Coriolus versicolor			o 50 5	f 75 5					f 17 3	f 50
Mycena sanguinolenta	vf100 19	f 75 28	a 75 83	o 50 13	f 100 25	vf100 68	vf 60	vf 75	vf 83 93	f 50
Schizopora paradoxa	o 50 12		o 50 8	o 25 10	o 25 3	o 100 20	0 20	f 50	f 50 38	o 50
Sphaerobolus stellatus	f 25 2			vf 25 3		o 25 3			f 17 3	
Tyromyces lacteus			r 50 3			o 25 3		r 25	r 17 3	
Lactarius quietus	a 100 98	vf100 75	vf100 70	f 75 28	vf100 43	a 75 93	o 40	f 75	a 100 63	f 50
Paxillus involutus	r 50 2	vf100 20	vf 75 15	vf 50 38	vf100 28	r 25 1	f 40	o 50	r 33 3	o 50
Lactarius theiogalus	r 75 2	vf100 33	a 75 88	a 75 50	a 100 25	f 75 15	o 60	r 25	f 67 10	vf 50
Clitocybe vibecina	va100 92	vf 50 18	a 100 85	f 50 3	va 75 98	a 75 18	o 20	o 25	a 67 88	f 50
Psathyrella squamosa	r 75 5	o 50 3	f 100 20	f 75 15	o 100 15	o 75 5	o 20	o 25	o 50 3	
Armillariella mellea	va 50 52	vf 25 18	va 75 98		a 50 55	vf 75 18	o 60		r 33 1	o 75
Galerina decipiens	r 25 3	vf 75 55	a 100 88	o 75 10	vf100 70	f 75 45	f 60	r 50	f 67 20	
Mycena polygramma	vf100 12	f 50 10	vf 75 25	r 25 3		f 25 3		o 25	o 50 3	o 25
Mycena galericulata	vf100 64	a 100 90	a 100 100	a 100 90	a 100 100	va100 100	vf 80	a 100	va100 95	a 100
Mycena galopus	vf100 45	vf100 88	a 100 100	vf100 25	va100 100	a 100 100	a 80	a 100	va100 100	vf 75
Hypholoma fasciculare	a 100 14	a 100 45	a 100 58	a 100 33	a 100 40	a 100 43	vf 80	a 100	va100 20	
Pluteus cervinus	o 100 7	r 50 5	o 75 25	o 75 20	o 100 15	r 75 10	r 60	o 100	o 100 10	r 50
Calocera cornea	r 75 10	r 25 3	o 75 25	r 25 5	o 75 13	r 75 8	r 40	o 25	o 50 15	
Psathyrella fulvescens	o 100 5	r 25 5	r 50 3	f 50 13	r 50 3	o 75 3		r 25	r 50 5	
Russula ochroleuca	o 75 2	o 75 3	f 75 10	r 25 1	f 75 20	f 75 15		o 25	r 33 3	
Exidia glandulosa	r 25 2		r 50 5	r 50 3	o 50 5	a 25 5				
Galerina allospora		r 50 3	r 25 3		o 25 5	o 75 10	r 20			r 25
Coprinus velox	o 25 2		o 25 3		r 50 3	a 25 3		f 25	vf 50 10	
Phlebia radiata	o 25 2		o 25 23		r 25 5	r 25 5	r 20		r 17 3	
Tephrocybe ambusta	r 25 5					r 25 3		r 25		
Lepista nuda							r 40	r 25		
Mycena speirea	o 25 10		r 25 3						r 17 3	
Psathyrella spadiceogrisea						r 25 3	o 20			
Mycena iodiolens				r 25 3				o 25		
Russula nigricans					r 25					

Table D4. Abundance, annual frequency and spatial frequency of fungi in Violo-Quercetum ilicetosum.

Plot number	22			23			24			25		26		27		28		29	
Plot area (m^2)	875 -1900			1000 -2000			1000 -3000			300		1000		800		500		500	
Number of records	10			11			9			10		6		5		10		7	
Number of frequency records	4			3			3												
Time (years)	4			4			4			4		4		3		4		3	
Number of species	71			71			82			35		60		37		44		35	
Number of species in frequency records	57			52			47												
2. Species of Quercion robori-petraeae																			
a. with a preference for Querco-Betuletum																			
Polyporus brumalis										o	50	r	25	o	33	f	50		
Stereum hirsutum	r	50	3	o	100	10	r	75	8	o	25	o	75	r	33				
Tephrocybe tylicolor	o	25	3									f	50						
Chondrostereum purpureum	r	25	3				o	25	3			r	50	r	33				
Psathyrella hydrophila				vf	75	3						f	50						
Mycena mucor							B												
b. with a preference for Violo-Quercetum																			
Mycena sepia	r	25	3	f	25	18	o	75	20	f	25	f	50					vf	33
Cudoniella acicularis	o	50	20	r	75	3	vf	100	83	o	25	r	25	r	66	o	50	x	33
c. with a preference for Violo-Quercetum typicum																			
Oudemansiella platyphylla	vf	75	71	o	75	5	f	75	3	vf	100	o	75	f	100	vf	75	o	66
Mycena stylobates	r	50	3																
Collybia cookei	a	50	17									r	25						
Marasmiellus ramealis	f	50	4																
Psilocybe crobula							o	50	5	r	50	o	25						
d. with a preference for Violo-Quercetum ilicetosum																			
Mycena haematopus				f	75	8	a	100	95			o	25			vf	50	f	33
Mycena vitilis	a	100	100	a	100	100	vf	75	40	vf	75	a	75	vf	66	vf	75	vf	100
Kuehneromyces mutabilis							f	50	4	a	75	f	25						
Hohenbuehelia atrocaerulea	f	25	3							a	50	r	25						
Clitopilus hobsonii							vf	25	4	f	25								
Piptoporus betulinus	o	50	4				r	50	1			vf	100						
Pleurotus ostreatus	o	25	1	o	25	3	B									r	25		

Table D4. Continued.

Plot number	22			23			24			25		26		27		28		29	
e. with a preference for Querco-Betuletum and Violo-Quercetum ilicetosum																			
Xylaria hypoxylon	r	75	14	r	50	15	o	75	28	o	75	f	75	r	33	f	75	o	66
Bjerkandera adusta	r	25	1	r	25	3	o	25	3	o	25	r	50	o	66	r	25	o	33
Panellus serotinus	f	100	11	vf	25	4	f	75	5	vf	25	vf	50			a	75	x	33
Xylaria polymorpha														o	33				
Gymnopilus spectabilis												f	50						
Crepidotus haustellaris				r	25	3													
Coprinus tuberosus	o	25	3																
Clavulina cristata				r	25														
Calocera viscosa																		r	66
f. with a preference for Querco-Betuletum and Violo-Quercetum typicum																			
Clitocybe metachroa	f	50	37	o	25	13						o	50					r	33
g. Indifferent species																			
Nectria sp.	f	100	66	f	75	25	f	100	50	f	75	f	75	o	33	o	50	o	33
Rutstroemia firma	o	50	11	o	25	5	o	25	8			vf	25					f	66
Stereum rugosum	o	75	11	r	50	15	o	75	13	o	25	r	25	o	33	o	50		
Phallus impudicus	r	50	9	o	100	8	r	50	1			o	50	o	100	f	50	r	66
Galerina cinctula	r	25	6	o	50	3	r	25	3										
Clitocybe fragrans	o	25	6																
Mycena epipterygia							o	50	3							f	25		
Hypholoma sublateritium	o	50	3	f	50	3						r	25	vf	33				
Pluteus salicinus	r	25	3	r	50	3				r	25								
Tyromyces chioneus	o	100	6									r	75	r	33			r	33
Hapalopilus rutilans	o	50	6							o	25					o	50		
Merulius tremellosus	o	50	6													r	25		
Crepidotus pubescens							B									o	25		
Inonotus radiatus	r	25	3				B							r	33				
Xerocomus chrysenteron				r	25	3	B												
Xerocomus subtomentosus				r	25	1													
Clitocybe umbilicata	o	25	3																
Tubaria furfuracea							B												
Laccaria laccata				o	75	3												r33	
3. Species of Querco-Betuletum																			
Mycena rorida	r	25	3	r	50	3						r	25						
Panellus stipticus														f	33	o	25		
4. Species of Violo-Quercetum																			
Mycena inclinata	a	75	14	a	50	5	vf	75	5			f	25			a	25		
Collybia fusipes				vf	75	18													
Tyromyces caesius	o	50	3				o	100	8	o	25	r	25					r	33

Table D4. Continued.

Plot number	22			23			24			25		26		27		28		29	
Galerina ampullaceocystis	f	50	3	r	25	1	o	25	5										
Stropharia aeruginosa	r	25	3				r	25	1					r	33	f	100		
Entoloma euchrous							r	25	3										
Russula parazurea	r	25	3																
Inonotus dryadeus	r	25	1											r	33				
5. Species of Violo-Quercetum typicum																			
Collybia peronata	r	50	3				r	50	3			o	75			f	75		
Marasmius splachnoides												r	50						
6. Species of Violo-Quercetum ilicetosum																			
Coprinus Sect. *Micacei*							vf	25	1	r	25	r	25			r	25	a	33
Psathyrella frustulenta	f	100	6	r	25	1										vf	50		
Ciboria batschiana	o	25	20	a	50	100	o	25	8			r	25					vf	66
Typhula erythropus							a	75	83							f	50		
Typhula phacorrhiza							a	50	45							vf	25		
Polyporus varius							o	100	5			r	25	o	33	f	50		
Mutinus caninus	f	50	3	r	50	3	B					vf	100			o	25		
Cortinarius tabularis	r	25	1															r	33
Phellinus ferreus				o	50	20												r	66
7. Species of Dicrano-Quercetum and Querco-Betuletum																			
a. with a preference for Dicrano-Quercetum																			
Laccaria amethystina				o	50	3													
Lactarius camphoratus							B												
Laccaria proxima	r	25	3	o	50	18						o	25						
8. Species of Dicrano-Quercetum, Querco-Betuletum and Violo-Quercetum typicum																			
a. with a preference for Dicrano-Quercetum																			
Russula emetica																r	25		
Cystoderma amianthinum										o	25								
c. with a preference for Querco-Betuletum and Violo-Quercetum typicum																			
Collybia butyracea				r	50	5	r	25	3										

Table D4. Continued.

Plot number	22			23			24			25		26		27		28		29	
e. Indifferent species																			
Amanita rubescens				r	50	3						r	25						
Scleroderma citrinum				o	25	3												r	33
Collybia dryophila				r	25	3	r	25	3					B					
Mycena cinerella							r	25	3										
Crepidotus variabilis							B												
Fistulina hepatica				B															
9. Accompanying species																			
Hymenoscyphus fructigenus	r	50	6	a	50	65	o	25	10			o	25						
Coryne sarcoides	o	75	17	r	25	1	r	25	3	o	25	r	25	r	33			x	33
Gymnopilus hybridus	r	25	3	o	50	3										o	25		
Coriolus versicolor				f	50	3						f	75			r	50		
Mycena sanguinolenta	r	50	6	f	50	33	vf	75	78	f	50	o	75					o	33
Schizopora paradoxa	f	100	66	f	50	33	o	50	15	o	50	r	50	o	66	r	25	o	33
Sphaerobolus stellatus							f	75	40	a	50	a	75			r	25		
Tyromyces lacteus							r	25	3					r	33				
Lactarius quietus	a	100	86	vf	100	60	vf	100	25	vf	75	o	50	r	66	o	50	f	33
Paxillus involutus	r	25	3	o	75	3	o	75	15	r	25	o	50	r	33	o	25	o	66
Lactarius theiogalus	o	50	9	f	50	1	r	25	3			r	25			vf	50	r	33
Clitocybe vibecina	vf	75	34	a	75	13	r	25	1			r	25	r	33				
Psathyrella squamosa	f	25	6	f	75	18	o	75	5			o	25			o	25		
Armillariella mellea	f	50	29	r	50	3	r	25	3	f	50					vf	25		
Galerina decipiens	o	75	17	r	50	3	r	50	3	vf	50	o	25	r	66	r	25		
Mycena polygramma	r	25	3	r	50	4	r	25	3										
Mycena galericulata	va	100	100	a	100	60	a	100	100	a	100	a	100	f	66	a	100	f	100
Mycena galopus	a	100	91	va	100	100	a	100	100	a	75	a	100	o	33	a	75	f	100
Hypholoma fasciculare	vf	100	29	vf	100	8	a	100	30	vf	50	a	100	a	100	a	75	vf	66
Pluteus cervinus	r	75	3	r	50	8	r	75	3	o	75	r	50	r	33			r	33
Calocera cornea	r	75	23	r	50	5	o	75	23	o	50	o	25	r	33	r	25	o	33
Psathyrella fulvescens	o	75	3	r	25	3	o	75	8	o	50			f	25				
Russula ochroleuca	o	50	11	f	75	15	r	25	1			o	50					r	66
Exidia glandulosa	r	25	3	r	25	3	r	25	3										
Galerina allospora	o	50	3	o	25	8													
Coprinus velox				f	25	3						r	25	f	33				
Phlebia radiata	r	25	3	o	50	8	r	25	3	o	25	x	25						
Tephrocybe ambusta	o	25	6	r	25	3													
Lepista nuda	f	50	11	r	25	3						r	25						
Mycena speirea							r	25	1										
Psathyrella spadiceogrisea							r	25	1					r	33				
Mycena iodiolens	r	25	3	r	25	3						f	25						
Ganoderma applanatum														r	66				
Onygena corvina				r	25	3													
Tremella mesenterica							B					r	25						
Russula amoenolens																		r	33
Inocybe cookei				r	25	1													

Notes

Fungi found only once, and therefore not mentioned in Table 4 and tables of Appendix D.
Plot 1: *Cantharellus cibarius* var. *amethysteus* r 17 (0.1, 1); *Clitocybe cerrusata* o 17 (0.4, 1); *Psathyrella cotonea* r 17 (0.2,).
Plot 2: *Cortinarius hinnuleus* o 17,8 (0.7, 1, 4); *Galerina* cf. *cerina* r 17,3 (0.1, 1, 1); *Inocybe margaritispora* o 17 (0.4, 1); *Tricholoma aestuans* r 17 (0.1, 1); *Cortinarius pseudosalor* r 17 (0.1, 1).
Plot 3: *Cortinarius pluvius* r 17 (0.1, 1); *Inocybe lanuginella* r 17 (0.1, 1); *Russula mairei* r 17 (0.1, 1); *R. raoultii* r 17 (0.1, 1); *R. laurocerasi* r 17 (0.2, 1); *Cortinarius hemitrichus* r 17 (0.1, 1); *Panaeolus fimicola* r 17, 3 (0,1, 1, 1); *Coltricia perennis* r 17 (0.1, 1); *Sarcodon underwoodii* r 17 (0.1, 1); *Hydnellum compactum* r 17 (0.1, 1); *Phellodon confluens* r 17 (0.1, 1); *P. niger* r 17 (0.1, 1).
Plot 4: *Amanita porphyria* r 25, 1 (0.1, 3, 0.2); *Clitocybe odora* o 25, 3 (0.4, 3, 0.6); *Dermocybe crocea* o 25, 1 (0.6, 3, 0.2); *Hebeloma crustuliniforme* r 25, 3 (0.1, 3, 0.6); *Psathyrella gossypina* o 25, 3 (0.8, 3, 0.6); *P. fusca* r 25, 3 (0.1, 3, 0.6); *Entoloma farinogustus* o 25, 3 (0.4, 3, 0.6); *Hebeloma velutipes* r 25, 3 (0.1, 3, 0.6).
Plot 5: *Cortinarius* cf. *fasciatus* r 25, 2 (0.1, 3, 0.4).
Plot 6: *Clitocybe angustissima* r 25 (0.1, 3); *Galerina inversa* o 25 (0.6, 3).
Plot 7: *Clitocybe lohjaensis* o 33 (0.4, 4); *Russula brunneoviolacea* leg. J.J. Barkman 7084 (Herb. WAG-W).
Plot 8: *Cantharellus sinuosus* f 25 (3, 3); *Galerina* cf. *incurvata* r 25 (0.2, 3); *Cyathipodia macropus* o 25 (0.4, 3); *Inocybe petiginosa* o 25 (o.4, 3).
Plot 10: *Cordyceps militaris* r 25, 2 (0.1, 3, 0.4); *Psilocybe inquilina* r 25, 2 (0.1, 3, 0.4).
Plot 11: *Rickenella setipes* r 25, 3 (0.1, 3, 0.6); *Tubaria conspersa* o 25, 3 (0.6, 3, 0.6).
Plot 12: *Lycoperdon spadiceum* r 25, 1 (0.1, 3, 0.1); *Cystoderma granulosum* o 25, 2 (0.3, 3, 0.3); *Ramaria flaccida* o 25, 1 (0.3, 3, 0.1).
Plot 13: *Cortinarius delibutus* r 25, 1 (0.1, 3, 0.1); *Russula nitida* r 25, 3 (0.2, 3, 0.4).
Plot 14: *Mycena polyadelpha* f 25, 8 (1, 3, 1); *Ripartites helomorpha* o 25, 3 (0.3, 3, 0.4); *Russula cyanoxantha* f. *peltereaui* r 25, 1 (0.1, 3, 0.1); *Incrustoporia semipileata* r 25, 3 (0.1, 3, 0.4).
Plot 15: *Coprinus stellatus* o 25, 3 (0.6, 3, 0.4); *Melanoleuca melaleuca* r 25, 1 (0.2, 3, 0.1); *Psathyrella* cf. *obtusata* o 25, 8 (0.4, 3, 1); *Tyromyces floriformis* r 25, 1 (0.1, 3, 0.1); *Hebeloma vaccinum* r 25, 1 (0.1, 3, 0.1); *Scleroderma areolatum* r 25, 1 (0.2, 3, 0.1).
Plot 16: *Cordyceps* sp. 1 r 25, 3 (0.1, 3, 0.4).

Plot 17: *Coprinus heterosetulosus* f 25, 3 (1, 3, 0.4); *Collybia* cf. *kuehneriana* r 25, 3 (0.1, 3, 0.4).
Plot 18: *Crucibulum laeve* o 20 (0.7, 2); *Helvella crispa* o 20 (0.5, 2); *Russula heterophylla* o 20 (0.3, 2); *Lepiota cristata* r 20 (0.1, 2).
Plot 19: *Clitocybe gibba* r 25 (0.1, 3).
Plot 20: *Flammulaster carpophiloides* r 17 (0.1, 2); *Inonotus polymorphus* r 17 (0.1, 2); *Trametes semisupina* r 17 (0.1, 2); *Fomes fomentarius* r 17 (0.1, 2).
Plot 21: *Daedaleopsis confragosa* r 25 (0.1, 3).
Plot 23: *Russula aeruginea* r 25, 4 (0.2, 3, 1); *Phylloporus rhodoxanthus* o 25, 2 (0.6, 3, 0.6).
Plot 24: *Galerina heimansii* o 25, 3 (0.4, 3, 1); *Tyromyces subcaesius* r 25, 3 (0.3, 3, 1); *Mycena hemispaerica*, leg J.J. Barkman 6475, det. R.A. Maas Geesteranus; *Russula fellea* found by J.J. Barkman (pers. commun.); *Leucocoprinus brebissonii*, leg. J.J. Barkman 6646, det. J.J. Barkman; *Clavariadelphus junceus*, leg. J.J. Barkman 6019, det. R.A. Maas Geesteranus; *Typhula quisquiliaris*, leg. J.J. Barkman 6794, det. R.A. Maas Geesteranus; *Macrotyphula fistulosa*, leg. J.J. Barkman 6008, det. R.A. Maas Geesteranus; *Phlebia rufa*, leg. J.J. Barkman 6673, det. M. Donk; *Stereum gausapatum*, leg. J.J. Barkman 5840, det. R.A. Maas Geesteranus (all collections in Herb. WAG-W).
Plot 26: *Mycena oortiana* o 25 (0.4, 3).
Plot 27: *Pleurotus dryinus* r 33 (0.3, 4).
Plot 28: *Psathyrella* sp. r 25 (0.1, 3).

Remarks to Table 4 and Appendix Table D1-D4.
Coprinus Sect. *Micacei* is mentioned in these tables. The species was *C. domesticus* in Plots 20 and 26, *C. micaceus* in Plot 24, *C. radians* in Plot 29, and *C. xanthothrix* in Plots 25 and 28. In Plot 24, *C. domesticus* was also found (J.J. Barkman, 6687, det. C. Bas, Herb. WAG-W), without indication of abundance. As the species are closely related and had a preference for Violo-Quercetum ilicetosum, they were combined as Sect. *Micacei* in the tables. The species had the following values for P, GAMAC, MAF and MCSF in Table 4: *C. domesticus* in Violo-Quercetum typicum I, 0.1, 2, 0.4, in Violo-Quercetum ilicetosum I, 0.1, 3, -; *C. micaceus* I, 7, 3, 0.3; *C. radians* I, 28, 2, -; *C. xanthothrix* II, 0.1, 6, -.

Cystoderma longisporum was aggregated with *C. amianthinum*, because it was not easy to distinguish these species macroscopically and they were not always studied microscopically. *C. longisporum* was certainly found in Plot 3 (r 17, 1) and Plot 4 (r 25, 3) with respective P, GAMAC, MAF and MCSF in Dicrano-Quercetum I, 0.1, 1, 0.5 and in Querco-Betuletum I, 0.4, 3, 0.6.

Bjerkandera adusta and *Polyporus ciliatus* were each found once in Dicrano-Quercetum by P. Ypelaar, in a plot that was investigated for only one year. So both species had an annual frequency of 100 % in that plot, and therefore a MAF of 9 % for the association. The species are not frequent in Dicrano-Quercetum; a MAF of I would be more appropriate.

Phellinus ferreus was also found once in Dicrano-Quercetum by P. Ypelaar. As he did not indicate abundance, I have given only P and MAF in Table 4.

Appendix E List of plots

For each plot is given: Province (Dr.=province of Drenthe, Ov.=province of Overijssel), Municipality, and more detailed indication such as the name of the region; Tm=Topographical map, followed by the number and letter of the sheets 1:25 000, and the map coordinates; the sample plot area, and (if it concerned a composite plot) the area outside the plot, in the same association, that was also investigated; a short characterization of the vegetation and the growth form of the wood, and sometimes particulars of age or situation; situation in the form-units of the Geomorphological map sheet 17 + 18, (Stiboka, 1978) - as no other sheets were available form-units were only given for plots lying on this sheet. Old topographical maps were studied to determine how old the woods were. Especially the series 1:25 000 reconnaissance between 1896-1900 (published 1902-1904), but the slightly older map 1:50 000, and the Choro-topographische Kaart der Noordelijke Provinciën van het Koninkrijk der Nederlanden, scale 1:115 200, published 1823 (facsimile reprint Haarlem 1979) was also consulted.

1. Dr., Beilen, Boswachterij Dwingeloo plot 59; Tm 17C, 536.9 - 226.6 Area 800 m^2. Scrubby oak wood almost without a herb layer, with extensive local moss 'carpets'. Lying on a low inland sanddune (4L8). Probably originated or planted about 1920.
2. Dr., Beilen, 5 km NW of the village of Beilen, Zuid Hijkerzand; Tm 17A, 546.7 - 227.3. Area 1000 m^2 + about 1000 m^2. Scrubby oak wood almost without a herb layer, with extensive local moss 'carpets', surrounded by pine woods and heathlands. Situated in an area of low inland sanddunes and associated plains (4L8). The woods probably originated or were planted between 1852 and 1896.
3. Ov., Steenwijk, 5 km N of the village of Steenwijk, Heerlijkheid De Eese; Tm 16E, 538.1 - 203.7. Area 1000 m^2 + about 2000 m^2. Oak coppice with a sparse herb layer where *Deschampsia flexuosa* dominated, with extensive local moss 'carpets'. Probably lying in an area of inland sanddunes. The wood originated or was planted before 1932.
4. Dr., Rolde, 1 km N of the village of Schoonloo, Schoonloër strubben; Tm 17E, 547.9 - 243.2. Area 1000 m^2 + about 500 m^2. Scrubby oak-birch woods bordering on heathland, with a herb layer of mainly *Vaccininium myrtillys*, *V. vitis-idaea*, and *Calluna vulgaris*. Situated in low inland sanddunes with associated plains (4L8). The woods originated between 1852 and 1896 from spontaneous regeneration of the woods on heathland.

5. Dr., Ruinen, 3 km E of Pesse, Amshoff's bos; Tm 17C, 531.7 - 229.9. Area 1050 m^2 + about 1000 m^2. Oak-birch wood with a sparse herb layer of *Vaccinium myrtillus*. Spaartelgen wood (former coppice, transformed into high wood). Situated in a relatively high area of ground moraine with coversand ($3L2^a$). The wood was planted between 1852 and 1896 on heathland.
6. Dr., Ruinen, 1 km N of Pesse; Tm 17C, 533.4 - 226.7. Area 1500 m^2. High oak-birch wood, the herb layer with a great deal of *Vaccinium myrtillus*. Situated in a relatively high area of ground moraine with coversand ($3L2^a$). The woods were planted between 1852 and 1896 on heathland, probably originally with conifers, which were later replaced by oaks.
7. Dr., Oosterhesselen, Havezathe De Klencke; Tm 17G, 531.7 - 246.2. Area 2000 m^2. High oak-birch wood with a great deal of *Vaccinium myrtillus*. Situated in a relatively high area of ground moraine with coversand ($3L2^a$). This wood already existed in 1852, probably then with conifers, which were later replaced by oaks.
8. Dr., Norg, 2 km S of the village of Norg, Tonckensbos; Tm 12A, 562.6 - 226.1. Area 2000 m^2. High oak-birch wood with a great deal of *Vaccinium myrtillus* and *Melampyrum pratense*. An old wood, already marked on the map of 1823.
9. Dr., Westerbork, 1 km NNW of the village of Mantinge, Mantingerbos; Tm 17D, 536.5 - 236.9. Area 1000 m^2 + about 1000 m^2. Oak-birch wood with a great deal of *Vaccinium myrtillus*. Coppice, which has not recently been cut, situated on a raised ground moraine in a brook valley. An old wood, already marked on the map of 1823.
10. Dr., Vries, 1 km NW of the village of Zeijen, Zeijerstrubben; Tm 12B, 563.8 - 232.2. Area 1050 m^2 + about 500 m2. Oak-birch wood with a great deal of *Deschampsia flexuosa*, and some *Vaccinium myrtillus* and *Molinia caerulea*. Coppice, not recently cut. Situated in an old strip of woodland surrounding the common fields, already marked on the map of 1823.
11. Dr., Westerbork, 1 km NNW of the village of Mantinge, Noordlagerbos; Tm 17D, 536.9 - 237.4. Area 1000 m^2 + about 1000 m^2. Oak-birch wood with a great deal of *Vaccinium myrtillus* and some *Pteridium aquilinum*. Spaartelgen wood, situated on a relatively high plain of ground moraine with coversand (2M5) in a brook valley. Marked as woods on the map of 1823, as cultivated land on the 1852 map, and again as woods on the 1904 map.
12. Dr., Beilen, Boswachterij Hooghalen, Heuvingerzand; Tm 17B, 547.2 - 233.1. Area 1050 m^2 + about 500 m^2. Oak-birch wood with amongst others *Lonicera periclymenum*, *Deschampsia flexuosa*, and *Maianthemum bifolium*. Coppice, not recently cut. Situated in a relatively high area of ground moraine with coversand ($3L2^a$). Originating between 1852 and 1896 by planting or spontaneous regeneration of the woods on heathlands, directly bordered by the planted strip of woodland surrounding the common fields of the Holtes.
13. Dr., Ruinen, 2 km NW of the village of Pesse, Kraloo; Tm 17C, 533.3 - 225.3. Area 1000 m^2 + about 500 m^2. Oak-birch wood with amongst others

Trientalis europaea. Coppice, last cut about 10 years ago, with low, moss covered stubs. Situated in a relatively high area of ground moraine with coversand ($3L2^a$), bordering on a brook valley. Probably planted between 1800 and 1852.

14. Dr., Rolde, 1 km N of the village Schoonloo, Schoonloër strubben; Tm 17E, 547.8 - 243.1. Area 1000 m^2 + about 500 m^2. Oak-birch wood with amongst others *Maianthemum bifolium*, *Trientalis europaea*, and *Hedera helix* (terrestrial). Coppice, not recently cut, with high, moss covered stubs. Situated on low sanddunes with associated plains (4L8). The wood was first marked on the 1852 map.

15. Dr., Havelte, near Holtinger es; Tm 16H, 534.9 - 213.2. Area 1000 m^2 + about 1000 m^2. Oak-birch wood with amongst others *Maianthemum bifolium*, *Stellaria holostea*, and *Hedera helix* (terrestrial). Coppice, not recently cut, with high stubs. Part of a strip of woodland surrounding the common fields of the Holtinger es, planted in the 19^{th} century.

16. Ov., Steenwijk, 5 km N of the village of Steenwijk, Heerlijkheid De Eese; Tm 17E, 537.7 - 203.6. Area 1000 m^2 + about 500 m2. Oak-birch wood with amongst others *Maianthemum bifolium* and *Pteridium aquilinum*. Coppice, not recently cut, with high stubs. Probably part of a strip of woodland surrounding the common fields, planted in the 19^{th} century.

17. Dr., Vries. 1 km NW of the village of Zeijen, Zeijer strubben; Tm 12B, 563.8 - 232.1. Area 1000 m^2 + about 200 m^2. Oak-birch wood with a great deal of *Hedera helix* (terrestrial), *Maianthemum bifolium*, and *Pteridium aquilinum*. Part of a strip of woodland surrounding the common fields, already marked on the 1823 map.

18. Dr., Beilen, 1 km SE of the village of Hooghalen, Winkelbos; Tm 17B, 548.3 - 233.3. Area 700 m^2. Oak-birch wood with amongst others *Convallaria majalis*, *Trientalis europaea*, and *Maianthemum bifolium*. High wood, lying on a ridge of coversand (3L5). The wood originated or was planted between 1852 and 1896; it is possibly a remnant of a former strip of woodland surrounding the common fields.

19. Dr., Gieten, slightly N of the Zwanemeer; Tm 12G, 560.3 - 247.2. Area 800 m^2. High oak-birch wood with a great deal of *Pteridium aquilinum* and *Rubus* sp. Situated on the border of the Hondsrug ridge. An old wood, already marked on the 1823 map.

20. Dr., Westerbork, 1 km NNW of the village of Mantinge, Mantingerbos; Tm 17D, 536.5 - 236.9. Area 1000 m^2 + about 500 m^2. High oak-birch wood, with a great deal of *Stellaria holostea* and *Trientalis europaea*. Situated on a raised ground moraine with coversand in a brook valley. An old wood, already marked on the 1823 map.

21. Dr., Westerbork, 1 km NNW of the village of Mantinge, Thijnsbosje; Tm 17D, 536.7 - 236.7. Area 500 m^2. High oak-birch wood with a great deal of *Trientalis europaea*, *Stellaria holostea*, and *Pteridium aquilinum*. Situated on ground moraine with coversand, bordering a brook valley. An old

wood, marked on the 1823 map.

22. Dr., Vries, 1 km NW of the village of Zeijen, Zeijerstrubben; Tm 12B, 563.7 - 232.2. Area 875 m^2 + about 1000 m^2. High oak-*Ilex* wood. An old wood, marked on the 1823 map.

23. Dr., Norg, Norgerholt; Tm 12A, 564.1 - 226.3. Area 1000 m^2 + about 1000 m^2. High oak-*Ilex* wood. Old, marked on the 1823 map.

24. Dr., Westerbork, 1 km NNW of the village of Mantinge, Mantingerbos; Tm 17D, 536.5 - 236.9. Area 1000 m^2 + about 2000 m^2. High oak-*Ilex* wood. Situated on a rise in the ground moraine in a brook valley. Old wood, marked on the 1823 map.

25. Dr., Beilen, 4 km SSW of the village of Wijster, De Hulzedink, Tm 17D, 532.9 - 232.2. Area 300 m^2 (the area became still smaller during this investigation). High oak-*Ilex* wood, situated on a small rise in the ground moraine with coversand in a brook valley. Old wood, marked on the 1823 map.

26. Dr., Hoogeveen, at the W border of the village of Hoogeveen, Kinholts bosje; Tm 17C, 527.0 - 226.7. Area 1000 m^2. High oak-*Ilex* wood, situated on ground moraine with coversand, bordering a brook valley. Old wood, marked on the 1823 map.

27. Dr., Emmen, at the SE border of the village of Emmen, along the Oevermansweg; Tm 17H, 531.8 - 259.1. Area 800 m^2. High oak-*Ilex* wood, situated on a ridge of possibly tectonic origin (4K1). Old wood, first marked on the 1852 map.

28. Dr., Westerbork, 1 km NNW of the village of Mantinge, Thijnsbosje; Tm 17D, 536.7 - 236.7. Area 500 m^2. High oak-*Ilex* wood, situated on ground moraine with coversand, bordered by a brook valley. Old wood, marked on the 1852 map.

29. Dr., Assen, Asserbos; Tm 12D, 556.2 - 233.7. Area of about 500 m^2, criss crossed or transversed by many paths and drains. High oak-*Ilex* wood. Old wood, marked on the 1823 map.

Literature

Bakker, H. de, & J. Schelling, 1966. Systeem van bodemclassificatie voor Nederland. De hogere niveaus. Pudoc, Wageningen.

Bakker, J.G., 1969. Vegetatiekundig en oecologisch-geografisch onderzoek van het Quercion robori-petraeae in de Nederlandse zandgebieden ten zuiden van de Waal. Thesis, Wageningen.

Barkman, J.J., 1963. Over de standplaats van Cornus suecica in Oostfriesland. Gorteria 1: 100-105.

Barkman, J.J., 1969. Het geslacht Galerina in Nederland. Coolia 14(3):49-86.

Barkman, J.J., 1973. Synusial approaches to classification. In: Whittaker, Handbook of Vegetation Science 5:437-491.

Barkman, J.J., 1974a. Le Dicrano-Quercetum, nouvelle association des chênaies acidophiles aux Pays-Bas. Colloques Phytosociologiques 3:251-254.

Barkman, J.J., 1974b. Le Violion caniae existe-t-il? Colloque 1973 de l'Association Internationale de Phytosociologie.

Barkman, J.J., 1976. Algemene inleiding tot de oecologie en sociologie van macrofungi. Coolia 19:57-66

Barkman, J.J., 1980. Dictaat caputcollege Mycosociologie. Syllabus Univ. Utrecht.

Barkman, J.J., H. Doing & S.Segal, 1964. Kritische Bemerkungen und Vorsläge zur quantitative Vegetationsanalyse. Acta Bot. Neerl. 13:394-419.

Barkman, J.J., J. Moravec & S. Rauschert, 1976. Code of phytosociological nomenclature. Vegetatio 32:131-185.

Barkman, J.J. & V. Westhoff, 1969. Botanical evaluation of the Drenthian district. Vegetatio 19:330-388.

Berthier, J., 1976. Monographie des Typhula Fr., Pistillaria Fr. et genres voisins. Bull. Soc. Linn. Lyon 45 (Numéro spécial).

Birken, S., 1976. Pilzfloristische Untersuchungen im nördlichen Westfalen. Zeitschr. f. Pilzkd. 42:95-112.

Bohus, G. & M. Babos, 1960. Coenology of terricolous macroscopic fungi of deciduous forests. Bot. Jahrb. Stuttgart 80(1):1-100.

Bohus, G. & M. Babos, 1967. Mycocoenological investigation of acidophilous deciduous forests in Hungary. Bot. Jahrb. Stuttgart 87:304-360.

Bon, M. & J.M. Gehu, 1973. Unités supérieures de végétation et recoltes mycologiques. Doc. mycol. 6:1-40.

Boois, H.M. de, 1976. Schimmelgroei in strooisellagen van enkele bosgronden. Thesis, Utrecht.

Bourdot, H. & A. Galzin, 1927. Hyménomycètes de France. M.Bry, Sceaux.

Broek, J.M.M. van den, & W.H. Diemont, 1966. Het Savelsbos. Bosgezelschappen en Bodem. Rivon, Wageningen. Verhandeling 3.

Bruylants, J., 1957. Inocybe sambucina Fr. Bull. Soc. myc. Fr. 73(Atlas planche):111.

Cailleux, A. & G. Taylor, 1958. Code Expolaire. N. Boubee, Paris.

Carbiener, R., N. Ourisson & A. Bernard, 1975. Erfahrungen über die Beziehungen zwischen Grosspilzen und Pflanzengesellschaften in der Rheinebene und den Vosgesen. Beitr. naturkd. Forsch. Südw.-Dtl. 34:37-56.

Corner, E.J.H., 1950. A monograph of Clavaria and allied genera. Oxford Univ. Press, London.

Corner, E.J.H., 1968. A monograph of Thelephora (Basidiomycetes). Nova Hedwigia 27 (Beih.). 110 pp.

Darimont, F., "1973" [1975]. Recherches mycosociologiques dans les forêts de Haute Belgique. Inst. R. Sci. nat. Belg., Brussels. Mémoire 170.

Demoulin, V., 1968. Gastéromycètes de Belgique: Sclerodermatales, Tulostomatales, Lycoperdales. Bull. Jard. Bot. Nat. Belg. 38:1-101.

Dennis, R.W.G., 1978. British Ascomycetes. J. Cramer, Lehre.

Dennis, R.W.G., P.D. Orton & F.B. Hora, 1960. New checklist of British agarics and boleti. Trans. Brit. myc. Soc. Vol. 43 (Supplement). 224 pp.

Doing, H., 1962. Systematische Ordnung und floristische Zusammensetzung Niederländischer Wald- und Gebüschgesellschaften. Wentia 8:1-85.

Doing, H., 1963. Übersicht der floristische Zusamennsetzung, der Struktur und der dynamischen Beziehungen Niederländischer Wald- und Gebüschgesellschaften. Meded. Landbouwhogeschool, Wageningen 63(2). 60 pp.
Domanski, S., H. Orlos & A. Skirgiello, 1973. Fungi. Polyporaceae. 2 (Pileatea). Mucronoporaceae. 2 (Pileatea). Washington D.C.
Donk, M.A., 1974. Check list of European polypores. Verh. K. Ned. Akad. Wet., Amsterdam (2e reeks) 62. 469 pp.
Einhellinger, A., 1964. Die Pilze der Eichen-Hainbuchenwäller des Münchener Lohwaldgürtels. Ber. Bayerischen Bot. Ges. 37:11-30.
Eriksson, J. & L. Ryvarden, 1973-1979. The Corticiaceae of North Europe, 5 vols. Fungiflora, Oslo.
Friedrich, K., 1940. Untersuchungen zur Ökologie der höheren Pilze. Pflanzenforschung 22: 1-47.
Haas, H., 1978. Die Pilzflora des Naturparks Schönbuch. Mykologia 44:5-11.
Harmaja, H., 1969. The genus Clitocybe (Agaricales) in Fennoscandia. Karstenia 10:5-168.
Heineman, P., 1956. Les landes à Calluna du district Picardo-Brabançon de Belgique. Vegetatio 7:99-147.
Heineman, P. & D. Thoen, 1973. Observations sur le genre Cystoderma. Bull. Soc. myc. Fr. 89:5-34.
Henry, R., 1936. Etude de quelques cortinaires. Bull. Soc. myc. Fr. 52:90-99.
Hueck, H.J., 1953. Myco-sociological methods of investigation. Vegetatio 4:84-101.
Jahn, H., 1963. Mitteleuropäische Porlinge (Polyporaceae s. lato) und ihr Vorkommen in Westfalen. Westfälische Pilzbriefe 4:1-143.
Jahn, H., 1971. Steroide Pilze in Europa. Westfälische Pilzbriefe 8:69-176.
Jahn, H., A. Nespiak & R. Tüxen, 1967. Pilzsoziologische Untersuchungen in Buchenwäldern (Carici-Fagetum, Melico-Fagetum und Luzulo-Fagetum) des Wesergebirges. Mitt. flor.-soz. Arbeitsgem. (N.F.) 11/12:159-197.
Jansen, A.E., 1981. Opnamen van vegetatie, bodem en paddestoelen in eikenbossen op zandgrond in Drenthe in 1976-1979. Report Biologisch Station, Wijster (NL).
Jansen, A.E. & M.E. Noordeloos, 1980. Sleutel tot de soorten van de genera Marasmius, Collybia, Marasmiellus, Micromphale en Crinipellis in Nederland, aangrenzend België en West Duitsland. Coolia 23:2-9.
Kits van Waveren, E., 1968. The Stercorarius group of the genus Coprinus. Persoonia 5: 131-176.
Kornerup, A. & J.H. Wanscher, 1978. Methuen handbook of colour. Methuen, London. 252 pp.
Krieglsteiner, G.J., 1977. Die Makromyzeten der Tannen-Mischwälder des Inneren Schwäbisch-Fränkische Waldes (Ostwürttemberg) mit besonderer Berücksichtigung des Welzheimer Waldes. Lempp Verlag, Schwäbisch Gmünd. 195 pp.
Kubiëna, W.L., 1953. Bestimmungsbuch und Systematik der Böden Europas. Stuttgart.
Kühner, R., 1935. Le genre Galera (Fr.) Quél. P. Lechevalier, Paris. 240 pp.
Kühner, R., 1959. Notes descriptives sur les Agarics de France. Bull. mens. Soc. Linn. Lyon 28:131-141.
Kühner, R., 1961. Notes descriptives sur les Agarics de France. 1. Cortinarius. Bull. Soc. myc. Fr. 75:88-101.
Kühner, R. & H. Romagnesi, 1953. Flore analytique des champignons supérieurs. P. Lechevalier, Paris. 557 pp.
Kühner, R. & H. Romagnesi, 1977. Compléments à la "Flore Analitique". (Reprint) J. Cramer, Vaduz. 484 pp.
Lange, J.E., 1935-1940. Flora Agaricina Danica. 5 vol. Copenhagen.
Lange, M., 1978. Fungus Flora in August. Bot. Tidsskrift 73(1):21-54.
Leischner - Siska, E., 1939. Zur Soziologie und Ökologie der höheren Pilze. Beih. Bot. Centralbl. 59:359-429.
Lisiewska, M., 1965. Udzial grzybów wyzszych w gradach Wielkopolski. (Higher fungi of the Querco-Carpinetum of the Wielkopolska Province.) Acta mycol. 1:169-268.
Lisiewska, M., 1974. Macromycetes of beech forests within the eastern part of the Fagus area in Europe. Acta mycol. 10(1):3-72.
Maarel, E. van der, 1971. Florastatistieken als bijdrage tot de evaluatie van natuurgebieden. Gorteria 5(7/10):176-188.
Maas Geesteranus, R.A., 1975. Die terrestrischen Stachelpilze Europas. Verh. K. Ned. Akad. Wet., Amsterdam, (2e reeks) 65. 127 pp.
Matuszkiewicz, W., 1962. Zur Systematik der natürlichen Kieferwälder des mittel- und osteuropäischen Flachlandes. Mitt. flor.-soz. Arbeitsgem. (N.F.) 9:145-186.
Moser, M., 1978. Die Röhrlinge und Blätterpilze. G. Fischer Verlag, Stuttgart/New York.
Munsell Soil Color Charts, 1954. Munsell Color Company, Baltimore.
Nespiak, A., 1959. The investigations on the character of the correlations between the higher fungi and wood associations in the National Park of Białowieza. Monographiae botanicae 8:3-141.

Nespiak, A., 1962. Observations sur les champignons à chapeau dans les associations forestières en Pologne. Vegetatio 11:71-74.
Noordeloos, M.E., 1980. Entoloma subgenus Nolanea in the Netherlands and adjacent regions with a reconnaissance of its remaining taxa in Europe. Persoonia 10:427-534.
Noordeloos, M.E., 1981. Entoloma subgenera Entoloma and Allocybe in the Netherlands and adjacent regions with a reconnaissance of its remaining taxa in Europe. Persoonia 11: 153-256.
Oberdorfer, E., 1957. Süddeutsche Pflanzengesellschaften. Ed. Fischer, Jena.
Oberdorfer, E., S. Goers, D. Korneck, W. Lohmeyer, Th. Mueller, G. Phillippi & P. Seibert, 1967. Systematische Übersicht der westdeutschen Phanerogamen- und Gefässkryptogamen Gesellschaften. Schriftenreihe f. Vegetationskunde 2:7-62.
Orton, P.D., 1955. Cortinarius. 1. Naturalist July-September 1955. Suppl.
Passarge, H. & G. Hofmann, 1968. Pflanzengesellschaften des nordostdeutschen Flachlandes 2. Jena.
Pielou, E.C., 1969. An introduction to mathematical ecology. London/New York.
Raunkiaer, C., 1918. Récherches statistiques sur les formations végétales. Kgl. Danske Vidensk. Selskab Biol. Medd. I,3.
Runge, A., 1960. Pilzökologische und -soziologische Untersuchungen in den Bockholter Bergen bei Münster. Landesmus. f. Naturk., Münster Westfalen - Abhandlungen.
Runge, A., 1963. Pilzsukzession in einen Eichen-Hainbuchenwald. Zeitschr. f. Pilzkd. 29: 65-72.
Scamoni, A. & H. Passarge. 1959. Gedanken zu einer natürlichen Ordnung der Waldgesellschaften. Arch. f. Forstwesen 8(5):386-426.
Šmarda, F., 1972. Pilzgesellschaften einiger Laubwälder Mährens. Acta scientiarum naturalium academiae scientiarum Bohemoslovacae, Brno, 6:3-53.
Smith, A.H., & R. Singer, 1964. A monograph of the genus Galerina Earle. Hafner Publ., New York. 385 pp.
Stangl, J., 1977. Die eckigsporingen Risspilze. 3. Z. f. Mykol. 43:131-144.
Stangl, J., 1980. Inocybe xanthomelas Kühn. et Bours. und andere Risspilze während der 12. Mykologische Dreiländertagung 1979. Z. f. Mykol. 46:111-113.
Stiboka, 1978. Geomorfologische kaart van Nederland 1:50 000. Blad 17 en 18 Beilen/Roswinkel.
Stiboka, 1977, 1978. Bodemkaart van Nederland 1:50 000. Blad 12 Oost-Assen, Blad 17 West/ Oost-Emmen.
SWAN, 1963. Atlas van Nederland. Stichting Wetenschappelijke Atlas van Nederland. Staatsuitgeverij, The Hague.
Thoen, D., 1976. Facteurs physiques et fructification des champignons supérieurs dans quelques pessières d'Ardenne meridionale (Belgique). Bull. Soc. linn. Lyon 45:269-284.
Trappe, J.M., 1962. Fungus associates of ectotrophic mycorrhizae. Bot. Rev. 28:538-606.
Tüxen, R., 1930. Ueber einige nw-deutsche Waldassoziationen von regionaler Verbreitung. Geogr. Ges., Hannover - Jahrbuch 1929.
Tüxen, R., 1937. Die Pflanzengesellschaften Nordwestdeutschlands. Mitt. Flor.-Soz. Arbeitsgem. Niedersachsen 3:1-170.
Tüxen, R., 1955. Das System der Nordwestdeutsche Pflanzengesellschaften. Mitt. Flor.-Soz. Arbeitsgem. (NF) 5:155-176.
Tüxen, R.; B. Caron, 1977. Bibliographia Phytosociologica Syntaxonomica Lieferung 30: Quercetea robori-petraeae. J. Cramer, Vaduz.
Vreugdenhil, D. & J.J. Barkman, 1974. A plant sociological and ecological study of a new association. Report Biologisch Station, Wijster (NL).
Vries, G.A. de, 1971. De Fungi van Nederland. 3. Hypogaea. Kon. Ned. Natuurhistorische Ver., Hoogwoud.
Westhoff, V. & A.J. den Held, 1969. Plantengemeenschappen in Nederland. Thieme, Zutphen.
Wilde, S.A., 1946. Forest soils and forest growth. Chronica Botanica, Waltham.
Wilkins, W.H., J.L. Harley & G.C. Kent, 1938. The ecology of the larger fungi 2. Ann. appl. Biol. 25:472-489.
Winterhoff, W., 1975. Die Pilzvegetation der Dünenrasen bei Sandhausen (nördliche Oberrheinebene). Beitr. z. naturkundlichen Forschung Südwestdeutschlands 34:445-462.
Winterhoff, W., 1976. Die Pilzflora des Naturschutzgebietes Sandhauserer Dünen bei Heidelberg. Veröff. Naturschutz Landschaftspflege Baden-Württenburg 44/45:51-118.
Whittaker, R.H. (Ed.), 1973. Ordination and classification of communities. Handbook of vegetation science 5. Ed. Junk, The Hague.
Ypelaar, P., 1974. Mycosociologisch onderzoek van het Dicrano-Quercetum. Report Biologisch Station, Wijster (NL).

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