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The vegetation and macrofungi of acid oakwoods in the North-East Netherlands

Proefschrift
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op gezag van de rector magnificus,
dr. C.C. Oosterlee,
hoogleraar in de veeteeltwetenschap,
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des namiddags om vier uur in de aula
van de Landbouwhogeschool te Wageningen

Stellingen

1. De ruimtelijke frequentie van carpophoren is een betere maat voor de abundantie van fungi dan de abundantie van carpophoren.

2. Om te voorkomen dat veel fungi die typisch zijn voor het Dicrano-Quercetum daar zullen verdwijnen als de strooisel- en humuslaag te dik wordt, zal strooiselroof moeten worden toegepast.

3. In bossen op voedselarme zandgrond is de dikte van de humuslaag meer bepalend voor de voedselrijkdom dan de concentraties van de ionen in de humus.

4. Het Luzulo-Fagetum leucobryetosum en het Fago-Quercetum dicranetosum dienen, net als het Dicrano-Quercetum, in het Dicrano-Pinion te worden geplaatst.
   Lisiewska,M.(1974): Macromycetes of beech forests within the eastern part of the Fagus area in Europe. Acta Mycol. 10: 3-72.
   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.

5. De keuze van Agaricus dryophila Fr. als typesoort van het genus Collybia is een ongelukkige keuze, daar dit tot gevolg zal hebben dat Marasmius sectie Androsacei (M. androsaceus en M. splachnoides) onder Collybia gerekend moeten worden.
   Lennox,J.W. (1979): Collybioid genera in the Pacific Northwest. Mycotaxon 9: 117-231.
   Clémençon,H. (1981): Kompendium der Blätterpilze I. Collybia. Z. Mykol. 47: 5-25.

6. Aangezien biotoopverstoring, b.v. door bemesting of ontwatering, en het verdwijnen van groeiplaatsen, b.v. door bebouwing, meer bijdragen aan de achteruitgang van de paddestoelenflora dan plukken (waarvan de schade uitsluitend visueel is) zijn plukverboden niet zinvol en zeker niet afdoende om een verdere achteruitgang van de paddestoelenflora te voorkomen.

7. Het hooghouden van de reeënstand door bijvoedering in de winter lijkt meer op extensieve veehouderij dan op natuurbehoud.

8. Het idee dat aquatische milieus altijd "eenvoudiger" zijn dan terrestrische is, zeker waar het eutroof, hydrologisch niet afgesloten water in Nederland betreft, een hardnekkig vooroordeel.

9. Het gebruik de menselijke bevolking uit te drukken in een aantal "zielen" dient vermeden te worden daar dit uitgaat van een bepaalde, zeer beperkte interpretatie van het begrip ziel en daarom kwetsend kan zijn voor personen die hierover een andere opvatting hebben.

Stellingen bij het proefschrift van A.E.Jansen,
The vegetation and macrofungi of acid oakwoods in the North-East Netherlands.
Wageningen, 2 oktober 1981.

Anna Elisabeth Jansen. Agricultural University, Wageningen, section Biological Station, Kampsweg 27, 9418 PD, Wijster (Netherlands). The vegetation and macrofungi of acid oakwoods in the North-East Netherlands. Thesis. 1981. 131 pp, 11 Tbs, 40 Figs. Engl., Ned. inl. en samenv.

The fungus vegetation, the vegetation of phanerogams, mosses, and lichens, the soilprofiles are described and soil chemical analyses are made in the associations Dicrano-Quercetum, Querco-Betuletum, Violo-Quercetum, and its sub-association ilicetosum (sub-ass. nov.) in the province of Drenthe (North-East Netherlands). New methods are applied in the soil chemical analysis (amount of ions expressed in mass concentration, calculation of total ion supply), in the vegetation analysis (separate analysis of the moss synusia on rotten tree stumps and dead wood), and in the mycosociological analysis (determination of spatial frequency). The last-named method is used for the determination or estimation of the abundance of the mycelia per species, of the plot homogeneity, of the pattern of the species, and of the correlation between species. Based on the phytocoenose the Querco-Betuletum and the Violo-Quercetum appeared to be closely related, and to belong to the alliance Quercion robori-petraeae. It was confirmed that the Dicrano-Quercetum is less related, and did not belong to this alliance. In the soil there are differences between the syntaxa in the profiles and in the 'total ion supply'. The syntaxa have many differential species among the fungi in a way to support the concepts on the affinities based on the phytocoenoses. The 'minimal area' of the fungus vegetation was determined. Distribution patterns of fungus species within plots are discussed. Annotations on identifaction and taxonomy of fungi are given; a new fungus taxon is described: *Psathyrella fulvescens* var. *dicrani*.

VOORWOORD

Dit onderzoek is als een promotie-onderzoek aan de Landbouwhogeschool te Wageningen, vakgroep Vegetatiekunde, Plantenoecologie en Onkruidkunde, sectie Biologisch Station, uitgevoerd in de periode augustus 1976 - april 1980. De begeleiding berustte bij prof.dr. J.J. Barkman.

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INLEIDING

Vanuit het Biologisch Station te Wijster (Drenthe) wordt al zeer vele jaren een onderzoek gedaan naar de sociologie en de oecologie van paddestoelen. Barkman en De Vries doen dergelijk onderzoek aan jeneverbes struwelen, Arnolds aan grasland vegetaties, en enkele andere medewerkers en studenten aan sparrebossen, droge heidevelden, en eikenkreupelbosjes op voormalig stuifzand. Het uiteindelijke doel is de paddestoelenvegetaties van alle vegetatietypen in het Drents district te beschrijven, zowel kwalitatief als kwantitatief. Daarmee hopen we een volledig inzicht in de sociologische amplitudo en status en in de oecologische amplitudo van de paddestoelensoorten in Drenthe te verkrijgen. Ook verwachten we dat deze kennis zal bijdragen tot het oplossen van vele synsystematische problemen, speciaal in die vegetaties met maar weinig hogere planten en mossen.

Onderzoek naar paddestoelenvegetaties, meestal mycosociologisch of mycocoenologisch onderzoek genoemd, wordt in Nederland alleen bedreven vanuit het Biologisch Station te Wijster. Buiten Nederland vindt verspreid in West Europa enig onderzoek plaats. Onderzoek dat op een systematische manier alle vegetatietypen in een bepaalde streek omvat, vindt eigenlijk alleen plaats in Oost Europa (Polen, Hongarije, Tsjechoslowakije).

Over het algemeen is nog maar weinig bekend van paddestoelenvegetaties in associaties van hogere planten. De mycosociologie is een nog vrij jonge tak van wetenschap die tamelijk los staat van de mycologie, doordat de vraagstelling vegetatiekundig is, maar ook tamelijk los staat van de vegetatiekunde, doordat eigen - aan paddestoelen aangepaste - methoden worden gebruikt. Wel zijn beide specialisaties, vegetatiekunde en mycologie, nodig om mycosociologisch onderzoek te kunnen doen. We beschouwen de paddestoelenvegetatie, de mycocoenose, net als de vegetatie van vaatplanten en mossen, de fytocoenose, als een onderdeel van de levensgemeenschap, de biocoenose. De fytocoenose wordt gebruikt om de biocoenose te herkennen en is dus de basis waarop de paddestoelenvegetatie bestudeerd wordt. We beschrijven daarom geen aparte paddestoelenassociaties, maar beschouwen de paddestoelenvegetatie als onderdeel van de biocoenose en in de praktijk als onderdeel van de fytocoenose.

Door Ypelaar was in 1972 en 1973 een onderzoek gedaan naar de paddestoelen in eikenkreupelbosjes op voormalig stuifzand, het Dicrano-Quercetum. In dit vegetatietype bleken zeer veel soorten paddestoelen voor te komen, waaronder veel zeldzame soorten die (tot dan toe) niet van andere vegetatietypen in Drenthe bekend waren. Het onderzoek waarvan de resultaten hier voor u liggen, is opgezet om de paddestoelenvegetatie van enkele andere

typen eikenbos op voedselarme, zure zandgrond te beschrijven en te vergelijken met die van het Dicrano-Quercetum. Hiertoe zijn van de in Drenthe aanwezige eikenbossen 3 typen gekozen: 1. het Querco-Betuletum, eiken-berkenbos; 2. het Violo-Quercetum typicum, een eikenbos waar vooral de kruidlaag soortenrijker is; 3. het Violo-Quercetum ilicetosum, een type eikenbos met een uitgebreide boom- en/of struiklaag van hulst. Tevens werden een paar proefvlakken van het Dicrano-Quercetum (die ook al door Ypelaar waren onderzocht) in het onderzoek betrokken, om het inzicht in de paddestoelenvegetatie van het Dicrano-Quercetum verder te verdiepen.

De vegetatie van groene planten en mossen van de bestudeerde bostypen is ook beschreven. Dit gebeurde om de proefvlakken te karakteriseren en om na te kunnen gaan welke associaties het betrof. Met behulp van de literatuur moesten ook enkele syntaxonomische problemen worden opgelost. Het was niet duidelijk welke naam van het Querco-Betuletum en van het Violo-Quercetum de juiste naam was. Bij het Violo-Quercetum was bovendien de plaats in het syntaxonomische systeem onzeker. Het Violo-Quercetum ilicetosum was een nog niet eerder beschreven bostype, dat dus beschreven moest worden en ingedeeld in het systeem van vegetaties. Het Dicrano-Quercetum was nog niet eerder uitgebreid beschreven voor Nederland en er was geen overeenstemming over zijn syntaxonomische plaats.

Werkwijze

De proefvlakken werden alle gekozen in het (plantengeografische) Drents district. Er werden van het Dicrano-Quercetum 3 proefvlakken uitgezet, 8 proefvlakken van het Querco-Betuletum, 10 van het Violo-Quercetum typicum en 8 van het Violo-Quercetum ilicetosum. De proefvlakken werden met paaltjes gemarkeerd, zodat steeds precies dezelfde plek teruggevonden kon worden. Dit is nodig omdat niet met één opname van de paddestoelenvegetatie in een gunstige tijd of met enkele opnamen in één jaar kan worden volstaan. De verschijning van paddestoelen hangt nogal af van de weersgesteldheid, er zijn duidelijke seizoensaspecten en ook kan de paddestoelenflora van jaar tot jaar erg verschillen. In dit onderzoek zijn de opnamen gemaakt in de zomer en herfst van 1976, 1977, 1978 en 1979. De opnamen zijn per proefvlak gecombineerd tot één synthetische opname.

Bij het kiezen van de proefvlak-grootte werd uitgegaan van de mycosociologische vraagstelling. Hoe groot een proefvlak moet zijn om representatief te zijn bij paddestoelenopnamen, is niet bekend. Verschillende auteurs kozen die afmetingen die in hun vraagstelling het meest geschikt was, en hanteerden dus elk andere afmetingen, van 1 m^2 tot enkele tientallen hectares. Bepalingen van het 'minimum areaal' zijn maar zelden gedaan. Ypelaar (in voorber.) schatte het minimum areaal in het Dicrano-Quercetum (onderzocht gedurende 2 jaar) op 600 m^2. Jahn, Nespiak en Tüxen (1967) schatten dat 1000 m^2 in het Luzulo-Fagetum leucobryetosum (4 jaar onderzocht) represen-

tatief zal zijn. Winterhoff (1975) vond in een *Festuca lemani*-associatie (een maal onderzocht) dat 1000 m² niet representatief, dus te klein was. Een proefvlak kiezen we bij voorkeur in een homogene vegetatie, hier dus in een homogene paddestoelenvegetatie. Aan een paddestoelenvegetatie is echter niet zo gemakkelijk te zien of deze homogeen is. Daarom zijn de proefvlakken daar gekozen, waar vegetatie van hogere planten en mossen er homogeen uitzag. Er zijn echter (bijna) geen homogene vegetaties te vinden waarin proefvlakken groter dan 1000 m² uit te zetten zijn. In dit onderzoek zijn de proefvlakken bij voorkeur 1000 m² groot gemaakt, een afmeting die waarschijnlijk wel representatief is en nog net geschikt is om binnen een redelijke tijd (4-6 uur) een paddestoelenopname te maken. Een enkele maal moest echter een kleiner oppervlakte worden gekozen, in verband met de homogeniteit van de fytocoenose. Waar dat mogelijk was binnen een homogene fytocoenose werd naast het proefvlak nog 500-2000 m² geïnventariseerd op paddestoelen. Hierbij werd alleen gelet op soorten die in het proefvlak niet waren gevonden en werd alleen de aanwezigheid genoteerd.

Een paddestoelenvegetatie wordt beschreven met 'abundantie opnames', opnames waarbij van elke paddestoelensoort het aantal exemplaren op een bepaalde oppervlakte wordt geteld of geschat, in andere woorden waarbij van elke soort de abundantie van de vruchtlichamen wordt bepaald. Hoewel niet alle proefvlakken even groot zijn, zijn hier alle abundantie waarden, eventueel na omrekening, betrokken op 1000 m².

Het aantal vruchtlichamen is de resultante van het aantal mycelia en van het aantal vruchtlichamen per mycelium. De werkelijke abundantie van een paddestoelensoort is eigenlijk de abundantie van de mycelia. Het is helaas onmogelijk deze direct waar te nemen. Het enige waaruit de aanwezigheid van een mycelium blijkt zijn de vruchtlichamen. Darimont (1975) bepaalde het aantal 'stations', het aantal plekken waar de vruchtlichamen van een soort staan. Een station kan dus één mycelium zijn, maar ook een fragment ervan, of twee dicht bijeen gelegen mycelia. In dit onderzoek werd de grootheid 'Ruimtelijke Frequentie' ingevoerd om de abundantie van de mycelia te schatten. De Ruimtelijke Frequentie wordt bepaald in proefvlakken die zijn onderverdeeld in deelproefvlakjes van 25 m² elk. Geteld wordt in hoeveel van de deelproefvlakjes een soort voorkomt ('frequentie opname'). De Ruimtelijke Frequentie van een soort is het deel (percentage) van het aantal deelproefvlakjes waar de vruchtlichamen van die soort zijn gevonden. Door deze methode kon ook de homogeniteit van de proefvlakken, de ruimtelijke verdeling van soorten binnen een proefvlak en de correlatie tussen soorten bestudeerd worden.

Van alle proefvlakken zijn opnamen gemaakt van de vegetatie van vaatplanten en op de grond groeiende mossen en korstmossen. Aparte opnamen werden gemaakt van mossen en korstmossen die op dood, rottend hout van stronken, stobben of stammen groeiden, omdat dit synusia het substraat is voor sommige paddestoelen. In proefvlakken die waren ingericht om frequentie

opnames te maken, werd voor de opname van de fytocoenose hetzelfde oppervlakte gekozen als voor de opnames van de paddestoelenvegetatie. Deze opname werd ook als frequentie opname gemaakt, om de fytocoenose met de mycocoenose te kunnen vergelijken. In de proefvlakken die niet waren ingericht om frequentie opnames te maken, werd voor de opname van de fytocoenose een wat kleiner oppervlakte gekozen, namelijk 150-200 m^2. De vegetatie opnames zijn op de gebruikelijke wijze in een tabel gerangschikt; de volgorde waarin de proefvlakken kwamen te staan is ook bij de tabellen van bodem en paddestoelen aangehouden.

Voor een nadere karakterisering van de proefvlakken zijn ook de bodemprofielen bestudeerd, en werd een aantal bodemchemische kenmerken van de A0 laag (half verteerd strooisel) en van de A21 laag (zand met ingespelde humus bepaald.

SAMENVATTING

In dit proefschrift wordt de paddestoelen-vegetatie, 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.

De vegetatie van hogere planten, mossen en korstmossen werd beschreven met opnames volgens de Braun-Blanquet methode, gewijzigd volgens Barkman en anderen. Het synusia van mossen op rottende stronken, stobben en stammen werd 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 subassosiatie beschreven. De mening van Barkman, dat het Dicrano-Quercetum een zelfstandige associatie is, kon worden bevestigd. Deze associatie heeft veel differentiërende 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 een proefvlak was een broek eerdgrond aanwezig, de andere proefvlakken hadden alle duidelijke humus podzol profielen. De proefvlakken in het Violo-Quercetum ilicetosum hadden relatief diepe profielen waarin vaak een dikke A1h laag aanwezig was. In het Violo-Quercetum typicum en het Querco-Betuletum was het profiel korter en was een A1h laag gewoonlijk niet aanwezig. De bovenste laag van de bodem van de Querco-Betuletum proefvlakken bleek over het algemeen gestoord te zijn. De proefvlakken van het Dicrano-Quercetum bleken te liggen op tamelijk recent stuifzand waarin slechts een uiterst kort profiel was ontwikkeld (duin vaaggrond met een micropodzol).

De chemische analyses werden gedaan in monsters van de A0 en de A21 laag. In deze lagen is het eeste mycelium aanwezig. De bodems bleken alle zeer zuur te zijn, pH 2,9 - 3,5 in de A21 laag, 3,3 - 4,7 in de A0 laag. In de A0 laag waren de Na, K, Mg, en Ca ionenen (uitgedrukt in massafractie en massaconcentratie) in elk van de vegetatietypen in nagenoeg gelijke hoeveelheden aanwezig te zijn, in de A21 laag waren de hoogste concentraties in het Violo-Quercetum ilicetosum en de laagste in het Dicrano-Quercetum. De 'totale ionen voorraad' 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 C/N verhouding gedroeg zich omgekeerd en nam toe in deze volgorde.

De paddestoelen-vegetatie is beschreven met behulp van synthetische opnamen van proefvlakken die gedurende 4 jaar onderzocht zijn. Er werden veel meer soorten paddestoelen (314) dan groene planten (72) of mossen en lichenen (67) gevonden. Criteria om differentiërende soorten bij fungi te onderscheiden werden geformuleerd.

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 paddestoelen-vegetatie beter te karakteriseren. Dit geldt met name voor het Violo-Quercetum ilicetosum, dat ook zeer arm is aan (terrestrische) mossen en korstmossen.

Het 'minimum areaal', of eigenlijk de representatieve proefvlak grootte bleek in de associaties van het Quercion 1.500 m^2 te zijn, en in het Dicrano-Quercetum minstens 3.000 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 (Total Spatial Frequency, TSF): 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 TSF, maar het is gewoonlijk niet mogelijk de ene eenheid in de andere om te rekenen.

De bepaling van de TSF gaf ook een aantal andere resultaten. Zo kon worden vastgesteld dat de derde wet van Raunkaer 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 mos-tapijten 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 (onderdispers) waren. Slechts 35 soorten waren in 2 of meer proefvlakken geklusterd (overdispers). Dit kan worden veroorzaakt doordat de mycelia zo groot zijn dat zij over verscheidene deelproefvlakken verspreid zijn, of doordat de mycelia geklusterd groeien, bijvoorbeeld doordat het proefvlak inhomogeen 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 mos-tapijten. 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*. Daarnaast zijn nog enkele andere correlaties besproken.

De paddestoelen werden ingedeeld naar oecologische groepen (waarvan de mycorrhiza soorten, de humus-saprofyten, 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 mycorrhiza soorten voor te komen. Het Dicrano-Quercetum had weinig saprofyten op hout, het Violo-Quercetum ilicetosum weinig humus saprofyten. De saprofyten op blad e.d. waren het talrijkst in het Querco-Betuletum en het Violo-Quercetum typicum.

Van een aantal paddestoelensoorten, 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.

1 *INTRODUCTION*

The Biological Station (province of Drenthe, The Netherlands), a section of the Agricultural University Wageningen (The Netherlands), has for many years been a centre of research on the sociology and ecology of macrofungi. Research had been done in Juniper scrubs (Barkman and De Vries), in grassland vegetations (Arnolds), in Picea woods, Calluna heathers, oak scrubs (other co-workers and students). In describing the fungus vegetation of all phytocoenoses in the Drenthian district, it is hoped to aquire a full knowledge on the sociological range and status, and ecological range of all macromycetes in Drenthe. This knowledge is also expected to help solve many synsystematical problems, especially in associations with few phanerograms, mosses or lichens.

Only macromycetes are involved in these studies: all Hymenomycetes and Gasteromycetes, and those Ascomycetes and Aphyllophorales with a well developed, not very small fruiting body. De Vries is also studying the small Ascomycetes and Aphyllophorales of the Juniper scrubs.

The study of the fungus vegetations requires its own methods, suited to the fungi. It is not possible to use exactly the same methods as studying a phytocoenose. We consider the fungus vegetation, the mycocoenose, as a part of the biocoenose, just like the phytocoenose is a part of the biocoenose. The phytocoenose was used to recognise the biocoenose, and so forms a basis for the study of the mycocoenose. We therefore do not describe separate, independent fungus vegetations.

The fungus vegetation of oak scrubs on former driftsand, the Dicrano-Quercetum (Ypelaar in prep.) appeared to be very species rich and to contain many rare species known only from this type of vegetation.

The object of this thesis was to describe the fungus vegetations of other types of oakwood on nutrient poor, acid, sandy soil, and to compare it with that of the Dicrano-Quercetum. Three types of oakwood were chosen: 1. Querco-Betuletum, oak-birch wood; 2. the Violo-Quercetum typicum, a type with a more varied herblayer, and 3. the Violo-Quercetum ilicetosum, a type with a well developed holly (Ilex aquifolium) tree or shrub layer. Three Dicrano-Quercetum plots (already investigated by Ypelaar in 1972 and 1973) were included, in order to get more detailed information of the fungus vegetation of the Dicrano-Quercetum.

The vegetation of phanerogams, mosses and lichens was also described to characterize the plots, to determine the name of the syntaxon, and to solve some synsystematical problems. The correct names for the Querco-Betuletum and the Violo-Quercetum had to be determined. The synsystematical position

of the Violo-Quercetum was uncertain. The Violo-Quercetum ilicetosum had not previously been described, this was done, together with a synsystematical classification. In the Neterlands the Dicrano-Quercetum had not been described extensively and there was no agreement on its synsystematical position. All plots were situated in the plantgeographical district of Drenthe. Three plots were made in the Dicrano-Quercetum, 8 in the Querco-Betuletum, 10 in the Violo-Quercetum typicum, and 8 in the Violo-Quercetum ilicetosum. The plots were fixed with pickets in order make it possible to refind exactly the same place. This was necessary because one relevé in a good season or several relevés in one year only is not sufficient in order to be able to describe a fungus vegetation, as the formation of carpophores depends greatly on the weather. Distinct seasonal aspects exist and the fungus flora can also differ much from year to year. In this study the relevés were made in the summer and autumn of 1976, 1977, 1978 and 1979. The relevés were combined per plot into one synthetical relevé.

The size of the plots depended on the size needed for making a fungus relevé, but the plot area that is representative for a relevé of a fungus vegetation, is unknown. Authors have used different areas, suit to their own situation, so using areas of 1 m^2 up to ten or more hectares. Determination of the 'minimal area' has been done rarely. Ypelaar (in prep.) estimated the representative plot area in the Dicrano-Quercetum (a 2 years study) to be 600 m^2. Jahn, Nespiak and Tüxen (1967) estimated a plot of 1000 m^2 in the Luzulo-Fagetum leucobryetosum (research that lasted at least 4 years) to be representative. Winterhoff (1975) found in a *Festuca lemani*-vegetation (one survey) that a plot of 1000 m^2 was not representative.

A plot is preferably chosen in a homogeneous vegetation, and for a fungus relevé in a homogeneous fungus vegetation. As homogeneity of a fungus vegetation is not easily seen the plots were chosen in a phytocoenose that looked homogeneous. Homogeneous phytocoenoses in which plots of 1000 m^2 or larger can be situated, were sparse. In this study a plot area of 1000 m^2 was chosen for the relevés of the fungus vegetation. This area is probably representative and has the size to be able to make a fungus relevé in 4-6 hours. A few times a smaller plot had to be chosen, depending on the size of the phytocoenose. An area of 500-2000 m^2 around the plot in the same phytocoenose (depending on the possibilities within the homogeneous phytocoenose) was also investigated for species that were not present in the plot area. Only the presence of these species was noted.

In the relevés of the fungus vegetation the abundance of the carpophores was determined by counting or estimating the number of carpophores in an area of 1000 m^2. In plots larger or smaller than 1000 m^2 abundance was converted and also counted in number of carpophores per 1000 m^2.

The number of carpophores is the product of the number of mycelia and the number of carpophores per mycelium. The real abundance is in fact the

abundance of mycelia, which cannot be directly determined. Darimont (1975) determined the number of 'stations', the number of patches where the carpophores of a species occurred. A station can be one mycelium, a fragment of a mycelium, or 2 mycelia growing close to each other. In this study the value 'Spatial Frequency' was created to estimate the abundance of mycelia. The Spatial Frequency is determined in plots divided into partial plots of 25 m^2. The number of partial plots where a species occurred were counted ('frequency relevé'). The Spatial Frequency of a species is the proportion of the partial plots where the carpophores of that species were found. This method was also used for the determination or estimation of the homogeneity of the plots, of the spatial distribution of the species in the plots, and of the correlation between species.

Relevés were made of the vegetation of phanerogams, and terrestrial mosses and lichens in all plots. Separate relevés were made of the mosses and lichens growing on dead, rotten wood of truncs, stumps, and logs, because this synusia is the substrate for some fungus species. The relevés of the vegetation of higher plants in plots used for frequency relevés, were taken as large as the relevés of the fungus vegetations, in order to be able to compare the fungus vegetation with the vegetation of higher plants. In plots that were not used for frequency relevés, a smaller area was chosen for the relevés of the phytocoenose: 150-200 m^2. The vegetation relevés were arranged in a table in the usual way. The sequences of plots were also used in the tables of the soil characteristics and the fungi.

The soil profiles of the plots were studied, and some soil chemical factors of the A0 (fermentation layer) and the A21 layer (mineral layer with infiltrated humus) were determined in order to characterize the plots further.

2 *THE PHYTOCOENOSES*

2.1 INTRODUCTION AND METHODS

The plots were selected in homogeneous-looking vegetations. The size was at least 150 m^2, which conformed to the representative plot area for vegetation in woods. All plots, however, were larger, ca. 1000 m^2 (except for some plots of the Violo- Quercetum ilicetosum, if a larger area was not available. See plot areas in table 1). An area of 1000 m^2 was not needed to describe the vegetation, but to describe the fungus vegetation. For 17 plots the whole plot (1000 m^2) was described and not only a representative part of the plot. Relevés of 150 or 100 m^2 and the moss layer of all relevés (except in the plots 2 and 3), were made as one relevé, those of 875, 1000, or 1050 m^2 were made in partial relevés of 25 m^2, comparable with the frequency relevés for the fungus vegetation. Partial relevés were later united to one 'total' relevé, using the values given below for Mean Real Cover.

The vegetations were described with Braun-Blanquet relevés. The cover values are given in Braun-Blanquet symbols -modified according to Barkman et al. (1964)- and are explaned as follows (mentioned in parentheses are the values for the 'Real Mean Cover'):

r	rare, 1-2 specimens (0.1%)	cover always ≤ 5%
+	little numerous, 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 wood of stumps, stubs, trunks, and fallen logs, often with a remarkably high mosscover. In vegetation relevés this non-terrestrial synusia is usually not included, but in this study this synusia was important, because some fungus species only occured on this substrate. 'Stump relevés' therefore were made in addition to the vegetation relevé. Firstly an estimate was made of how much of the plot area was covered by dead stumps and logs, then a separate relevé was made of this synusia. The cover of the moss layer and of the moss species was estimated as a portion of the area of the dead stumps and logs. These relevés were made just as those of the terrestrial moss layer, namely as one relevé per plot (not in partial relevés as in the

large plots).

The vegetation relevés were made in the summer of 1977 and 1978. The relevés of the terrestrial moss layer and of the mosses on dead stumps and logs were made in May 1979 together with J.J. Barkman. The relevé of plot 1 has been copied from Vreugdenhil & Barkman (Report Biol. Station, Wijster).

In the synoptical table (table 2) the Presence, P, in a scale of 10 parts in Roman numerals, and the Total Cover Value, TCV, are given. The TCV is the mean cover × 100, calculated with the values for the Real Mean Cover (see above). The synoptical table was calculated for the Dicrano-Quercetum from 42 relevés given by Vreugdenhil & Barkman, those for the other (sub)-associations from the relevés given in table 1.

There are methods for calculating mathematical affinity between 2 associations. In this paper Barkman's methods (1974) were used. A_C is the affinity based on the number of common and not common species, and was calculated according to

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

(c is the number of species in common in both associations, a is the number of species occurring only in the one, b the number occurring only in the other asociation). Therefore only absence and presence of species was used to calculate A_C.

Based on the values for Presence, P, is the affinity

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

(C_P is the Presence value in common, so the lowest of the two P values of a species, A_P is the Presence value of a species lessened with C_P in favour of the one association, B_P the same for the other association).

Based on the cover values of the species, TCV, is the affinity

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

(C_T is the TCV value in common, so the lowest of the 2 TCV values of a species, A_T is the TCV of a species lessened with C_T in favour of the one association, B_T the same in favour of the other association). So for the A_T both the values for presence as well as those for cover were used.

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

Table 2: Synoptical vegetation table of the four vegetation types. Presence and Total Cover Value are given.

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

	Dicrano-Quercetum		Querco-Betuletum		Violo-Quercetum typicum		Violo-Quercetum ilicetosum	
	P	TCV	P	TCV	P	TCV	P	TCV
1. Differential species of the 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	2	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 pyxiadata* (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 the Querco-Betuletum								
h *Vaccinium myrtillus* L.	I	1	X	3800	VII	126	VII	47
h *Vaccinium-idaea* L.	I	17	IX	254	I	1		
h *Melampyrum pratense* L.			VII	75	I	1		
3. Differential species of the 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

	Dicrano-Quercetum		Querco-Betuletum		Violo-Quercetum typicum		Violo-Quercetum ilicetosum	
	P	TCV	P	TCV	P	TCV	P	TCV
4. Differential species of the 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 the Violo-Quercetum ilicetosum								
t *Ilex aquifolium* L.							VII	2812
s *Ilex aquifolium* L.					I	80	X	2587
6. Differential species of the Dicrano-Quercetum and the 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 the Querco-Betuletum and the Violo-Quercetum typicum								
h *Molinia caerulea* (L.) Moench			IX	225	VII	82		
h *Rubus idaeus* L.			III	8	III	20		
8. Differential species of the Dicrano-Quercetum, the Querco-Betuletum and the Violo-Quercetum typicum								
h *Deschampsia flexuosa* (L.) Trin.	IV	273	IX	1437	VI	480	II	6

	Dicrano-Quercetum		Querco-Betuletum		Violo-Quercetum typicum		Violo-Quercetum ilicetosum	
	P	TCV	P	TCV	P	TCV	P	TCV
9. Differential species of the 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. Accompaning 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

		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. et 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

	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 the 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 the Violo-Quercetum typicum								
Campylopus fragilis (Brid.) B.S.G.			III	14	VI	10		
7. Differential species of the Querco-Betuletum and the Violo-Quercetum typicum								
Mnium hornum Hedw.			IX	494	X	2010	IX	53
Dicranum scoparium Hedw.	I	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 the Dicrano-Quercetum, the Querco-Betuletum and the 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		

	Dicrano-Quercetum		Querco-Betuletum		Violo-Quercetum typicum		Violo-Quercetum ilicetosum	
	P	TCV	P	TCV	P	TCV	P	TCV
9. Differential species of the 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. Accompaning 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				

Annex to tables 1 and 2.
The following, rare species are not mentioned in both tables. Mentioned are the cover value in Braun- Blanquet symbols and, in parentheses, Presence and Total Cover Value. If not indicated otherwise in the moss species, it was moss that was growing terrestrially.
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. treelayer 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. et 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).
Not mentioned in table 2 are some species with Presence I (mentioned in parentheses is the Total Cover Value), in the Dicrano-Quercetum: *Orthodicranum montanum* (Hedw.) Loesk. (5), *Dicranum fuscescens* Turn. (1), *Dicranum majus* Sm. (7); in the Violo-Quercetum ilicetoscum: *Fagus sylvatica* L. in shrub layer (1).

2.2 RESULTS

The results are given in a vegetation table (table 1) and in a synoptical vegetation table (table 2). The vegetations are distinguished in the usual way into tree, shrub, herb and moss layers. In the tables the layers are not given separately. The layer from which a species came is always noted before the species, with t (tree layer), s (shrub layer), h (herb layer), and m (moss layer). The relevés of the mosses on dead stumps and logs are given separately at the end of the tables.

The associations are discussed separately.

2.2.1 *The Querco-Betuletum*

Querco roboris - Betuletum Tx. 1930.
Type relevé Tüxen 1930, p. 7-8, relevé 2, as Querceto-Betuletum. For grammatical reasons the name has to be Querco-Betuletum.
Synonyms:
Molinio - Quercetum roboris Scam. et Pass. 1959.
Vaccinio - Quercetum loniceretosum Doing 1962.
Melampyro - Quercetum roboris Pass. et Hofm. 1968.

Westhoff & Den Held (1969), who reviewed the Querco-Betuletum including the Dicrano-Quercetum (to be discussed further on) 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) called the Querco roboris-Betuletum a weakly characterized association poor in character species ("Rumpf-association"). They did not name any differential species. Passarge & Hofmann (1968) did not name character or differential species, but they give a synthetical table. Doing (1962) and Bakker (1969) gave certain groups of species as characteristics for this association.

Tüxen (1937) divided the Querco roboris-Betuletum into 2 subassociations: molinietosum and typicum. The plots investigated here alle belong to the subassociation typicum.

From this survey the following species appeared to be differential species for the Querco-Betuletum (see tables 1 and 2), in relation to the Dicrano-Quercetum and the Violo-Quercetum: *Vaccinium myrtillus, V. vitis-idaea,* and *Melampyrum pratense*; for the Querco-Betuletum and the Violo-Quercetum together in relation to the Dicrano-Quercetum: *Molinia caerulea*

and *Rubus idaeus*; for the Querco-Betuletum and the Dicrano-Quercetum together in relation to the Violo-Quercetum: *Leucobryum glaucum* and *Campylopus flexuosus*. It is clear that some taxa called differential taxa by Westhoff & Den Held, are in my opinion differential taxa for the Dicrano-Quercetum in relation to the Querco-Betuletum and the Violo-Quercetum, and not for the Querco-Betuletum in relation to the Violo-Quercetum. It concerns *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 can not be treated as differential or character species: *Pinus sylvestris*, *Juniperus communis*, *Polypodium vulgare*, *Buxbaumia aphylla*, *Polytrichum juniperinum*, *Rhytidiadelphus squarrosus*, and *Cornus suecica*. I only found *Pinus sylvestris* very rarely in the Dicrano-Quercetum, and never in the Querco-Betuletum. This species will not start to grow spontaneously in a wood, neither will *Juniperus communis*, which was not found in the vegetations investigated. *Polypodium vulgare* and *Buxbaumia aphylla* were observed only once in the Querco-Betuletum, and the Dicrano-Quercetum respectively so cannot be treated as differential species. *Polytrichum juniperinum*, *Rhytidiadelphus squarrosus*, and *Cornus suecica* were not observed in any of the vegetations investigated. It is unlikely that *Rhytidiadelphus squarrosus* occurs in the Dicrano-Quercetum or in the Querco-Betuletum; other *Rhytidiadelphus* species were also not observed. *Cornus suecica*, a very rare species and therefore only a local character species in the Netherlands, is more typical for north facing wood-edges, and is more likely to be found in association with open woods than with a well developed Querco-Betuletum.

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

The investigated vegetations were scrubby woods, coppices, high woods, or former coppices transformed into high woods. In scrubby woods and coppices the tree layer is not very high, and the shrub layer is poor or undeveloped. Usually the shrub layer can not be distinguished as a separate layer. In high woods the tree layer is higher and more distinctly separated from the shrub layer, which is better developed. The herb layer is nearly always well developed. The aspect is determined by *Deschampsia flexuasa*, *Molinia caerulea*, *Corydalis claviculata*, and *Vaccinium myrtillus*, the last mentioned sometimes covers up to 65%.

2.2.2 *The Violo-Quercetum*

Violo-Quercetum Oberd. 1957.
Synonyms:
Querceto sessiliflorae-Betuletum violetosum rivinianae Tx. et Diem. in Tx. 1937 (this name is illegitimate, because the name of the association was not validly published, Tx. 1937).
Fago-Quercetum petraeae (Tx. 1937) Tx. 1955 p.p.
Maianthemo-Quercetum Bakker 1969.

This association can be considered as the form of the Fago-Quercetum petraeae in the low-lying plains, in which *Quercus robur*, and not *Q. petraea*, dominates (see Van den Broek & Diemont 1966). If we consider this vegetation as an association, as has been done here, the correct name is Violo-Quercetum. Tüxen (1937), however, considered this vegetation as a subassociation; then, the correct name is Fago-Quercetum petraeae violetosum rivinianae (Tx. et Diem. in Tx. 1937) nov. comb.

Doing (1962) distinguished in the Netherlands at least 3 vicarious associations, the Solidagino-Quercetum (= Fago-Quercetum petraeae (Tx. 1937) Tx. 1955 p.p.) on acid, undisturbed loam soils, in the South of the Netherlands; the Violo-Quercetum roboris on acid, but not very poor sandy soils; the 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 Netherlands. The woods I investigated, belong to this association. Bakker (1969) because of the very slight differences combined these 3 associations, into the Maianthemo-Quercetum and distinguished 2 subassociations, anemonetosum and typicum. The woods I investigated, belong to the subassociation typicum.

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

Westerhoff & Den Held gave a lot of differential species for the Violo-Quercetum in relation to the Querco-Betuletum. Some of these dit not occur or only very rarely in the Violo-Quercetum and then only in aberrant, disturbed phytocoenoses: *Scrophularia nodosa*, *Narcissus narcissus*, *Sambucus racemosa*, and *Selinum carvifolium*. *Mespilus germanica* and *Hypericum pulchrum* were mainly found in the South part of the procince of Limburg (in the Solidagino-Quercetum). *Stellaria nemorum* ssp. *glochidisperma* occurred in Drenthe only in the Norgerholt, mainly in the Stellario-Carpinetum. All these species and *Viola riviniana* were not found in the plots I investigated. The other species they mentioned are: *Anthoxantum odoratum*, *Polygonatum multiflorum*, *Luzula pilosa*, *Atrichum undulatum*, *Hedera helix*, *Oxalis acetosella*, *Convallaria majalis*, *Stellaria holostea*, *Corylus avellana*, and *Prunus serotina*. In this survey *Anthoxantum odoratum* was found only once, in a Querco-Betuletum at a slightly disturbed spot; so it can not be considered as a differential species. *Oxalis acetosella*, *Hedera helix*, *Convallaria majalis*, and *Corylus avellana* appeared to be distinctly differential species for the Violo-Quercetum (typicum and ilicetosum together) in relation to the Querco-Betuletum and the Dicrano-Quercetum. *Stellaria holostea* is a differential species for the Violo-Quercetum typicum in relation to the Querco-Betuletum, the Dicrano-Quercetum and the Violo-Quercetum ilicetosum, together with *Trientalis europaea*, *Maianthemum bifolium* (character species for the Quercion robori-petraeae according to Westhoff & Den Held), and *Pteridium aquilinum*. *Luzula pilosa*, *Atrichum undulatum*, and *Polygonatum multiflorum* appeared not to be differential for the Violo-Quercetum in relation to the Querco-Betuletum. These species were, however, together with a number of other species, group 9 in table 1 and 2, differential for the Violo-Quercetum typicum and ilicetosum and the Querco-Betuletum in relation to the Dicrano-Quercetum. *Prunus serotina* is not or at the most very weakly differential for the Violo-Quercetum typicum and the Querco-Betuletum together in relation to the Dicrano-Quercetum and the Violo-Quercetum ilicetosum.

Of the mosses growing on dead stumps and logs, *Campylopus fragilis* appeared to be differential for the Violo-Quercetum typicum in relation to the other (sub)associations. *Dicranella heteromalla*, *Eurhynchium praelongum*, and *Plagiothecium latebricola* are differential for the Violo-Quercetum typicum and ilicetosum in relation to the Dicrano-Quercetum and the Querco-Betuletum. A group of 8 species is differential for the Violo-Quercetum typicum and the Querco-Betuletum together: *Mnium hornum*, *Dicranum scoparium*, *Tetraphis pellucida*, *Orthodontium lineare*, *Cladonia glauca*, *C. digitata*, *Polytrichum formosum*, *Plagiothecium curvifolium*, and *Campylopus flexuosus*. Differential species for the Violo-Quercetum typicum and ilicetosum and for the Querco-Betuletum in relation to the Dicrano-Quercetum are *Brachythecium rutabulum*, *Isothecium myosuroides*, *Lepidozia reptans*, and *Isopterygium seligeri*.

In this association there were coppices and high woods, as in the 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 the Querco-Betuletum. The tree layer of the Violo-Quercetum typicum did not differ greatly from that of the Querco-Betuletum. The composition of the herb layer differs the most from that of the Querco-Betuletum. Herbs that are aspect determining in the Querco-Betuletum will occur in the Violo-Quercetum, but only in a sparse cover. The aspect of the herb layer in the Violo-Quercetum typicum is determined by *Pteridium aquilinum, Maianthemum bifolium, Trientalis europaea, Oxalis acetosella,* terrestrial *Hedera helix, Stellaria holostea,* and *Convallaria majalis.*

2.2.3 *The Violo-Quercetum ilicetosum*

Violo-Quercetum ilicetosum subass. nov.
type: relevé 23 (table 1), The Norgerholt, prov. of Drenthe, The Netherlands.
non Querceto-Ilicetum Tx. 1930.

The Querceto-Ilicetum Tx. 1930 is a completely different vegetation type, with not only *Maianthemum bifolium* and *Ilex aquifolium* as character and differential species, but also *Teucrium scorodonium, Thelypteris dryopteris, Luzula luzuloides,* and *Solidago virgaurea.* Herb and shrub layers are much more developed than those of the Violo-Quercetum ilicetosum, and contain species such as *Carpinus betulus, Crataegus* spec., *Prunus spinosa, Athyrium filix-femina, Circaea lutetiana.*

The only differential species for the Violo-Quercetum ilicetosum in relation to the Violo-Quercetum typicum is *Ilex aquifolium* in the tree and shrub layer. The occurrance of *Isopterygium seligeri* in the Violo-Quercetum ilicetosum was called characteristic by Westhoff & Den Held (1969), but appeared not to differ from that in the Violo-Quercetum typicum and the Querco-Betuletum, both for terrestrial specimens and the specimens growing on dead stumps. The Violo-Quercetum ilicetosum and the Violo-Quercetum typicum have 9 differential species in common in relation to the Querco-Betuletum: *Oxalis acetosella, Hedera helix, Convallaria majalis, Corylus avellana, Maianthemum bifolium, Trientalis europaea, Stellaria holostea, Pteridium aquilinum, and Ilex aquifolium.* There are no differential species for the Violo-Quercetum ilicetosum and the Querco-Betuletum in common in relation to the Violo-Quercetum typicum.

Ilex aquifoilium 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 the Violo-Quercetum typicum 50%). In open spaces and at the edge a herb layer was observed similar to that of a Violo-Quercetum typicum. For this reason and because of the numbers of differential species I consider this

vegetation to belong to the Violo-Quercetum and have ranked it as a sub-association.

The almost complete absence of a herb layer is probably caused by screening all the year round by *Ilex* trees, which prevents the strong light from penetrating to this level. The *Ilex* vegetations probably originated from a Violo-Quercetum typicum by spontaneous growth. This spontaneous growth of young Ilex shrubs was also observed in some of the Violo-Quercetum typicum plots.

The Violo-Quercetum ilicetosum is possibly restricted to the Drenthian district (Barkman & Westhoff 1969). It is also rather rare within the Drenthian district.

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

2.2.4 *The Dicrano-Quercetum*

Dicrano-Quercetum Pass. 1962 emend. Barkm. n.p.
Synonyms:
Querco-Betuletum Tx. 1930 p.p.
Vaccinio-Quercetum cladonietosum Doing 1962.
Classification:
According to Barkman (1974) and to Vreugdenhil & Barkman (Report Biol. Station, Wijster) the Dicrano-Quercetum in the Netherlands can be divided into two subassociations: plagiothecietosum Barkm. 1974 (with two variants) and polypodietosum Barkm. 1974. The Dicrano-Quercetum of Passarge is so poor in species, that it can not be placed in one of these subassociations.

In a study on the vegetation of the Dicrano-Quercetum Vreugdenhil & Barkman made 42 relevés in the province of Drenthe, and 11 relevés in the inner coastal dunes near Alkmaar (province of N.-Holland). These 53 relevés were compared with relevés on related vegetations, mostly rather poor Querco-Betuletum vegetations, known from literature. They found a large number of differential species, mostly mosses, for the Dicrano-Quercetum in relation to the Querco-Betuletum. I compared Vreugdenhil & Barkman's 42 relevés from Drenthe with the relevés given here of the Querco-Betuletum and the Violo-Quercetum typicum and ilicetosum, from the same province. There appeared to be 14 distinctly and 14 weakly differential species for the Dicrano-Quercetum in relation to the 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*; respectively *Lophocolea heterophylla, Campylopus fragilis, Aulacomnium androgynum, Dicranoweisia cirrhata, Festuca ovina, Empetrum nigrum, Cladonia uncialis, Orthodicranum montaum, Agrostis canina, Dicranum fuscescens, Ptilidium ciliare, Corni-*

cularia aculeata, *Cladonia floerkeana* and *Cetraria glauca*. All mosses and lichens named here, were growing terrestrially. Some of these species will sometimes occur in a Querco-Betuletum or in a Violo-Quercetum, but then always on bark, or dead stumps or logs. In the relevés of mosses on dead stumps and logs, no species appeared to be differential for the Dicrano-Quercetum in relation to the other associations.

In this study only 3 plots of the Dicrano-Quercetum were investigated. The synoptical table of the Dicrano-Quercetum was not made of these 3 relevés, but of the 42 relevés made in Drenthe by Vreugdenhil & Barkman. The 3 relevés given here belong to the subassociation plagiothecietosum, the relevés 1 and 2 belong to the variant of *Cetraria glauca*, the relevé 3 to the variant of *Tetraphis pellucida*.

The investigated vegetations were scrubby woods, or sometimes coppices. The tree layer was always very low, 0.5-8(-15) m high; without a shrub layer. The herb layer was always very sparse, cover 1-12%, which consited of *Calluna vulgaris*, *Festuca ovina*, *Deschampsia flexuosa*, and less frequently of *Empetrum nigrum* and *Carex pilulifera*. This herb layer therefore lacks the species that are characteristic for the Querco-Betuletum and the Violo-Quercetum, and some species occur that are typical of very dry heaths and inland drift sand areas. The moss layer was very characteristic for the Dicrano-Quercetum, this occurred in patches, with a mean cover of 70%. In Drenthe *Dicranum scoparium* dominated in the moss layer.

2.2.5 *Classification in higher ranks*

Generally the Querco-Betuletum and the Violo-Quercetum are 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. et 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 the Betulo-Vaccinietalia uliginosi and the Vaccinio-Piceetalia. Passarge & Hofmann used their own classification. The Molinio-Quercion Scam. et Pass. 1959, the Agrostido-Quercion Scam. et Pass. 1959, and the Melampyro-Quercion Pass. et Hofm. 1968 may be considered together as synonym with the Quercion robori-petraeae. They classed the Molinio-Quercion in the order Molinio-Quercetalia Pass. et Hofm. 1968; both other alliances were classed in the order Melampyro-Quercetalia robori-patraeae Pass. et Hofm. 1968. The 2 orders were united into the class Deschampsio-Quercetea robori-petraeae Br.-Bl. et Tx. 1943 em. Pass. et Hofm. 1968, together with the Dicrano-Quercetalia robori-petraeae Pass. et Hofm. 1968.

The Dicrano-Quercetum was classed by Passarge & Hofmann in the alliance Dicrano-Quercion Pass. 1963, in the order Dicrano-Quercetalia robori-

petraeae, and in the class Deschampsio-Quercetea robori-petraeae. Barkman (1974) proposed uniting the Dicrano-Quercetum with the Dicrano-Juniperetum and the Leucobryo-Pinetum to the alliance Dicrano-Pinion. The Dicrano-Quercetum was not mentioned by other authors.

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

In this study a large number of species was found to differentiate the Dicrano-Quercetum from the Querco-Betuletum and the Violo-Quercetum: 28 for the Dicrano-Quercetum in relation to the Querco-Betuletum and the Violo-Quercetum, and together 30 for the Querco-Betuletum and the Violo-Quercetum, separately and together, in relation to the Dicrano-Quercetum. These numbers of differential species justify the opinion that the Dicrano-Quercetum does not belong to the Quercion robori-petraeae. The species of group 9 (tables 1 and 2) are to be considered as differential species of the Quercion robori-petraeae in relation to the Dicrano-Quercetum.

2.2.6 *Mathematical affinities*

The values for A_C, A_P, and A_T (table 3) and for D_C, D_P, and D_T (fig. 1; the length of the connections are measures for the differences between the associations) show that there is a great affinity between the Querco-Betuletum and the Violo-Quercetum typicum, even greater than between the Violo-Quercetum typicum and the Violo-Quercetum ilicetosum. This was unexpected as it was anticipated that the highest affinity values would have been between both the subassociations of the Violo-Quercetum. The affinity of the Violo-Quercetum ilicetosum was slightly greater with the Violo-Quercetum typicum than with the Querco-Betuletum in all calculations.

The affinity of the Dicrano-Quercetum with the other vegetations was very low, especially with the Violo-Quercetum ilicetosum. This was expected in relation to the large number of differential species of the Dicrano-Quercetum.

The affinities of the vegetations based on the differential species (a relative small number) were best estimated by the values for A_C. The relation of the affinities appeared to change if also the Presence and the Total Cover Value were included in calculating mathematical affinities: the affinity of the Violo-Quercetum ilicetosum with the Violo-Quercetum typicum or the Querco-Betulteum decreased, and increased of the Dicrano-Quercetum with the Violo-Quercetum typicum or the Querco-Betuletum.

Table 3: Mathematical affinities according to 3 different calculations. See text.

	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

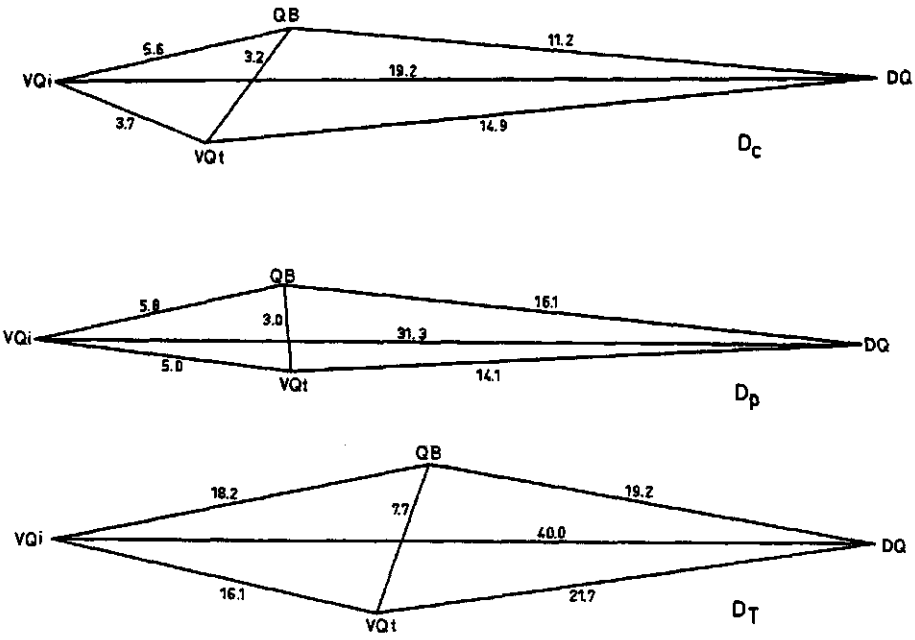

Fig. 1. The differences between the vegetation types, D_C, D_P, and D_T, based on the vegetation of plants, mosses, and lichens.

2.3 CONCLUSIONS

The Querco-Betuletum and the Violo-Quercetum can be regarded as very closely related, but independent associations, which occur side by side. They belong to the Quercion robori-petraeae. The Violo-Quercetum ilicetosum is a subassociation of the Violo-Quercetum because of the differential species and in spite of the low affinity values, lower than those of the Violo-Quercetum typicum with the Querco-Betuletum.

The Dicrano-Quercetum has much differential species and low affinity values. It has to be considered as an independent association that is not very closely related to the associations of the Quercion robori-petraeae. It probably belongs to the Dicrano-Pinion.

3 *SOIL*

3.1.1 *Introduction*

Soil research was done in order to give a further description of the habitat of the phytocoenoses. The soil profiles and a number of chemical factors were investigated.

The soil profile of some plots was known, as well as the big differences between these profiles. A more detailed survey seemed necessary. Simultaneously the ground water levels were studied too.

The chemical factors analysed were the pH, the conductivity, the amounts of exchangeable sodium, potassium, calcium, and magnesium ions, and the amounts of total carbon and nitrogen. Other ions, including the anions, are also needed for growth of plants. In measuring the amounts of the 4 kations, together with the conductivity, we have an indication, but not a complete description, of the nutrient supply. Fungi are likely more to depend on the amounts of carbon and nitrogen than on the amounts of ions. The amounts of total C and total N were therefore measured, and the C/N ratio determined.

3.1.2 *A general description of the soil in Drenthe.*

From a geological point of view, the soils of the province of Drenthe are relatively young, dating from Holocene and Pleistocene. Drenthe consists mainly of the Drenthe Formation, glacial ground moraine (till) deposits, with some small areas of fluvioglacial deposits, dating from the Saale glaciation (Pleistocene). It is covered by a thin layer of the younger Twente Formation. The Twente formation, dating from the last glacial phase, the Weichselien (Pleistocene), is represented by coversands, and in the East and South East parts of Drenthe by fluvio-periglacial peat deposits covered by a thin layer of cover sands. Holocene deposits are found in the South East, partly reclaimed deposits of peat, of the Griendtsveen Formation. Scattered throughout the province inland dune-sands are found of the Kootwijk Formation (Holocene). In the brookvalleys there are organic brook deposits of the Singaraven Formation (Holocene).

The influence of glacier activity is also be seen in the geomorphology of Drenthe. The main part of the province consists of low rises in ground moraine, usually with cover sands. Some valley-like depressions are found that have been made by melting snow water, and depressions that can be considered - at least partly - 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, were possibly formed by tectonic movements. 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 there are plains that have been formed by peat reclaimation, and areas with elevated peat remnants.

3.2 SOIL PROFILES

3.2.1 *Methods*

Soil profiles were taken in april 1978, and again in june 1979. A 120-170 cm long and 6 cm wide soilauger was used. The profile was examined to a depth of 100-150 cm. The depth, thickness, colour, grainsize, amount of humus and humus structure of each humus and mineral layer was noted, together with necessary particularities. The layers were studied macroscopically in the field, and afterwards with a binocular loupe (up to 30×) in the laboratory. Colours are described and coded according to the Munsell Soil Colour Charts. The soil was described fresh as well as dried for ca. 24 h at 105°C.

Soils were determined according to De Bakker & Schelling (1966). Soilmap sheets 12 E (Stiboka 1977), 17 E and 17 W (Stiboka 1978) scale 1:50.000 were studied.

The level of the ground water is given in 7 classes, 'grondwatertrappen' (Gt) on the soilmaps, defined after the 'mean highest ground water level' and the 'mean lowest ground water level' (Stiboka 1977). The Gt values were read from the soilmaps. If no soilmap was available, the Gt was estimated from the soil profile.

Additional notes on table 4.

Plot nr.

1. At 85->110 cm depth: an older profile, buried under driftsand.
2. At 110->125 cm depth: an older A1 layer, buried under driftsand.
3. At 50- 100 cm depth: an older profile, buried under driftsand.
5. The Ap layer had cavities and mixed colours.
6. The Ap layer was a mixture of former A, B and C layers and had been turned up when the drains were dug..
7. The upper 14 cm showed evidence of human activity (digging) and only a small profile has developed over the years. The C1 layer was 5 cm thick.
8. The upper 16 cm showed evidence of human activity and only a small profile has developed. The A22b and the B2b layers had no clear characteristics.
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 layer is, however, very thin. So it is given as an undisturbed profile.
10. The Ap layer 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.
11. The upper 24 was turned up when the drains were dug. It has a clear A1 character.
12. The A21 layer can be divided into a 4 cm A211 layer, a 1 cm driftsand layer and a 5 cm A212 layer.
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) layer.
29. The B layer is lacking. The C2 layer has iron spots and gleysymptomes.

Annex to table 4.

Concise description of the layers.

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

A0 Fermentation layer: partly decomposed litter with recognizable leaf-like structures. The thickness of the layer is given. Colour appeared to be very 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 the F-layer (Fermentation).

A1 Humus layer: decomposed litter, without visible plant structures. Tickness is indicated. Colour appeared to be very 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).

Sandgrains were often found scattered in the A1 layer. This layer is clearly a humus layer, and not a mineral layer with infiltrated humus. The addition of sandgrains was due to animal activity. The humus appeared always to be of an amorphous structure, only once some 'moder' particles were found. Humification is apparently caused by fragmentation and growth of fungal mycelia. This type of humus is called 'mor' or 'raw humus' (Wilde 1946, Kubiëna 1953). In some soils of the Violo-Quercetum ilicetosum a A1 layer was missing, and was replaced by a A1h layer (see below). In some literature this layer is called a H-layer (Humus).

A1h Expecially in soils of the Violo-Quercetum ilicetosum a black layer was found consisting mainly or entirely of infiltrated, amorphous humus. The layer was plastic and slippery when wet. Sandgrains were scarse to very scarse, and always leached. When dried very hard pieces were 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 layer because of the organic origin and in spite of the infiltrated character, and added h to indicate the richness in infiltrated humus. A layer of this type can occur on badly drained soils (Wilde 1946).

A21 Mineral layer of leached sandgrains with a fair to large amount of infiltrated humus. The humous part is dominant. 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 layer of leached sand with some infiltrated humus. The sand fraction is always dominant. Eluvial layer with podsolic 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 layer, disturbed by human activity, such as ploughing.

B Layers characterized by accumulation of dispersed humus, coating the sandgrains.

B2 The layer with the biggest 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 A layer with very few, 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 layer, deeper it gradually became lighter.

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 character and origin. Rare, encounted only once (plot 15).

The character of the C and the D layer is indicated on table 4: S=sand, LS=Loamy sand, SL=sandy loam, L=gray loam, B=red boulder clay with manganese lenses.

Disturbance. Some of the profiles showed evidence of human activity (ploughing or digging). It is not known when the plots had been disturbed, but it was not done recently. Distrubances were only encounted in the Querco-Betuletum, and were indicated with '×' in table 4.

The name of the profiles are also indicated: B='Broek' earth soil, D=micro podzol in 'Duin' vague soil, H='Haar' podzol soil, M='Moerige' podzol soil, V='Veld' podzol soil.

3.2.2 *Results*

The character, thickness, and depth of the layers of each profile and synoptical profiles of the 4 (sub)associations are given (table 4).

The soils all developed in a layer of coversand. Often grey loam was found in the subsoil. In general the soils were low or medium high lying. Nearly all plots had a distinct podzol profile. The B horizont was distinctly developed; the humus was always amorphous and coated the sandrains. This means that these were humuspodzol soils. From heating samples of alle horizonts of a profile (an experiment carried out only once, on a profile of plot 20) it appeared that the A21 layer had less iron than the A1 layer above it, the A22 layer contained no iron, and the B2 layer had much more iron than the A1 layer. Apparantly the iron together with the humus was washed out and accumulated in the B2 layer. Nevertheless, iron coatings on sandgrains in the layer just below the B2 were not found here, nor in other plots. An accumulation of iron in a iron pan was not encounted. So hydromorphic characteristics were present. No thick sand or clay cover was present, the A1 layer was thin, and a peaty topsoil or a intermediate peaty layer was generally absent. A soil with these characters is called a 'Veld' podzol soil and was encounted in 17 plots.

In some plots a peaty topsoil was present. This meant it was a 'Moer' podzol soil. In 2 plots a 'Haar' podzol soil was found, a relatively dry humuspodzol. In one plot a B layer was absent; this was a 'Broek' earth soil.

The soils in the Dicrano-Quercetum were all formed in young drift sands. The C layer consisted of fine to rather coarse sand; loam was not found. No distinct profiles were found, except for micropodzol profiles, of a mean length of 13 cm. Soils like this are called 'Duin' vague soils. Older profiles, buried under younger drift sand, were often present. As the depth of

these older profiles were very variable, also within one plot, they were not marked in table 4. The soils were very dry, Gt values VII.

The soils in the Querco-Betuletum, had, except for one, a more or less disturbed profile. Sometimes the soils had been dug and an Ap layer was present. Sometimes drains were dug, and a sandcover of 11-24 cm thick was dug up between the drains. Sometimes a short, new profile had already developed in the dug up soil. Under this sandcover an old podzol profile was always present. Both 'Veld' podzol soils (6×) and a 'Moer' podzol soil (1×) were observed. The only undisturbed profile was a 'Haar' podzol soil. The vegetation in this plot was slightly different from that in the other Querco-Betuletum plots. Including the sandcover that had been dug up, the C layer was found at a mean depth of 70 cm. If we exclude the sandcover, the C layer was found at a mean depth of 60 cm, and consisted of faintly fine to rather coarse sand (3×), loam (2×), or intermediates (3×). The soils in the Querco-Betuletum were wetter than those in the Dicrano-Quercetum: the Gt values varied from V (2×), to VI (5×) and VII (1×).

The profiles of the soils in the Violo-Quercetum typicum were always undisturbed and had easily recognizable horizonts. It were always distinct podzol soils, both 'Veld' podzol soils (6×), as 'Moer' podzol soils (2×) occured, and once a 'Haar' podzol soil. The C layer was found at an average depth of 75 cm, and consisted of sand (4×), loamy sand to sandy loam (5×), and once red boulder clay. Compared with the soils in the Querco-Betuletum the profiles of the Violo-Quercetum were about 15 cm deeper, and lacked grey loam (without sand) in the C layer. It was remarkable that the 2 plots with a vegetation close to the Violo-Quercetum ilicetosum, also had soils that were very similar to those in the Violo-Quercetum ilicetosum: a relative long profile and a distinct Alh layer. The soils in the Violo-Quercetum typicum were slightly dryer than those in the soils in the Querco-Betuletum, Gt values V (3×), VI (4×), and VII (3×) were found.

The soils in the Violo-Quercetum ilicetosum always had undisturbed profiles. The plots had podzol soils except for one plot where a 'Broek' earth soil occurred. Both 'Veld' podzol soils (4×) as 'Moer' podzol soils (3×) were found. The C layer was at a mean depth of 82 cm, and consisted of sand (3×), or loamy sand or sandy loam (5×). The profile here was on the average 7 cm longer than in the Violo-Quercetum typicum, and 22 cm longer than in the Querco-Betuletum. The C layer was loamy or sandy as in the Violo-Quercetum typicum, and slightly less loamy than in the Querco-Betuletum. Alh layer occurred more often, and was thicker in the Violo-Quercetum ilicetosum than in the other associations. This type of layer can only form in badly drained soils (Wilde 1946). These soils were usually wetter than in the other associations, Gt values III (3×), V (2×), VI (1×), and VII (2×) were found.

3.3 SOIL CHEMICAL FACTORS

3.3.1 *Methods*

Samples for analysis of chemical factors were taken in september 1978. Samples were taken of the A0 and of the A21 layer, because the highest amount of fungal mycelium and the largest mycelium growth occurred in these layers (De Boois 1976). Samples were taken from the A1h instead of the A21 layer if the A1h layer was 10 cm or more thick, because it is unlikely that a deep lying A21 has a large amount of mucelium.

The pH-fresh, the pH-H_2O, the pH-KCl, the conductivity, the Specific Gravity, the amounts of exchangeable Na, K, Ca, and Mg ions and the total C and N were determined, the 'total ion supply' and the C/N ratio calculated.

To determine the pH-fresh, 5 samples of about 30 ml soil were taken per plot, in both layers. Water was added to a volume of about 40 ml. One hour later was stirred again; if there was any sand it rapidly sank to the bottom. The pH was measured in the suspension.

To determine the other factors, a more exact method was used. With pF-rings 9 samples were taken of a volume of 99 cm^3 each in each plot and both layers. The samples of each layer were combined into 3 'mixed samples' of 3 samples each. They were stored until they were analysed in a freezer at -25°C. The next stage was that they were dried at 50°C for 5-7 days. After weighing, the specific gravity was calculated. The samples were ground in a mill, the A0 soils for 10 min., the A21 soils for 5 min. or, if they were very peaty, also for 10 min. The end product of these treatments is further refered to as soil.

To determine the pH-H_2O and the conductivity, 5 g soil was shaken with 50 ml water (distilled) for half an hour. To determine pH-KCl, 5 g soil was shaken with 50 ml 1N KCl solution in water for one hour. Measured was in the supernatant. All pH values were measured to one hundredth; the averages are the arithmetic means of the pH values, and rounded off to one tenth. The conductivity values were corrected for the pH, so lessened by the conductivity of the H ions. Conductivity is expressed in µS/cm.

To determine the amount of exchangeable Na, K, Mg and Ca ions, 6 g soil was shaken with 40 ml NH_4OAc (ammonium acetaat) pH 7.0; washed successively with 16, 12, and 12 ml NH_4OAc over a Schleicher & Schüll no 589 blackband filter, filtred through a Sartorius 0.8 µm membrane filter, and filled up with NH_4OAc solution to 100 ml. These solutions were used, usually undiluted occasionally diluted once, to determine the Na and K ion concentration in a flame-photometer. For determination of the Mg and Ca ion concentration in a Perkin-Elmer atomic absorption spectrophotometer, a dilution was made: 1 ml extract of A0 soil, and 5 ml extract of A21 soil, was added to 5 ml $La(NO_3)_3$ solution in water (containing 10,000 mg La per 1) and filled up with water to 50 ml. The amount of exchangeable ions is given in

mass fraction (mg/100 g soil) and in mass concentration (mg/l soil).

To determine the amount of carbon some soil was dried again at 105°C. A portion of some grams of this soil was weighed and the loss on ignition was measured after heating to 800°C for 2½ hour. The amount of carbon is 58% of the weight loss (Van Bemmelen-factor). The table gives the amount of carbon in mass fraction (g/100 g soil) and in mass concentration (g/l soil).

To determine the amount of total nitrogen, some soil was dried again at 105°C. Soil of A0 (0.200 g) and of A21 (0.500 g or 1.000 g) was weighed, and heated in an acid mixture of 6 g salicylic acid in 110 ml diluted sulphuric acid (90 ml water on 500 ml H_2SO_4 s.g. 1.84) at 400°C for 1 hour. The solution was chilled and diluted with 75 ml water. In a Tecator Kjeltec System 1002 Distilling Unit 50 ml NaOH 4% was added. This solution was distilled into 25 ml boric acid 4% with mixed indicators, and titrated with KH $(IO_3)_2$ 0.01 N. The amount of nitrogen is given in mass fraction (g/100 g soil) and in mass concentration (g/l soil).

3.3.2 *Results*

The average of 3 observations is given per plot and per factor (for the pH-fresh the average of 5 observations) (table 5). Per (sub)associatie per factor the average of all observations is given; the extreme values are mentioned in parentheses.

3.3.2.1 pH-fresh and pH-H_2O

The soils were all very acid. The pH varied from 3.0 to 4.7 in the A0 layer, and from 2.8 to 4.4 in the A21 layer. There was little difference between the associations. The values in the pH-fresh varied more than in the pH-H_2O, because more samples were measured and the method was less exact. In the A21 layer the values of the pH-H_2O were always higher (average 0.6) than those of the pH-fesh. Also in the A0 layer there was some difference between the pH-H_2O and the pH-fresh within one plot, but there was more variation; both lower and higher values occurred. These differences were probably caused by the degree of dilution. In measuring the pH-fresh the soil was only diluted slightly and was measured in a suspension. In measuring the pH-H_2O the soil was diluted more. In the samples of the A21 layer, which were more or less sandy, a distinct supernatant was formed; the measurements were made in the supernatant. In the A0 layer, usually peaty and not sandy, there was almost no deposit and the soil remained more or less in suspension; the measurements had to be taken in teh suspension.

3.3.2.2 pH-KCl

The pH-KCl varied from 2.5 to 3.3 in the A0 layer. It was always lower

than the pH-H_2O, mean difference 0.8. There was not much difference between the associations. The pH-KCl varied from 2.4 to 3.5 in the A21 layer. It was always lower than the pH-H_2O, mean difference 0.9. In the serie Dicrano-Quercetum, Querco-Betuletum, Violo-Quercetum typicum, Violo-Quercetum ilicetosum there were decreasing pH-KCl values. The differences were not very large, 0.5, but it can be concluded that the A21 layer in the Violo-Quercetum ilicetosum were slightly more acid than in the Dicrano-Quercetum. They were, however, of quiet a different character: in the Dicrano-Quercetum it consisted mainly of sand, in the Violo-Quercetum ilicetosum mainly of infiltrated humus.

The relation pH-KCl and pH-H_2O is nearly linear in both the A0 and the A21 layer (fig. 2). The values of one serie pH measurements are normally distributed, it was thus correct to take the arithmetical mean of the pH values in calculating the mean pH values.

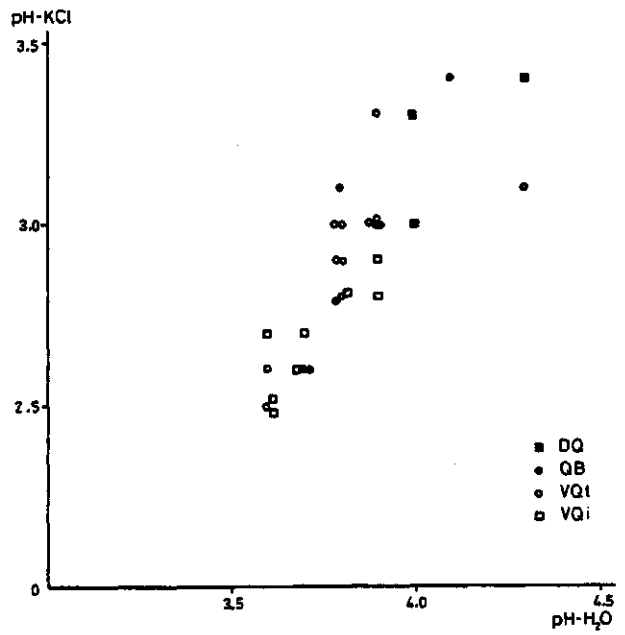

Fig. 2. The relation between pH-H_2O and pH-KCl in the A21 layer.

3.3.2.3 Conductivily and 'total' ion supply

The conductivity was rather high in the A0 layer compared with that in the A21 layer. The mean conductivity values in the A0 layer were higher in the Dicrano-Quercetum and in the Violo-Quercetum ilicetosum than in Violo-Quercetum typicum and in Querco-Betuletum. The differences were large and were contrary to initial expectations that the conductivity would be equally high in all associations, or lower in the Dicrano-Quercetum and the Querco-Betuletum than in the Violo-Quercetum. Although there is a considerable variation between the observations, there is a significant difference between the means of the several (sub)associations (F-test on log-transformed observations: $F=4.14$; 3, 25 df; $P > 0.025$).

The conductivity was relatively low in the A21 layer. In the Dicrano-Quercetum the conductivity was obviously less than in the Querco-Betuletum and in the Violo-Quercetum typicum, and the conductivity in the Violo-Quercetum ilicetosum was obviously higher than in the Querco-Betuletum and in the Violo-Quercetum typicum. The differences between means are statistically highly significant (F-test on log-transformed observations: $F=12.7$; 3, 25 df; $P << 0.005$). There is a distinct positive correlation with the amount of carbon (fig. 3).

The conductivity is a measure for the amount of available ions in a given soil volume. The total ion supply depends also on the thickness of the layer. To estimate the 'total' ion supply the conductivity of the A0 layer was multiplied by the thickness of both the A0 and the A1 layer together (ion supply in A0+A1), the conductivity of the A21 layer was multiplied by the thickness of both the A1h and the A21 lauer together (ion supply in A1h+A2). The sum of both values is the 'total' ion supply (table 6). In this estimation I assumed that the conductivity in the A1 layer was as large as in the A0 layer, and in the A1h layer as large as in the A21 layer. It is more likely that the conductivity in the A1 layer is lower than in the A0 layer, so this multiplications gives a too high value. The conductivity in the A21 layer is supposed to be lower than in the A1h layer. In most plots an A1h layer was not pesent, so this multiplication will give the accurate value. If a thin A1h layer was present, the value will be slightly too low; if a thick A1h layer was present and the conductivity of this layer was established, the value will be slightly too high.

The ion supply in the A0+A1 layer is about equally in the Dicrano-Quercetum, the Querco-Betuletum and the Violo-Quercetum typicum, and is much higher in the Violo-Quercetum ilicetosum. The ion supply in the A1h+A21 layer is very low in the Dicrano-Quercetum, much higher in the Querco-Betuletum and in the Violo-Quercetum typicum, and still higher in the Violo-Quercetum ilicetosum. The 'total' ion supply is highest in the Violo-Quercetum ilicetosum, is less by half in the Violo-Quercetum typicum and the Querco-Betuletum that almost equals each other, and is still lower

Table 6: 'Total' ion supply. Ion supply in the A0+A1 layer, in the A1h+A21 layer, and the 'total' ion supply, per plot and per vegetation type.

	plot number	conductivity A0 layer × thickness A0+A1 layer × 10^{-2}	conductivity A21 layer × thickness A21+A1h layer × 10^{-2}	'Total' ion supply
VQi	29	24	32	56
	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	20
QB		16	7	23
DQ		14	0.5	14

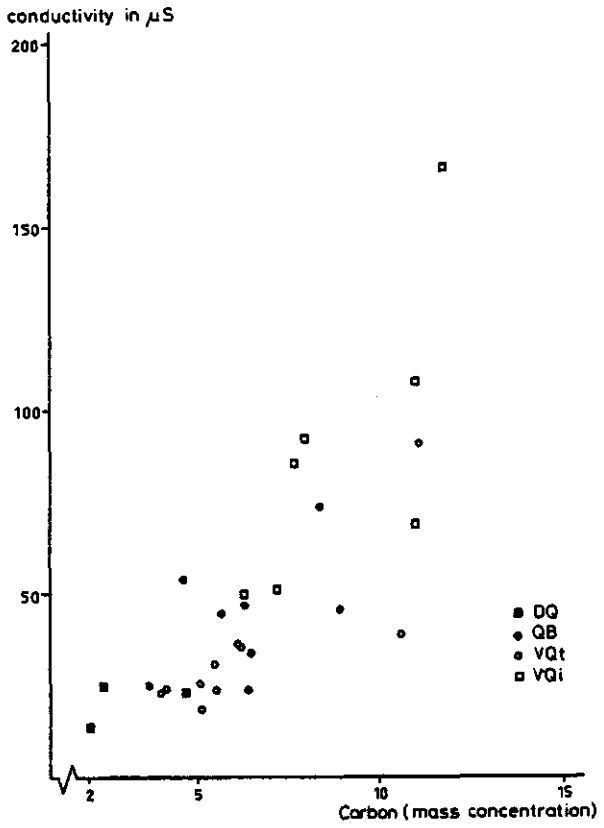

Fig. 3. The relation between the conductivity and the proportion of carbon in the A21 layer.

in the Dicrano-Quercetum. A distinct series from a large to a small ion supply can be distinguished.

3.3.2.4 Specific gravity

The specific gravity in the A0 layer is very constant in all types of vegetation. In the A21 layer the variation in the Sg is easily explained from the amount of humus. (fig. 4).

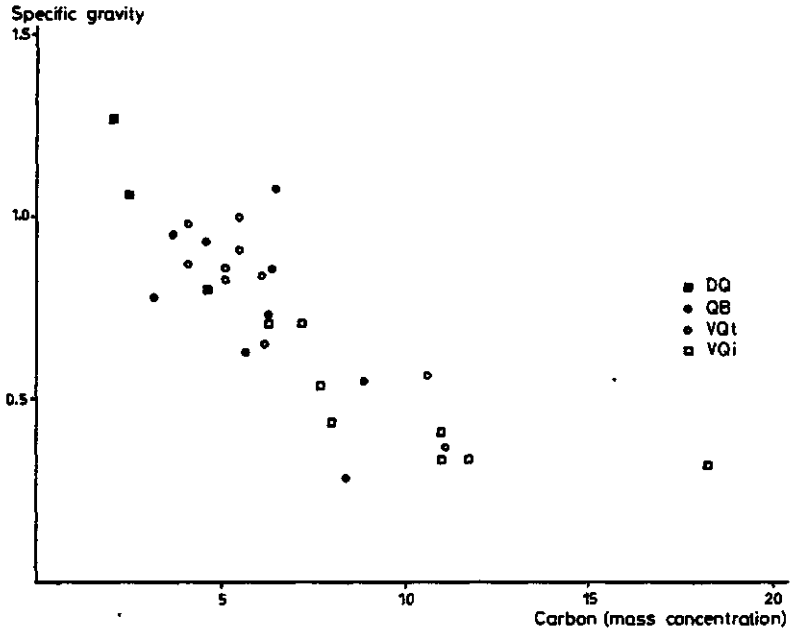

Fig. 4. The relation between the Specific Gravity and the proportion of carbon in the A21 layer.

3.3.2.5 Na, K, Mg, and CA ions

The amounts of available ions is often given in mass fraction (mg ion/ 100 g soil). It seems more likely that the roots of plants or the mycelia of fungi have a certain volume in the soil and are not, or little, affected by the weight of the soil. Because of this it is better to give the amounts in mass concentration (mg ion/l soil).

In the A0 layer the amount of Na and of K ions was slightly larger in the Violo-Quercetum ilicetosum than in the other associations, where it was almost the same. Ca and Mg ions were available in about the same quantity in all (sub)associations.

In the A21 layer the amount of Na ions was larger, and the amount of K, Mg, and Ca ions was smaller, compared with the A0 layer. In general the variation in amount of ions in this layer was large, and there was a considerable overlap between the values in the (sub)associations. Nevertheless some differences existed. The amount of Na ions was largest in the Violo-Quercetum ilicetosum, and was almost the same in the other associations.

The amount of K ions was largest in the Violo-Quercetum ilicetosum and decreased in the serie Querco-Betuletum, Violo-Quercetum typicum, Dicrano-Quercetum. The amount of Mg ions decreased in the serie Violo-Quercetum ilicetosum, Querco-Betuletum, Violo-Quercetum typicum, Dicrano-Quercetum; it was distinctly smaller in the Dicrano-Quercetum than in the other associations. The amount of Ca ions was largest in the Violo-Quercetum ilicetosum, and smaller in the Violo-Quercetum typicum and the Querco-Betuletum - where it was almost the same -, and was considerably smaller in the Dicrano-Quercetum.

The Violo-Quercetum ilicetosum generally had the largest amounts of ions. Those in the Violo-Quercetum typicum and in the Querco-Betuletum were lower, and had about the same values. Those in the Dicrano-Quercetum were generally lower than in the Querco-Betuletum and the Violo-Quercetum typicum.

A linear correlation with high correlation coefficients appeared to exist between the ions (in mass fraction) and carbon (in mass fraction). The correlation of ions and carbon expressed in mass concentration was also linear, but the correlation coefficients were slightly lower (fig. 5 and 6). It is therefore possible to use the amounts of carbon as an estimate of the amounts of ions.

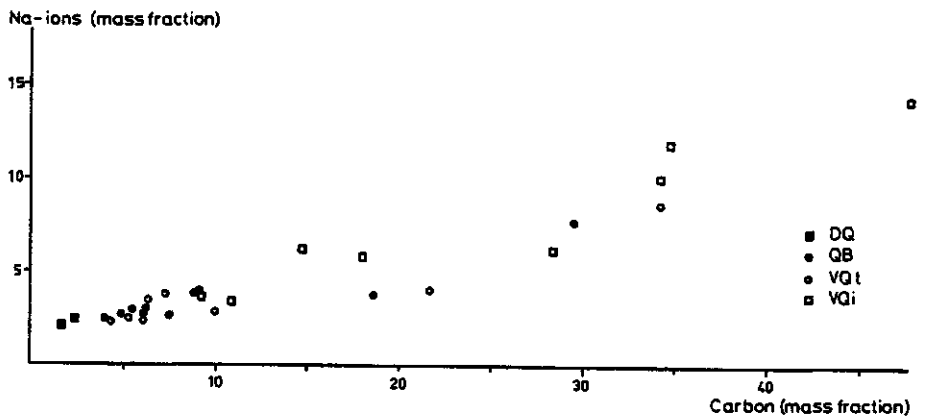

Fig. 5. The relation between the amount of Na ions and carbon in the A21 layer.

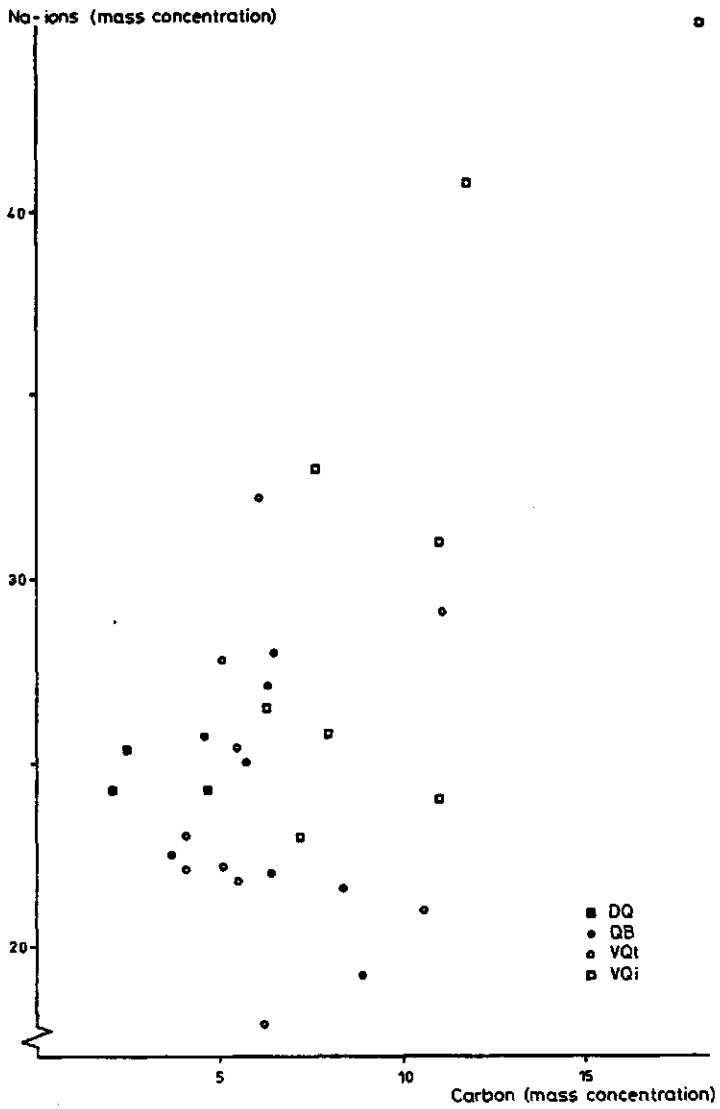

Fig. 6. The relation between the amount of Na ions and carbon in the A21 layer.

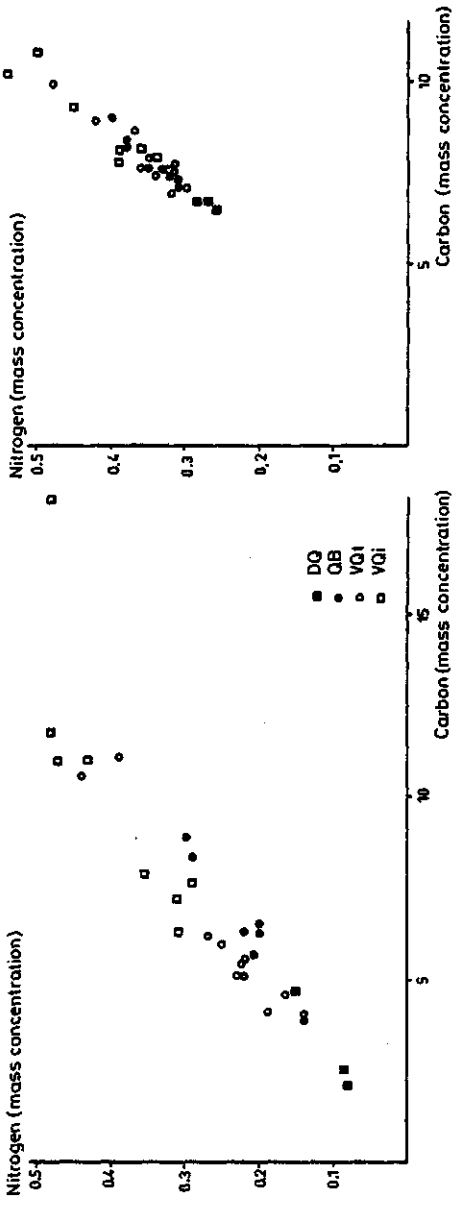

Fig. 7. The relation between the proportions of nitrogen and carbon in the A21 layer (left) and in the A0 layer (right).

3.3.2.6 Total carbon and nitrogen

In the A0 layer the amounts of carbon and nitrogen both decreased in the serie Violo-Quercetum ilicetosum, Violo-Quercetum typicum, Querco-Betuletum, Dicrano-Quercetum, but the differences were rather small. Also the C/N ratio differed very little, it increased slightly in the same serie.

In the A21 layer the difference between the associations was more distinct. Both the amount of carbon and nitrogen was largest in the Violo-Quercetum ilicetosum, smaller and about equal in the Violo-Quercetum typicum and the Querco-Betuletum, and smallest in the Dicrano-Quercetum. The C/N ratio was highest in the Dicrano-Quercetum and the Querco-Betuletum, where it was almost equal. It was lower and also almost equal in the Violo-Quercetum ilicetosum. There is a strong linear correlation between the amounts of nitrogen and carbon, in both the layers (fig. 7), comparable to the correlation of the amounts of ions and carbon.

3.4 CONCLUSIONS

The soils in the four (sub)associations differ greatly from each other. Differences were found in the soil profiles and in the chemical factors, especially in the A21 layer. In the Violo-Quercetum ilicetosum the plots had relatively deep profiles with a thick A1h layer, the highest ion supplies, the lowest pH, the highest Na, K, Mg, and Ca ion concentrations, the highest proportions of nitrogen and carbon. The C/N ratio's are relatively low and equal those in the Violo-Quercetum typicum. In the Violo-Quercetum typicum and the Querco-Betuletum the plots had more shallow profiles, in the Querco-Betuletum slightly more shallow compared to the Violo-Quercetum typicum. The topsoil in the Querco-Betuletum plots generally was disturbed by former human activity. The pH, the K and the Mg ion concentrations, and the C/N ratio's were slightly higher, the Ca concentration was slightly lower in the Querco-Betuletum compared to the Violo-Quercetum typicum, the ion supply, the Na concentration, the proportions of nitrogen and carbon were almost equal in both the vegetation types. In the Dicano-Quercetum the plots had very shallow profiles, quiete different from those in the other associations. The pH was higher, the ion supply, the concentrations of K, Mg, and Ca ions, and the proportions of nitrogen and carbon were lower than in the other associations. The Na ion concentration is almost equal here and in the Violo-Quercetum typicum and the Querco-Betuletum. The C/N ratio's were relatively high and equal those in the Querco-Betuletum.

4 *THE MYCOCOENOSES*

4.1 INTRODUCTION

To describe the fungus vegetation of phytocoenose, it is not sufficient to make just one relevé, just like the description of a phytocoenose by one relevé of the phanerogam vegetation. Fungi have much more pronounced seasonal aspects than green plants: the late summer aspect differs partly from the early autumn aspect and to a large extent from the late autumn aspect. A fungus vegetation may also show big differences, qualitatively and quantitatively, from year to year. This depends a great deal on the weather, especially the rain, on humidity and temperature of air and soil (Barkman 1976b, Thoen 1976), on the weather of preceding periods, and possibly also on other, partly unknown factors.

4.2 METHODS

4.2.1 *Relevés and tables*

To get acquainted with the whole fungus vegetation of a plot it is necessary to make a number of relevés each year for several years. It was planned to make 2 or 3 relevés per fructification season (late summer and autumn) in each plot for 4 years. This goal was not always achieved, partly because the frequency relevés, and sometimes determinations were very time consuming, partly because of fluctuations in fructification (for instance in 1976 fructification did not start until the beginning of october).

The plots were not visited often in the other seasons. In winter, spring, and early summer the number of fungi was always very low, mostly very old specimens from the preceding autumn. Observations on fungi in winter, spring, and early summer were also used as relevés and worked into the tables.

In a relevé, abundance was determined by counting or estimating the number of carpophores of each fungus species (abundance relevé). Counting the number of carpophores is a more exact, but more time consuming method than estimating. Here a combination of both was used. Abundance was noted in the following scale (according to Barkman 1976, slightly modified; mentionned in parenthesis are the mean number of carpophores of that class):

r	(rare)	1 or 2 carpophores (1.4)
o	(occasional)	3 - 9 carpophores (5)
f	(frequent)	10 - 29 carpophores (17)

vf (very frequent) 30 - 99 carpophores (54)
a (abundant) 100 - 500 carpophores (223)
va (very abundant) more than 500 carpophores
The abundance was counted in an area of 1000 m². In plots that were larger or smaller than 1000 m², abundance was converted and also counted in number of carpophores per 1000 m².

The number of carpophores was not determined for some species with very small fruiting bodies. Here the number of (small) growing spots was noted instead. This was never applied to *Agaricales*, only to species growing clustered on wood or an other limited substrate, such as species of the genera *Hymenoscyphus*, *Cudoniella*, *Sphaerobolus*, *Onygena*, *Ciboria*, and to species, growing on wood, whose carpophores are not seperate individuals, such as species of the genera *Stereum*, *Phlebia*, *Merulius*, *Exidia*.

An abundance table was made of each plot where the species and the abundance were given of each relevé. Data were also included of earlier research on these plots (Barkman pers. comm., Ypelaar in prep.). In these tables it was easy to read the Maximum Abundance of Carpophores (MAC) of a species per year, and the Absolute Maximum Abundance of Carpophores (AMAC), the highest of all MAC values of that species (Barkman 1976). It was also easy to read the number of years in which a species was found, so to determine its Annual Frequency (AF) (Barkman 1976). Values for AMAC and AF are given in table 7.

In 17 plots not only the abundance of the fungus species was determined, but also the Spatial Frequency. These plots - frequency plots or composite plots - were for this purpose divided into partial plots of 25 m². So the composite plots of 1000 m² were divided in 40 partial plots, those of 1050 m² in 42 partial plots, and the one of 875 m² in 35 partial plots. A frequency relevé consisted of 35, 40, or 42 partial relevés, one of each partial plot. Per frequency relevé it is easy to read in how many partial relevés a species was found, so to determine its Spatial Frequency: the proportion (in percentage) of the area of a composite plot where the species was found in one relevé.

The 17 composite plots were distributed over the different associations: 2 in the Dicrano-Quercetum, 5 in the Querco-Betuletum, 7 in the Violo-Quercetum typicum, and 3 in the Violo-Quercetum ilicetosum. There were comparitively few frequency relevés made as it required a great deal of time and work: 6 in the Dicrano-Quercetum (3 per composite plot), 19 in the Querco-Betuletum (3.8 per composite plot), 23 in the Violo-Quercetum typicum (3.3 per composite plot), and 10 in the Violo-Quercetum ilicetosum (3.3 per composite plot). The frequency relevés were made in the late summer and autumn of 1976 (12 frequency relevés), of 1977 (28), and of 1978 (18).

As the partial plots were fixed (with pickets) and numbered it was possible to combine the frequency relevés of a composite plot into one total frequency relevé. In this way it was possible to determine in which

and how many of the partial plots a species was found during these 3 years. I have called the total number of partial plots where a species was found the Total Spatial Frequency. The TSF values of the species are given in a proportion (percentage) of the area of the composite plot (table 7). The TSF gives the proportion of the plot area were the carpophores of a species were found and is an estimation of the cover of the mycelia. (see p. 68).

In a frequency relevé the number of carpophores was also counted (for 1-3 carpophores) or estimated (for 4 carpophores and more, in 5 classes, see p. 76) of each species in each partial plot. So the abundance of the species was determined too, and included in the abundance table of that plot.

Some synoptical characters were calculated for each (sub)association (table 8): the Presence, P; the Mean Absolute Maximum Abundance of Carpophores, GAMAC (Barkman 1976); the Mean Annual Frequency, MAF (Barkman 1976); and the Mean Total Spatial Frequency, MTSF.

To calculate GAMAC, the AMAC values were first reconverted into the number of carpophores, using the values mentioned in the abundance scale (p. 48) or the real number of carpophores (if they were counted). The GAMAC was calculated over all plots, including the plots where a species did not occur, so where its AMAC was 0. The GAMAC values were not given in the abundance scale, but in the number of carpophores per 1.000 m^2 rounded off to whole figures (if smaller than one, rounded off to one tenth).

The MAF is the mean of the AF values of a species in a (sub)association. The AF was given in proportion of years (percentage). The MAF is the mean proportion of years (mean percentage) in which a species was found. Also the MAF was calculated over all plots, including the plots where a species did not occur, so where its AF was 0.

The MTSF is the mean of the TSF values of a species in a (sub)association. The TSF was given in proportion of the plot area (percentage). So the MTSF is the mean proportion of the plot area (mean percentage) where a species was observed. The MTSF was only calculated on frequency plots, but including plots where a species did not occur, so where its TSF was 0.

The Presence, P, another synoptical chatacter indicates the proportion of the plots where a species was found. It is the same character as used in the synoptical table of green plants. Presence was calculated in percentage. It is given in a scale of 10 parts in the Roman numerals I - X.

In the Dicrano-Quercetum the synoptical table was calculated on 11 plots: on the plots 1, 2, and 3 of this survey and on 8 other plots investiged by Ypelaar. In the other (sub)associations the synoptical table was calculated only on the plots reported here. The data of earlier research on the plots by Barkman usually concerned only the presence of species and not abundance and were only included in the calculation of P, not in the calculation of the other synoptical characters.

The formulas used to calculate the mathematical affinities (p. 12) can

also be used to calculate the affinities of the fungus vegetations. The formulas for the A_C and the A_P were used unchanged, for the A_T not the TCV values were used, but the GAMAC values. The differences between the fungus vegetations of the vegetation types D_C, D_P, and D_T were also calculated.

4.2.2 *The increase in the number of species per year of investigation*

Not all fungus species were found every year, and each year species were found that were not previously observed. The total number of species found in a plot increased with each year of investigation.

In each plot the number of species was determined after one, after 2, and after 3 years of research as a proportion (percentage) of the number of species observed after 4 years of research. The means of these values per association were also calculated (Fig. 8). Data from earlier research and the incomplete data from the plots 6, 7, 27, and 29 (these plots were only visited for 3 years) were omitted. In the Dicrano-Quercetum the increase was also calculated including the observations made by Ypelaar in 1972 and 1973.

In every following year the increase in the number of species became less, except in a year very rich in species. The increase in the fourth year varied from 7 to 10%, and was much lower than the increase in the third year of 10 to 24%. In the 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 fungus species in the Dicrano-Quercetum. Barkman (Syllabus Univ. of Utrecht) found an average increase of 13% in the fourth year on plots in the Dicrano-Juniperetum studied during 13 years. I found a smaller increase after the fourth year, average 8.5%, probably because I visited the plots several times a year.

Barkman had after 4 years only found 54% of the number of species that were present in the Dicrano-Juniperetum after 13 years research. This means that an investigation lasting only 4 years is not enough to find all the fungi in a phytocoenose. Probably I found a larger proportion of the species in these oakwoods, because I visited the plots several times a year. 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. 8 to an asymptotic end value this also yields about 80% of the end value after the fourth year. It is therefore not unlikely that the tables represent about 80% of the total mycoflora of the plots investigated.

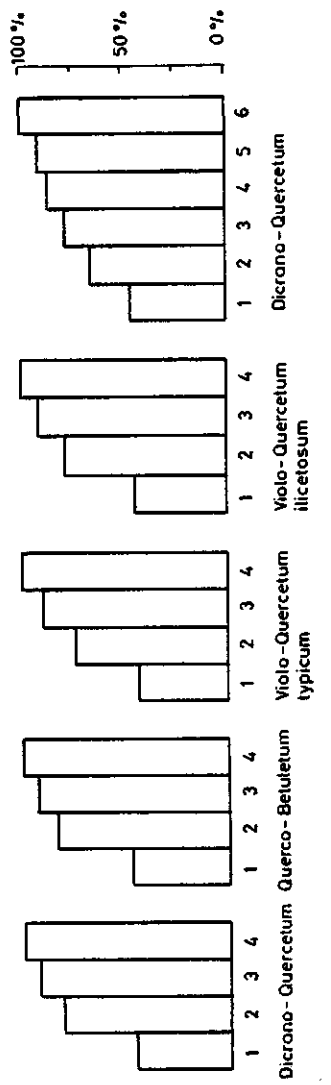

Fig. 8. The mean number of species in the (sub)associations after 1, 2, 3 and 4 years of research as a proportion (percentage) of the total number of species. 1=1976, 2=1976+1977, 3=1976+1977+1978, 4=1976+1977+1978+1979. Right: idem in the Dicrano-Quercetum including the data from earlier research. 1=1972, 2=1972+1973, 3=1972+1973+1976, 4=1972+1973+1976+1977, 5=1972+1973+1976+1977+1978, 6=1972+1973+1976+1977+1978+1979.

Annex to tables 7 and 8.

Species that were found only once. Mentionned after the name are the AMAC, the AF, and - sometimes - the TSF. Mentionned in parentheses are the GAMAC, the MAF, and - somtimes - the MTSF. The Presence of these taxa is always I.

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), *Tricholoa 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 lohjaënsis* o 33 (0.4, 4), *Russula brunneoviolacea* 2-X-1961 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* spec. 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), *Phyllopoprus 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* 24-XI-1959, leg J.J. Barkman 6475, det. R.A. Maas Geesteranus, *Russula fellea* found by J.J. Barkman, 22-X-1958 (pers. comm.), *Leucocoprinus brebissonii* 9-VIII-1960, leg. J.J. Barkman 6646, det. J.J. Barkman, *Clavariadelphus junceus* 15-XI-1958, leg. J.J. Barkman 6019, det. R.A. Maas Geesteranus, *Typhula quisquiliaris* 24-IX-1960, leg. J.J. Barkman 6794, det. R.A. Maas Geesteranus, *Macrotyphula fistulosa* 15-XI-1958, leg. J.J. Barkman 6008, det. R.A. Maas Geesteranus, *Phlebia rufa* 24-IX-1960, leg. J.J. Barkman 6673, det. M. Donk, *Stereum gausapatum* 22-X-958, 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* spec. r 25 (0.1, 3).

Remarks to the tables 7 and 8.

Coprinus section *Micacei* is mentionned in both tables. This was the species *C. domesticus* in the plots 20 and 26, *C. micaceus* in plot 24, *C. radians* in plot 29, and *C. xanthothrix* in the plots 25 and 28. In plot 24 *C. domesticus* was also found (J.J. Barkman, 6687, 24-9-1960, det. C. Bas, Herb. WAG-W), without indication on abundance. As the species are closely related and have a preference for the Violo-Quercetum ilicetosum, they are joined to section *Micacei* in the fungus tables. The species themselves have the following values for P, GAMAC, MAF, and MTSF in table 8: *C. domesticus* in Violo-Quercetum typicum I, o.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., 6, -.

Cystoderma longisporum has been included with *C. amianthinum*, because it was not easy to distinguish these species macroscopically and they were not always studied microscopically. *C. longisporum* was found for certain in plot 3 (r 17, 1) and in plot 4 (r 25, 3) and the values were for P, GAMAC, MAF, and MTSF, in the Dicrano-Quercetum I, 0.1, 1, 0.5; in the Querco-Betuletum I, 0.4, 3, 0.6.

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

Phellinus ferreus was also found once in a Dicrano-Quercetum by P. Ypelaar As he did not indicate abundance, I can only give the values for P and MAF in table 8.

4.3 RESULTS

4.3.1 *Number of species*

In the 4 (sub)associations together 313 fungus species (including subspecies and varieties) were observed. The distribution of the species in the 4 vegetation types (table 9) shows that the total number of fungus species is remarkably low in the Violo-Quercetum ilicetosum. This is also expressed in the mean number per plot. These low numbers were most likely caused by the small and not representative plot areas in the Violo-Quercetum ilicetosum. The mean number in the frequency plots in this subassociation, which are larger, so more representative, and more intensively investigated, do not differ from that of the Violo-Quercetum typicum. The Violo-Quercetum typicum has slightly less fungus species, total and mean per plot, than the Querco-Betuletum. In the Dicrano-Quercetum the total number of fungus species do not differ much from that in the Querco-Betuletum and the Violo-Quercetum typicum. The mean number per plot and per frequency plot is remarkably higher in the Dicrano-Quercetum than in the other vegetation types, or in other words, the Dicrano-Quercetum plots were very rich in fungus species.

Table 9: 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 types	57	26	35	20

4.3.2 *Differential species*

4.3.2.1 Introduction

Any quantitative parameter can be used to determine the ecological and

sociological optimum of a species. Here the values of P, GAMAC, and MTSF (table 8) were used for this purpose. Species with one optimum or several optima are faithful (character) species, and differential species respectively. Deciding if a species has an optimum in one association (or alliance etc.) only, is only possible if all plant communities of a region were investigated. With regard to fungi we are still far from this state of knowledge in any region. Therefore this study only permits the distinction of differential species for a certain sub-association, 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 is considered presumably differential if it is differential in one characteristic, and is considered differential if it is differential in two characteristics and the other characteristic does not contradict it. The main differential characteristic is the P value. A species is considered differential if it has a P of IV, V, or VI and a P at least 4 classes lower in every other vegetation, if it has a P of VII, VIII, or IX and a P at least 5 classes lower in every other vegetation, or with a P of X and a P at least 6 classes lower in every other vegetation.

The second differential characteristic is the GAMAC value. A species is considered differential if the GAMAC is at least 2 classes lower in every other vegetation. The classification of abundance values (p. 48) was used; 0.1-0.9 was added as a separate class.

The third differential characteristic is the MTSF value, which has less distinguishing value than the P and the GAMAC, because it was based on only a few plots and was not measured in all species. A species is considered differential if the MTSF is 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 literature, in order to get some information on the ecological range. Literature was studied on acid oakwoods (Quercion robori-petraeae), on richer oak and beech woods (Querco-Carpinetum, Fago-Quercetum, Luzulo-Fagetum, Melico-Fagetum) and on poor acid coniferous woods or scrubs (Vaccinio-Piceetalia).

4.3.2.2 The Dicrano-Quercetum

Many of the species of the Dicrano-Quercetum (tables 7 and 8, group 1) are differential or presumably differential species, indicated with DQ, and pDQ respectively in table 8. Fourteen species with a low presence that were not differential according to the criteria, but were not found in one of the other associations, were added also 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 chrysorheus, Leotia lubrica, Marasmius androsaceus, Psathyrella fulvescens var. *dicrani, Russula adusta, R. fragilis, Sarcodon scabrosus, Telephora terrestris,* and *Tricholoma portentosum. Galerina calyptrata* is also differential for the Dicrano-Quercetum, but is listed in group 7 because it is also differential for the Querco-Betuletum in relation to the Violo-Quercetum. Presumably differential are 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 are also differential or presumably differential for the Querco-Betuletum in relation to the Violo-Quercetum).

No literature was available on fungi of the Dicrano-Quercetum. Many of the 'species of the 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 a Querco-Betuletum typicum (Runge 1960, and in this study), from a Genisto tinctoriae-Quercetum petraeae subcarpaticum dicranetosum (Bohus & Babos 1967), a Querco-Carpinetum (Eihellinger 1964, Smarda 1972), a Luzulo-Fagetum leucobryetosum (Jahn, Nespiak & Tüxen 1967, they found it a differential species for this sub-association), a Melico-Fagetum (Lange 1978), and also from associations with coniferous trees, a Melampyro-Abietetum variant with Leucobryum glaucum (Krieglsteiner 1977), a Querco-Piceetum (Nespiak 1959), and a Pino-Quercetum serratuletosum (Nespiak 1959).

All differential species are species of acid, sandy soils, poor in humus. Many of them have a wider ecological range than the Dicrano-Quercetum, but it is possible that when growing in richer woods, they are restricted to poorer, more acid patches. The real optimum for some of these species is probably in coniferous woods or scrubs, or on poor heath lands, such as *Marasmius androsaceus* and *Inocybe lacera.* Within the oakwoods on sandy soils in Drenthe, however, they have an optimum in the Dicrano-Quercetum and can be considered as differential species.

A few species are possibly character species, *Cantharellus cibarius, Cordyceps canadensis, C. ophioglossoides, Hydnellum scrobiculatum, H. spongiosipes, Inocybe sambucina, Psathyrella fulvescens* var. *dicrani, Sarcodon scabrosus, S. underwoodii. Cantharellus cibarius* and the two *Cordyceps* species are sometimes found outside the Dicrano-Quercetum, but the ecological range is narrow enough to consider them as character species. *Inocybe sambucina* and the *Hydnellum* and *Sarcodon* species are rare, and in Drenthe only found in the Dicrano-Quercetum (see also Ypelaar in prep.). *Sarcodon underwoodii* was mentioned only once (see annex to tables 7 and 8),

but it was also found in another Dicrano-Quercetum in Drenthe (Ypelaar in prep.) and was not reported from other localities in this province. *Psathyrella fulvescens* var. *dicrani* was found often in the Dicrano-Quercetum, and has not yet been reported from other habitats.

Many of the species of group 1 are mycorrhizal species, 40 (=82%). Only 6 species (12%) are humus saprophytes, 2 species are parasitic, 1 species grows on fallen leaves. There are no species in this group growing on wood.

4.3.2.3. The Quercion robori-petraeae

The Quercion robori-petraeae has many differential species (indicated with Qrp before the name of the species in table 8) and presumably differential species (indicated with pQ) (group 2 in tables 7 and 8). Some species that are not differential but have a preference for the Quercion were added to this group, they were absent from the Dicrano-Quercetum or had there much lower P or GAMAC values. The species were listed in sub-groups according preference for the Querco-Betuletum (sub-group a), the Violo-Quercetum (b), the Violo-Quercetum typicum (c), the Violo-Quercetum ilicetosum (d), the Querco-Betuletum and Violo-Quercetum ilicetosum (e), the Querco-Betuletum and Violo-Quercetum typicum (f), and without a preference (g).

There are 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 are presumably differential: *Clitocybe diatreta, Clitopilus hobsonii, Crepidotus pubescens, Galerina hypnorum, G. sahleri, Hypholoma sublateritium, Inonotus radiatus, Laccaria laccata, Merulius tremellosus, Mycena mucor, M. pura, Piptoporus betulinus, Pleurotus ostreatus,* and *Rickenella fibula.* The other species of this group are species with a low presence, which have a preference for the Quercion but are not differential.

The Quercion is well characterized in relation to the Dicrano-Quercetum and the numbers of differential species indicate the small affinity between the Quercion and the Dicrano-Quercetum. The differential species are, generally, species of deciduous woods on nutrient and humus richer soil. Many of the species were recorded in literature from associations such as the Querco-Carpinetum, the Mercuriali-Fagetum, the Melico-Fagetum, e.g. *Bjerkandera adusta, Clitocybe fragrans, Mycena haematopus, Xylaria hypoxylon.* Some of the species 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 species, 11 species (17%) humus saprophytes, 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 the species of the Dicrano-Quercetum (group 1).

The associations of the Quercion have distincly less differential species. The Querco-Betuletum (group 3 and group 7 partly) has only 2 differential species (indicated with QB in table 8), *Mycena rorida* and *Hymenoscyphus epiphyllus*, and 2 presumably differential species (indicated with pQB), *Panellus stipticus* and *Clitocybe brumalis*. Some species that occurred in both the Dicrano-Quercetum and the Querco-Betuletum (therefore listed in group 7) are also differential for the Querco-Betuletum, *Laccaria amethystina*, *Galerina calyptrata*, and *Lactarius camphoratus*, or presumably differential, *Amanita citrina*. *Cortinarius orellanoides*, *Galerina heterocystys*, and *G. triscopa* are not differential according to the criteria, and were added to group 3 because theire absence from the other associations.

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

The Violo-Quercetum has 3 differential species, *Collybia fusipes*, *Mycena inclinata*, and *Tyromyces caesius*, and 2 presumably differential species, *Galerina ampullaceocystis*, and *Stropharia aeruginosa* (group 4, indicated

with VQ, pVQ respectively). *Mycena inclinata* has a slight preference for the sub-association ilicetosum, the other 3 species for the sub-association typicum. The values for P in *Collybia fusipes* is higher in the sub-association typicum than in the sub-association ilicetosum, but the values for GAMAC and MTSF are nearly the same. *Entoloma euchrous*, *Inonotus dryadeus*, and *Russula parazurea* were added to group 4 because they were not found in one of the other associations.

I did not find recordings of *Galerina ampullaceocystis* in the literature studied. The other (presumably) differential species were all recorded from the Querco-Carpinetum (Nespiak 1959, Einhellinger 1974, Lisiewska 1965), and also from associations on richer soil, such as the Melico-Fagetum (Lisiewska 1974, Lange 1978) and the Fagetum typicum (Smarda 1972). They were not recorded from the more humus poor association, Querco-Betuletum, and can - except for *Tyromyces caesius* - be regarded as species of deciduous woods on not too nutrient and humus poor soils, but it is not known in which association they might have the optimum. *T. caesius* certainly reach its optimum in coniferous woods. It usually grows on wood of conifers, and was recorded from Pinus-Robinia woods (Winterhoff 1976), from the Melampyro-Abietetum and Asperulo-Abieti-Fagetum (Krieglsteiner 1977), from the Dicrano-Juniperetum (Barkman, pers. comm.), and also from the Querco-Carpinetum and the Melico-Fagetum. Coniferous trees were not present in the Violo-Quercetum plots of this study, but sometimes logs of conifers were present (artificial). *T. caesius* growing on wood of deciduous trees, however, was also observed.

Of the 8 species of group 4 there is one mycorrhizal species, one humus saprophyte, and 6 species growing on wood or branches.

The sub-associations are both well characterized by a number of differential species. The sub-association typicum has 3 differential species, *Collybia peronata*, *Marasmius splachnoides*, *M. epiphylloides*, and 2 presumably differential species, *Clitocybe flaccida* and *Scleroderma verrucosum* (group 5, indicated with Vt, and pVt respectively). *Laetiporus sulphureus*, *Mycena pearsoniana*, *Resupinatis applicatus*, and *Xerocomus parasiticus* were added to this group, because they were only found in the Violo-Quercetum typicum.

Collybia peronata was also frequent in the other sub-associations, but here reached the highest values for P, GAMAC, and MTSF. It was also recorded from other associations, such as the Querco-Carpinetum (Lisiewska 1965, Runge 1963, Einhellinger 1964), Mercuriali-Fagetum (Lisiewska 1974), Melico-Fagetum (Lisiewska 1974, Lange 1978), Melampyro-Abietetum (Krieglsteiner 1977), and the Dicrano-Juniperetum (Barkman pers. comm.). Jahn, Nespiak & Tüxen (1967) called it a accompaning species in the *Fagus* woods they investigated. *Marasmius splachnoides* has about the same value for GAMAC here as in the Querco-Betuletum, but much higher values for P and MTSF. It was also

recorded from the Querco-Carpinetum (Lisiewska 1965), the Mercuriali-Fagetum, and the Melico-Fagetum (Lisiewska 1974). Also from own experience it is known to occur in richer oakwoods such as the Querco-Carpinetum, where it possibly reaches its optimum. *Marasmius epiphylloides* is confined to terrestrial growing *Hedera helix*, and therefore restricted to the Violo-Quercetum. It can probably be a character species in the Netherlands. In literature it was recorded only from the Querco-Carpinetum (Lisiewska 1965). I did not find data in literature on the distribution of *Clitocybe flaccida*. The related taxa *C. gilva* and *C. inversa* were recorded from the Querco-Betuletum (Birken 1976), the Querco-Carpinetum (Runge 1963, Einhellinger 1964) and the Luzulo-Fagetum leucobryetosum (Jahn, Nespiak & Tüxen 1967). *Scleroderma verrucosum* is recorded from the Querco-Carpinetum (Lisiewska 1965), and the Melico-Fagetum (Lange 1978). The species of this group are all species occurring in richer oak woods, often also in beech woods. Their absence from the Violo-Quercetum ilicetosum is probably caused by the unfavourable litter, owing to the large proportion of Ilex leaves, or by the unfavourable microclimate.

Of the 9 species of this group there is one mycorrhizal species, one parasitical species, and 7 species growing on humus, litter or wood.

The sub-association ilicetosum has 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, indicated with Vi, and pVi respectively). *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 had a preference for the Violo-Quercetum ilicetosum, but the individual presence degrees were low. The section as a whole, however, is differential. The species also occur in other associations. *C. micaceus* was recorded from the Querco-Betuletum (Runge 1960), the Querco-Carpinetum (several authors), a *Pinus-Robinia* wood (Winterhoff 1977), the Melico-Fagetum (Lange 1978, and Jahn, Nespiak & Tüxen 1967, who called it a presumably differential species for the Melico-Fagetum). *C. xanthothrix* was recorded from the Querco-Carpinetum (several authors), and from *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 as far as wood associations are concerned. Both *Typhula* species were found to occur only in thick layers of *Ilex* leaves (see p. 87). They are also known from litter of other deciduous trees, but usually in a fairly moist habitat. *Polyporus varius* was recorded from the Melico-Fagetum (Lange 1978), *Mutinus caninus* from the Melico-Fagetum (Lange 1978) and the 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 species of the mycocoenose of the Violo-Quercetum ilicetosum is large compared with that of the phytocoenose (only one differential species). It is therefore possible, based on the mycocoenose, to consider the Violo-Quercetum ilicetosum as an independent association and not as a sub-association.

Of the 12 species of group 6, there is one mycorrhizal species, 2 humus saprophytes, 3 species growing on fallen leaves and fruits, and 6 species growing on wood or branches.

There are 19 species with a preference for the Dicrano-Quercetum and the Querco-Betuletum (group 7). Listed were species that were differential for both associations in relation to the Violo-Quercetum, and species that occurred with a low presence in the Dicrano-Quercetum and the Querco-Betuletum and were absent in the Violo-Quercetum. Seven species have a preference for the Dicrano-Quercetum (sub-group a), 4 of them are (presumably) differential for the Dicrano-Quercetum or the Querco-Betuletum (see there). Twelve species occurred almost equal in the 2 associations, with low presence and abundance, and were listed as 'indifferent species' (sub-group b). These species were all absent in the Violo-Quercetum. There were no species belonging to this group that had a preference for the Querco-Betuletum. Apparently these species can be considered as species of (oak woods on) acid, sandy soils, poor in humus. E.g. both *Laccaria* species when occurring in the Violo-Quercetum, prefered sites with a sandy layer at shallow depth.

There were 23 species present in the Dicrano-Quercetum, the Querco-Betuletum, and the Violo-Quercetum typicum, and absent or present with much lower P and GAMAC values in the Violo-Quercetum ilicetosum (group 8). They were listed in sub-groups according the preference for the Dicrano-Quercetum (sub-group a), for the Dicrano-Quercetum and Querco-Betuletum (b), for the Querco-Betuletum and the Violo-Quercetum typicum (c), for the Dicrano-Quercetum and the Violo-Quercetum typicum (d), and without preference (e). The species with a preference for the Dicrano-Quercetum, or the Dicrano-Quercetum and the 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* had a preference for the Querco-Betuletum and the Violo-Quercetum typicum. There were 5 species listed in sub-group d, but the preference for the Dicrano-Quercetum and the Violo-Quercetum was only weakly, because the values for P, GAMAC, and MTSF were very low. The other 11 species in group 8 were more or less equally distributed in the 3 vegetation types. The absence of these species from the Violo-Quercetum ilicetosum is a characteristic they have in common with the species of group 2f. Probably the forest floor in the 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 the herb layer, might be another factor.

Accompanying species (group 9, 38 species) are the species that were more or less equally distributed troughout the table. Listed here are the very common species, with high values for P, GAMAC, and MTSF, but also the rarer species with low values for P, GAMAC, and MTSF. Some of the species were most abundant in the Dicrano-Quercetum, e.g. *Lactarius quietus, L. theiogalus, Paxillus involutus,* in the Querco-Betuletum, e.g. *Mycena sanguinolenta,* or in the Violo-Quercetum typicum, e.g. *Clitocybe vibecina,* and *Armillariella mellea.* The common species sometimes had GAMAC. MTSF, or P values that were differential according to the criteria. But because the values were high in every vegetation type, these species were not really differential, and therefore listed in this group. Generally, the species of this group are species with a wide range, occurring also frequent in other associations.

4.3.3 *Mathematical affinities*

The values for A_C, A_P, and A_T (table 11) and for D_C, D_P, and D_T (fig. 9, the length of the connections is a measure for differences between the associations) show that the affinities of the fungus vegetation are more or less the same as those of the vegetation of phanerogams, mosses and lichens. There is a great affinity between the Violo-Quercetum typicum and the Querco-Betuletum, even greater than between both the subassociations of the Violo-Quercetum. The affinity of the Dicrano-Quercetum with the other vegetations was very low, especially with the Violo-Quercetum ilicetosum. The same relations were shown in the affinities of the phytocoenoses.

The relation of the affinities appeared to change if not only the number of species was used (fig. 9a), but also the Presence (fig. 9b) and the GAMAC values (fig. 9c), just as in the affinities of the phytocoenoses. But here both the affinities of the Violo-Quercetum ilicetosum and the Dicrano-Quercetum to the Querco-Betuletum and the Violo-Quercetum typicum decreased. Especially the affinity of the Dicrano-Quercetum with the other vegetations is extremely low in the values for A_T.

4.3.4 *Representative plot size*

The relation between the number of species in a plot and the size of that plot (fig. 10) was studied to determine the 'minimal' area or the representative plot size. The number of species distinctly increased with a plot area increasing from 300 m^2 up to 1500 m^2. The variation in the number of species in plots of 1500 m^2 was rather large, 50 to 101 species, with an

Table 11: Mathematical affinities according to 3 different calculations. See text.

	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

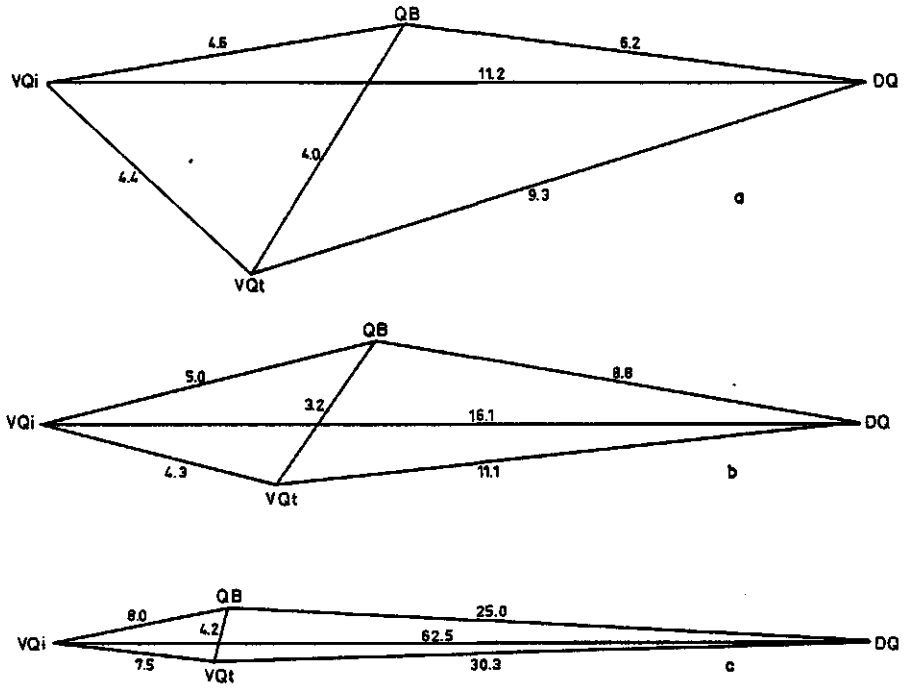

Fig. 9. The differences between the fungus vegetations, a according the calculation of D_C, b according the D_P, and c according the D_T.

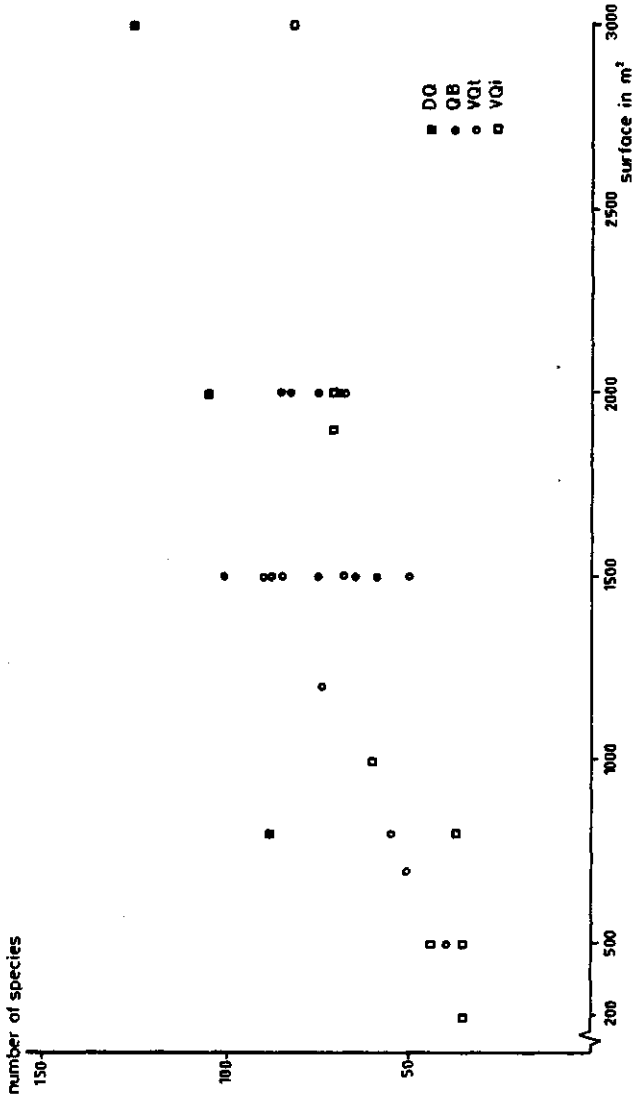

Fig. 10. The relation between the area and the number of species.

average of 75 species. In plots of 2000 m^2 the number of species did not differ much from this; the variation, 68 to 105 species, was nearly the same, and the average of 80 species was only slightly higher. Of the 2 plots of 3000 m^2, one had 82 species and did not differ from the plots of 1500 and 2000 m^2. The other one, a Dicrano-Quercetum plot, surveyed during 6 years, had more species, namely 126.

A plot seems to have a representative size if it has an area of 1500 to 2000 m^2, except perhaps in the Dicrano-Quercetum where a plot of this size had only 83% of the species in a plot of 3000 m^2. An area of 1000 m^2 is certainly not large enough to be representative. This is also shown by the frequency relevés (size about 1000 m^2) having an average of only 74% of the species found in the whole plot (size 1200 - 3000 m^2).

The original idea, that 1000 m^2 would be a representative plot size, appeared to be inaccurate. In the associations of the Quercion robori-petraeae the representative plot size appeared to be about 1500 m^2, in the Dicrano-Quercetum at least 3000 m^2.

4.4 CONCLUSIONS

Many more fungus species than plant species were found. The Violo-Quercetum ilicetosum appeared to be relatively poor, the Dicrano-Quercetum relatively rich in fungi.

A number of the fungus species are differential species, just as there are differential plant species. More differential fungus species than differential plant species were present, especially in the associations with only a few plant species, the Dicrano-Quercetum and the Violo-Quercetum ilicetosum.

The Dicrano-Quercetum and the Quercion robori-petraeae have in relation to each other many differential species. This supports the idea that the Dicrano-Quercetum does not belong to the Quercion robori-petraeae. The Quercion associations have in relation to each other less differential species, but are also well characterized. Based on the differential species it is possible to consider ranking the Violo-Quercetum ilicetosum as an association.

The affinities of the fungus vegetations of the (sub)associations are comparable with the affinities of the phytocoenoses.

The representative plot size appeared to be rather large, ca. 1500 m^2 in associations of the Quercion robori-petraeae, and at least 3000 m^2 in the Dicrano-Quercetum.

5 *ANNUAL FREQUENCY*

The research took 4 years, so it was possible to determine the number of species found in one, two, three, and four years, and to distinguish 4 Annual Frequency Classes. In each plot the number of species in the AF Classes was determined as a proportion of the total number of species in the plot, and the mean of these values per (sub)association were calculated (fig. 11). Data from earlier research and the incomplete date from the plots 6, 7, 27, and 29 (these plots were visited only in 3 years) are omitted.

The graphs do not differ greatly from each other. AF Class 1 is in each association the largest one and tends to increase slightly from Dicrano-Quercetum to Querco-Betuletum to Violo-Quercetum typicum to Violo-Quercetum ilicetosum. AF Classes 3 and 4 tend to decrease in this series. These are relatively large in the Dicrano-Quercetum and in the Querco-Betuletum, or in other words, the Dicrano-Quercetum and the Querco-Betuletum have a relatively constant mycoflora.

Table 7 gives the values for AF as a proportion of the number of research years (in percentage). Earlier research by Ypelaar and Barkman is included here. Table 8 gives per association the Mean AF values.

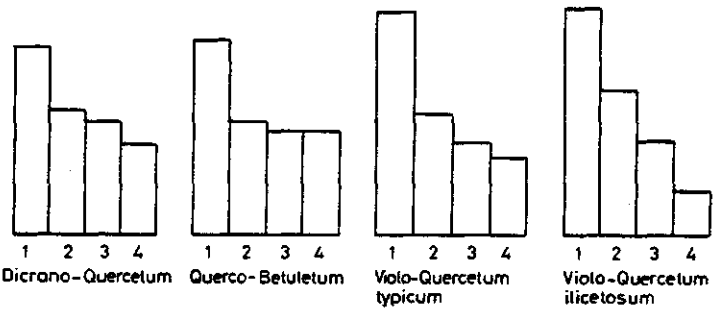

Fig. 11. Annual frequencies per (sub)association in proportion (mean percentage) of the number of species.

6 *SPATIAL FREQUENCY*

6.1 INTRODUCTION

The real abundance of a species is in fact the abundance of the mycelia, and not the abundance of the carpophores. The abundance of the mycelia, however, is difficult to determine. Darimont (1973) determines the abundance of the 'stations'. A 'station' is a group of carpophores that is separated from other groups, and therefore marks the spot where the individual, the mycelium, grows. The following difficulties may occur in working with 'stations'. The 'stations' are not sharply separated; not all mycelia form carpophores at the same time; a 'station' can be made up of 2 mycelia, or 2 'stations' are in fact one mycelium. In this study because of these difficulties the Total Spatial Frequency was introduced as an indication for the abundance of the mycelia; it is expected to be more exact than the abundance of 'stations'.

The Spatial Frequency of a species depends on the size of the partial relevés, and on the size, the number, and the spatial distribution of the individual. The size of mycelia of many macrofungi (parasites and fungi on dung are excluded here) will probably be 1 to 20 m^2 (based on the size of groups of carpophores). To get the most accurate values for SF the partial relevés must be not smaller than the mycelia. Only if all partial relevés have the same size can we compare the values for the Spatial Frequency. In this study the size was 25 m^2. This is slightly larger than the expected size of most mycelia. If a mycelium was larger than 25 m^2 this was recorded when the data were worked out.

The manner of growing and therefore the spatial distribution of a species greatly influences the SF. Because of this it is not possible to convert abundance of carpophores into Spatial Frequency. Because of the size chosen for the parial plots, it is expected that the SF is a more exact method of estimating the abundance of mycelia than it would be by estimating the abundance of carpophores.

6.2 METHODS

In order to make frequency relevés 17 plots (DQ 2 plots, QB 5 plots, VQt 7 plots, and VQi 3 plots) were divided in 35, 40, or 42 partial plots, depending on the size of the composite plot. A clear picture of the SF can be obtained from these partial plots and there are not too many for it become unworkable. Once or twice in 1976, 1977, and 1978 a frequency relevé

was made in each composite plot. A frequency relevé consists of 35, 40, or 42 partial relevés. All species were noted in each partial plot and the abundance of carpophores was estimated. The frequency relevés were united per plot into one 'total frequency relevé', which indicated in which of the partial plots the species had been found. The Total Spatial Frequency is the proportion of the plot area (in percentage) in which the species was observed during the 3 years research. In this paper Total Spatial Fequency will be refered to as frequency or as TSF.

Per association the mean of the values for TSF, the Mean Total Spatial Frequency (MTSF), were calculated.

In each composite plot the portion of species was counted (in percentage of the total number of species in that plot) occurring in 1-20% (Frequency Class I), in 21-40% (F II), in 41-60% (F III), in 61-80% (F IV), and in 81-100% (F V) of the plot area, and the mean values per (sub)association were calculated (fig. 12).

Indices of heterogeneity were determined according

$$H=(F\ I+F\ II)/(F\ IV+F\ V).$$

6.3 RESULTS

6.3.1 *Introduction*

As the frequency relevés were mainly made in September, October, and the first half of November, and only a few times in June, July and August, the values for the TSF can be too low in species with optimums before September or after the middle of November. This is only applicable to a few species, such as *Oudemansiella platyphylla, Mycena cinerella, 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 TSF-value are likely to be more accurate in species with a high AF-value. In general the TSF-values should be considered as minimum values.

Values for TSF are given in table 7 per plot, and those for MTSF per association in table 8.

6.3.2 *Frequency histograms and homogneity*

The frequency histograms for each of the 4 associations and for the 4 associations together (fig. 12) do not differ a great deal. Frequency Class I is very large, much larger than the other Classes. Class V is about twice as large as Class IV in the associations Querco-Betuletum, Violo-Quercetum typicum and Violo-Quercetum ilicetosum. This confirms what Raunkiaer (1934) found, namely that the Classes are in a proportion of $I>II>III\geq IV<V$. This principle was formulated for higher plants. Apparently it also applies to the fungi of the Querco-Betuletum, the Violo-Quercetum typicum and the

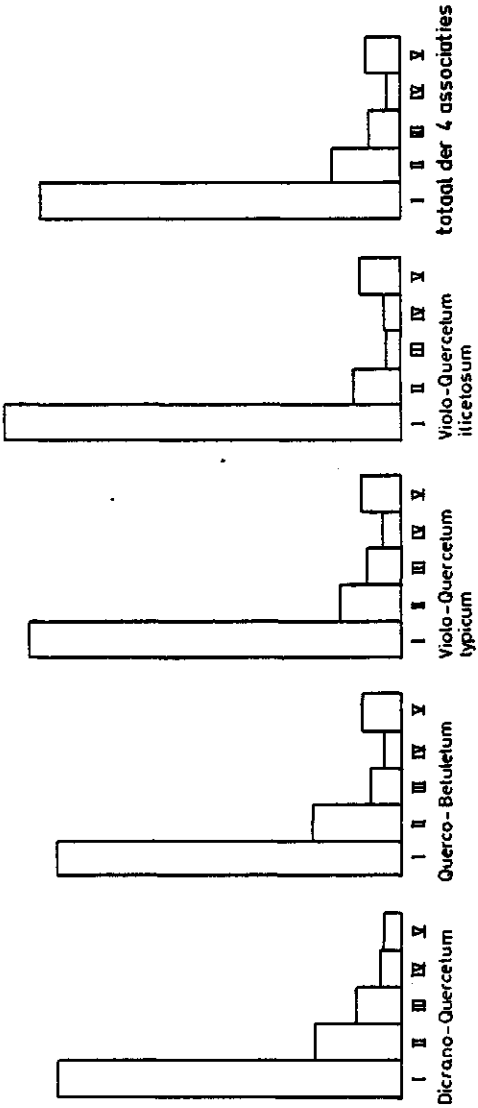

Fig. 12. Frequency histograms for each of the four (sub)associations and for the combined associations, in mean percentage of the number of species.

Violo-Quercetum ilicetosum.

A frequency histogram with Class V larger than Class IV occurs only if the vegetation is homogeneous and if the partial releves are of a certain size in relation to the 'minimal area'. Homogeneity can be measured by the indices of homogeneity or by the reciprocal, the index of heterogeneity. Heterogeneity for the Dicrano-Quercetum is 14.3, for the Querco-Betuletum 9.3, for the Violo-Quercetum typicum 8.5, and for the Violo-Quercetum ilicetosum 9.3. The Dicrano-Quercetum is notable because of the relatively large heterogeneity.

Raunkiaer considers that the size of the partial relevés in woods has to be ca. 0.125% of the 'minimal area' (minimal area used here in the sense of the usual relevé size in the Braun-Blanquet method). The Frequency Class I gets very large if the partial relevés are too small. All frequencies group together in Frequency Class V if the partial relevés are of about the same size as the 'minimal area'. The partial relevés are 25 m^2, that is 0.83% of the expected minimal area in the Dicrano-Quercetum (at least 3,000 m^2 for fungi) and 1.67% in the associations of the Quercion (1,500 m^2 for fungi). Frequency Class I is rather large, although the partial relevés are not too small. Frequency Class I appears to decrease and Frequency Classes IV and V appear to increase if we join these partial relevés together to partial relevés of 50 m^2 (fig. 14).

Class V in the Dicrano-Quercetum, however, is smaller than Class IV. Apparently, Raunkiaers principle does not apply to the fungi of the Dicrano-Quercetum. Possibly this is a special characteristic of the Dicrano-Quercetum or it may be caused by one of the following: the vegetation of the plots was not homogeneous; the partial plots were too small in relation to the 'minima area', in other words, the 'minimal area' of the Dicrano-Quercetum is much larger than of the other associations; the relevés were incomplete, not enough relevés and/or the relevés were made at an incorrect time.

Frequency histograms of the higher plants and of the mosses (fig. 13) do not indicate heterogeneity for the Dicrano-Quercetum. The distribution of mosses inside the plots shows some heterogeneity (see p. 82). This is inherent in the Dicrano-Quercetum. The partial relevés are 0.83% of the 'minimal' area' if that is 3,000 m^2 large, or 0.25% if it is 10,000 m^2. When the partial relevés are joined together to partial relevés of 50 m^2 or 100 m^2 the Frequency Classes IV and V increase somewhat (fig. 14) and the indices of heterogeneity decrease from 14.3 to 5.9 to 3.1. However, Raunkiaers principle still does not fit. Perhaps the 'minimal area' is so large that the partial relevés must be the size of the moss patches (see p. 82). The number of frequency relevés and the number of fungi in these frequency relevés is for the Dicrano-Quercetum neither extremely low or high when compared with the other associations. The Annual Frequency shows a relatively constant myco-vegetation, so it is unlikely that the relevés

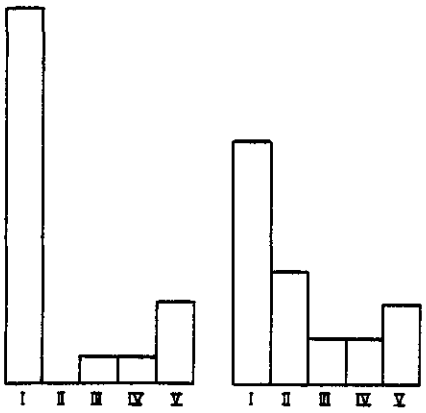

Fig. 13. Frequency histograms for the higher plants (left) and for the mosses (right) in the Dicrano-Quercetum.

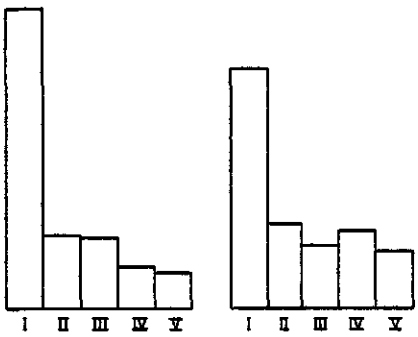

Fig. 14. Frequency histograms for partial relevés of 50 m^2 (left) and of 100 m^2 (right) in the Dicrano-Quercetum.

are incomplete.

The conclusion is that the Dicrano-Quercetum plots have a heterogeneous vegetation of mosses and fungi. The 'minimal area' for fungi may be very large. It should be noted that the myco-vegetation of the Dicrano-Quercetum is heterogeneous (in space) and constant (in time).

6.3.3 *The relation between the frequency and the abundance*

The relation between the TSF and the abundance of carpophores (highest abundance of carpophores measured in the frequency relevés was used) was similar in each vegetation type for (fig. 15, 4 plots were compared). Most of the fungi in this figure, 62%, had a characteristic abundance of 1-5 specimens per partial plot, of these 85% had a TSF of 50% or less; 13% had a characteristic abundance of 6-10 specimens per partial plot, 16% of 11 and more specimens, and 9% of less than 1 specimen per partial plot. The last mentioned were species that always grew in low abundance and SF, and reached a higher TSF because they grew in different partial plots every year.

Species with an abundance of carpophores in a composite plot of 10 or less had a TSF of 1-22(-32)%, those with abundance of 11-50 had a TSF of 1-68(-88)%, and those with 100 and more had a TSF of 15-100%. Because of this converting the abundance of carpophores into Spatial Frequency, or Spatial Frequency into abundance is impossible, or only a very rough estimate can be made.

For species that grew in nearly the same abundance in a partial plot, it is more or less possible to determine a characteristic relation TSF - abundance. Four examples are given in fig. 16. *Pluteus cervinus* had a characteristic abundance of 1-1.3 specimens per partial plot, and a TSF of 25% or less. *Phallus impudicus* had a characteristic abundance of 1-1.6 if the TSF was low, <15%, and up to nearly 3 if the TSF was higher. In *Hypholoma fasciculare* this relation is less stable. The values grouped themselves around 10 specimens per partial plot, but also 60 specimens per partial plot was reached. In *Armillariella mellea* the abundance was from 1 to more than 25 specimens per partial plot, showing that a characteristic relation between the TSF and the abundance did not exist.

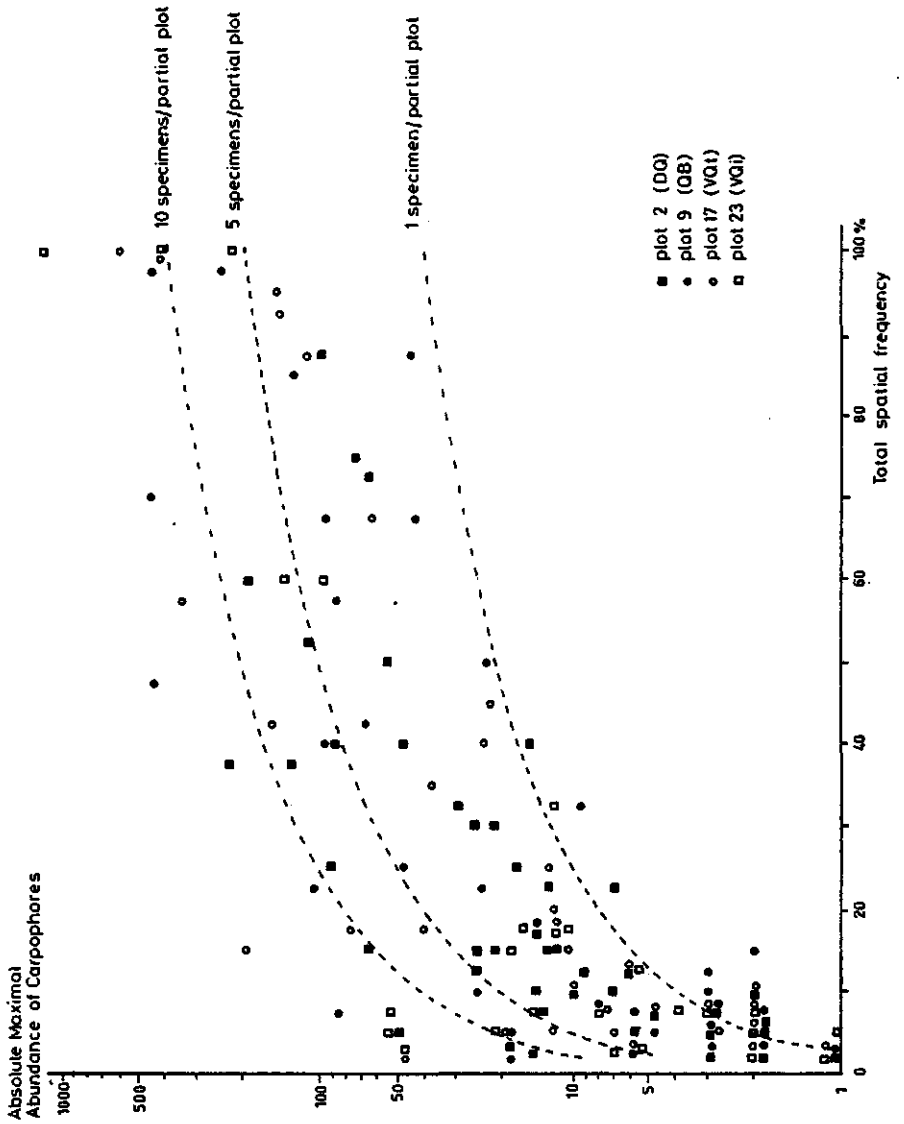

Fig. 15. The relation between the Total Spatial Frequency and the Absolute Maximum Abundance of Carpophores in four plots.

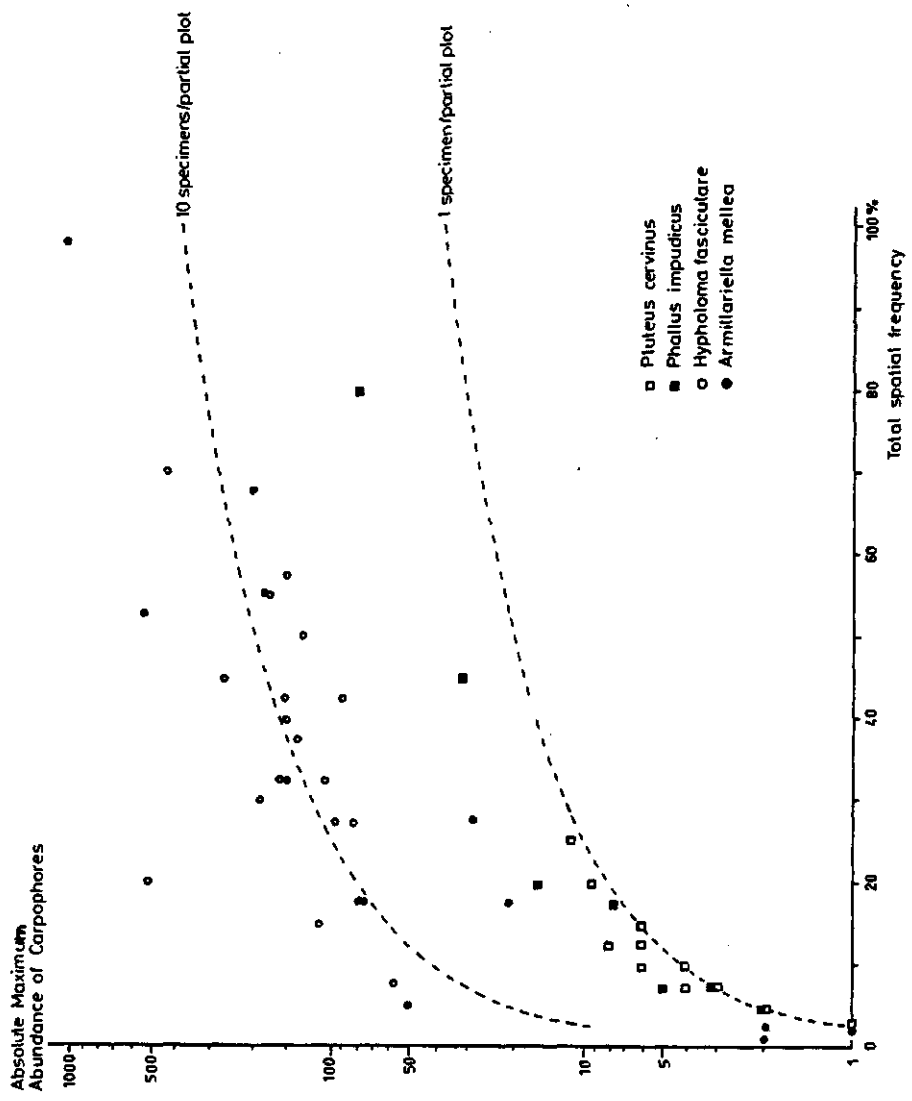

Fig. 16. The relation between the Total Spatial Frequency and the Absolute Maximum Abundance of Carpophores in four species.

7 *DISTRIBUTION PATTERNS*

7.1 INTRODUCTION AND METHODS

The total frequency relevés were 'mapped' for easy recognition of the spatial patterns. A 'map' was drawn of each fungus species in each composite plot. The Absolute Maximum Abundance of Carpophores was indicated in each partial plot: 1, 2, and 3 specimens were counted, 4 and more specimens were divided into classes of 4-10 specimens, 11-29, 30-79, 80-189, and 190 and more specimens. This is Van der Maarel's (1971) classification.

The distribution patterns of the fungus species in a composite plot, studied on the 'maps' could be random, underdispersed or overdispersed (=clustered). Pielou (1969: 107) gives a statistical method for discriminating random from underdispersed and overdispersed in a gridmap for each spatial frequency. On the maps the number of joins were counted between the partial relevés where a species was found. The distribution is called underdispersed if there are less joins (significant with $p<0.05$) than was expected according the null hypothesis of random mingling of partial relevés with and without the species. The distribution is called clustered if there are more joins (significant with $p<0.05$) than was expected.

The maps were also used to recognise correlated distribution patterns of fungi in relation to each other, or of fungi in relation to mosses or higher plants. Correlation between species is expressed by the coefficient $V=(ad-bc)/(mnrs)^{\frac{1}{2}}$. (a is the number of partial relevés where both species were present, b and c the number of partial relevés where only one species was present, d the number of partial relevés 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 according to Pielou (1969: 163) whether the values for V were significant. If significant with $p<0.05$ then a * is placed after the values for V. Values for V are meaningless for species with a very low TSF, <5%, or a very high TSF, >90%.

Correlation can be expected in fungi that depend on other fungi, mosses or higher plants. In general a plot is heterogeneous for a dependent fungus, because the substrate is usually not homogeneously distributed.

7.2 DISTRIBUTION PATTERNS

Three patterns are possible, random (actually: not significantly different from random), significantly clustered, and significantly underdispersed. Significantly underdispersed patterns were not found at all. Apparently

underdispersion is not only scarse in higher plants but it is also scarse in fungi. Significant clustering did not often occur. 680 distribution patterns were observed; the pattern was random 537 times and clustered 143 times. 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 random distributed: *Amanita rubescens* (random 1×, clustered 2×), *Clitocybe flaccida* (r 0, c 2) (fig. 17), *Galerina calyptrata* (r 1, c 2), *Hapalopilus rutilans* (r 1, c 2), *Inocybe napipes* (r 1, c 2), *Lactarius chrysorheus* (r 0, c 2), *Marasmius epiphylloides* (r 0, c 3), *Scleroderma citrinum* (r 4, c 7) (fig. 18), *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. 19), 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). Thw 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, 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 fungus species were only clustered in a few plots. Only *Scleroderma cirtinum, Lactarius quietus,* and *Psathyrella squamosa* formed patches in 4 or more composite plots. Patches can be formed if a. the mycelium is so extended that it is spread over 2 or more partial plots, or b. the mycelia are clustered.

a. The mycelium was spread over several partial relevés. It may happen that carpophores that apparently belong to a single mycelium growing at the border of a partial plot, are spread over 2 or more partial plots. This was often observed in fungi growing on prostrate decaying stems, such as *Hapalopilus rutilans, Tyromyces chioneus, Polyporus brumalis,* and *Gymnopilus hybridus*. (fig. 20-23). A small patch will probably be formed by only one mycelium. It was not possible to determine in extended patches whether it was one extended mycelium, or several small mycelia growing together. E.g. the clusters in *Clitocybe flaccida* in plot 12 (fig. 17), *Scleroderma citrinum* in plot 14 and 20 (fig. 18), *Collybia peronata* in plot 16 (fig. 19). This makes it difficult to separate point a from point b.

b. The mycelia are clustered. If the clustering of the mycelia is caused by intrinsic growth characteristics of the species, I expected them to cluster in all the plots in which they were observed, at least within one vegetation type. Three species showed this feature, *Lactarius chrysorheus*

(fig. 24), *Marasmius epiphylloides* (fig. 30), and *Typhula phacorrhiza* (fig. 31). The clustering of *M. epiphylloides* and of *T. phacorrhiza* is certainly caused by the inhomogeneity of the plots for these species (see p. 87). It was not possible to determine whether the plots were heterogeneous for *L. chrysorheus*, nor to determine whether it was one very extended mycelium (250-500 m^2) per plot, or several smaller mycelia, growing clustered. The clustering can either be a characteristic of *L. chrysorheus*, or can be the result of inhomogeneous plots.

Legend to the distribution patterns (Fig. 17-35).

Abundance of fungi is indicated as follows:

- 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

r indicates that the distribution was random, c that the distribution was clustered. The higher plant cover is given in Braun-Blanquet symbols.

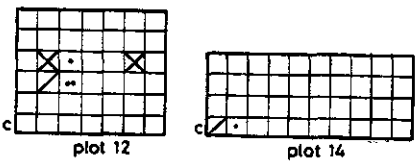

Fig. 17. Distribution and abundance of *Clitocybe flaccida*.

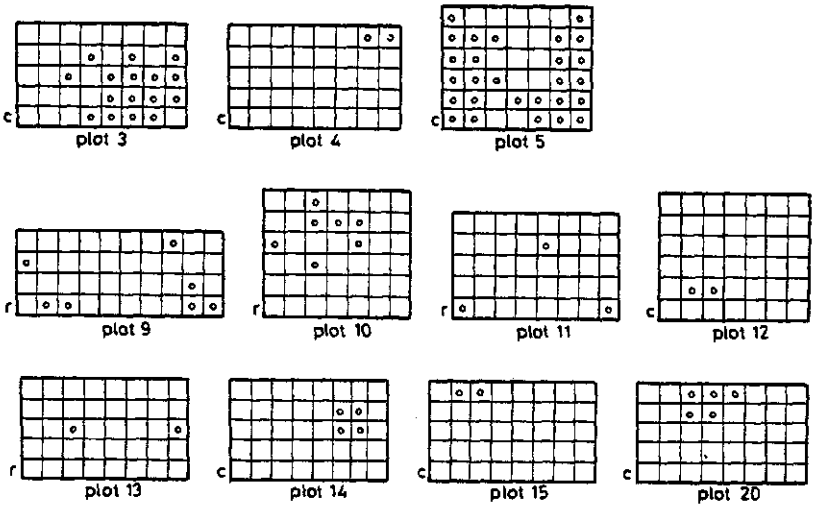

Fig. 18. Distribution of *Scleroderma citrinum* in several plots. Only presence is indicated.

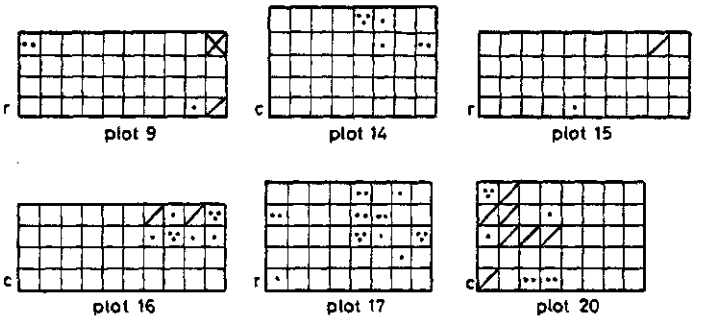

Fig. 19. Distribution and abundance of *Collybia peronata*.

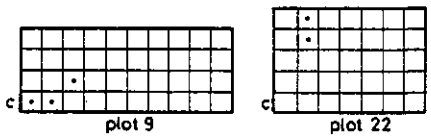

Fig. 20. Distribution and abundance of *Hapalopilus rutilans*.

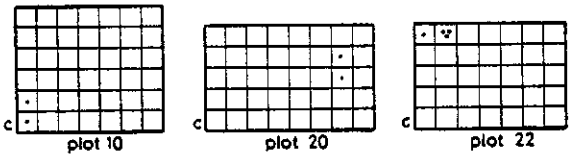

Fig. 21. Distribution and abundance of *Tyromyces chioneus*.

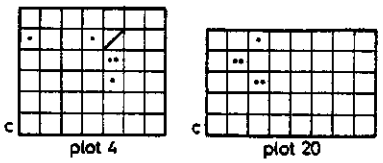

Fig. 22. Distribution and abundance of *Polyporus brumalis*.

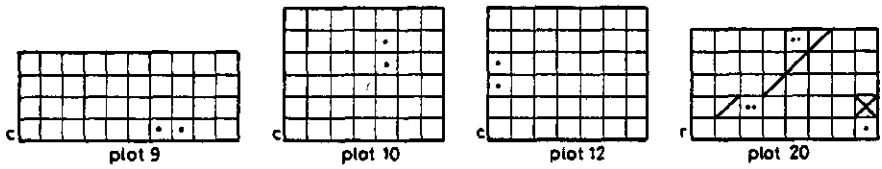

Fig. 23. Distribution and abundance of *Gymnopilus hybridus*.

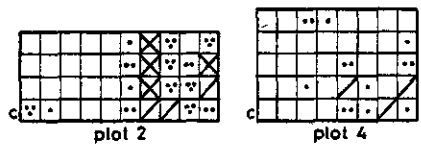

Fig. 24. Distribution and abundance of *Lactarius chrysorheus*.

7.3 CORRELATED DISTRIBUTIONS

In the Dicrano-Quercetum, plots 2 and 3, a strong correlation was observed between partial plots with a large number of fungus species (that is more species than the mean number of species in the partial plots of a composite plot) and partial plots with a high cover of terrestrial moss (cover >5%) (0.48*, 0.77*).[1])

Three species showed a significant correlation with high mosscover 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: *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 galopus* (0.38*, 0.02), *Russula emetica* (-0.12, 0.58*), *R. fragilis* (0.08, 0.56*), *Telephora terrestris* (-0.12, 0.45*), *Paxillus involutus* (0.00, 0.40*), *Xerocomus badius* (0.15, 0.43*), and *Amanita fulva* (0.24, 0.49*). See fig. 25 and 26.

[1]) Values for V are mentioned in parenthesis, first of plot 2, second for plot 3. - means no observation because the species did not occur in that plot or in less than 3 partial relevés.

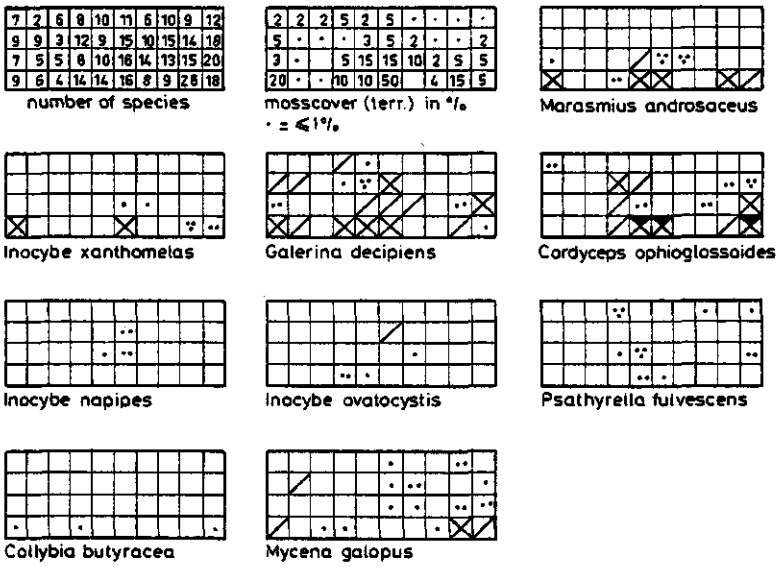

Fig. 25. Distribution of the number of species, of the moss cover, and the distribution and abundance of some fungi in plot 2.

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 micro-community with its own fungus species. The moss patches were rather large, 25 to 300 m², and covered 40% of the plot area in plot 2 and 35% in plot 3. The moss patches indicate, and probably cause, the heterogeneity of the DQ mentionned on pag. 71. Which agents determine the growth of mosses is not known. A correlation with Quercus robur cover <75% exist (0.29, 0.42), but if this is an agent it is probably not the only one.

Partial plots with a high number of fungus species (more species than the mean number in partial plots in this composite plot) correlated significantly with partial plots with a low cover of the herb layer (<10%) in plot 14. V=0.32*, see fig. 28. Partial plots with a low cover of the herb layer are significantly clustered, as are partial plots with a high number of fungus species. I do not know whether the fungi are the cause or the result of the 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 fungus flora was found where phanerogam flora was poor. Few species correlated with a low cover of

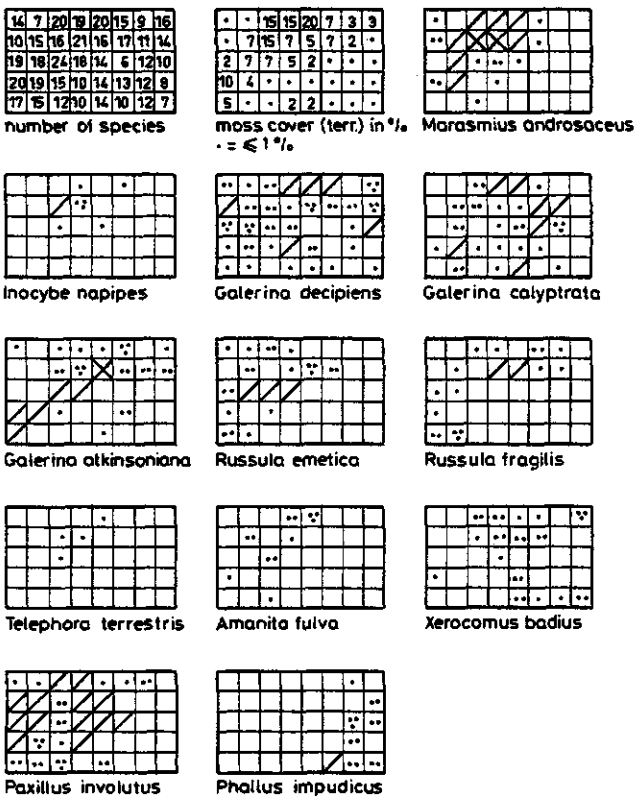

Fig. 26. Distribution of the number of species, of the moss cover, and the distribution and abundance of some fungi in plot 3.

the herb layer (fig. 27) *Clitocybe vibecina* V=0.49* and *Oudemansiella platyphylla* V=0.43*; and some other species with a lower value for V and not significant such as: *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 erect, dead wood.

High density of the herb layer in plot 14 was caused by high densities of *Maianthemum bifolium, Deschampsia flexuosa,* and *Hedera helix,* only or in combination, and never exceeded 40% of a partial relevé. *Marasmius epiphylloides* (V=0.91*, see fig. 30) 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.

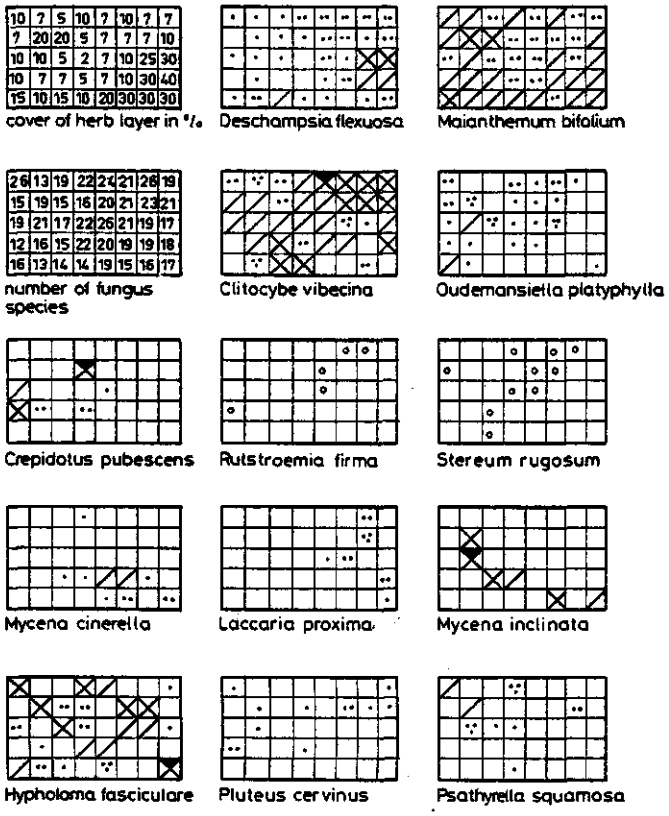

Fig. 27. Distribution of the herb layer cover, of the number of fungus species, and the distribution and abundance of some plant and fungus species in plot 14. (In *Rutstroemia firma* and *Stereum rugosum* only presence was indicated.)

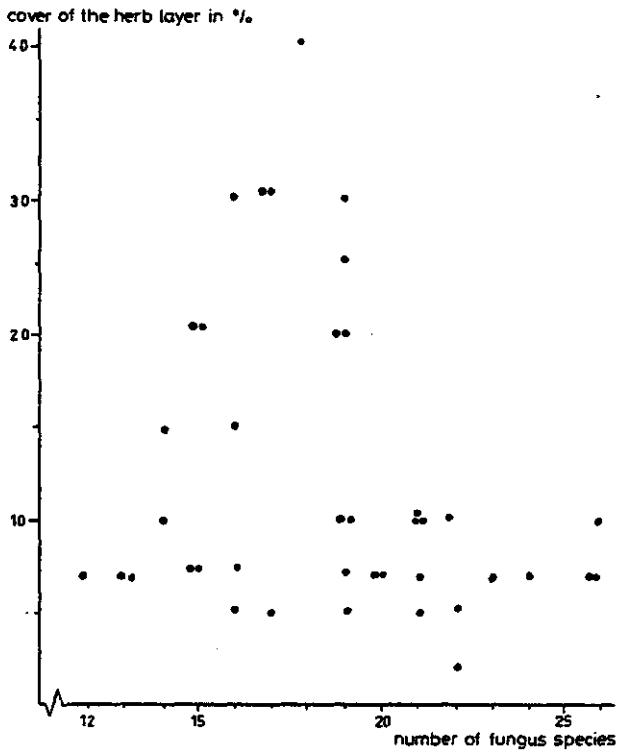

Fig 28. Relation between the number of fungus species and the herb layer cover in the partial relevés of plot 14.

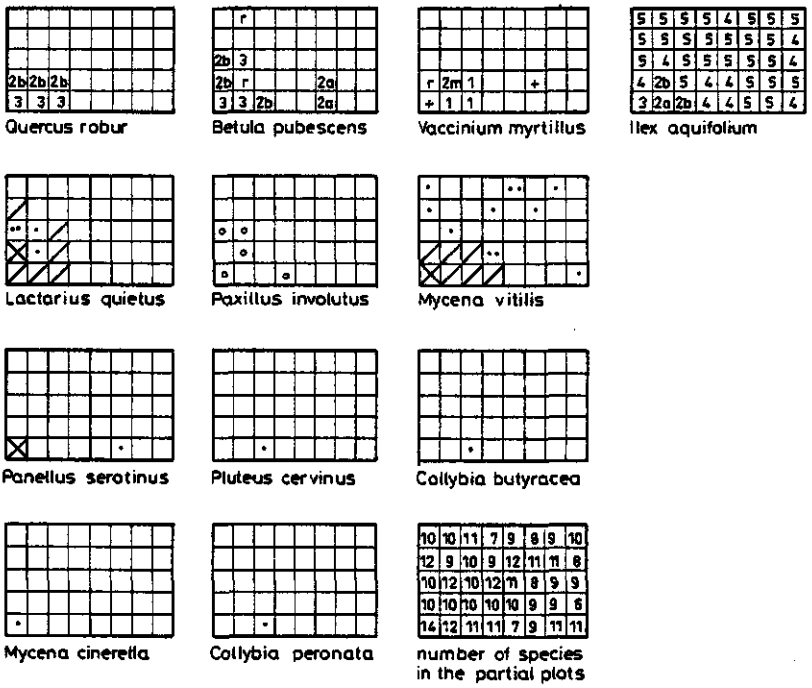

Fig. 29. The distribution and abundance of some higher plants and fungi, and the distribution of the number of fungus species in plot 24. (In *Paxillus involutus* only presence was indicated.)

In plot number 24 the plant species *Quercus robur*, *Betula pubescens*, and *Vaccinium myrtillus* were not homgeneously distributed but grew together in only a small part of the plot (fig. 29). The density of *Ilex aquifolium* in this part was slightly less than in the rest of the plot (fig. 31). Shrub and herb layer were almost absent in the whole plot.

Several fungus species followed *Quercus robur*, *Betula pubescens*, and *Vaccinium myrtillus*. Correlations were (values for V are given):

	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*
id. ⩾4 specimens	0.91*	0.49*	0.83*
Panellus serotinus	0.22	0.40*	0.20
Pluteus cervinu s	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 fungus species mutually was very low and not significant. These fungi probably depended on these plants. The influence of the plants was not very great. The number of fungus species in this part was not larger than in the other parts of this plot.

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

Heterogeneity of a plot is also shown for fungi depending on a special substrate, such as (litter of) a specific plant or another fungus. These substrates are often not quite homogeneously distributed throughout the plot, so the plot is not homogeneous 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 terrestrially, cover >5% of 0.91* in plot 14, of 0.46* in plot 15, and of 0.43* in plot 17 (fig. 30). *H. helix* had a clustered distribution in these 3 plots, so the plots were inhomogeneous for *M. epiphylloides*. As a result the distribution of *M. epiphylloides* was also clustered. It is not known which agents prevented *M. epiphyloides* from growing in all partial plots with a 5% or more cover of terrestrial *H. helix*.

The leaves of *Ilex aquifolium* are the substrate for *Typhula erythropus* and *T. phacorrhiza*. These fungi were only found in the plots 20 and 24, where they correlated with *I. aquifolium* in the tree layer cover >75% (fig. 31). Values for V are 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 is only suitable for the *Typhula* species if the density of the *Ilex* trees is high. The fungi were not found in other plots with high *Ilex* densities. Apparently there are other factors that prevented the fungi from growing there.

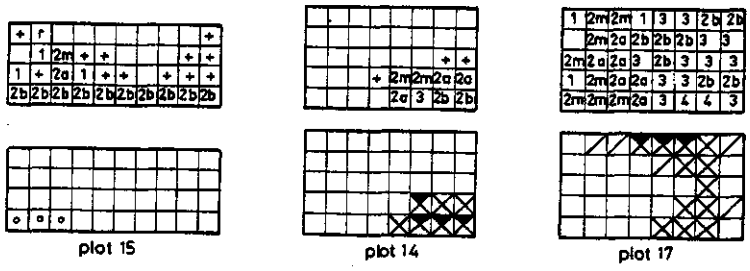

Fig. 30. Distribution and abundance of terrestrial *Hedera helix* (above) and of *Marasmius epiphylloides* (below, in plot 15 only presence is indicated).

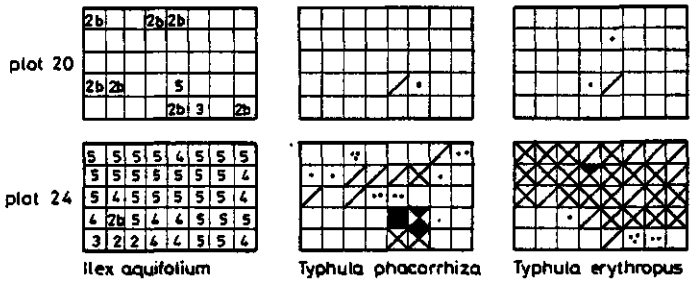

Fig. 31. Distribution and abundance of *Ilex aquifolium* (tree layer), *Typhula phacorrhiza*, and *T. erythropus* in plot 20 and 24.

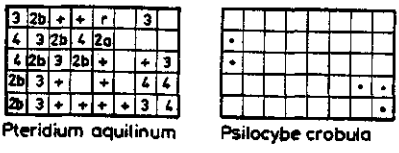

Fig. 32. Distribution and abundance of *Pteridium aquilinum* and of *Psilocybe crobula* in plot 20.

Psilocybe crobula was found to grow on the petiolus of leaves of *Pteridium aquilinum* in plot 20 (fig. 32). Correlation was 0.52*. Correlation with *P. aquilinum* cover >50% was much higher, 0.90*. Apprently *P. crobula* prefers high densities of *P. aquilinum*. The species also grew together in two other plots, but no correlation was found, -0.08 in plot 15, and 0.07 in plot 17.

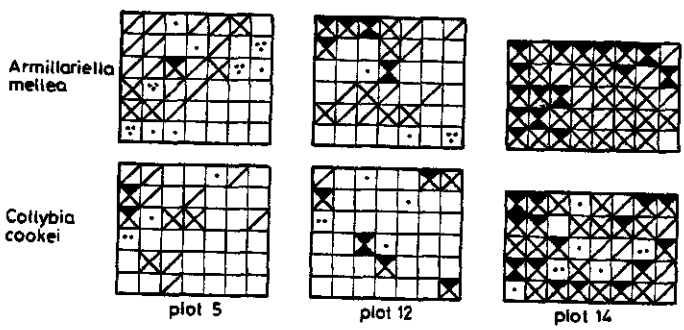

Fig. 33. Distribution and abundance of *Armillariella mellea* and *Collybia cookei* in plot 5, 12 and 14.

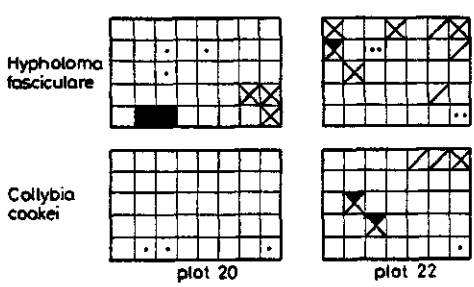

Fig. 34 Distribution and abundance of *Hypholoma fasciculare* and *Collybia cookei* in plot 20 and 22.

Collybia cookei grows on 'rotten' fleshy fungi. In fact the substrate is not 'rotten', but it is a kind of sclerotium. In several plot *C. cookei* grew on *Armillariella mellea* (fig. 33). In plots where both species grew together, in at least 2 and at the most all but 5 partial relevés, 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 the plots 5 and 12 the distribution of *C. cookei* depended, at least partly, on the distribution of *A. mellea*. In plot 14 the Spatial Frequency 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*. It is clear that also in this plot 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, do not explain the distribution of *C. cookei* in the plots 5, 12, and 14. In the plots 20 and 22 the distribution of *C. cookei* was correlated with the distribution of *Hypholoma fasciculare*, V=0.57*, and 0.38*. (fig. 34). 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% and/or cover >25% was found (fig. 35). The following values for V were found (only calculated in plots were *P. involutus* had a spatial frequency of at least 5% and *B. pubescens* at the most a spatial frequency of 90%):

	correlation(V) of *Paxillus involutus* with *Betula pubescens*		Spatial Frequency of *Betula pubescens*	
plot nr.	cover >12.5%	>25%	cover >12.5%	>25%
5	0.41*	-	12	0
9	0.19	0.35*	88	50
10	0.17	0.26	71	35
11	-	0.13	93	43
13	0.25	0.41*	80	38
14	0.43*	0.31	35	32
15	0.13	0.14	80	50
16	0.14	0.09	53	8
24	0.46*	0.48*	20	8

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 frequency (>80%) of *B. pubescens* there was a correlation with *B. pubescens* cover >25%. No (significant) correlation was found in 4 plots. *P. involutus* can also form mycorrhiza with *Quercus robur*. This was apparently the case in the 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*.

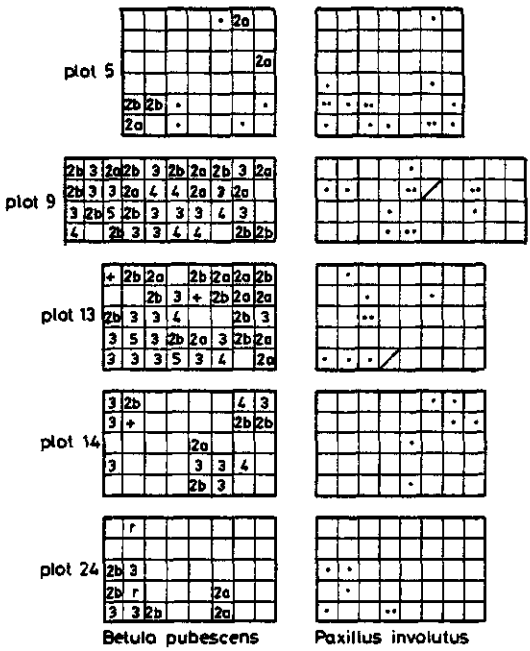

Fig. 35. Distribution and abundance of *Betula pubescens* in tree layer, and *Paxillus involutus* in several plots.

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 partial plots): in plot 3: -0.59*, in plot 5: -0.02, in plot 11: -0.21, in plot 13: -0.14, in plot 15: -0.05, in 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. 26).

8 *COMPOSITION OF ECOLOGICAL GROUPS*

Within the fungus vegetation in these oakwoods 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; parasites; and fungi on dung and bird pellets. Every species was classed in one of those groups. Some species were difficult to class, e.g. it is not always known whether a species is mycorrhizal. For the species of genera such as *Cortinarius* and *Lactarius* this question is beyond doubt, but in genera such as *Inocybe* and *Tricholoma* opinions are at variance. Species can also be optionally mycorrhizal, such as *Laccaria* species. Following literature (mainly Trappe 1962) I considered as mycorrhizal the species of the genera *Amanita, Boletus, Cantharellus, Cortinarius, Dermocybe, Hebeloma, Hydnellum, Inocybe, Lactarius, Leccinum, Paxillus, Phallus, Phellodon, Phylloprus, Russula, Sarcodon, Scleroderma, Tricholoma, Tylopilus, Xerocomus* (except *X. parasiticus*), and *Lepista nuda*.

The saprophytus were split up in 3 groups, terrestrial growing humus saprophytus, saprophytes on decaying wood of stumps, trunks, logs, branches, and saprophytes on litter, fallen leaves, fruits, dead herbaceous plants, and mosses (shortly called litter saprophytes). Saprophytes growing on decaying wood of stumps, trunks, logs, and branches are generally easy to distinguish, as this way of growing is usually a clear characteristic. Classed as wood saprophytes are the 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 grow to the humus or on the fallen leaves. I considered humus saprophytes the 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*.

In the group of litter saprophytes it was sometimes difficult to distinguish between saprophytes and parasites. Especially in some species

growing on herbs, such as *Mycena rorida, Crepidotus pubescens,* it was not clear whether they grew on dead or on still living herbs, or in other words, whether they were saprophytes or parasites. I considered them as saprophytes just 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 the species of the genera *Ciboria, Clavariadelphus, Collybia* (except *C. fusipes*), *Crepidotus* (except *C. haustellaris*), *Marasmius, Psilocybe, Rickenella, Typhula,* and some of the species of *Galerina, Mycena.*

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

The number of species in each ecological group were counted per vegetation type and for all vegetation types together (table 10). The ecological group of the mycorrhiza species is especially important in the Dicrano-Quercetum. Many of the mycorrhiza species found in this study were present here, and nearly one third of the number of species in the Dicrano-Quercetum were mycorrhiza species. The number and proportion of mycorrhiza species was much lower in the Querco-Betuletum, and still lower in the Violo-Quercetum.

The group of the humus saprophytes is almost equally important in all the vegetations types. The number in the Violo-Quercetum ilicetosum was slightly lower, but in proportion it equaled that in the other vegetation types.

The group of saprophytes on wood is especially important in the Violo-Quercetum ilicetosum, where 62 species were present. Nearly half the number of species in this sub-association were wood saprophytes. About the same number of species was present in the Violo-Quercetum typicum and the Querco-Betuletum, but there it were smaller proportions of the total number of species. A much smaller number (and proportion) was present in the Dicrano-Quercetum. The low number in the Dicrano-Quercetum is probably caused by the sparse covering of the microhabitat of 'dead stumps and logs', 0.07% (see table 2). This microhabitat is more frequent in the Quercion robori-petraeae, covering 1.5% in the Querco-Betuletum, 1.6% in the Violo-Quercetum typicum, and 1.0% in the Violo-Quercetum ilicetosum.

The ecological group of saprophytes on litter is largest in the Querco-Betuletum and the Violo-Quercetum typicum. A smaller number was present in the Violo-Quercetum ilicetosum, but in proportion it equaled that in the Querco-Betuletum and the Violo-Quercetum typicum. In the Dicrano-Quercetum the number (and proportion) was slightly lower than in the associations of the Quercion robori-pertraeae.

Table 10: Ecological groups. Number of species in the 6 groups per vegetation type (in parentheses: percentage of the total number of species in that vegetation type) and of all the vegetation types together. M=mycorrhiza species, H=humus saprophytes, W=saprophytes on decaying wood, L=saprophytes on litter, and branches, fallen twigs, leaves or 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 ilicetosum	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 groups of the parasites and of the species on dung had only a very small share in the composition of the mycoflora, which did not differ much in the 4 (sub-)associaions.

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

SUMMARY

In this thesis the fungus vegetation, the vegetation of phanerogams, mosses, and lichens, and the soil (profiles and chemical analysis) are described in the associations Dicrano-Quercetum, Querco-Betuletum, and Violo-Quercetum, both typicum and ilicetosum in the province of Drenthe (North East Netherlands).

The vegetation of phanerogams, mosses, and lichens were described with the aid of relevés according to the Braun-Blanquet method with a modification according to Barkman et al. The synusia of mosses on dead truncs, stubs, and logs was separately described, because it is the substrate for some fungus species. The correct names of the syntaxa and the synsystematical position were determined with the aid of literature. The character and differential species mentioned in literature were discussed. The Querco-Betuletum and the Violo-Quercetum appeared to be closely related associations, belonging to the alliance Quercion robori-petraeae. The Violo-Quercetum ilicetosum was described as a new sub-association. Barkman's opinion, the Dicrano-Quercetum is an independent association, was confirmed. This association has many differential species (almost only mosses and lichens), therefore the affinity with the associations of the Quercion robori-petraeae is low, and it is not included in this alliance.

The plots of the 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 other had distinct humus podzol profiles. The Violo-Quercetum ilicetosum plots had relatively deep profiles, with often a thick A1h layer. In the Violo-Quercetum typicum and the Querco-Betuletum the profiles were more shallow, and an A1h layer was usually absent. The topsoil is the Querco-Betuletum plots was generally disturbed. The Dicrano-Quercetum plots appeared to be located on soils of young drift sands, in which a profile was only weakly developed ('duin', vague soil with a micropodzol).

Chemical analyses were made from samples of the A0 and the A21 layers. In these layers the largest amount of mycelia is present. The soils appeared to be very acid, pH 2.9 - 3.5 in the A21 layer, 3.3 - 4.7 in the A0 layer. In the A0 layer Na, K, Mg, and Ca ions (given in mass fraction and mass concentration) were present in almost the same quantities in all the different types of vegetation. In the A21 layer the concentrations were highest in the Violo-Quercetum ilicetosum, and lowest in the Dicrano-Quercetum. The 'total ion supply' was highest in the Violo-Quercetum ilicetosum, was much lower in the Violo-Quercetum typicum and the Querco-Betuletum, and lowest in the Dicrano-Quercetum. The C/N ratio, however, increased in this sequence.

Description of the fungus vegetation was based upon synthetical relevés of permanent sample plots studied during four years in succession. The number of fungus species (314) largely exceded that of phanerogams and ferns (72) or mosses and lichens (67). Criteria were drawn up to distinguish differential species in the fungus vegetation.

The Dicrano-Quercetum and the Quercion robori-petraeae have in relation to each other many differential species. This supports the idea that the Dicrano-Quercetum does not belong to the Quercion robori-petraeae. The Querco-Betuletum and the Violo-Quercetum have in relation to each other less differential species, but are also good characterized. The Dicrano-Quercetum and the Violo-Quercetum ilicetosum, both very poor in vascular plant species, appeared with the aid of fungus species to be characterized better. This holds especially for the Violo-Quercetum ilicetosum, which is also very poor in (terrestrial) mosses and lichens.

The 'minimal area', or actually the representative plot size appeared to be 1500 m^2 in the Quercion associations, and to be at least 3000 m^2 in the Dicrano-Quercetum.

A new characteristic, the 'Total Spatial Frequency' (TSF) has been created to give an aproximation of the real abundance of fungi, i.e. the abundance of mycelia: the proportion of the number of partial plots of a permanent plot in which carpophores of that species were ever observed during the research period. The absolute maximum abundance (AMAC) does have a certain correlation to the TSF, but it is generally impossible to convert one characteristic into the other.

The determination of the TSF also yielded results on some other aspects. Thus it was possible to prove that Raunkiaers law of constant species also applies to the fungi of the Quercion robori-petraeae, but not to the fungi of the Dicrano-Quercetum (in contrast to the vegetation of green plants of the Dicrano-Quercetum). The Dicrano-Quercetum appeared to be characteristicaly heterogeneous, more heterogeneous than the stands of the other syntaxa, owing probably to the large moss patches. Distribution patterns of the species within the plots were also studied. The distribution was mostly random, and never underdispersed (regular). Only 35 fungus species were clustered (overdispersed) in two or more plots. This may either occur if a mycelium is so extensive that it is spread over two or more partial plots, or if the mycelia were clustered, e.g. because of inhomogeneity of the plot, at least with regard to environmental factors affecting this species. Some examples were studied of correlated distributions of fungi in relation to each other, or of fungi in relation to vascular plants or mosses. Several fungus species (e.g. *Marasmius androsaceus, Galerina decipiens, Inocybe napipes*) had a correlation with the moss patches in both the Dicrano-Quercetum plots. In a Violo-Quercetum typicum plot high numbers of fungus species in partial plots correlated with a low cover of the herb layer. *Marasmius epiphylloides* correlated with terrestrial *Hedera helix*, but dit not

occur in all partial plots with a high cover of *H. helix*. *Collybia cookei* correlated with *Armillariella mellea* in some plots. Some other correlations were discussed.

The fungi were classed in ecological groups (the main groups were the mycorrhizal species, the saprophytes on humus, the saprophytes on wood and branches, and the saprophytes on leaves, fruits, herbs, and mosses) and the share of each of the groups in the fungus vegetation was determined. The Dicrano-Quercetum appeared to have very many, the Violo-Quercetum ilicetosum very few mycorrhizal species. The Dicrano-Quercetum had the fewest number of saprophytes on wood, the Violo-Quercetum ilicetosum the fewest number of humus saprophytes. The number of saprophytes on leaves etc. was highest in the Querco-Betuletum and the Violo-Quercetum typicum.

Short or longer notes, or descriptions are given of a number of fungus species with indentification difficulties, caused by the material or by taxonomical problems. A new fungus taxon is described: *Psathyrella fulvescens* var. *dicrani*.

LITERATURE

Bakker, H. de, & J. Schelling, 1966. Systeem van bodemclassificatie voor Nederland. Wageningen.

Bakker, J.G., 1969. Vegetatiekundig en oecologisch-geografisch onderzoek van het Quercion robori-petraeae in de Nederlandse zandgebieden ten zuiden van de Waal. Diss. 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 R.H. 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., H. Doing & S.Segal, 1964. Kritische Bemerkungen und Vorsläge zur quantitative Vegetationsanalyse. Acat 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. Numero special du Bull. Soc. linn. Lyon 45.

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

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

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

Bon, M. & J.M. Gehu, 1973. Unites superieures de vegetation et recoltes mycologiques. Doc. mycol. 6: 1-40.

Boois, H.M. de, 1976. Schimmelgroei in strooisellagen van enkele bosgronden. Diss. 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 verh. 3, Wageningen.

Bruylants, J., 1957. Inocybe sambucina Fr. Bull. Soc. myc. Fr. 73: Atl. pl. 111.

Cailleux, A. & G. Taylor, (s.a.). Code Expolaire. Paris.

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

Corner, E.J.H., 1950. A Monograph of Clavaria and allied Genera. Oxford. (Reprint 1967).

Corner, E.J.H., 1968. A Monograph of Telephora (Basidiomycetes). Beihefte z. Nova Hedwigia 27.

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

Dennis, R.W.G., P.D. Orton & F.B. Hora, 1960. New Checklist of british Agarics and Boleti. Suppl. to Trans. Brit. myc. Soc. (Reprint 1974, Lehre.)

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): 1-60.

Domanski, S., H. Orlos & A. Skirgiello, 1973. Fungi. Polyporaceae 2 (pileatea), Mucronoporaceae 2 (pileatea). Washington.

Donk, M.A., 1974. Check list of European polypores. Verh. K. Ned. Akad. Wet. 2e reeks, deel 62.

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 I-V. Oslo.

Friedrich, K., 1940. Untersuchungen zur Ökologie der höheren Pilze. Pflanzenforschung 22: 1-47.

Haas, H., 1978. Die Pilzflora des Naturparks Schönbuch. Mykol. 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(2): 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. & 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 3(1): 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. London.

Krieglsteiner, G.J., 1977. Die Markomyzeten der Tannen- Mischwälder des Inneren Schwäbisch-Fränkische Waldes (Ostwürttemberg) mit besonderer Berücksichtigung des Welzheimer Waldes. Schwäbisch Gmünd.

Kubiëna, W.L., 1953. Bestimmungsbuch und Systematik der Böden Europas. Stuttgart.

Kühner, R., 1935. Le genre Galera (Fr.) Quél. Paris.

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 I. Cortinarius. Bull. Soc. myc. Fr. 75: 88-101.

Kühner, R. & H. Romagnesi, 1953. Flore analitique des chapignons supérieurs. Paris.

Kühner, R. & H. Romagnesi, 1977. Compléments à la "Flore Analitique". (Reprint) Vaduz.

Lange, J.E., 1935-1940. Flora Agaricina Danica I-V. 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., afd. Natuurk. 2e reeks, deel 65.

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. Stuttgart/New York.

Munsell Soil Colour 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 Bialowieza. 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 recconaissance 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. 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 heft 2: 7-62.

Orton, P.D., 1955. Cortinarius I. Suppl. to "The Naturalist" July-September 1955.

Passarge, H. & G. Hofmann, 1968. Pflanzengesellschaften des nordostdeutschen Flachlandes II. Jena.

Pielou, E.C., 1969. An Introduction to Mathematical Ecology. London/New York.

Runge, A., 1960. Pilzökologische und -soziologische Untersuchungen in den Bockholter Bergen bei Münster. Abhandl. Landesmus. f. Naturk. Münster Westfalen.

Runge, A., 1963. Pilzsukzession in einen Eichen-Hainbuchenwald. Zeitschr. f. Pilzk. 29: 65-72.

Scamoni, A. & H. Passarge. 1959. Gedanken zu einer natürlichen Ordnung der Waldgesellschaften. Arch. f. Forstwesen 8(5): 386-426.

Smarda, 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. New York.

Stangl, J., 1977. Die eckigsporingen Risspilze 3. Z. Mykol. 43: 131-144.

Stangl, J., 1980. Inocybe xanthomelas Kühn. et Bours. und andere Risspilze während der 12. Mykologische Dreiländertagung 1979. Z. Mykol. 46: 111-113.

Thoen, D., 1976. Facteurs physiques et fructification des chapignons superieurs dans queques pessieres d'Ardenne meridionale (Belgique). Bull. Soc. linn. Lyon 45: 269-284.

Trappe, J.M., 1962. Fungus associates of ectotrophic mycorrhizae. The Bot. Rev. 28: 538-606.

Tüxen, R., Ueber einige nw-deutsche Waldassoziationen von regionaler verbreitung. Jahrb. Geogr. Ges. Hannover 1929.

Tüxen, R., 1937. Die Pflanzengesellschaften Nordwestdeutschlands. Mitt. Flor.-soz. Arbeitgem. Niedersachsen heft 3: 1-170.

Tüxen, R., 1955. Das System der Nordwestdeutsche Pflanzengesellschaften. Mitt. Flor.-soz. Arbeitsgem. NF 5: 155-176.

Tüxen, R., unter Mitwirkung von B. Caron, 1977. Bibliographia Phytosociologica Syntaxonomica Lieferung 30: Quercetea robori-petraeae. Vaduz.

Vries, G.A. de, 1971. De Fungi van Nederland III. Hypogaea. KNNV, Hoogwoud.

Westhoff, V. & A.J. den Held, 1969. Plantengemeenschappen in Nederland. 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 Bad.-Württ. 44/45: 51-118.

Ypelaar, P., in prep. Mycosociologisch onderzoek van het Dicrano-Quercetum.

LIST OF PLOTS APPENDIX 1

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 m². Schrubby oak wood almost without a herb layer, but 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 m² + about 1000 m². 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 m² + about 2000 m². 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 m² + about 500 m2. 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 m² + about 1000 m². 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 m². 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 m². 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 m². 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 m² + about 1000 m². 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 m² + about 500 m2. Oak-brich 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., Wersterbork, 1 km NNW of the village of Mantinge, Noordlagerbos; Tm 17D, 536.9 - 237.4. Area 1000 m² + about 1000 m². 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 m² + about 500 m². Oak-brich wood with amongst others *Lonicera periclymenum*, *Deschapsia 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 m² + about 500 m². 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 m² + about 500 m². 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 m² + about 1000 m². 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 19th century.

16. Ov., Steenwijk, 5 km N of the village of Steenwijk, Heerlijkheid De Eese; Tm 17E, 537.7 - 203.6. Area 1000 m² + 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 19th century.

17. Dr., Vries. 1 km NW of the village Zeijen, Zeijer strubben; Tm 12B, 563.8 - 232.1. Area 1000 m² + about 200 m². Oak-brich 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 Hooghalen, Winkelbos; Tm 17B, 548.3 - 233.3. Area 700 m². 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 m². 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 Mantinge, Mantingerbos; Tm 17D, 536.5 - 236.9. Area 1000 m² + about 500 m². High oak-birch wood, with a great deal of *Stellaria holstea* 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 Mantinge, Thijnsbosje; Tm 17D, 536.7 - 236.7. Area 500 m². 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 Zeijen, Zeijerstrubben; Tm 12B, 563.7 - 232.2. Area 875 m² + about 1000 m². High oak-*Ilex* wood. An old wood, marked on the 1823 map.
23. Dr., Norg, Norgerholt; Tm 12A, 564.1 - 226.3. Area 1000 m² + about 1000 m². High oak-*Ilex* wood. Old, marked on the 1823 map.
24. Dr., Westerbork, 1 km NNW of the village Mantinge, Mantingerbos; Tm 17D, 536.5 - 236.9. Area 1000 m² + about 2000 m². 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 Wijster, De Hulzedink, Tm 17D, 532.9 - 232.2. Area 300 m² (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 Hoogeveen, Kinholts bosje; Tm 17C, 527.0 - 226.7. Area 1000 m². 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 Emmen, along the Oevermansweg; Tm 17H, 531.8 - 259.1. Area 800 m². 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 Mantinge, Thijnsbosje; Tm 17D, 536.7 - 236.7. Area 500 m². 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 m², criss crossed or transversed by many paths and drains. High oak-*Ilex* wood. Old wood, marked on the 1823 map.

Nomenclature is used according to Moser (1978) for *Agericales* and *Boletales* (except for some recently monographed genera the monographs were followed); 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 identifiaction.

Material of many species were conserved (exsiccata) at the herbarium of the Biological Station, Wijster. Some collections from the Rijksherbarium, Leiden, were studied, these are indicates with (L).

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

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

Armillariela mellea. The small species into which *A. mellea* has been split are not distinguished here.

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

C. candicans. Often a small, membranaceous, white Clitocybe was found. It had crowded, thin gills, nearly without smell or taste and clearly belonged to the group of the *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 younger synonym.

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

C. vibecina. *C. langei* Sing. ex Hora is included, as I consider them as 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-coralloid branched, to clavate with thin branches, to capitate or almost spheropedonculate. They were both

found growing terrestrial and on oaktruncs.

C. cf kuehneriana. Only one specimen was found. It was too old to determine accurately.

Coprinus domesticus, *C. micaceus*, *C. radians* and *C. xanthothrix* are listed under *Coprinus* section *Micacei* in table 7 and 8 (see also p.54).

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

Cordyceps spec. 1. Sent to dr. R.A. Samson for determination; publication is in preparation.

Cortinarius albofimbriatus Det. P. Ypelaar.

C. alboviolaceus. Det. P. Ypelaar.

C. bolaris. Det. P. Ypelaar.

C. decipiens s. Lge. Det. P. Ypelaar.

C. decipiens s. Henry. Very often a rather small, brown Telamonia with distinct, conical papil, on a rather long and slender stem was found, which I consider as *C. decipiens* s. Henry. As there are very few publications available on this fungus here fellows a description of the specimens studied.

Cap 15 - 35 mm wide, first convex to pulviné, then plano-convex to flat, sometimes with undulate to ascending margin, always with distinct, conical papil with rounded top, dark brown, dark redbrown, Munsell 2.5YR 2/4-3/6, 5YR 2/2, 3/2-4, 4/3, 7.5YR 3-4/2-4, often paler 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 velum fibres, when older these are only present on the margin or it is glabrous. Gills (L 21-28, l 3-7) slightly emarginate, (3-)4-5(-7) mm high, distant, about 8-12/cm half way margin and cap centre, yellowish ochre, 7.5YR 4/4, 5/6-8, 10YR 5/8, 6/6, edge entire or crenated, when young whiter than the sides, when old nearly the same colour as the sides. Stem (30-)45-75(-90)×2-5 mm, cylindric, base sometimes slightly broader up to ×6 mm, occasionaly bent, and sometimes rooting slightly, with fine longitudinal white, silk-like shining fibrils, when very wet colour of stem flesh shines through, sometimes it has an indistinct band of white velum fibres halfway, foot with white, occasionally slightly pink tomentum, which sticks the substrate together. Flesh in cap thin, ± 1 mm, in the papil thicker, same colour as the surface; in stem 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 (approximately 200 measurements in 11 collections), Q 1.68-1.76-1.90, ellipsoid to oblong, often with one big oildrop, 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, 1- to more-celled, topcell sometimes nearly spherical, in clusters, in old specimens often indistinct; edge usually partly sterile. Habitat.-- In rather nutrient poor but humus rich oakwoods on sandy soils, on and between half rotten litter, clustered together. Collections examined.-- Netherlands: prov. Drenthe, Amshoffsbos 10-X-1977, AEJ 252, 1-X-1979, AEJ 559 and 560; Tonckensbos 30-X-1978, AEJ 402, 1-XI-1979, AEJ 587; Schoonloër strubben 19-X-1976, AEJ 492, 29-IX-1977, AEJ 586, 22-VIII-1979, AEJ 471; Schoonloër strubben 3-X-1978, AEJ 366; Heuvingerzand 12-IX-1977, AEJ 220; prov. Overijssel, De Eese 7-IX-1977, AEJ 491, 15-IX-1977, AEJ 233, 26-X-1978, AEJ 400, 20-VIII-1979, AEJ 464, 10-IX-1979, AEJ 529. (All collections in Herb. Wag-W).

The big, large spores and the cheilocystidia are characteristic. Both characters fit *C. decipiens* s. Henry mentioned by Kühner & Romagnesi (1953). Moser (1978) did not mention this fungus. It is a great pity that I was not able to consult Henry's original description.

In the Winkelbos (plot 18) I found some specimens (8-X-1979, AEJ 566) which were very similar to the above described *C. decipiens* but the papil 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 if it belongs to the same or to some other species. In table 7 it is given under *C. decipiens* s. Hy, but it should be read as cf *decipiens*.

C. cf *fasciatus*. In Amshoffsbos (plot 5) a fungus was found (10-X-1977, AEJ 592) with the following characters: Cap 22 mm wide, with rather sharp papil and ascending margin, hygrophanous, bleached to very pale brown, Munsell 10YR 8/4, papil brown 10YR 5/3. Gills 4 mm high, rather distant, yellow, 10YR 7/6. Stem 75×3 mm, honey coloured, the upper half shining and glabrous, the lower half with some white velum 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, distincly rough.

Refering to Lange (1938) and Kühner & Romagnesi (1953) it is easy to identify it as *C. fasciatus*. It also fits with a description by Kühner (1961). The specimens were rather old and dried when they were found, so I could not describe the fresh colours. This makes the determination uncertain, so I have called this fungus *Cortinarius* cf *fasciatus*.

C. fusisporus. A very rare fungus, described by Kühner in 1955 and has since not been mentioned in 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: Cap 9-29 (-45) mm wide, first conical with broad involuted margin, later becomming half-spherical 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 radial fibrillose, first entire later only at margin covered with whitish or yellowish velum 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 crenated, same colour as the sides. Stem 17-40 (-70)× 2-4(-6) mm, more or less cylindric, slightly shining brown yellow, M 7.5YR 7/6, 10YR 6-7/6, 8/4, at 1/3 to 1/2 below top with small yellow annulus, the lower half with some whitish velum 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 coll.), Q mean 2.2, distinctly rough, top with bigger warts. Basidia clavate, e.g. 24×7.8 µm, 28×8.3 µm, 4 spored. Gilltrama 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 10-X-1978, AEJ 373; Zuid Hijkerzand 21-IX-1977, AEJ 240, 7-IX-1978, AEJ 342 and 343; Schoonloër strubben 11-X-1979, AEJ 581.

C. hinnuleus. As I found it difficult to find the right name for this species I give a description of the specimens studied. Cap 18-56 mm wide, first more or less half-spherical, later broadly conical to convex, with flat umbo and broad, inflexed margin, dark brown, Expo F-H 52, near margin Expo F 62, dried up yellowish brown, Expo C 63, Munsell 10YR 7-8/6, margin sometimes slightly grayer, indistinctly radially fbirillous, later nearly completely fine scaly, sometimes radial cleft, margin not stiate, with some velum fibres. Gills (L 27-32, 1 3) 5-9 mm high, adnexed, rather distant, more or less the same colour as the cap, yellowish brown, M 10YR 5-6/4. Stem 40-50×5-9 mm, cylindric or broadeing towards the base to ×5-11 mm, at first white fibrillous with about halfway a distinct white, persistent velum belt and further down many white velum flocs, later browner, foot white felted, sometimes with a little lilac. Smell insignificant, 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, distincly rough, with one big oildrop. Habitat.-- In nutrient- and humus-poor oakwoods on sandy soils; on sand. Collections examined.-- Netherlands, prov. Drenthe, Zuid Hijkerzand, 21-X-1977, 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 also difficult to find the right name for this species. Although the spores are slightly too big and a different habitat is given, these collections agree with those described by Kühner (1961). The following is a description of specimens from the province of Overijssel. Cap 10-30 mm wide, first half-spherical 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, near margin orange brown to yellowish, 5YR 5-6/8, 7.5YR 5/6-6/8, hygrophanous, margin when wet striate, with white velum fibres. Gills up to 3 mm high, a bit anastomosing, first light brown, later darker, yellow brown, ochre brown, Munsell 7.5YR 5-6/8, 5YR 5/8, towards edge slightly slighter, 7.5YR 7/8. Stem 35-45×2-5 mm, more or less culindric 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 stem top orange brown, 5YR 5/8, towards base lighter to 7.5YR 6/8 in foot. Smell inconspicuous. Spores (6.6-)7.3-8.3(-9.3)×4.4-5.6 µm, ellipsoid, sometimes slightly ovoid, indistinctly rough, light yellowish to brownisch yellow under the microscope. Gilltrama yellowish to brownish yellow in KOH, hymenium with some, inconspicuous, yellow necropigment. Habitat.-- In oakwoods on nutrient- and humus-poor sandy soils. Collections examined.-- Netherland, prov. Overijssel, De Eese, 2-XII-1976, AEJ 594 and 595, 13-X-1978, AEJ 379.

C. orellanoides. A beautiful and interesting fungus, that I found only in one plot in 2 successive years at exactly the same place. Cap 26-32 mm wide, broadly conical with a rather acute top and slightly involute margin, later convex with distinctly flat umbo and infexed margin, orange brown, yellowish red, Munsel 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 ± 35, 1 (0-)1 (-3)) up to 7 mm high, narrowing near stem and decurrent by a small tooth (uncinate), rather distant, ca. 12/cm halfway margin and cap centre, the same colour as the cap or slightly lighter, Methuen 6D6; margin entire, the same colour as sides. Stem 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, a bit longitudinally 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 a bit white tomentous. 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 oildrop. Basidia (34-)38.5-41.5(-47.3)×8.8-10.7 (-12.2) µm (11 measurements), slenderly clavate, 4 spored, old light brown pigmented. Gilltrama 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-poot sandy soils (Querco-Betuletum), between litter and *Polytrichum formosum*. Collections examined.-- Netherlands, prov. Drenthe, Amshoffsbos 29-IX-1978, AEJ 359, 1-X-1979, AEJ 561.

C. paleaceus s.l. Here I have included *C. paleaceus* Fr. and *C. flexipes* Fr. as mentioned by Lange (1938); *C. paleaceus* Fr. ex Weinm. and the form *flexipes* Fr. as mentioned by Kühner & Romagnesi (1953); *C. paleaceus* Fr. and *C. paleiferus* Svrcek as mentioned by Moser (1978). Lange noted that *C. paleaceus, C. flexipes* and *C. hemitrichus* were very intimately related, specially *C. paleaceus* and *C. hemitrichus. C. flexipes* should be more easilly 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* s. Lange synonymous. *C. paleiferus* is distinguished from *C. paleaceus* by the violaceous gills. Therefore it appears to me to be synonymous with *C. paleaceus* var. *flexipes* s. Kühner & Romagn.

For a time I thought the specimens I had found could be divided claerly into *C. paleaceus* and *C. paleiferus*. A fungus with violaeceously tomentous stemfoot, violaceous gills, and a conico-convex cap with acute papilla and many velum flocs was *C. paleiferus*.. A more slender fungus with a flater 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 were found: one similar to *C. paleiferus*, 2 others similar to *C. paleaceus*.

	form of cap	velum on cap	colour of: gills	top of stem	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 (scarse)

(viol=violaceous; lbrown=light brown)

The material studied was so varied that it is possible that more combinations are probable. At this moment I cannot say whether these specimens belong to 1, 2, or to several species. Besides this, in the field studies "*C. paleaceus*" was often recorded without details being noted about colours etc., so it was impossible to distinguish the 5 forms later. I have therefor grouped them all under the name *C. paleaceus* s.l.

C. pluvius. Kühner (1959) describes *C. pluvialis* as a new name for *C. pluvius* s. Orton. Kühner's fungus is, however, slightly more robust and has bigger spores than coll. AEJ 521; the colours are comparitive. Orton's description (1955) is rather short, so, without studying the collections, I do not know if they are separate species. I have called this collection *C. pluvius* s. Orton. Description: Cap 11 mm wide, broadly conical with a rounded top, later almost flat, cream coloured in centre Methuen 4A2, margin pure white, surface viscous, a bit peeling, without scales, fibrils, or velum. Gills (L ± 30, l 1-3) 2 mm high, adnate to subdecurrent, rather distant, ± 12/cm halfway margin and cap centre, first yellow ochre, Methuen 4A6, later browner, 5C6. Stem 15-20×2 mm, toward base broadering to 3.5 mm, subradicating, white, whitish, a bit brownish 4A3 translucent, solid. Flesh in cap and stem white, in cap with KOH brownish violaceous. Smell nasty (*Inocybe* like). 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 mostly indistinct. Habitat.-- In oakwoods on nutrient- and humus-poor sandy soil (Dicrano-Quercetum), between mosses, especially *Dicranum scoparium*. Collection examined.-- Netherlands, prov. Overijssel, De Eese, 10-IX-1979, AEJ 521 (2 exx.).

C. porphyropus. Det. P. Ypelaar.

C. pseudosalor. Det. P. Ypelaar.

C. cf *punctatus*. (fig. 36) I was not able to 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* s. Lge and *C. glandicolor* s. Rick. Moser (1978) identifys *C. glandicolor* as a species from coniferous woods. Therefore I named the specimens *C.* cf *punctatus*. Description: Cap 20-35(-50) mm wide, first conico-convex, later convex with reflexed to slightly ascending, undulate margin, with a big, acute to rounded umbo, very dark brown, nearly black, Munsell 5YR 3/1-3, 10YR 2/1-2, margin with radial velum 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, old specimens sometimes radial cleft. Gills (L 24-32, l 3-5 (-15)) 2-4 (-7) mm high, sometimes veined, adnate or slightly subdecurrent, distant, 8-10/cm halfway margin and 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. Stem 30-50(-70)×(3-)4-6(-9) mm, cylindrical or slightly atten-

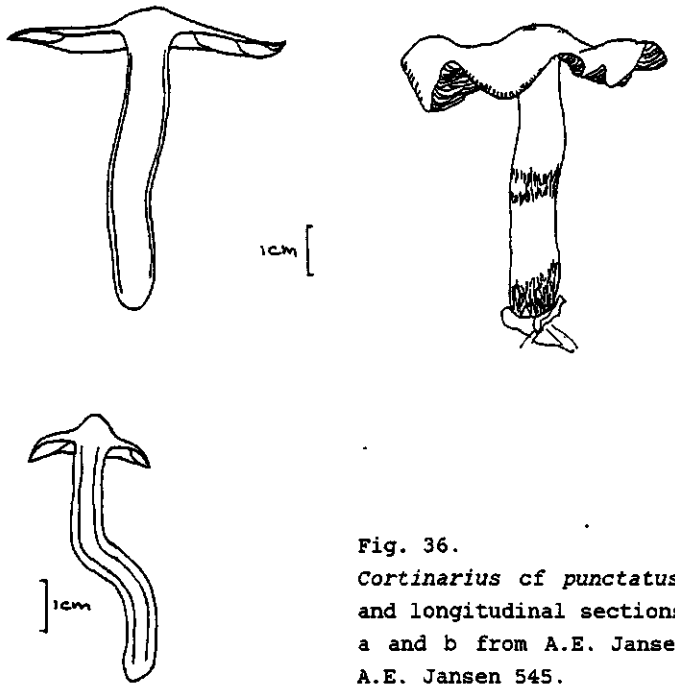

Fig. 36.
Cortinarius cf *punctatus*. Habit sketch and longitudinal sections.
a and b from A.E. Jansen 475, c from A.E. Jansen 545.

uate upward, first finely fibrillous, 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 velum remains, foot white tomentous with violaceous tint, not rooting, solid or narrow fistulose. Smell weakly raphanoid. Taste inconspicious, weakly raphanoid or weakly nut-like. Flesh in cap very thin except in umbo, as dark as the cap surface, in stemcortex (ca. 1 mm) as dark as the cap surface, downward sometimes lighter to yellowbrown, in stem pith a looser tissue, shining yellowish to light brown. Spores (6.8-) 7.8-10.3(-11.2)×(4.4-)4.9-5.9 µm (± 65 measurements, 5 coll.), ellipsoid or weakly ovoid, distinctly rough, with 1 big oildrop.
Basidia (29-)32-35(-39)×6.8-7.8(-8.2) µm, slenderly clavate, sometimes constricted under the top, ca. 7-12 µm protruding above the hymenium, mostly 4-spored with 2.9-3.9 µm long sterigmata, old basidia light yellow brown pigmented. Cheilocystidia inconspicuous, clavate,

(13.6-)16-20(-23)×(4.9-)5.9-7.8(-8.3) µm, with thin, hyaline wall, sometimes more-celled or branched and then longer, e.g. 26×9.8 µm, lying or ascending, along the sterile edge. Habitat.-- In oakwoods on nutrient-poor sandy soils (Querco-Betuletum, Violo-Quercetum), in swarms together, under *Betula*. Collections examined.-- Netherlands, prov. Drenthe, Thijnsbosje, 24-VIII-1979, AEJ 475, 17-IX-1979, AEJ 539, 23-IX-1979, AEJ 545; Noordlagerbos, 13-XI-1978, AEJ 405; Amshoffsbos, 27-IX-1978, ARJ 361.

C. cf *stemmatus* (fig. 37). Often a small, brown *Telamonia* was found, that was similar to *C. stemmatus* s. Henry. Henry's fungus, however, is somewhat bigger, has broader gills, more velum on the stem and less variation in the size of the spores. Therfore there is some doubt whether this was really *C. stemmatus*. Description: Cap (6-)12-22(-35) mm wide, first half-spherical, conical, or broad conical with involute margin, later convex, plano-convex to flat or with ascending margin, with a big, rounded or sometimes acute umbo, dark brown, dark red brown, Munsell 5YR 3/4, 4/8, 4/2, 7.5YR 4/2-6, old slightly more yellow, 10YR 4/3, 5/4, hygrophanous, drying to 7.5YR 5/6, 6-7/8, 10YR 8/4-6, first entire, later only at margin covered with white or very pale brown velum fibres, old glabrous. Gills (L ± 26, l 1-3(-7)) 2 mm high, adnate to uncinate, distant, 10-12/cm halfway margin and cap centre, yellow brown to brown, 7.5YR 4/4, 5-6/6, 10YR 5/8, edge the same colour as the sides. Stem (10-)20-50×2-4(-6) mm, cylindrical or broadering slightly towards the base, to ×6.5 mm, whitish, light brown, yellowish brown, Munsell 10YR 8-6/4, 7-6/6, fine longitudinal fibrillous, in middle with small, white velum ring, lower down sometimes some scattered velum flocs, foot slightly rooting, with little, white or sometimes blueish-pink tomentum, which adhers the substrate together. Flesh in cap very thin, brown, darkbrown, 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 at cut. Taste inconspicuous. Spores (6.6-) 7.3-9.3(-10.2)×(4.4-)4.9-5.6(-6.3) µm (± 80 measurements in 8 collections), Q 1.3-1.6-1.8, ellipsoid, sometimes ovoid or oblong, sometimes with one or two oildrops. Basidia 26-31×6.3-7.8 µm, slenderly clavate, 4 spored, old basidia light to very dark brown pigmented. Cystidia were not seen. Gilltrama consisting of thin cylindrical to inflate hyphae, 3-15 µm wide, with brown yellow to dark brown, finely to coarsely incrusted walls. Habitat.-- In oakwoods on nutrient- and humuspoor sandy soils (Dicrano-Quercetum), in small to big swarms together, on sand between mosses (esp. *Dicranum scoparium*). Collections examined.-- Netherlands, prov. Drenthe, Zuidhijkerzand, 21-IX-1977, AEJ 242 and B.W.L. de Vries 3496, 7-IX-1978, AEJ 344 and 345, 26-IX 1978, AEJ 354, 3-IX-1979, AEJ 495 and 501, 9-X-1979, AEJ 571 and 573.

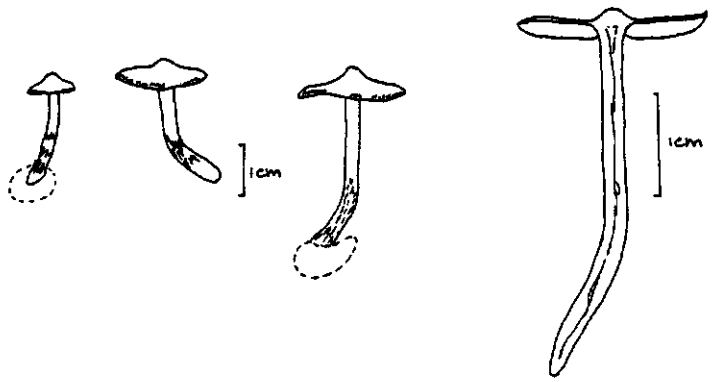

Fig. 37. *Cortinarius* cf *stemmatus*. Habit sketchs, and longitudinal section. From A.E. Jansen 495.

C. tabularis. The specimens correspond to the plates of Cooke 766/783 and Lange 94B.

Cystoderma longisporum. In table 7 and 8 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 determined with certainty.

G. heimansii. This species was only found once: 3 exx. on a rotten twig, under *Ilex aquifolium* in a Violo-Quercetum ilicetosum, Mantingerbos (plot 24), 18-X-1978, AEJ 393. The speciemens were exactly the same as those that were described by Reijnders (1959). Habitat and fructification-time, however, were stikingly different!

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

G. inversa. Nom. prov., see Barkman (1969).

G. triscopa. (fig. 38) This species is new to The Netherlands. A description of the collection AEJ 271 is given: Cap 4-7 mm wide, first conical, later convex, with distinct papilla, brownish yellow, Munsell 10YR 6/6, translucently stiate 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. Stem 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

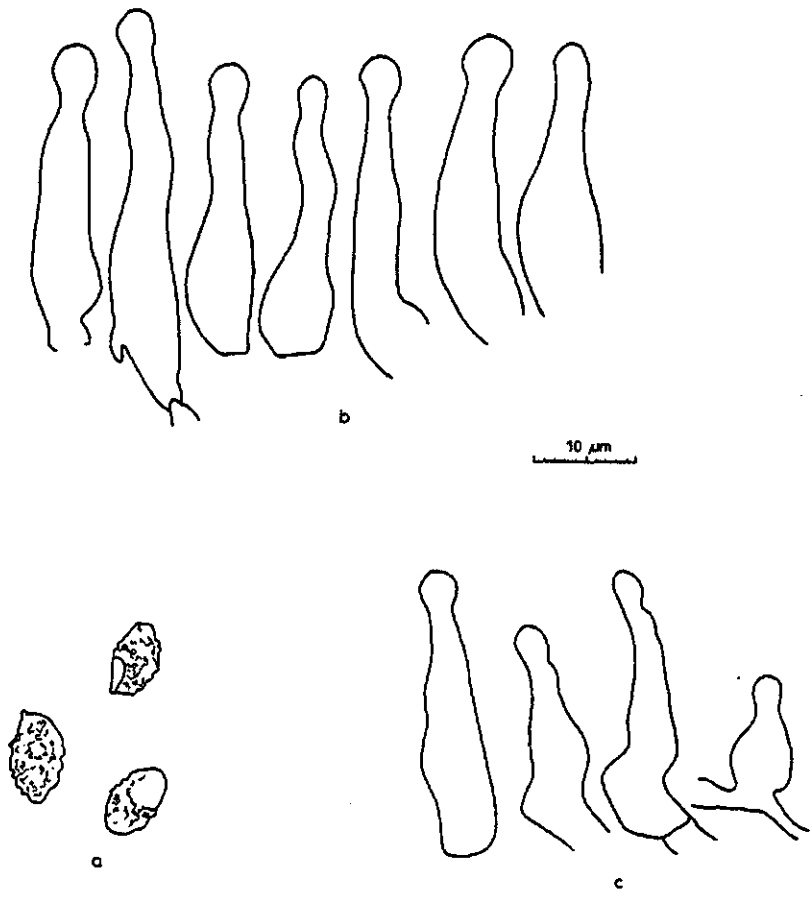

Fig. 38. *Galerina triscopa*. a Spores, b Cheilocystidia, c Caulocystidia, all drawings from A.E. Jansen 271.

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. Cheilocysidia 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, top usually with distinct spherical capitulum, sometimes only rounded; abundant, edge sterile. Caulocystidia slightly smaller, approximately the same form as the cheilocystidia. Habitat.-- On rotten wood in oak-

birchwood on nutrient-poor sandy soils (Querco-Betuletum). Collection examined.-- Netherlands, Prov. Drenthe, Noordlagerbos, 25-X-1977, AEJ 271,. Found at the same locality on 27-IX-1976, AEJ 162, and 11-X-1978, AEJ 377.

When these specimens were compared to the literature (e.g. Kuhner, 1935, Smith & Singer, 1964) and other collections of *G. triscopa* (BRD, Eifel, Gerolstein, 4-X-1971, C.Bas 5718 (L) they were smaller and somewhat lighter, more yellowish, coloured. Microscopical features were the same as those in literature and in the collection CB 5718.

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

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

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

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

Inocybe xanthomelas. fig. 39. Description: Cap 14-30 mm wide, first conical, later 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 ± 2.5 mm high, adnexed, rather crowded, whitish to light yellowish gray, M 2.5Y 7/2, later browner, 10YR 6-7/4-6. Stem 15-40×2.5-4 mm, cylindrical or slightly broadering 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 more brown, 2.5Y 7/4-6, 10YR 5/3, 6/3-4, fine fibrillose, the whole length pruinose; solid. Flesh in cap white, in stem very light yellow, in bulb white. Smell and taste inconspicuous. 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 noduls. Basidia 26-36×8.2-12.2 µm, clavate, 4 spored with up to 6 µm long sterigmata. Pleurocystidia 51-92×11-20 (-25) µm, lageniform, seldom clavate to spheropedonculate, with a 2.5-3.4(-4.4) µm thick, in KOH yellow, smooth wall, the top often with some crystals. Cheilocystidia from about same form and size. Caulocystidia lageniform, (52-)70-100(-112)×12-24 µm, with a thick, in KOH yellow wall, even thicker at the neck, between less striking clavate cells. Habitat.-- In oakwoods on nutrient and humus poor sandy soils, in small swarms on bare sand or between mosses such as *Dicranum scoparium*, *Pohlia nutans*. Collections examined.-- Netherlands, prov.

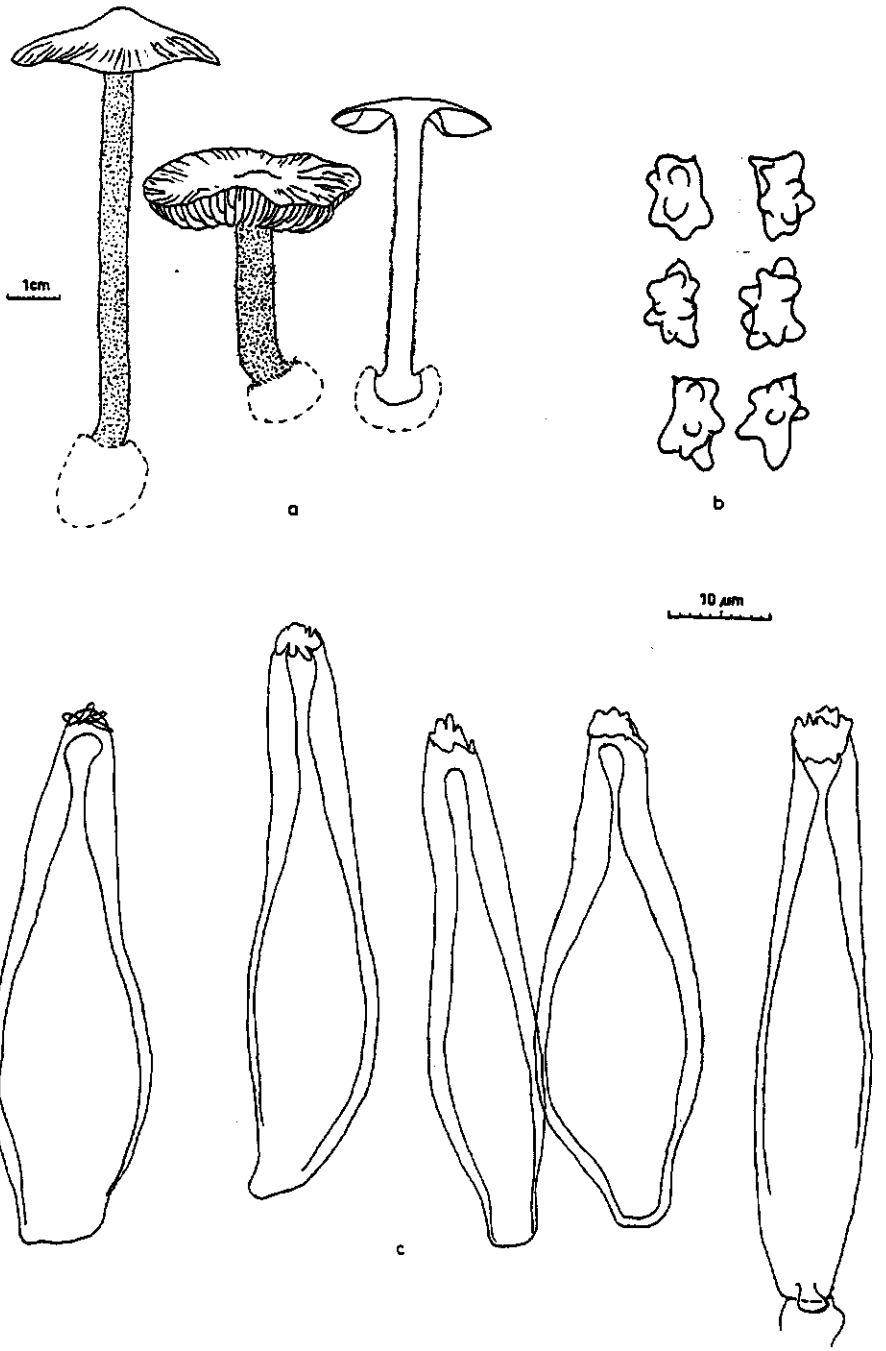

Fig. 39. *Inocybe xanthomelas*. a Habit sketchs and longitudinal section, b Spores, c Pleuro- and cheilocystidia. a from A.E. Jansen 499, b and c from A.E. Jansen 189.

Drenthe, Zuid Hijkerzand, 28-X-1976, AEJ 284, 19-VIII-1977, AEJ 189, 26-VII-1978, AEJ 304, 3-IX-1979, AEJ 499, 9-X-1979, AEJ 570; Schoonloër strubben 11-X-1979, AEJ 579; prov. Overijssel, De Eese, 10-X-1979, 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 location; there were probably 3 mycelia in that 1000 m² sample plot area.

There was some variation in microscopic features. Collections 304 and 570 had comparatively 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).

Distinguishing *I. xanthomelas* and *I. mixtilis* (Britz.) Sacc. was not easy. *I. xanthomelas* should have a blackening stem, bigger spores with more prominent noduls and more slender pleuro- and cheilocystidia, than *I. mixtilis*. In the collections studied I never observed blackening of the stem when drying, but aged specimens in the field had brownish stems. Spores were mostly of the form and size appropriate to *I. xanthomelas*, but in some collections the size was more like that of *I. mixtilis*. Form and size of the pleuro- and cheilocystidia was, in spite of the variation, more like that of *I. xanthomelas*, but the thickening of the wall was more like that of *I. mixtilis* (see Stangl 1977 and 1980). It is most likely that the specimens studied belonged to *I. xanthomelas*, but there were some differences.

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

Psathyrella. Many of the specimens were determined by dr. E. Kits van Waveren.

P. fulvescens var. *dicrani*. Fig. 40: A small *Psathyrella* was often found in the Dicrano-Quercetum. It had a hygrophanous, warm orange brown cap 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 was so kind as to study some of the specimens, it is a form of *P. fulvescens*. *P. fulvescens* is a very variable species and it is at present difficult to describe new varieties or forms. Nevertheless it seems to me that this form has some constant differences with the typical form. It has bigger spores, striking cheilocystidia with often bent tops, and has only been found in the Dicrano-Quercetum, never in the more humus-rich oakwoods. Therefor I want to give it a taxonomical rank and as it is not yet clear whether intermediates occur or not, I give it the low rank of variety.

Psathyrella fulvescens var. *dicrani* A.E. Jansen, var. nov. Fig. 40. A varietate typica differt 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 seape curvato.
Typus. The Netherlands, Prov. of Drenthe, Zuid Hijkerzand, 26 jule 1978, A.E. Jansen 303 (Herb. Wag-W).
Description:
Cap (10-)18-30(-40) mm wide, conico-convex to convex with a samll to rather stout, rounded umbo, rather dark red brown in centre, Munsell 5YR 4/3-8, 7.5YR 4/4, lighter near the 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 more light, 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 flocs covering half of the cap, when older with only some flocs near margin or glabrous. Gills (L 20-35, l 1-3) 3-5.5 mm broad, adnate, very thin and therefore rather distant, ca. 16/cm halfway margin and cap centre, first yellow brown, Munsell 10YR 7/6, later with spores grayish brown, lightgray, 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. Stem 30-60×2-4(-5) mm, cylindrical, sometimes near basis becoming slightly broader to ×3-7(-9) mm, white, seldom yellow white or light brownish white, top pruinous, in lower half fine fribrillous and with some velum 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 stem white or creamy white at the top, light yellow brown 10YR 8/6 round the fistula, yellow brown 10YR 5/6 at the foot; in gill hyaline to light yellow brown. Smell and taste inconspicious. Spores (8.3-)9.3-11.4 (-12.2)×(4.9-)5.5-6.1(-6.8) µm (± 50 measurements, 9 collections), Q 1.4-1.7-1.9, ellipsoid, with small pore, dark brown gray in KOH under microscope. Basidia ca. 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 light yellow (in KOH), thin wall. Chailocystidia of almost the same form and size, but neck often more slender and more distinctly separated from ventricose base, top often bent, mixed 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 oakwoods on nutrient and humus poor sandy soils (Dicrano-Quercetum). Collections examined.-- Netherlands, prov. Drenthe, Zuid Hijkerzand, 9-XI-1972 P. Ypelaar 72, 28-X-1976 AEJ 455, 11-V-1977 AEJ 170, 19-VIII-1977 AEJ 456, 21-IX-1977 B.W.L. de Vries 109-1, 26-VII-1978 AEJ 303, 9-VIII-1978 AEJ 316, 7-IX-1978 AEJ 346, 348 and 349, 3-IX-1979 AEJ 494, 9-X-1979 AEJ 569; Boswachterij Dwinge-

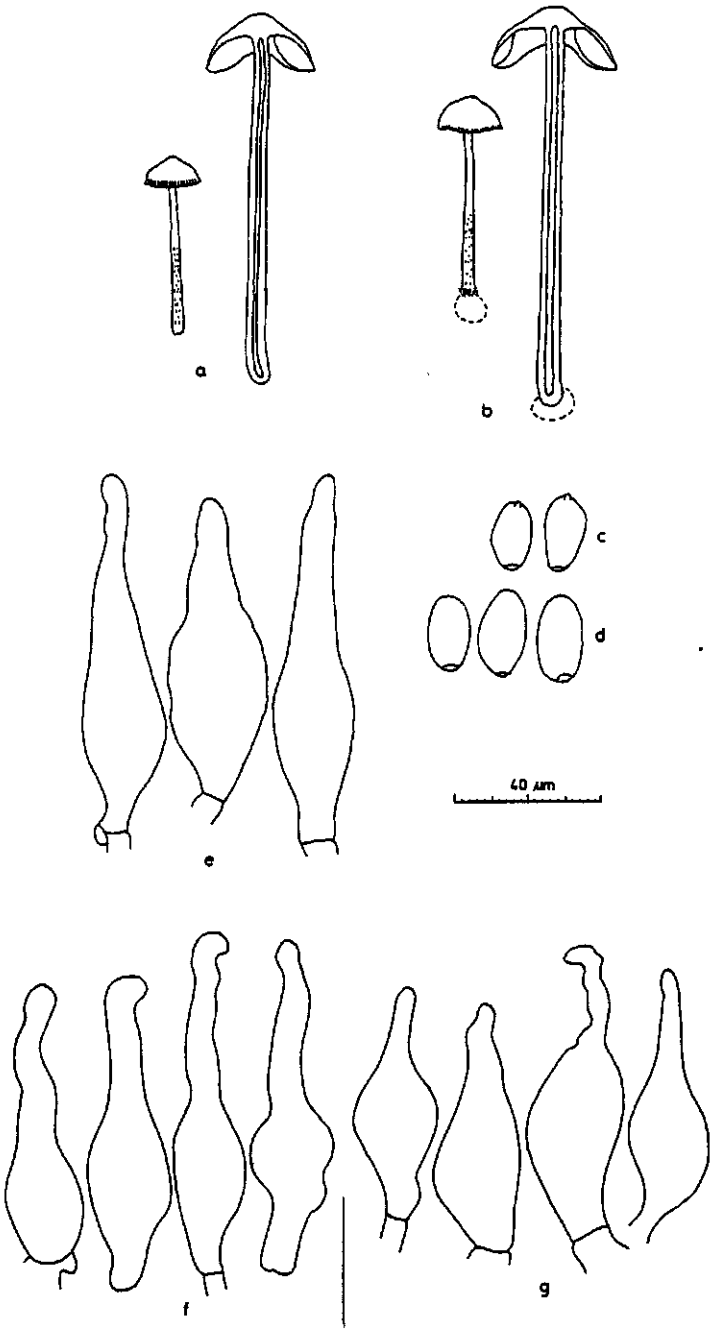

Fig. 40. *Psathyrella fulvescens* var. *dicrani*. a and b Habit sketchs (×0.7) and longitudinal sections (×0.4), c and d Spores, e Pleurocystidia, f and g Cheilocystidia. a from A.E. Jansen 494, b from A.E. Jansen 569, c and f from A.E. Jansen 170, d, e, and g from A.E. Jansen 303.

loo, 25-VII-1960 A.K. Masselink 6543, 19-VIII-1972 P. Ypelaar 4, 8-V-1977 AEJ 168, 10-X-1978 AEJ 372; Boswachterij Smilde, 10-VIII-1973 P. Ypelaar 96; prov. Overijssel, De Eese, 2-XII-1976, 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* s.l.

Stropharia aeruginosa was considered including *S. caerulea* Kreisel (=*S. cyanea* (Bolt. ex.Fr.) Tuomikoski).

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

(G1 means table 7 and 8 group 1, G2 means table 7 and 8 group 2, etc., only indicated in fungi not mentioned in the text.)

Amanita citrina (Schaeff.) S.F. Gray 57, 59
A. fulva (Schaeff. ex) Pers. 56, 81
A. muscaria (L. ex Fr.) Hooker G1
A. porphyria (A. & S. ex Fr.) Secr. 53, 107
A. rubescens (Pers. ex Fr.) S.F. Gray 77
Armillariella mellea (Vahl. ex Fr.) Karst. s.l. 63, 73, 77, 90, 93, 97, 107
Bjerkandera adusta (Wild per Fr.) Karst. 54, 58
Boletus edulis Bull. ex Fr. 56
B. erythropus (Fr. ex. Fr.) Pers. 57
Bulgaria inquinans Fr. G2
Calocera cornea Batsch 77, 83
C. viscosa Pers. G2
Cantharellus cibarius Fr. 57
C. cibarius var. *amethysteus* Quél. 53
C. sinuosus (Fr.) Kühn. & Romagn. 53
Chondrostereum purpureum (Pers. ex Fr.) Pouz. 58
Ciboria batschiana (Zopf) Buchw. 49, 61
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CURRICULUM VITAE

Anna Elisatbeth Jansen werd op 1 juni 1950 te Breda geboren, alwaar zij de lagere school en de HBS-B bezocht. In 1967 ving zij haar studie biologie aan, aan de Rijksuniversiteit te Leiden. Het kandidaatsexamen B1 werd afgelegd op 1 juni 1971. Voor het doctoraal examen werden de volgende onderwerpen de volgende onderwerpen bewerkt. Op het gebied van de plantengeografie, een onderzoek naar de grens tussen het Fluviatiel en het Kempens district, o.l.v. drs. J. Mennema, aan het Rijksherbarium te Leiden. Op het gebied van de chemotaxonomie naar iridoide glucosiden bij *Lamium*-soorten, o.l.v. prof.dr. R. Hegnauer, aan het Laboratorium voor Experimentele Plantensystematiek te Leiden. Op het gebied van de taxonomische mycologie, samen met M.E. Noordeloos, een onderzoek naar de systematiek en floristiek van de genera Marasmius, Marasmiellus, Micromphale en Crinipellis in Nederland, o.l.v. dr. C. Bas, aan het Rijksherbarium te Leiden. Van 1 september 1970 tot 1 september 1975 was zij als studentassistent bij het Laboratorium voor Experimentele Plantensystematiek in dienst bij de Rijksuniversiteit te Leiden. Na het doctoraal examen, dat op 25 november 1975 werd afgelegd, deed zij een onderzoek naar de systematiek en floristiek van het genus Collybia in Nederland. Van augustus 1976 tot april 1980 was zij als promotie-assistent in dienst bij de Landbouwhogeschool te Wageningen voor het bewerken van een proefschrift over de paddestoelen in enkele typen eikenbos in Drenthe. Sinds maart 1981 is zij opnieuw in dienst bij de Landbouwhogeschool (part-time) om een verdere bijdrage te geven aan het mycosociologisch onderzoek van het Biologisch Station.