sommerfeltia

27

A. Granmo, T. Læssøe & T. Schumacher

The genus *Nemania* s.l. (Xylariaceae) in Norden

1999

sommerfeltia
is owned and edited by the Botanical Garden and Museum, University of Oslo.

SOMMERFELTIA is named in honour of the eminent Norwegian botanist and clergyman Søren Christian Sommerfelt (1794-1838). The generic name *Sommerfeltia* has been used in (1) the lichens by Flörke 1827, now *Solorina*, (2) Fabaceae by Schumacher 1827, now *Drepanocarpus*, and (3) Asteraceae by Lessing 1832, nom. cons.

SOMMERFELTIA is a series of monographs in plant taxonomy, phytogeography, phytosociology, plant ecology, plant morphology, and evolutionary botany. Authors of Norwegian institutions other than the Botanical Garden and Museum in Oslo pay a page charge of NOK 30, other authors pay NOK 100 per printed page.

SOMMERFELTIA appears at irregular intervals, normally one article per volume.

Editor: Rune Halvorsen Økland.
Editor of this volume: Per Sunding.
Editorial Board: Scientific staff of the Botanical Garden and Museum.
Address: SOMMERFELTIA, Botanical Garden and Museum, University of Oslo, Trondheimsveien 23B, N-0562 Oslo 5, Norway.
Order: On a standing order (payment on receipt of each volume) SOMMERFELTIA is supplied at 30 % discount.
Separate volumes are supplied at the prices indicated on pages inserted before the back cover.

Copyright: The author(s) & Botanical Garden and Museum, University of Oslo

sommerfeltia

27

A. Granmo, T. Læssøe & T. Schumacher

The genus *Nemania* s.l. (Xylariaceae) in Norden

1999

ISBN 82-7420-038-1

ISSN 0800-6865

Granmo, A., Læssøe, T. & Schumacher, T. 1999. The genus *Nemania* s.l. (Xylariaceae) in Norden. - Sommerfeltia 27: 1-96. Oslo. ISBN 82-74200-0-038-1. ISSN 0800-6865.

A taxonomic study of *Nemania* Gray, *Entoleuca* Syd. and *Euepixylon* Füisting (= *Nemania* s.l.; Xylariaceae) was carried out for the Nordic countries: Norway, Sweden, Finland and Denmark. No species of *Nemania* have been found in the remaining Norden: Iceland and the Faeroes. Fourteen species of *Nemania* s. str. were found in the area: *Nemania aenea*, *N. aureolutea* comb. n., *N. atropurpurea*, *N. carbonacea*, *N. chestersii*, *N. colliculosa* comb. n., *N. confluens*, *N. diffusa*, *N. effusa*, *N. prava* n. sp., *N. reticulata* comb. n., *N. serpens*, and two unknown species (*Nemania* spp. A and B) not formally described because of scanty material. In addition the two split-outs from *Nemania*, *Entoleuca mammata* and *Euepixylon udum*, are treated. A dichotomous key has been prepared and the species are reviewed alphabetically with comments on taxonomy, ecology and chorology. All species have been drawn, photographed and mapped.

In addition to conventional taxonomic procedures, a selection of species from *Nemania* s.l., *Biscogniauxia* and *Hypoxylon* were subjected to an ITS nrDNA sequencing study. This study supported the delimitation of taxa as defined in this work, and confirms *Nemania* as different from *Hypoxylon* and *Biscogniauxia*.

Four European *Nemania* taxa are still unknown in Norden: *Nemania gwyneddii* (Whalley, R.L. Edwards & S.M. Francis) Pouzar, *N. illita* (Schwein.) Pouzar, *Nemania serpens* (Pers.: Fr.) Gray var. *macrospora* (J.H. Mill.) Pouzar. The fourth taxon, *Hypoxylon terricola* J.H. Mill. certainly also belongs to *Nemania*.

Keywords: Ascomycota, chorology, ecology, *Entoleuca*, *Euepixylon*, *Hypoxylon*, key, molecular study, morphology, *Nemania*, Norden, Nordic countries, phylogeny, taxonomy, Xylariaceae.

Alfred Granmo, Tromsø Museum, University of Tromsø, N-9037 Tromsø. Norway (e-mail: alfredg@imv.uit.no).

Thomas Læssøe, Department of Mycology, Botanical Institute, Copenhagen University
Øster Farimagsgade 2D, DK-1353 Copenhagen K, Denmark.

Trond Schumacher, Division of Botany and Plant Physiology, Department of Biology, University of Oslo, P.O. Box 1045 Blindern, 0316 Oslo, Norway.

CONTENTS

INTRODUCTION

Gray's genus *Nemania* from 1821 comprised 21 species of various pyrenomycetes, of which *Nemania serpens* (Pers.: Fr.) Gray was selected type species of the genus by Donk (1964). It is the only one of the original species still retained in *Nemania.* Following the tradition of Fries (1849), *Nemania* species have until recently been treated under *Hypoxylon* by all subsequent authors. In Miller's (1961) monograph on *Hypoxylon* s.l., approximately 10 taxa of *Nemania* were referred to subsection *Primocinerea* J.H. Mill. of *Hypoxylon* sect. *Papillata.* Pouzar (1985) presented a basic study on *Nemania.* Reinstating Gray's genus and amending it, Pouzar included 11 species, accepting *Nemania serpens* as the type species. A new subgenus, *Diatrypina* Pouzar, was erected to accommodate *N. illita* (Schwein.) Pouzar, the rest of the species being referred to subgenus *Nemania* (Pouzar 1985b). He further demonstrated that *Nemania serpens* s. Miller was heterogeneous, comprising some well distinguishable species related to *N. serpens.* The complex around *N. serpens* was further elucidated by L. Petrini & Rogers (1986, as *Hypoxylon*). Though Pouzar (1985a) still suspected *N. serpens* to be heterogeneous, he did not succeed in further resolution of the species. It has subsequently been referred to as *Nemania serpens* agg. The genera *Entoleuca* Sydow and the monotypic *Euepixylon* are at present used for two segregate species of *Nemania* s.l., *N. mammata* (Mathiassen & Granmo 1996) and *N. uda* (Gray 1821), respectively.

The aim of the present study is to give a comprehensive account of the genus *Nemania* Gray in Norden, including the split-outs *Entoleuca* Syd. and *Euepixylon* Füisting, with a taxonomic treatment that also considers the results of culture morphology and phylogenetic analysis of nuclear Internal Transcribed Spacer (ITS) rDNA sequences of selected specimens, in addition to taxonomic procedures based upon morphology.

Some records of *Nemania* from the Nordic countries have been reported under the genus *Hypoxylon.* A survey of the Nordic species of *Hypoxylon,* including three distinct species of *Nemania* s.l.: *N. confluens* (as *Hypoxylon c.*), *Entoleuca mammata* (as *Hypoxylon m.*) and *Euepixylon udum* (as *Hypoxylon u.*), was given by Granmo et al. (1989). The remaining species of *Nemania* were omitted therein, pending further investigation. The results of that investigation (Granmo 1998), is the basis for the present paper.

INVESTIGATION AREA

SITUATION AND DIVISION

The territory of Norden includes the countries Norway, Sweden, Finland, Denmark and Iceland. Because no species of *Nemania* s.l. have been recorded for either Iceland or the Faeroe Islands, these parts of Norden are not treated further. Each of the investigated countries is divided into provinces or counties (Fig. 1; Appendix 1), which are commonly referred to in biogeographical studies. The studied land area covers about 1.2 million km^2, situated between lat. 55-71 °N, and long. 5-31 °E.

THE VEGETATION REGIONS OF NORDEN

A simplified map of the vegetation regions in Norden is shown in Fig. 2. The division follows Dahl et al. (1986) for Norway, and Påhlsson & Danielsson (1984) for the other countries. The definitions of the vegetation regions are largely according to Dahl et al. (1986). Variation in climate, from oceanic climate in the west to to subcontinental or continental in the east, occurs within most regions.

(1) Nemoral region (temperate deciduous forest region). The oak forest region with frost-sensitive, southern species. The climate is temperate suboceanic. The region is lacking in Finland.

(2) Boreonemoral region (conifer-oak region). Dominated by coniferous, birch and grey alder (*Alnus incana*) woods. In favourable localities broad-leaved deciduous forests with oaks (*Quercus robur* and *Q. petraea*), ash (*Fraxinus excelsior*), elm (*Ulmus glabra*), lime (*Tilia cordata*) and hazel (*Corylus avellana*) occur. This is a transition zone between 1 and 3.

(3) Southern boreal region (southern conifer region). Dominated by coniferous woods, interspersed with extensive areas of alder (*Alnus glutinosa*) woods and mires. Southern deciduous trees occur locally. *Betula pendula* is typical of the agricultural landscape.

(4) Middle boreal region (middle conifer region). Dominated by coniferous forest, and birch woods towards the west and in the north. Grey alder (*Alnus incana*) woods are present and southern deciduous trees are lacking. Mires cover extensive areas.

(5) Northern boreal (northern conifer region) and *alpine regions*. The *northern boreal region* is dominated by birch (*Betula pubescens*) woods, slow-growing coniferous woods and minerotrophic mires. The region is limited upwards by the climatic timber line, above which the *low -*, *middle* - and *high alpine regions* occur. In the *low alpine region* common woody plants are dwarf birch (*Betula nana*), grey willows (*Salix glauca*, *S. lanata* and *S. lapponum*), and some heathers (*Empetrum*, *Vaccinium*).

In Finnmark and Troms, and in adjacent Sweden and Finland, Påhlsson & Danielsson (1984) also recognized an *arcto-alpine region*, which was not maintained by Dahl et al. (1986).

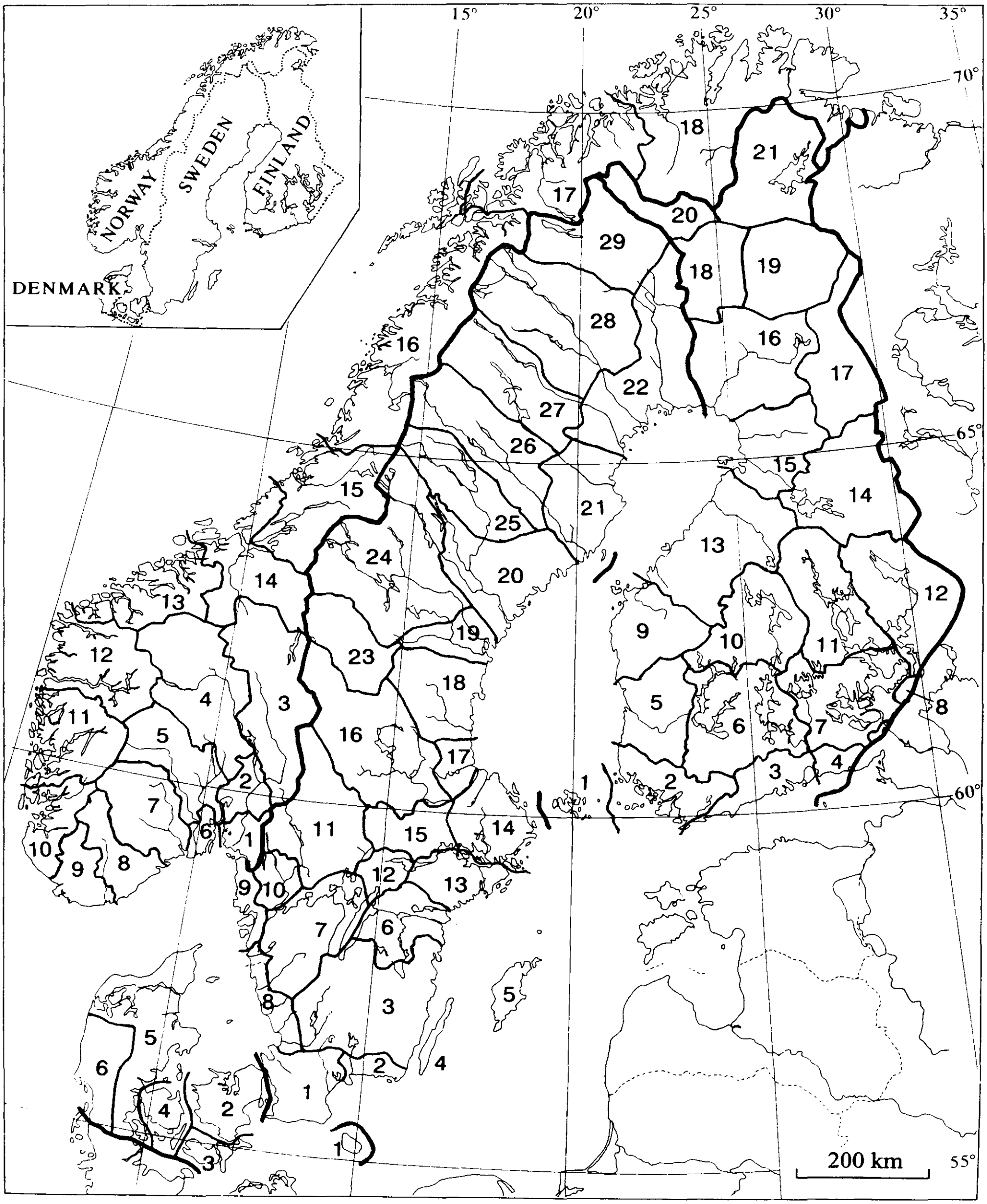


Fig. 1. The provinces of the investigated area.

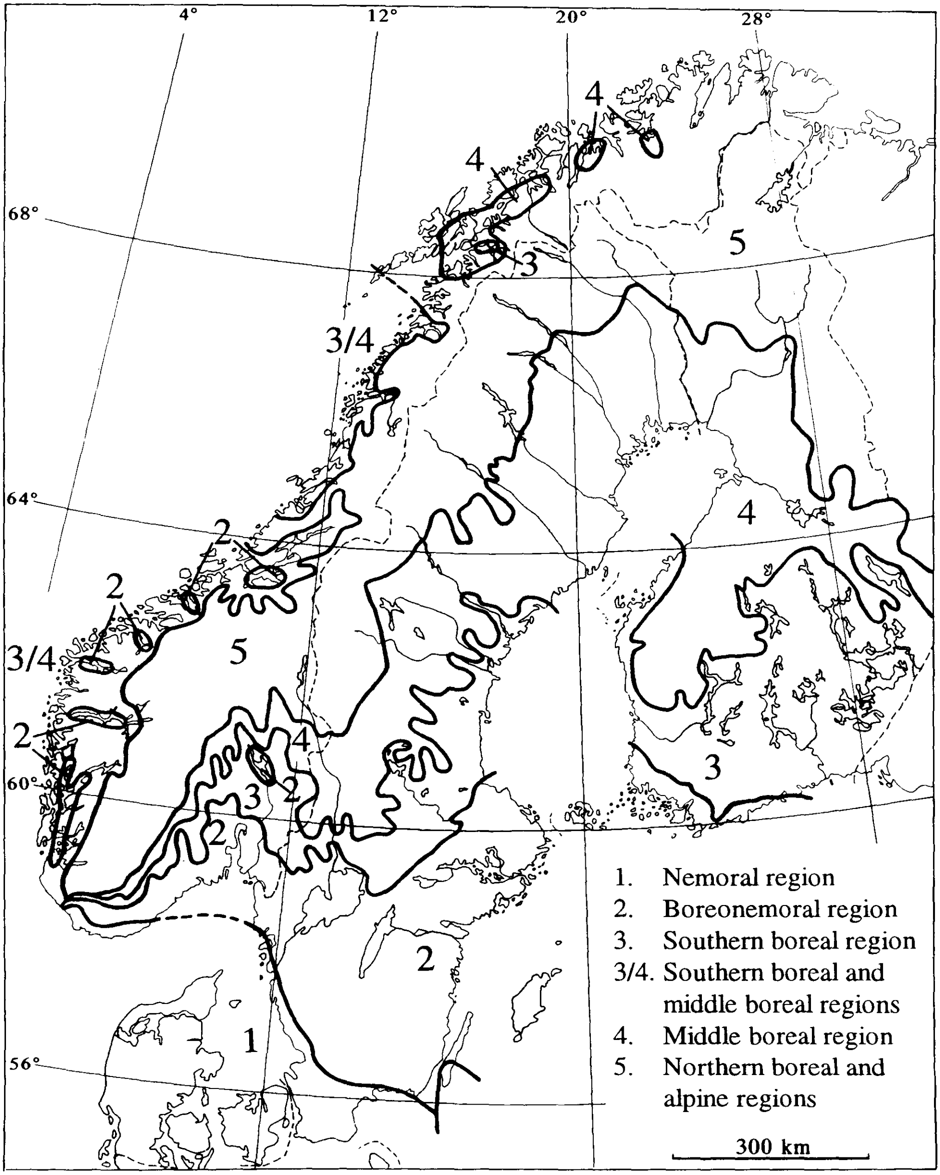


Fig. 2. Simplified map of the vegetation regions in Norden.

MATERIALS AND METHODS

MATERIALS

Herbarium material deposited in the following Nordic herbaria was investigated: Bergen (BG), Oslo (O), Tromsø (TROM), Trondheim (TRH) (Norway); Göteborg (GB), Lund (LD), Stockholm (S), Umeå (UME), Uppsala (UPS) (Sweden); Helsinki (H), Kuopio (KUO), Oulu (OULU), Turku (TUR) (Finland). The Danish material is deposited in Copenhagen (C, some in CP), unless otherwise stated. The recent Norwegian collections are deposited in TROM. The ample material of *Entoleuca mammata* collected by G. Mathiassen is located in TROM. Important material for comparative studies has been borrowed from several herbaria, particularly from Praha (PRM, Pouzar's collections), Uppsala and Leiden (L).

Herbarium abbreviations follow Holmgren et al. (1990), and references to International Code of Botanical Nomenclature (ICBN) are from Greuter et al. (1994). Colour codes are according to Kornerup & Wanscher (1967).

Whenever possible the type of wood, or tree, was determined to genus by microanatomy. The term 'host' used in the following simply refers to the tree species inhabited by the fungus. For collections verified as to host tree, the type of substrate was noted, i.e. bark (b), wood (w), or both (bw).

METHODS

The species were divided into two groups according to saprobic ability: (1) *primary saprobes*, which sporulate on wood at an early stage of decay, and (2) *secondary saprobes*, which produce sporophores on moderately to strongly decayed wood, and never or only rarely have been found on fresh wood .

As regards host preference, four groups could be distinguished: (1) the *host genus-selective* species had a strong preference for only one or two particular host species (or rather host genera), appearing infrequently on additional hosts, (2) the *host family-selective* species had a preference for one or a few particular host families, (3) the *host order-selective* species had a preference for one or a few particular host orders, and (4) the *host-indifferent* species occurred on numerous hosts from several host families, without preference for one. The classification into types of host association used in this study only take into account the hosts on which the sexual reproductive phase is completed. Nothing can be said for sure about the frequency and distribution of a mycelial stage in these or other host trees.

Measurements of macro- and microanatomy, wood identification and photographing techniques follow those of Granmo (1999). Vertical, median sections of the peridium at the junction side-bottom were studied in order to compare peridium structure among different taxa. Tissue types follow Korf (in Eckblad 1968). Lugol's solution (I/KI/water = 0.5/1.5/20, in weight units) was routinely used in testing amyloidity in asci, while Melzer's reagent (I/KI/chloral hydrate/water =

0.5/1.5/20/20, in weight units) was used as a supplement. The perithecial content was mounted in a drop of water and one drop of the iodine reagent was added at the edge of the cover glass. Hence the actual iodine concentration was about half of the original one. The persistence of spore wall colour was tested by adding a drop of domestic sodium hypochlorite ("Klorin", 3-5% NaOCl) to a mount of asci and spores, as recommended by Eriksson (1989). The colour of individual spores was observed through the microscope, while the colour of spore deposits on stromata was judged by using a stereo-microscope (magnification 10 × 3.2) equipped with a halogen ring lamp (200W). Colour codings are according to Kornerup & Wanscher (1967).

Cultures of specimens were obtained by streaking the contents of rehydrated perithecia onto water agar (WA) containing streptomycin and chloramphenicol. Cultures were maintained on 2% potato dextrose agar (PDA) in the dark at 19 °C. The extent of intra- and interspecific divergence of the Internal Transcribed Spacer (ITS) region (ITS 1, 5.8S gene and ITS 2) were determined for up to four specimens each of *Nemania aenea*, *N. chestersii*, *N. colliculosa*, *N. prava*, *N. serpens*, *Entoleuca mammata*, *Hypoxylon fuscum*, *H. multiforme*, *H. porphyreum*, *Biscogniauxia nummularia* and *Xylaria hypoxylon*. Specimens and isolates used for the ITS rDNA analyses are listed in Tab. 1.

DNA isolations were obtained from stromata or mycelia using a single tube paramagnetic bead approach (Rudi et al. 1997). Dried stromata from herbarium specimens (1-5 mg) or fresh mycelia from cultures on agar plates were scraped off and disrupted in 1.5 ml microcentrifuge tubes with a forceps, before adding the lysis buffer containing the paramagnetic beads. PCR amplification, using the primer set ITS 1(5′ - TCC GTA GGT GAA CCT GCG G - 3′) and biotinylated-ITS 4 (5′- TCC TCC GCT TAT TGA TAT GC - 3′) (White et al. 1990), was done directly on the solid matrix-DNA complex. Manual direct sequencing of the PCR products was carried out using a solid phase approach (Hultman et al. 1989), as modified by Fangan et al. (1994), employing a Sequenase kit (version 2.0, United States Biochemical, Cleveland, Ohio, U.S.A.) and the sequencing primers ITS 1, ITS 3 (5′ - GCA TCG ATG AAG AAC GCA GC - 3′) and ITS 4 (White et al. 1990).

DNA sequences were imported and visually adjusted in the program SeqApp (Gilbert, 1993) with legal character states being the bases A, C, G, T and gap (-). The multiple alignment used in the analyses is shown in Appendix 3.

Uncertainties in sequence determination were either scored as missing (question marks inserted) or N = ACGT (stop), and each nucleotide and gap were treated as single characters in the phylogenetic analyses.

To examine the biasing effect of indels, phylogenetic analyses were also performed excluding the fifth character of gaps. The matrix was analysed to detect all ITS sequence genotypes, including the intraspecific variation within each taxon. Phylogenetic analyses were performed on a subset of isolates representing all the observed DNA genotypes using maximum parsimony (PAUP version 3.1.1, Swofford 1993).The analyses were performed with the Branch and Bound search algorithm and the default settings in PAUP. For a comparison of the obtained phylogeny with the assumption that *Entoleuca mammata* may represent a *Nemania*, we also introduced the constraint forcing *E. mammata* to be part of the *Nemania* clade, using the constraints option in PAUP. We also examined the Bremer index (Bremer 1988) using Autodecay, Version 3.0 (T. Eriksson 1995).

Abbreviations and symbols are explained in Appendix 2.

Tab. 1. List of fungal specimens included in the ITS nrDNA sequencing study, with location, host and voucher. Specimens are deposited at Tromsø Museum, University of Tromsø (TROM), or at the Herbarium, Copenhagen University (C). AAS – culture collection at the Department of Mycology, Botanical Institute, Copenhagen University.

Taxon	Specimen (Locality, host, voucher)
Biscogniauxia nummularia (Bull.: Fr.) Kuntze	British Isles. Hereforeshire. *Fagus*. TL 4071 (C). AAS 275
Entoleuca mammata (Wahlenb.) J.D. Rogers & Y.-M. Ju	Norway. Tr. *Salix pentandra*. AG 221/95 (TROM 18)
Hypoxylon fuscum (Pers.: Fr.) Fr.	Norway. AA. *Corylus*. AG 93/95 (TROM 302)
Hypoxylon multiforme (Fr.: Fr.) Fr.	Norway. Tr. *Prunus padus*. AG 219/95 (TROM 602)
Hypoxylon porphyreum Granmo	Norway. AA. *Quercus*. AG 132/95 (TROM 304)
Nemania aenea (Nitschke) Pouzar	Denmark. Sj. *Alnus glutinosa*. TL 4055 (C) AAS 253
Nemania atropurpurea (Fr.: Fr) Pouzar	Norway. No. *Populus tremula*. AG 233/95 (TROM 18, C). AAS 234
Nemania chestersii (J.D. Rogers & Whalley) Pouzar	Denmark. Sj. *Fagus*. TL 3893 (C, TROM). AAS 234
Nemania colliculosa (Schwein.) Granmo	Norway. VA. *Quercus*. AG 170/95 (TROM 120), as *N. serpens* 'amyl.' Norway. No. *Populus*. AG 228/95 (TROM 129), as *N. serpens* 'amyl.'. NEOTYPE
Nemania prava Granmo, Laessøe & T. Schumach.	Norway. Ho. *Fraxinus*. AG 50/94 (TROM 104), as *N. atropurpurea* var. *brevistipitata* (HOLOTYPE of *N. prava*) Denmark. EJy. *Fraxinus*. TL 1739, as *N. atropurpurea* var. *brevistipitata* (C, TROM) Switzerland. Kt. Neuenburg. *Fagus*. L. Petrini 1.VI.1985, as *Hypoxylon atropurpureum* var. *brevistipitatum*. TYPE (ZT) Switzerland. Davos. *Alnus viridis*. L.E. Petrini 2.IX.1982, as *Hypoxylon atropurpureum* var. *brevistipitatum* (PRM 869039, duplicate of a specimen in ZT)
Nemania serpens (Pers.: Fr.) Pouzar	Norway. VA. *Quercus*. AG 171/95 (TROM 174, C), as *N. serpens* 'dext.'. NEOTYPE. AAS 255 Norway. AA. *Populus tremula*. AG 122/95 (TROM 162), as *N. serpens* 'dext.' Denmark. Lol. *Salix*. TL 3859 (C), as *N. serpens* 'dext.'. AAS 222 Denmark. Lol. *Aesculus*. TL 3865 (C), as *N. serpens*. AAS 233
Xylaria hypoxylon (L.: Fr.) Grev.	Norway. VA. *Fraxinus*. AG 179/95 Denmark. Lol [host unknown]. TL 3875 (C). AAS 227 Denmark. EJy. *Fagus*. TL 4410 (TROM)

RESULTS

MOLECULAR STUDY AND PHYLOGENETIC ANALYSIS

The complete sequence matrix (Appendix 3) of the ITS region (ITS 1, 5.8S and ITS 2) of 21 specimens of the 12 taxa included in this study consisted of 498 aligned nucleotide positions, of which 139 characters were parsimony informative.

Sequences were invariant for four strains each of *Nemania serpens* and *N. prava*, two strains of *N. colliculosa* and three strains each of *Xylaria hypoxylon*. Cladistic analysis of the data set using *Xylaria hypoxylon* as outgroup produced 6 equally most parsimonious trees (MPTs) of 473 steps, with consistency (CI) and retention (RI) indices of 0.755 and 0.610, respectively. The different MPTs gave the same main topology, the differences being the relative position of the *Nemania* species on the *Nemania* branch (data not shown) in Fig. 3. One out of the 6 recorded MPTs is shown, with bootstrap values and Bremer support superimposed at the tree internodes. A similar analysis treating gaps as missing characters gave 4 MPTs of 328 steps, with the same main topology as that in Fig. 3 (data not shown).

The analyses consistently yielded two strongly supported evolutionary lineages, of which the *Nemania* species together constituted a strongly supported monophyletic clade (96% bootstrap support; Bremer index = 10), and the specimens of *Biscogniauxia*, *Entoleuca* and *Hypoxylon* constituted the other well supported branch (87% bootstrap support; Bremer index = 4). The relationship between *Hypoxylon* and *Biscogniauxia* derived from conventional taxonomy was thus confirmed. The included *Hypoxylon* and *Entoleuca* species yielded a well supported subclade in all analyses (89% bootstrap support; Bremer index = 5). A constraint forcing *Entoleuca mammata* and *Nemania* species to constitute a monophyletic group gave two trees eighteen steps longer than the MPTs as shown in Fig. 3 (data not shown).

Ignoring at the moment the grouping of *Entoleuca*, the two lineages within *Hypoxylon*, one leading to *H. multiforme* and the other to *H. fuscum* and *H. porphyreum*, coincided with the two sections of *Hypoxylon* (*Annulata* and *Hypoxylon*, respectively) recognized by conventional taxonomy.

MORPHOLOGICAL FEATURES

Stromata

The stromata of *Nemania*, *Entoleuca* and *Euepixylon* resemble those of *Hypoxylon*, but lacked the typical stromatal pigments and colours characteristic of that genus. The *ectostroma* in *Nemania* was always carbonized, forming a hard, dark brown to black crust. The *entostroma* was either loose and whitish, or soft and brownish. It frequently consisted of both brown parts and of white parts which darkened with age and would soon deteriorate. The basal part of the entostroma was mostly indistinct. It consisted of a mixture of fungal tissue and wood remnants.

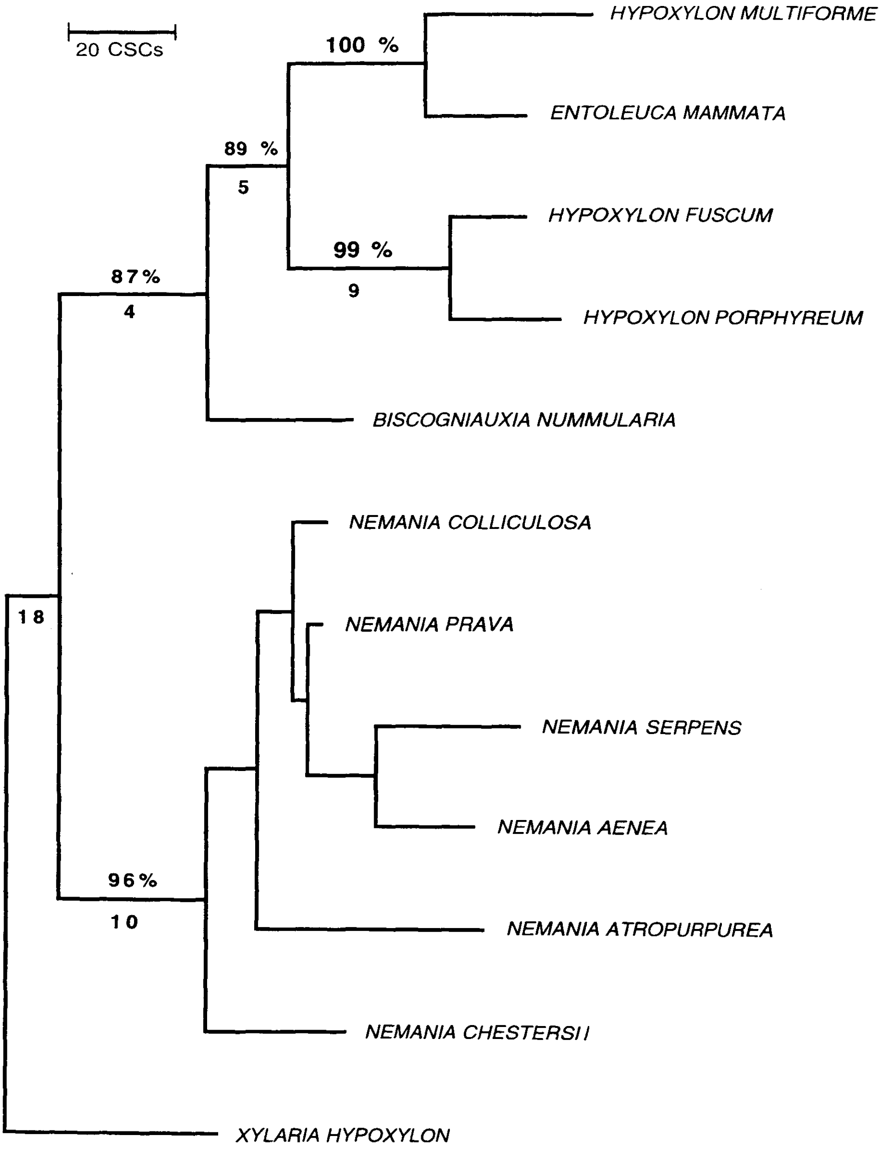


Fig. 3. Relationships of *Nemania* to some other genera of the Xylariaceae based on an analysis of ITS sequences from 12 taxa, using *Xylaria hypoxylon* as outgroup. Phylogram of one out of 6 most parsimonious trees (MPTs) yielded with the branch and bound algorithm in PAUP and the sequence matrix of the 12 taxa. Tree statistics are: Length (L) = 485, consistency index (CI) = 0.755, CI excluding uninformative characters (CIx) = 0.676, retention index (RI) = 0.610 and rescaled consistency index (RC) = 0.460. The values above internodes are bootstrap values (>50%) obtained from 2,000 bootstrap replicates; the Bremer support (≥ 1) indicating the number of additional steps required to collapse each clade is shown below the internodes. Internode lengths correspond to the number of character state changes postulated for each internode. Scale bar corresponds to 20 character state changes (CSCs).

We have discriminated between two types of surface structures of the stromata: *stromatal grooves*, which subdivide groups of perithecia, and at times cross the stromata as more or less continuous grooves, and *perithecial contours* which represent elevation of individual perithecia. The perithecia were lacrymoid to ovoid, or subglobose to globose. Their ostioles were papillate, and in one species (*Nemania* sp. B) were surrounded by a disk-like or ring-like area (annulate ostioles). Some species in addition had *false ostioles* (Figs 72-74), which were like ordinary ostioles except for being less evident and apparently lacking a pore. Nevertheless, sometimes these ostioles functioned as auxiliary ostioles, having an extremely narrow pore through which spore mass was seen oozing out. We noticed 1-4 false ostioles on one perithecium, or in between neighbouring perithecia. They probably originated from aborted perithecial initials. The way the perithecial apex was 'arched' was sometimes distinct and species specific.

The stromata of all *Nemania* species formed caespitose elliptical spots, or they were effused, oblong to irregular patches on wood, usually extending parallel with the wood fibres. At times stromata were found on bark, when they tended to be pulvinate. At the margins, the ectostroma extended into the wood as a black zone line. Young stromata of species like *Nemania atropurpurea*, *N. effusa* and *N. serpens* often had an interrupted creamy white to greyish covering. It soon vanished, probably by merging with the ectostroma. In *N. colliculosa* and *N. reticulata* a brown to rusty, hirsute covering could be found on young and recently mature stromata. The covering consisted of short hyphae, yellowish granules and scattered conidia and likely belonged to the anamorph. In *N. serpens* we frequently observed its *Geniculosporium* anamorph as an ash-grey to greyish brown floccose mould on adjoining wood.

It was often possible to distinguish between the dextrinoid reacting *N. serpens* and the amyloid taxa in the rest of the aggregate species on perithecial contours alone: in a large proportion of *N. serpens* perithecial contours and stromatal grooves were conspicuous, while the dominant feature of the amyloid taxa was a more even stroma with immersed perithecia. Except for a faintly yellowish colouring sometimes, no conspicuous colour was attained by applying 10 % KOH to stromatal particles of *Nemania* spp. Only in the cryptic *Nemania* sp. B an orange KOH-extractable pigment was immediately obtained from the peridium.

At times a glistening covering of green algae was found on stromata of *Nemania serpens* (e.g. AG 53/95, 55/95, 61/95). Additionally, tetrads of green algae reminiscent of *Apatococcus* was accidentally observed in entostromatal sections of some specimens in the amyloid segment of *N. serpens* agg. (PRM 871869, aff. *N. prava*; AG 71/74, AG 75/74), but not with certainty in *N. serpens*.

Peridium

When sectioned, the peridium was seen to be stratified in 2-3 layers. The tissue of the outermost layer commonly consisted of a mixture of t. prism. and t. ang., or t. porr. However, in some species the outermost layer was carbonaceous throughout (Tab. 2). In these, the tissue always had an element of t. epid. The peridium of *Nemania serpens*, commonly carbonized, lacked carbonization when young or immature, except for the apical area, and might even lack carbonization at the very bottom in mature perithecia when seated directly on wood. A similar pattern was noticed for *N. diffusa*.

Except for the species mentioned in Tab. 2, none had carbonization in the peridium except for the wall of the ostiolar canal. However, the peridium of *N. colliculosa*, *N. prava* and *N. reticulata* sometimes adjoined carbonized tissue at the interstices of the perithecia at their bottoms and tops. The outermost layer of the peridium of *Nemania confluens* and of *Euepixylon udum* diverged from that of the other species. In *N. confluens* it consisted of a t. ang. mixed with wood cells, while that of *E. udum* was a homogeneous mixture of t. prism. and t. porr., forming an almost bilateral tracery.

Tab. 2. Species with carbonization of the outermost peridial layer: patterns of occurrence. + – carbonization strong; (+) – carbonization moderate.

Taxon	Continuous layer	Scattered irregular spots
Nemania atropurpurea	+	·
N. confluens	·	+
N. diffusa	+	·
N. effusa	(+)	·
N. prava	·	+
N. serpens	+	·
Entoleuca mammata	·	+

Asci and paraphyses

The asci were cylindrical with a long stipe (viz. about as long as, or longer than the spore part). The lengths of ascal stipes, often used as an additional character in species discrimination, were found to vary considerably within the species. They were useful only for roughly estimating the intervals of variation, or mean values. The ascus annulus was urn-shaped, square to rectangular, and higher than broad when seen in optical section. This is similar to that observed in the genera *Rosellinia* and *Xylaria*, but deviates from the more or less discoid type found in *Hypoxylon* and *Biscogniauxia*. The ascus annulus was amyloid in all taxa except for *N. serpens* where it reacted dextrinoid in LG. Paraphyses were copious in fresh material. They were hyaline or partly filled in with yellow content, unbranched, or sparsely branched towards the base. They looked much similar in all species, and we have made no systematic study to compare the different taxa.

The effect of LG and MZ to asci

We found important differences in the reaction of the ascus annuli when treated with LG as opposed to MZ. Results for *Nemania serpens* and *N. colliculosa* are shown in Tab. 3.

One of the most important implications of these results was that when using only LG, a positive dextrinoid reaction was obtained in *Nemania serpens*, that is: a reddish or yellow annulus. Pretreatment with KOH caused an amyloid reaction in both *N. serpens* and *N. colliculosa*. The use of MZ was destructive to the dextrinoid reaction. This was evidently because of the strongly oxidizing chloral hydrate. This also explains why old MZ was observed to give reactions much like LG: the chloral hydrate, when exposed to light and warmth, will be reduced and loose its effect. LG stained the inner wall membrane of the ascus black, particularly the apical part. The reactions in the other amyloid taxa (*N. prava*, *N. reticulata*) in the former *N. serpens* aggregate did not differ from those of *N. colliculosa*.

Reactions to the different treatments seemed to be less consistent in very old material. For example, the amyloid reaction was sometimes greenish or turquoise rather than blue, and in a 130-year-old voucher specimen of *N. reticulata* mature asci were amyloid, while some immature asci

Tab. 3. Comparison of reactions of ascus annuli and asci of *Nemania serpens* and *N. colliculosa* to consecutive treatments. * – applied treatment(s): KOH – 2 (or 5) % KOH solution; MZ – Melzer's reagent; CH – chloral hydrate; LG – Lugol's solution. Dext – Dextrinoid reaction in ascus annulus (bl – blue; blbl – blackish blue; lbl – light blue); Amyl – Amyloid reaction in ascus annulus. dBb – de Bary bubble(s) in spores. + – distinct reaction; (+) – faint reaction, or reaction in some annuli only; - – no reaction; → – changes to ...

Treatment					Species	Reaction		
						Annulus		Ascal content, immature spores and paraphyses
KOH	MZ	CH	LG	CH		Dext	Amyl	
·	*	·	·	·	*N. serpens*	- (+)	·	yellow
					N. colliculosa	·	+ lbl	yellow
·	·	·	*	·	*N. serpens*	+	·	golden yellow
					N. colliculosa	·	+ blbl	golden yellow
*	*	·	·	·	*N. serpens*	·	+ bl	hyaline→yellowish
					N. colliculosa	·	+ lbl	hyaline→yellowish
*	·	·	*	·	*N. serpens*	·	+ bl	golden yellow
					N. colliculosa	·	+ blbl	golden yellow
·	*	·	*	·	*N. serpens*	- (+)	·	golden yellow
					N. colliculosa	·	+ bl	golden yellow
·	·	*	·	·	*N. serpens*	-	-	hyaline; dBb
					N. colliculosa	-	-	hyaline; dBb
·	·	*	*	·	*N. serpens*	- (+)	·	golden yellow
					N. colliculosa	·	- (+)	yellow
·	·	·	*	*	*N. serpens*	+ → -	·	yellow→hyaline
					N. colliculosa	·	+ → -	yellowish→hyaline
·	*	*	·	·	*N. serpens*	(+)→-	·	yellow→hyaline
					N. colliculosa	·	+ → -	yellowish→hyaline

showed dextrinoid reaction. Probably irrespective of age, different colours were also noticed in the ascus annulus of dextrinoid specimens, i.e. of *N. serpens*, which might be yellow, orange, rusty, or reddish brown. A few specimens reacted negatively to all of the above treatments and in fact seemed to lack an annulus, but otherwise agreed with *N. serpens*.

Ascospores

The ascospores were ellipsoid-inequilateral, usually with one side – by some authors referred to as the 'ventral' side – more flattened than the other ('dorsal') side, slightly bipolar asymmetric, smooth, pale brownish to brown, or dark brown. They had a delicate, indehiscent, usually non-sticky perispore, judging from the appearance of crushed spores and spores which had been treated with hypochlorite solution. In immature ascospores a non-persistent hyaline cellular appendage was seen at the more tapered end. The germ slit was of variable length, and with few exceptions located on the least convex (ventral) side of the ascospore. One to three guttules ('drops') were commonly noticed in water mounts of the ascospores, and de Bary bubbles (gas bubbles) appeared in several ascospores in several media (e.g. glycerol, Shear's medium, LG).

Ascospore form seemed to be a basic characteristic, and sometimes had to take precedence over spore size. Because of considerable variation here too, types of forms had to be assessed either in terms of prevalence, or as the occurrence of constant, deviating forms. Thus, of the treated taxa in *Nemania serpens* agg., only *N. serpens* had predominantly broadly rounded spore ends (60-80% of the spores) with nearly parallel sides, though several collections also showed the spore form common to the other taxa in the aggregate: more or less gibbose to navicular spores approaching those of *N. atropurpurea*. In the last species, however, many spores, though not a majority, typically exhibited a navicular form with a flat ventral side and acute ends in lateral view. The colour of fresh spores of the *N. serpens* agg. seen in the microscope will often have a greenish tone, but became more brownish or faintly reddish brown in material stored for a long time.

The short germ slit in the ascospores of taxa in the *Nemania serpens* agg. was sometimes almost invisible, and it was suspected to be lacking in a proportion of the spores. The short germ slit of *N. aenea* was clearly visible, as in taxa with a long germ slit (*N. carbonacea*, *N. diffusa*). The short germ slit could in some species deviate a little from the central, axial position on the ventral spore side, and occasionally even occurred on the more convex side (*N. aenea*). Some ostensible *N. aenea* and *N. serpens* var. *macrospora* from Czechoslovakia (PRM) consistently had the germ slit on the more convex side of the ascospore, a position otherwise seen only in the rare, extra-Nordic *N. illita*.

The application of a domestic hypochlorite solution (NaOCl) to ascospores revealed variation in resistance to bleaching: *N. atropurpurea* and taxa in *Nemania serpens* agg. resisted a complete bleaching for several hours, while most spores of *N. diffusa* and *N. carbonacea* were bleached after 30-45 minutes. There were also variations in this respect within *N. serpens* agg. Thus, after two hours 80-90% of the spores of *N. colliculosa* were still brown, but only 30-40% of the spores of *N. serpens*. The rapid bleaching of the dark-spored *N. diffusa* and *N. carbonacea* might be explained by a more rapid intrusion of hypochlorite due to their long germ slit, but this cannot apply to *N. serpens* versus *N. colliculosa*. The cause for the differences in spore wall decolorization remains to be elucidated.

Spore deposits

The colours of naturally occurring spore deposits on stromata were examined particularly in the *Nemania serpens* aggregate. Wherever possible the colour was determined of recently collected though not completely fresh material, and compared to that of older material. The colours were found to correlate with other features of the taxa on several occasions, and have been used in species delimitation in *N. serpens* agg. It should be noted that the colour of spore deposits in some cases altered with time, attaining a more brownish or reddish brown hue in old material irrespective of species. Even in *Nemania atropurpurea*, with its dark blueish green spore deposit, a reddish tint could be noted on the surface of the spore mass on stromata of long stored material. Small, shining golden (green-)yellow heaps of crushed ascospores might additionally occur on the stromata of *Nemania serpens* agg.

Tab. 4. Species of *Nemania*, including *Entoleuca mammata* and *Euepixylon udum*, and their percentage frequency on recorded host genera in Norden. The hosts are grouped systematically. *Nemania aureolutea* is omitted due to few records. n – number of collections.

	n	Polypores	Gymnosperms	Angiosperms																
				Hamameliidae							Dilleniidae			Rosiidae				Asteriidae		
			Pinales	Fagales						Urticales	Salicales		Malvales	Sapindales		Rosales		Oleales	Dipsacales	
			Pinaceae	Betulaceae				Fagaceae		Ulmaceae	Salicaceae		Tiliaceae	Aceraceae	Hippocastanaceae	Rosaceae		Oleacea	Caprifoliaceae	
			Picea	*Alnus*	*Betula*	*Carpinus*	*Corylus*	*Fagus*	*Quercus*	*Ulmus*	*Populus*	*Salix*	*Tilia*	*Acer*	*Aesculus*	*Malus*	*Sorbus*	*Fraxinus*	*Lonicera*	*Sambucus*
Entoleuca mammata	177	·	·	·	2.1	·	·	·	·	·	13.4	70.6	·	·	·	·	13.9	·	·	·
Euepixylon udum	40	·	·	·	·	·	17.5	5.0	77.5	·	·	·	·	·	·	·	·	·	·	·
N. aenea	7	·	·	28.6	·	14.3	·	57.2	·	·	·	·	·	·	·	·	·	·	·	·
N. atropurpurea	51	·	·	·	·	·	·	33.3	·	3.9	62.8	·	·	·	·	·	·	·	·	·
N. carbonacea	7	·	·	·	57.1	·	14.3	14.3	14.3	·	·	·	·	·	·	·	·	·	·	·
N. chestersii	20	·	·	·	·	·	·	90.0	5.0	·	·	·	·	·	·	·	·	5.0	·	·
N. colliculosa	10	·	·	·	·	·	·	·	10.0	·	50.0	40.0	·	·	·	·	·	·	·	·
N. confluens	24	·	·	·	·	4.2	·	29.2	58.3	·	·	·	8.3	·	·	·	·	·	·	·
N. diffusa	5	·	·	·	·	·	40.0	·	40.0	·	·	·	·	·	·	·	·	20.0	·	·
N. effusa	21	23.8	·	·	14.3	·	·	·	4.8	·	14.3	42.9	·	·	·	·	·	·	·	·
N. prava	6	·	·	·	16.7	·	33.3	·	33.3	·	·	·	·	·	·	·	·	16.7	·	·
N. reticulata	11	**100.0**	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·	·
N. serpens	227	·	0.9	2.6	4.4	0.9	3.5	14.5	11.9	6.2	18.1	11.5	4.4	3.1	0.4	0.4	6.6	9.7	0.4	0.4

Tab. 5. Species of *Nemania*, including *Entoleuca* and *Euepixylon* and their percentage frequency on recorded host genera and substrate types in Norden (specimens on polypores not included). n – number of collections.

Species	n	Distribution on host genera and substrate type				Distribution on substrate type		
		Host genus	bark	wood	both	bark	wood	both
Entoleuca mammata	187	*Betula*	2.1	·	·	**100.0**	·	·
		Populus	13.4	·	·			
		Salix	70.6	·	·			
		Sorbus	13.9	·	·			
Euepixylon udum	40	*Corylus*	2.5	15.0	·	7.5	90.0	2.5
		Fagus	5.0	·	·			
		Quercus	·	75.0	2.5			
Nemania aenea	7	*Alnus*	·	28.6	·	28.6	57.2	14.3
		Carpinus	14.3	·	·			
		Fagus	14.3	28.6	14.3			
N. atropurpurea	51	*Fagus*	·	33.3	·	·	**100.0**	·
		Ulmus	·	3.9	·			
		Populus	·	62.8	·			
N. carbonacea	7	*Betula*	·	57.1	·	·	**100.0**	·
		Corylus	·	14.3	·			
		Fagus	·	14.3	·			
		Quercus	·	14.3	·			
N. chestersii	20	*Fagus*	·	90.0	·	·	**100.0**	·
		Quercus	·	5.0	·			
		Fraxinus	·	5.0	·			
N. colliculosa	10	*Quercus*	·	10.0	·	·	90.0	10.0
		Populus	·	40.0	10.0			
		Salix	·	40.0	·			
N. confluens	24	*Carpinus*	·	4.2	·			
		Fagus	·	29.2	·			
		Quercus	·	58.3	·			
		Tilia	·	8.3	·			
N. diffusa	5	*Corylus*	20.0	·	20.0	40.0	20.0	40.0
		Quercus	20.0	·	20.0			
		Fraxinus	·	20.0	·			
N. effusa	16	*Betula*	·	18.8	·	6.3	87.5	6.3
		Quercus	·	6.3	·			
		Populus	6.3	12.5	·			
		Salix	·	50.0	6.3			
N. prava	6	*Betula*	·	16.7	·	·	**100.0**	·
		Corylus	·	33.3	·			
		Quercus	·	33.3	·			
		Fraxinus	·	16.7	·			

Tab. 5 (continued).

Species	n	Distribution on host genera and substrate type				Distribution on substrate type		
		Host genus	bark	wood	both	bark	wood	both
Nemania serpens	227	*Picea*	·	0.9	·	0.8	95.3	3.7
		Alnus	·	2.2	0.4			
		Betula	0.4	4.0	·			
		Carpinus	·	0.9	·			
		Corylus	·	3.1	0.4			
		Fagus	·	14.1	0.4			
		Quercus	0.4	10.1	1.3			
		Ulmus	·	6.2	·			
		Populus	·	18.1	·			
		Salix	·	11.5	·			
		Tilia	·	4.4	·			
		Acer	·	3.1	·			
		Aesculus	·	0.4	·			
		Malus	·	0.4	·			
		Sorbus	·	6.2	0.4			
		Fraxinus	·	9.3	0.4			
		Lonicera	·	·	0.4			
		Sambucus	·	0.4	·			

ECOLOGY

Habitats

Favourable localities for *Nemania* specimens were for instance eutrophic deciduous forests, where stromata were found on fallen trunks and branches, usually in contact with the ground. In Norway dry, sunny, rocky sites were preferred, where for instance *Nemania atropurpurea* was encountered on dried-out wood of decaying *Populus* trunks. In Denmark the occurrence of ascomata did not seem to be particularly favoured on sunny sites. Instead ascomata were often encountered in quite humid localities, like those typical of, for example, *N. chestersii*. *Nemania serpens* produced ascomata under somewhat humid conditions as well, and frequently occupied the basal, moist underside of fallen trunks. *Nemania colliculosa* or *N. prava* were frequently found associated with *N. serpens*. *Entoleuca mammata* was collected in different types of habitats, the stromata being located on trunks or branches well above the ground, or on branches recently fallen to the ground, whereupon the stromata quickly deteriorate.

Saprobic types and host connection

By far the majority of *Nemania* species were *secondary saprobes*, producing sporophores on various types of decayed wood. A few species probably belonged to the *primary saprobes*. In the latter group we have recognized *Nemania atropurpurea*, which in Denmark was frequently observed on the inside of fresh, split stumps of wind-felled *Fagus*, and *Entoleuca mammata*, with ascomata on drying branches and trunks of *Salix*. However, it should be noted that collec-tons of *E. mammata* on *Betula*, and sometimes on *Sorbus*, occurred on very deteriorated wood. For *N. atropurpurea* we do not know if the observation of *Fagus* as the preferred host in nemoral Denmark, as compared to *Populus* being the preferred host further north, simply reflects the frequency of available hosts in different regions or a factual adaptation to different hosts.

Nemania carbonacea probably belonged to the primary saprobes as well, because from observations of voucher specimens the species was seen to sporulate on dry, relatively fresh wood. Two species, *Euepixylon udum* and *N. confluens*, were mostly recorded on very strongly decayed *Quercus* showing an extensive white-rot. The two species have been termed *tertiary saprobes*. Two species were found to be *mycosaprobes*: *Nemania reticulata* on old polypores, particularly *Fomitopsis pinicola*, and *N. effusa* on wood and on deteriorated or fresh basidiocarps of *Phellinus* spp. Of the treated species, all collections which were confidently determined as to host and substrate have been arranged in Tabs 4-5.

By far the majority of samples occurred on naked wood (Tab. 5), which was to be expected from their character of being mostly secondary saprobes. The primary saprobe *Entoleuca mammata* behaved differently, being restricted to the outer cortex of trunks and branches, breaking through the bark when mature.

Though no Nordic *Nemania* was connected to only one host, several species preferred a restricted selection of hosts. These were tentatively arranged in four groups (Tab. 6). *Nemania chestersii* in Norden preferred *Fagus* as host tree, a picture which will probably not be altered by future collecting. The scanty records of *N. aenea*, *N. aureolutea* and *N. carbonacea* did not allow definitive conclusions as to host affinities, but *N. aenea* and *N. carbonacea* seemed to prefer hosts from the families *Betulaceae* and *Fagaceae*. *Nemania effusa* has been arranged in the host-indif-

Tab. 6. Nordic species of *Entoleuca*, *Euepixylon* and *Nemania* grouped according to host preference. Only taxa represented by 10 or more specimens included. Species given in brackets are host selective, but occur on more than one host taxon.

Host preference type	Hosts	Fungus species
Genus-selective	*Fagus*	(*N. atropurpurea*), *N. chestersii*
	Populus	(*N. atropurpurea*)
	Fomitopsis	*N. reticulata*
Family-selective	Fagaceae	*N. confluens*
	Salicaceae	*Entoleuca mammata*, *N. colliculosa*
Order-selective	Fagales	*Euepixylon udum*
Indifferent		*N. effusa*, *N. serpens*

Tab. 7. Nordic species of *Entoleuca*, *Euepixylon* and *Nemania* arranged according to occurrence in vegetation regions and ranked hosts. Vegetation regions: N – nemoral; BN – boreonemoral; SB – southern boreal; MB – middle boreal; NB – northern boreal; LA – low alpine. + – common; (+) – few records. - – no obvious host preference. *Nemania colliculosa* and *N. prava* are omitted due to lack of records from Norden outside Norway.

Species	Vegetation region						Hosts	
	N	BN	SB	MB	NB	LA	Primary host	Secondary host(s)
Nemania aenea	+	·	·	·	·	·	*Fagus*	*Alnus glutinosa*
N. aureolutea	(+)	·	·	·	·	·	-	-
N. chestersii	+	·	·	·	·	·	*Fagus*	*Fraxinus*, *Quercus*
N. diffusa	+	·	·	·	·	·	*Quercus*	*Corylus*
N. confluens	+	·	·	·	·	·	*Quercus*	*Fagus*
Euepixylon udum	+	+	·	·	·	·	*Quercus*	*Corylus*
N. carbonacea	+	+	·	·	·	·	*Betula*	*Corylus*, *Quercus*
N. reticulata	·	+	+	(?)	·	·	*Fomitopsis*	*Phellinus*
N. effusa	+	+	+	+	·	·	*Salix*	polypores
N. atropurpurea	+	+	+	+	(+)	·	*Populus*	*Fagus*
N. serpens	+	+	+	+	(+)	·	*Populus*	*Fagus*, *Quercus*
Entoleuca mammata	·	(+)	+	+	+	(+)	*Salix*	*Populus*, *Sorbus*

ferent group, though further finds may change the picture, because its ecology is only scantily known. *Nemania serpens* has been found on practically all kinds of wood. It was one out of the two species of *Nemania* which was found to occur also on coniferous wood (the second being *Nemania* sp. A).

CHOROLOGY

Seven species were restricted to the nemoral, boreonemoral and southern boreal regions (see Tab. 7): *N. aenea*, *N. aureolutea*, *N. chestersii*, *N. confluens*, *N. diffusa*, *N. carbonacea* and *Euepixylon udum*. Some uncertainty exists as to *N. reticulata*. In our opinion these species belong to a southern geoelement in Norden. Their distribution proved to be more restricted than that of their primary hosts, and far more than that of their secondary hosts such as *Corylus* and *Fraxinus* (cf. Tab. 7). While all the above mentioned species were found in Denmark, they were either rare or lacking in the other Nordic countries. However, the lack of records in the nemoral part of Sweden is most likely due to insufficient collecting.

While there was no northern distribution element in *Nemania*, *Entoleuca mammata* had a northerly distribution (Fig. 6, map). This species is most common in the middle and northern boreal regions, but *E. mammata* has also been collected in boreonemoral Sweden, once even in the nemoral province of Skåne. Most of these southern collections were on *Populus*, only rarely on *Salix*. The scarcity of *E. mammata* in northern Sweden and Finland is not real according to recent field work performed by G. Mathiassen (pers. comm.).

Nemania atropurpurea, *N. effusa* and *N. serpens* were found to be widely distributed. They may eventually prove to be ubiquitous for the area, although both *N. atropurpurea* and *N. effusa* had a weak eastern tendency of distribution according to the present picture (Figs 11, 46). Nothing definite could be stated about the distribution of the still insufficiently known *N. colliculosa*, *N. prava* and *N. reticulata* (Figs 33, 47 & 50, maps). The old records of *N. reticulata* apparently coincided with centres of botanical research in Norden.

DISCUSSION

øMOLECULAR PHYLOGENY AND TAXONOMY

The phylogenetic analyses of the ITS 1, ITS 2 and 5.8S sequences demonstrate that the included specimens of *Nemania* form a well supported clade that is distinct from specimens of *Hypoxylon* and *Biscogniauxia*. In this respect, the sequence data are consistent with cultural and morphological data. Furthermore, the aggregate species *Nemania serpens* s. Pouzar also nicely resolves into different genetical entities. A closer examination of the morphological differences between these specimens also demonstrates that they are sufficiently distinctive to warrant recognition of separate taxa. A broader selection of *Nemania* species submitted to molecular analyses is desirable. This would certainly give a better understanding of the variation within the genus, and help to indicate the taxonomic ranks and the systematic position of taxa. At this stage we have preferred to treat all taxa at species level. Additional taxa from genera suspected to be close to *Nemania* (e.g. *Rosellinia*) should also be included in future phylogenetic work.

Species of *Hypoxylon*, *Biscogniauxia* and *Entoleuca* group together in our analysis. However, the inclusion of a single specimen of *Entoleuca* and one of *Biscogniauxia*, and three taxa of *Hypoxylon*, is insufficient to resolve the phylogeny within the group. The fact that *Biscogniauxia* forms a well supported branch in our analyses may indicate that it will separate from *Hypoxylon* when more representatives of the group are added. The *Hypoxylon* specimens constitute two well supported subclades, which conform with the arrangement of these three species in two different sections (sections *Hypoxylon* and *Annulata*) based on morphology. Furthermore, the separation of *Hypoxylon porphyreum* and *H. fuscum* (Granmo 1999) gains molecular support from our analysis; altogether 36 ITS characters separate the included specimens of these two taxa.

The disposition of *Entoleuca mammatata* as a member of *Nemania*, as proposed by Mathiassen & Granmo (1996) is not supported by molecular evidence. In addition, its character of being a saprobe solely connected to bark is different from any *Nemania*. The parsimony and constraint analyses strongly indicate that *Entoleuca* belongs to the *Biscogniauxia*/*Hypoxylon* lineage, being evolutionary related to *Hypoxylon multiforme*. This is not obvious judging from morphological evidence. The generic status of *Entoleuca* has to be reconfirmed by sequencing additional specimens of *Entoleuca mammata*, and more species in sect. *Annulata* of *Hypoxylon*.

MORPHOLOGY AND TAXONOMY

Evaluation of morphological features

The intraspecific variation within *Nemania* is considerable, both in external and internal characters. Relatively few characters show discontinuities, and a major problem is to evaluate the range of variation of putative distinguishing features and combine them for taxon delimitation. Measurable characters are few, and the visual impression is difficult to define and communicate. Small differences in, for instance, ascospore size, traditionally heavily relied upon, were judged to be of secondary importance to ascospore form, to which we have attributed higher weight. In addition to a few qualitative and measurable characters, features such as perithecial contours and stromatal grooves, the shape of perithecial apex and ostioles, are all judged to be of significance in species discrimination.

The carbonization of the outermost peridial layer in some species of *Nemania* does not seem to parallel other systematic features in the genus, in contrast to the situation in *Hypoxylon*. In *Hypoxylon* the two sections, sect. *Annulata* with carbonization and sect. *Hypoxylon* lacking carbonization, have several additional parallel features supporting a sectional separation. However, although the carbonization in *Nemania* and *Hypoxylon* may have the same function (prevent desiccation and protect the centrum), the origin seems to be different. The carbonized peridial layer in *Nemania* is almost certainly an extension of the ectostroma, while the carbonization surrounding the peridium of *Hypoxylon* (and some species of *Biscogniauxia*) appears to be of condensed entostromatic tissue. In a developmental perspective, the ectostromatic encasement of the peridium may be seen as a condition for a complete separation of single perithecia, as in the genus *Rosellinia*, which is otherwise evidently closely related to *Nemania*.

Anamorphs of *Entoleuca*, *Euepixylon* and *Nemania* are all classified as *Geniculosporium* (Chesters & Greenhalgh 1964, Whalley 1976, L. Petrini & O. Petrini 1985, L. Petrini & Müller 1986, L. Petrini & Rogers 1986). *Nemania serpens* has a quite easily recognizable anamorph stage which may aid in species discrimination. It consists of an ash grey covering on wood, consisting of numerous distinctly bushy conidiophores of *Geniculosporium*. The teleomorph will frequently grow nearby. The creamy white to greyish covering on young stromata of, for instance, *N. effusa* and *N. atropurpurea*, has hardly anything to do with the anamorph stage. Pouzar (1985a) noticed the same covering for *N. carbonacea*, and Chesters & Greenhalgh (1964: 396) denoted this in *N. serpens* as 'compacted surface hyphae' of the young stromata.

The now well-known induced amyloid reaction of *Nemania serpens* after pretreatment with KOH (or NaOH) was initially demonstrated by Eriksson (1966). The consistently dextrinoid reaction in *N. serpens* by using only LG has evidently not been reported previously, neither the suppression of this reaction by using MZ, or chloralhydrate. According to Baral (1987: 404) the suppression of the red (dextrinoid; hemiamyloid sec. Baral 1987) reaction in the ascus apical apparatus of some ascomycetes by MZ (and also by lactophenol) was not detected until 1978. The lack of iodine reaction, which we observed in some specimens of *N. serpens*, even after pretreatment with KOH, is reminiscent of the observations in some strains of *Cloroschypha sabinae* (Helotiales) by O. Petrini (1982: 221).

The occurrence of *Apatococcus*-like, green algae in the entostroma of some specimens of *N. serpens* agg. is remarkable. We do not know how common the phenomenon is, and whether the algae are just transiently trapped in the stroma or if they play any role in a mutualistic way.

The colour of the spore deposits seems to be of some value to distinguish taxa. There may be multiple causes for the change in colour of spore deposit with time in specimens of the examined *Nemania serpens* agg. (drying conditions, preserving conditions etc.). The change apparently corresponds with a similar alteration in colour of individual spores as observed by light microscopy. Future research should reconsider and evaluate the colours of fresh spore deposits and try to standardize observation conditions. Likewise, when studying the variable bleaching of the ascospores in NaOCl, it might be useful to introduce the concept 'half-life', the time it takes for half the number of ascospores in a sample to decolorate completely.

The species concept in Nemania

Most of the confusion concerning the *N. serpens* aggregate is evidently due to three reasons: (1) the use of different chemicals (MZ, LG, KOH + MZ), often in varying concentrations, to test annulus reaction, giving deviating results for the same taxon, (2) the heavy reliance on spore size as a decisive parameter in differentiation of taxa, and (3) mixing of material from different taxa during collecting. Evidently these factors also have caused mixing of *N. serpens* agg. with major species such as *N. aenea*, *N. atropurpurea*, *N. carbonacea* and *N. diffusa*. It is not possible for the unexperienced to evaluate the minor external differences between these species, and they may certainly be easily mixed when they are growing together, as they frequently do.

Though external morphological differences are often small, some taxa may be easily distinguished by their internal morphology (ascus annulus, form and size of ascospores, peridium construction). This situation is well demonstrated by some taxon pairs such as *N. serpens* versus *N. aureolutea*, and *N. atropurpurea* versus *N. effusa*. Based on these clearly different taxa, a closer examination of their stromatal morphology reveals how the small external differences may vary, and how knowledge of these may be applied to identify species with few internal characteristics (e.g. *N. colliculosa* and *N. reticulata*). This provides an argument for adopting a narrow taxon concept in *Nemania*, and in all likelihood also for other xylariaceous genera. This is confirmed by the DNA sequence data of a selection of these taxa. The variations observed between specimens with dextrinoid ascus annulus, here considered as the prime character for *N. serpens*, pose a question as to whether the dextrinoid taxon is homogeneous or not. It has not been possible to reconsider it more closely in this study. However, minor differences in ascus annulus reactions should not be over-emphasized in taxon discrimination.

ECOLOGY AND CHOROLOGY

Saprobic ability

For *Hypoxylon* it has been argued that a more aggressive saprobic ability was correlated with a decrease in the number of hosts (Granmo 1999). This hypothesis also fits reasonably well with the studied species of *Nemania*. Most of them are secondary saprobes, and thus should have a more lax host connection. However, it is not true for *Nemania confluens* and *Euepixylon udum*, which are tertiary saprobes and yet still have a strong preference for *Fagaceae*, particularly for *Quercus*. The explanation is probably that they are specialists on the type of substrate where a range of other fungi have degraded the wood to the extreme, leaving remnants of well aerated cellulose without putative fungal competitors.

We know of three taxa of *Nemania* from Norden occurring on conifers, an unusual substrate. One of those is *Nemania serpens* on *Picea*, which is not unexpected because of the generally wide host range of that species. Additionally there is one yet unnamed species (*Nemania* sp. A) from Sweden on *Picea*, and one taxon of uncertain affinity in the amyloid group of *N. serpens* agg. (UME 62) on *Juniperus communis*. Species of stromatic *Xylariaceae* known to produce ascocarps on conifers are scarce. L. Petrini (1993) reported six species of *Rosellinia* on such wood, of which two (*R. mycophila* and *R. desmazieresii*) are also found on polypores. *Hypoxylon terricola* (probably a *Nemania* sec. Ju & Rogers 1996), known from the U.S.A. and southern Europe, likewise occurs on coniferous debris (L. Petrini & Müller 1986). These species have to tolerate, or neutralize, a series of phenolic compounds in conifers which are lacking in wood of deciduous trees.

The occurrence of some *Nemania* spp., as well as some *Rosellinia*, on conifers, an evolutionary ancient plant group, represents interesting parallels to their evident intergeneric relationship as judged from morphology. Both genera have some putative ancient (plesiomorphous) features in common, such as scanty entostroma, no extractable pigments, ascospores with cellular appendages reminiscent of two-celled ascospores, and a simple anamorph structure (*Geniculosporium*), compared with the more complex types of the *Nodulisporium* anamorph in for instance *Hypoxylon*. These common features of the two genera are, however, only symplesiomorphies, not apomorphies (derived characters), indicative of phylogenetic relationship.

We do not know if the host-indifferent species will occur on all tree species in the area, or if they avoid some species, as was the case for the host-indifferent species of *Hypoxylon* (Granmo 1999). The scanty records of *N. serpens* on Betulaceae are striking, and all records on *Alnus* probably refer to the southern *A. glutinosa*, not to *A. incana*, which is common in the boreal regions of Norden.

Host connection and chorology

The distribution pattern in Norden of the studied species should, to some extent, reflect trends in the overall European distribution. The species belonging to the southern group, *Euepixylon udum*, *Nemania aenea*, *N. aureolutea*, *N. carbonacea*, *N. chestersii*, *N. confluens* and *N. diffusa* are also suggested to be reasonably common species in nemoral and boreonemoral parts of Europe. As far as reliable records are available, this appears to be the case. Thus *N. aenea* (and *N. aureolutea*), have been recorded from localities in Central and Middle Europe (Pouzar 1985, L. Petrini & Rogers 1986, Krieglsteiner & Enderle 1989), including the nemoral southeastern England (C, TROM). Pouzar's information on hosts and habitat ecology for *N. aenea* from Czechoslovakia (Pouzar 1985b) conforms well with observations from Denmark. In Norway these species are either rare or lacking, in spite of no shortage of appropriate hosts. This means that the conditions for sporophore development are rarely or not at all fulfilled at the northern border of the nemoral or boreonemoral area in this country.

Nemania carbonacea was described by Pouzar (1985a) on *Populus* and various broad-leaved trees from Czechoslovakia, and has till now been reported from that area only. Pouzar stated that both *N. carbonacea* and *N. diffusa* (as *N. bipapillata*) were thermophilic taxa, as they obviously are also in our area. Thus the only specimen of *N. diffusa* north of Denmark was collected in a Swedish greenhouse. In Europe both taxa are probably slightly continental, and we presume they are rare or absent in coastal western Europe including the British Isles.

The long known European *Nemania confluens* (= *Hypoxylon c.*, or *H. semiimmersum*), predominantly on *Quercus* wherever found, has been collected in several localities in Denmark. Its Nordic distribution indicates a taxon preferring an oceanic climate. This agrees with its occurrence in the British Isles where it is common (sec. Dennis 1981 as *H. semiimmersum*; Dennis 1986, 1995). It is rare in the rest of Europe (L. Petrini & Müller 1986, Krieglsteiner & Enderle 1989). From Denmark there is abundant material of *N. chestersii* on *Fagus*. Its occurrence in North Wales on *Fraxinus* (Rogers & Whalley 1978) indicates an oceanic, western European species, but due to few records nothing definite can be said.

The unusual habitat ecology of *Euepixylon udum* was commented upon by Granmo et al. (1989). The Nordic distribution closely follows that of the oaks (*Quercus petraea*, *Q. robur*), although *Corylus avellana*, its secondary host, has a wider distribution. The single station of *E. udum* on oak in western Norway suggests that the species tolerates an oceanic climate. This is in accordance with records from Scotland and the Hebrides (Whalley & Watling 1980, Dennis 1986, 1995). In the rest of Europe there are several records from the British Isles, all on oak, and a few from France, Germany, Italy and Switzerland (Krieglsteiner & Enderle 1989, L. Petrini & Müller 1986). The species is probably common in western Europe, but rare in continental Europe.

We conclude that the southern group of species is fairly well known from Europe on largely the same hosts as in Norden. We assume that the occurrences in Denmark, southern Sweden and parts of southernmost Norway and Finland are at the extreme border of a more southerly European distribution. Their Nordic distribution is approximately within the boundaries of the vegetation regions concerned, but far more restricted than the distribution of their hosts. We suggest climate (temperature, length of growing season or heat sum) to be the important factor for the distribution of these fungi. Interaction and competition with other organisms (fungi, bacteria) may also have an influence.

Entoleuca mammata is a common species in northern Scandinavia, having an eastern distributional tendency here. This is well demonstrated by its total absence in the coastal areas of southern Nordland, Norway (cp. Mathiassen 1993), and further south. The species is lacking in Denmark. Owing to this distribution pattern, we at first hesitated to accept a specimen stated to originate from the nemoral region Skåne, Sweden (UPS, on *Salix*). However, Krieglsteiner (1993) records *E. mammata* (as *Hypoxylon m.*) from the likewise nemoral northwestern Germany, and it is also known from the British Isles (Cannon et al. 1985, Dennis 1995). Even though *E. mammata* occurs in these areas, the picture of a species with a northern or northeastern centre of distribution is not altered.

We have no definite opinion at present as to whether *E. mammata* on *Populus* in the southern part of Scandinavia may differ from *E. mammata* on *Salix*, *Sorbus* and *Betula*, the only hosts further north (cf. Mathiassen 1993). The various collections are here considered to represent one species. A future study of DNA sequences from different strains of the species could possibly resolve the taxonomy considerably.

In the group stated to have a wide Nordic distribution (i.e. *Nemania atropurpurea*, *N. effusa* and *N. serpens*), we believe that the lack of voucher specimens from northernmost Norway and large parts of Sweden and Finland most probably arise from insufficient collecting. *N. effusa* must, however, be a rather uncommon species in Norden, despite its evidently large ecological amplitude. *N. effusa* is also rare in Europe (Pouzar 1985b, L. Petrini & Müller 1986), and found only once in the British Isles (southern England; Dennis 1974). The European distribution of *N. atropurpurea* is insufficiently known. Pouzar recorded the species from Central Europe particularly on *Fagus* (Pouzar 1985a), and its frequent occurrence on *Fagus* in Denmark should indicate a species which is not rare in western Europe. However, the absence of both *N. atropurpurea* and *N. effusa* in the oceanic western Norway points to species which also avoid oceanic areas in their European distribution. *Nemania serpens* has, even in the present restricted sense, most definitely a wide European distribution.

TAXONOMY

KEY TO SPECIES

1 Stromata with few (1-50) perithecia, partly immersed in wood or bark 2
1 Stromata with numerous (> 50) perithecia, superficial 4

2 (1) Ascospores with elliptic, poroid germ slit . . . . . . *Euepixylon udum*
2 Ascospores with narrow, long germ slit 3

3 (2) Stromata in wood. Ascus annulus broader than high . . . . . . *Nemania confluens*
3 Stromata in bark. Ascus annulus higher than broad . . . . . . *Entoleuca mammata*

4 (1) Ascospores without germ slit, longitudinally striate (1000×) . *Nemania chestersii*
4 Ascospores with germ slit, smooth 5

5 (4) Germ slit conspicuous, whole spore-length or almost so 6
5 Germ slit often inconspicuous, much shorter than spore-length 8

6 (5) Ascospores pale brown, 19-29 × 7-10 µm . . . . . . *Nemania gwyneddii* (not yet recorded for Norden)
6 Ascospores brown or dark brown, less than 19 µm long 7

7 (6) Stromata brown, ascospores brown, 9.5-13.5 × 4.5-6 µm, ends not elongated . . . . . . *Nemania diffusa*
7 Stromata black, ascospores dark brown, 11-13 × 5-6.5 µm, ends often elongated or pointed . . . . . . *Nemania carbonacea*

8 (5) Ostioles with disk-like area, ascospores very pale brown, 13.5-18 × 3.5-4.5 µm, occasionally septate . . . . . . *Nemania* sp. B
8 Ostioles lacking disk-like area, ascospores pale brown to brown 9

9 (8) Ascospores 6-9.5 × 3-4.5 µm . . . . . . *Nemania effusa*
9 Ascospores larger 10

10 (9) Ascus annulus dextrinoid in LG. Outer peridial tissue carbonaceous.Ascospores 10-14.5 × 4-6 µm, germ slit inconspicuous . . . . . . *Nemania serpens*
10 Ascus annulus amyloid in LG. Peridium with or without carbonaceous tissue 11

11 (10) Ascospores (13-)14-20 µm long, ellipsoid to ellipsoid-inequilateral 12
11 Ascospores 9-13.5(-14.5) µm long, the majority of spores ellipsoid-inequilateral 15

12 (11) Ascospores typically with broadly rounded ends and almost parallel sides, mean ratio ascus stipe : spore part about 0.6 13
12 Ascospores with narrowly rounded ends, mean ratio stipe : spore part 0.7-1.5 14

13 (12) Germ slit conspicuous, ascus annulus deep blue in LG .... *Nemania aenea*
13 Germ slit inconspicuous, ascus annulus not deep blue in LG .... *Nemania aureolutea*

14 (12) Ascospores strongly ellipsoid-inequilateral, germ slit conspicuous to inconspicuous, 14-17.5 × 5-6.5 µm .... *Nemania serpens* var. *macrospora* (not yet recorded for Norden)
14 Ascospores ellipsoid to ellipsoid-inequilateral, 15.5-19.5 × 6.5-9 µm, germ slit inconspicuous .... *Nemania* sp. A

15 (11) Outer peridial tissue carbonaceous. Perithecia large, 550-850 µm high. Ascospores 9-11.5 × 4-5.5 µm, several with one side completely flat .... *Nemania atropurpurea*
15 Outer peridial tissue not carbonaceous. Perithecia smaller. Ascospores 9-13.5(-14.5) × 4-6 µm, no side completely flat 16

16 (15) Perithecial contours almost none, stromatal grooves smooth and shallow. In small spots or in a reticulate manner on decaying polypores .... *Nemania reticulata*
16 Perithecial contours conspicuous, on woody hosts 17

17 (16) Perithecia 390-600 µm high (m. 470 µm). Ascospore deposit on stromata light brown or slightly reddish brown .... *Nemania prava*
17 Perithecia 300-450 µm high (m. 370 µm). Ascospore deposit on stromata yellowish green or olive yellow .... *Nemania colliculosa*

DESCRIPTIONS OF THE SPECIES

Entoleuca mammata (Wahlenb.) J.D. Rogers & Y.-M. Ju

in Ju & Rogers, Mycol. Mem. 20: 292 (1996); Rogers & Ju, Mycotaxon 49: 446 (1996) - *Sphaeria mammata* Wahlenb., Fl. Suec.: 1003 (1826) - *Hypoxylon mammatum* (Wahlenb.) P. Karst., Not. Sällsk. Fauna Fl. fenn. Förh. 8: 212 (1882, 1866 as prepr., n.v.) - *Nemania mammata* (Wahlenb.) Granmo, in Mathiassen & Granmo, Univ. Trondheim VitenskMus. Rapp. bot. Ser. 1995: 6: 32 (1996) - *Sphaeria mammiformis* Wahlenb., Fl. Lapp.: 520 (1812), non *S. mammaeformis* Pers. (: Fr) (1801) - *Hypoxylon pauperatum* P. Karst., Not. Sällsk. Fauna Fl. fenn. Förh. 8: 212 (1882, 1866 as preprint, n.v.) - *Hypoxylon pruinatum* (Klotzsch) Cooke, Grevillea 11: 130 (1883) - Anamorph: *Geniculosporium* (L. Petrini & Müller 1986); *Geniculosporium* and *Nodulisporium* (Griffin et al. 1992).

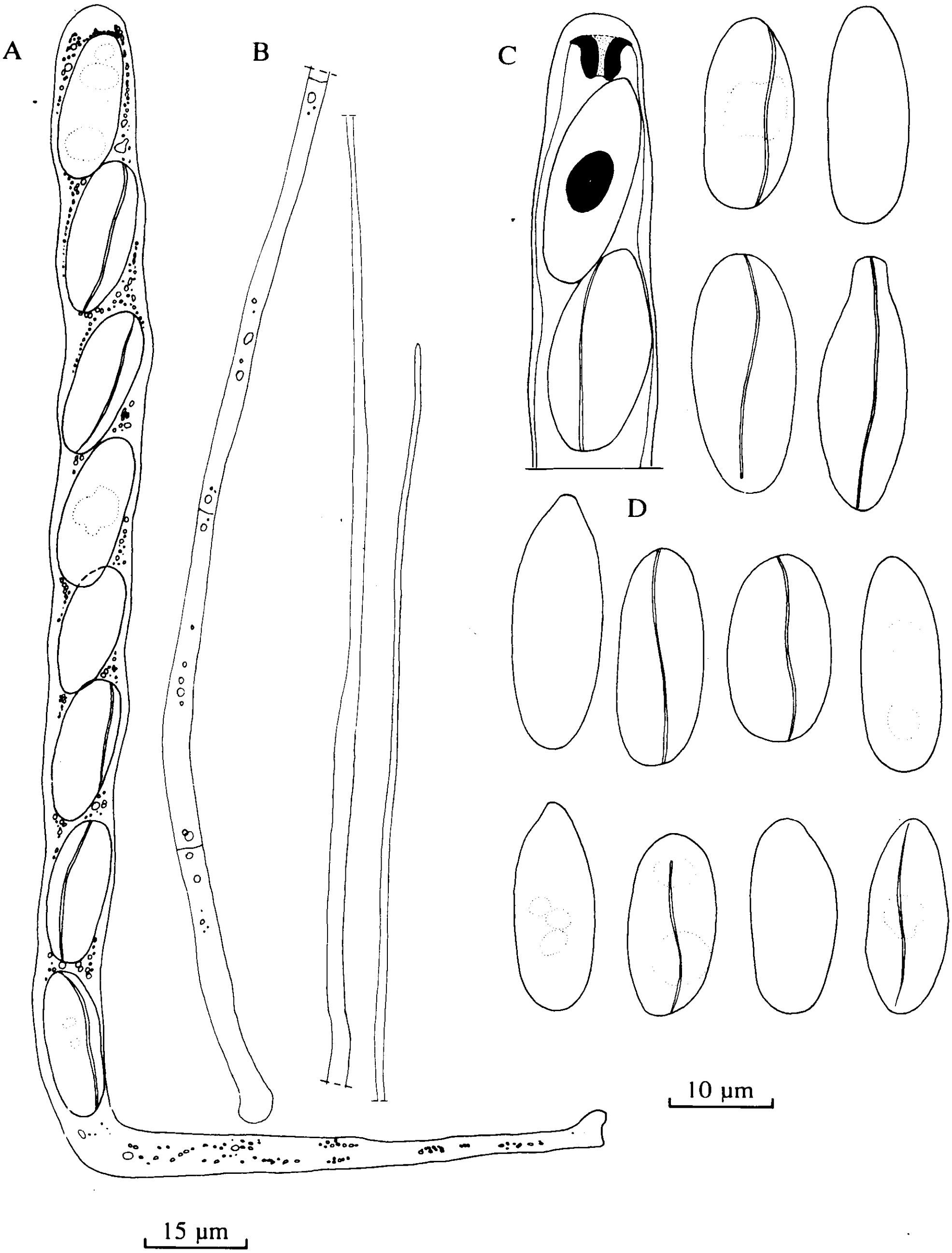


Fig. 4. *Entoleuca mammata*. A. Ascus. B. Paraphysis (basal, middle and apical part). C. Ascus apex in LG. D. Ascospores. A-B and the spores in the two uppermost rows, and the leftmost in the third row, from O 4 (on *Sorbus*), the other spores are from specimens on *Salix* in BG.

Figs 4 A-D, 6 (map), 16 (stroma), 24.

Description (based upon material on *Salix* and *Sorbus*). *Stromata* circular, 0.2-0.7 cm in diam., or elliptic, 0.7-1 × 0.3-0.6 × 0.1-0.25 cm, erumpent from bark, consisting of (2-)8-15(-30) perithecia with conspicuous elevations, at first white due to a thick sterile covering, later grey and finally black. Ectostroma 150-280 µm, carbonaceous, at times with a crenulate collar surrounding the perithecial group, continuing through the bark down to the blackened wood, thus circumscribing the complete stroma. Entostroma pale brown, mixed with bark elements, basal part to 300 µm thick. *Perithecia* 800-2200 µm high, 800-1400 µm broad, spherical to ovoid. Peridium 45-55 µm, consisting of an innermost, yellowish to pale brown t. ang.-t. prism., 17-20 µm, followed by a brown, long-celled t. prism.-t. porr., ca. 40 µm, with scattered carbonized spots. Ostioles strongly papillate, conical, acute, sometimes surrounded by a small depression. Perithecial contours conspicuous, each perithecium demarcated by angular V-shaped grooves. *Asci* p.sp. 140-180 × 9.5-13.5 µm, m. 165 × 12 µm (n = 36/2), st. 60-105(-120) µm, m. 84 (n = 20/2). Ascus annulus with an apical rim, amyloid in LG and MZ, 4-5 µm high, 3.5-5 µm broad. *Paraphyses* to 550 µm long, ca. 4 µm broad at base, tapering gradually toward the apex, with a few septa at the base, unbranched. *Ascospores* (17-)18-26.5 × 7-11(-12.5) µm, m. 21.2 × 8.9 µm (n = 122/6), oblong, a proportion also ellipsoid with one end more pointed than the other, occasionally with remnants of a hyaline cellular appendage, dark brown. Germ slit the whole spore-length, somewhat undulating or sinuous, on the more convex side in inequilateral spores.

Anamorph in nature (on *Populus* only) forming conidial pillars (Bier 1940, Berbee & Rogers 1964) bursting through blisters in the bark, individual pillars 250-600 µm broad, 100-200 µm thick and 450-1200 µm high, covered by an ash grey conidiogenous mycelium.

Entoleuca mammata is easily distinguished from species of *Nemania* by its oligoperitheciate erumpent stromata and polygonal perithecial demarcations.

Taxonomic notes. Though *Entoleuca mammata* has several characters in common with *Nemania* and *Rosellinia* and other genera in the subfamily Xylarioideae, and to a less extent to *Hypoxylon* and *Biscogniauxia* (in subfamily Hypoxyloideae), there are reasons for arranging it in a genus of its own. The most obvious characteristics are the innate growth habit, nearly cylindrical dark brown ascospores and the synanamorphs *Geniculosporium* and *Nodulisporium* (Griffin et al. 1992, both anamorphs from the virulent form).

Rogers & Ju (1996) revived the genus *Entoleuca*, of which the type is the little known *E. callimorpha* Sydow. Whalley & Edwards (1987, 1995) demonstrated that *E. mammata* (as *Hypoxylon m.*) had two particular secondary metabolites of the dihydroisocoumarin group in addition to the usual 5-methylmellein common for a number of *Hypoxylon* spp., some *Nemania* species and some *Biscogniauxia*. Those were 5-carboxymellein and 5-methoxycarbonylmellein. While the latter compound was present in *E. mammata* only, the former was also detected in *Nemania illita*, *Xylaria oxyacantha* and *Biscogniauxia marginata*, giving information of nothing but a possible relationship to genera in both of the two subfamilies of Xylariaceae.

The nr ITS DNA phylogeny supports a splitting of *Entoleuca* from *Nemania* and suggests a connection to *Hypoxylon multiforme*. This is at present not reconcilable with the results from conventional taxonomy, and it seems premature to change the generic status of *E. mammata*.

Fries was evidently confused about this species (Fries 1823: 335, 1828: 64) which is confirmed when studying his material. One specimen from Wahlenberg in 1824 (UPS) of ostensible *Sphaeria mammata* Fries he named '*Hypoxylon granulosum*', by which he was probably referring to *H. granulosum* Bull. (= *Hypoxylon multiforme*). In fact, this specimen is *Nemania atropurpurea* on *Fagus*. Another specimen of true *E. mammata* on *Salix*, putatively collected in Skåne, he had named '*Sphaeria (= Biscogniauxia) nummularia* minor' (UPS).

Ecology. *Entoleuca mammata* is a saprobe on corticated *Betula*, *Populus*, *Salix* and *Sorbus*. Susceptible hosts of the pathogenic form causing canker on *Populus* are *P. tremuloides*, *P. grandidentata*, *P. tremula* and their hybrids (Pinon 1975, Ginns 1986). *P. tremula* is however, rarely attacked, and in spite of several Swedish records of *E. mammata* on *Populus tremula*, the fungus is never reported to cause disease in forests of any Nordic country. Because of the capacity for parasitism on one particular host genus (*Populus*), one may suspect the taxon of being heterogeneous. In this study, however, it is treated as one entity.

Distribution. *Norway*. Op, No, Tr, Fi. *Sweden*. Sk, Ög, Nrk, Srm, Sth, Upl, Hls, Ång, Vb, Nb, Hrj, Jmt, Åsl, LL, TL. *Finland*. EH, PS, KP, OP, Ks, EnL, InL. Several authors have previously reported *Entoleuca mammata* (as *Hypoxylon m.*) from the Nordic countries. In Norden *Entoleuca mammata* shows a boreal and somewhat eastern distribution (cf. Mathiassen 1993). *Total.* Europe including the British Isles (Dennis 1995), Russia (evidently common), North America (cf. Granmo et al. 1989).

Specimens examined. Norway: S.l.d.n.c. *Sorbus aucuparia*(b) *Rosellinia mastoidea* Sacc. det. Rostrup (O 9) (Rostrup 1904: 18), id. *Sorbus aucuparia*(b) *Rosellinia thelena* det. Rostrup (O 10) (Rostrup 1904: 18). - Op: Nord-Aurdal: Haug 20 Aug 1932 *Sorbus aucuparia*(b) A. Hagen (O 20). Ringebu: Ringebu s.d. "*Betula*"= *Sorbus*(b) A. Blytt, *H. argillaceum* (Pers.) Berk. det. Rostrup (O 4) (Rostrup 1904: 19). - No: Narvik: Veggen Seglnes 6 Jun 1981 *Salix*(b) GM, AG 17/81 (TROM 16). Skjomen Forsheim 1 Oct 1994 *Salix*(b) AG 73/94 (TROM 12). - Tr: Balsfjord: E of Hamnes 19 Apr 1980 *Salix*(b) A. Elvebakk 80/166 & S. Sandvik (TROM 14). Laksvatn 18 Jul 1981 *Salix*(5b) GM 704, 709, 712, 730, 732. Bardu: Sørdalen Sørmo 15 Jul 1981 *Salix*(b) GM 449. Setermoen 16 Sep 1995 *Salix*(2b) AG 221/95, 222/95 (TROM 18,19). Bjarkøy: Sandsøy Altevik 6 Jul 1981 *Salix*(b) GM 203. Dyrøy: Brøstadbotn 11 Jul 1981 *Salix*(5b) GM 386, 392, 396a, 377, 394. Ibestad: Rolla 8 Jul 1981 *Salix*(5b) GM 330, 333, 334, 335, 336. Kvænangen: Burfjorddal 19 Jul 1981 *Salix*(3b) GM 820a, 825, 831. Badderen 5 Sep 1982 *Salix*(15b) GM 1844, 1849, 1851, 1855, 1824, 1825, 1826, 1831, 1834, 1835, 1836, 1837, 1862, 1863c, 1865. Kåfjord: Manndalen 18 Jul 1981 *Salix*(8b) GM 746, 750b, 751, 752, 768, 774, 758, 781. Lyngen: Lyngseidet 2 Aug 1973 *Salix*(b) I. Granmo & AG 208/73 (BG 5). Kvalvik 14 Sep 1982 *Salix*(10b) GM 2084, 2089, 2095, 2096, 2102, 2103, 2105, 2114, 2124, 2127. Målselv: Dividalen Svalheim, Åsen and Dødesvann 16 Jul 1981 *Salix*(6b) GM 662, 665, 669, 692, 693, 700, 16 Sep 1982 GM 2251. Nordreisa: Reisadalen Punta, Bergmo and Josdalen 19 Jul 1981 *Salix*(12b) GM 789, 793, 798, 802, 804, 811, 21 Jul 1981 924, 930, 933, 936, 938, 6 Sep 1982 GM 1931. Straumfjordbotn 20 Jul 1981 *Salix*(b) GM 866. Skånland: Tovik 7 Jul 1981 *Salix*(3b) GM 260, 265, 268. Storfjord: Signaldalen Rognli 15 Sep 1982 *Salix*(6b) GM 2142, 2154, 2161, 2162, 2163a, 2166. Skibotndalen Øvrevatn 15 Sep 1982 *Salix*(5b) GM 2189, 2192, 2216, 2227, 2228a. Helligskogen 3 Sep 1994 *Sorbus*(b) AG (TROM 13). Tromsø: Tromsøya 12 Aug 1981 *Salix*(4b) GM 1057, 30 Sep GM 1981 1098, 1101, 25 Sep 1995 *Salix*(b) AG 240/95 (TROM 17). Hundbergan 19 Sep 1981 *Salix*(b) GM 1158. - Fi: Alta: Kåfjordbotn 150 m E of Mattiselva N of E 6 29 Oct 1989 *Sorbus aucuparia*(b) AG (TROM 15). Tana: Rastigaissa Darjohka 17 Aug 1965 *Betula*(b) *Sorbus aucuparia*(b) J.A. Nannfeldt 19127, 19129 (UPS 21,22). Tana bridge riverbank of Sieiddajohka 8 Aug 1973 *Salix*(3b) AG 270/73 (BG 6, TROM), AG 269/73, 271/73 (BG 7,8). **Sweden:** S.l.d.n.c. Rehm Ascomycetes 1229c *Sorbus*(3b) (S 56,57,58). - Sk: 'Scania *Sphaeria nummularia minor*' (E. Fries scrips.) *Salix*(b) (UPS 62, herb. E. Fries). - Ög: Ödeshög 25 Jul 1889 *Populus tremula*(b) L. Romell (UPS 15). Västra Tollstad: Alvastra 1 Aug 1889 L. Romell (S 35). - Nrk: Kumla: s.d. *Populus*(b) L. Romell (S 49), 1885 *Populus*(b) L. Romell (S 51). St. Mellösa: Skäv vid Tjuran 2 Aug 1929 *Populus*(b) R. Johanson & E. Julin (UPS 11). At Tjuran 20 May 1948 *Populus*(b) R. Morander (UPS 12). Örebro: Near Örebro 1885 *Populus*(b) L. Romell (S 52). Nericiae 1885 *Populus tremula*(b) L. Romell (H 13). - Srm: Enköping: Vallby 1845 *Populus*(b) M.A. Lindblad (UPS 14, S 23). Nacka: Saltsjö-Duvnäs 9 May 1918 L. Romell (S 24). Nyköping: Østra bergen 4 May 1923 *Populus*(b) R. Morander (UPS 10). Nämndö: Rågskär Bulleröområdet 8 May 1968 *Populus*(b) Stig Lundberg (UPS 13). - Sth: Stockholm 18 Jun 1892 *Populus*(b) H. Hesselman (S 36), Jun 1892 *Populus*(b) H. Hesselmann (UPS 16). Ropsten 28 Jul 1896 *Fraxinus* L. Romell (S 33). Ulvsunda 16 Apr 1901 L. Romell (S 32). - Upl: Bälinge: Kipplingeberg 28 May 1968 *Populus*(b) st. con. K. Holm & L. Holm (UPS 5). Dalby: In the middle of the pond Dalkarlskärret 24 Nov 1985 *Salix cinerea*(b) K. Holm & L. Holm 3853k (UPS 2). Hässleborg 20 Feb 1987 *Populus*(b) st. con. K. Holm & L. Holm 4388f (UPS 3). Ekerö: 26 Jun 1966 *Populus*(b) st. con. S. Lundberg (UPS 4). Häverö: 6 Aug 1894 *Populus*(b) Maria Romell (S 31). Ljusterö: Hummelmora-Kårboda road junction 17 Apr 1995 *Salix cinerea*(b) Å. Strid (S 34). Näs: Uppsala Lurbo

22 Apr 1967 *Populus*(b) st. con. K. Holm & L. Holm (UPS 6). Tierp: E-side of Tämnaren *Salix* (b) s.d. TL- 4192 (C). Täby: Täby 18 Apr 1911 *Populus*(2b) T. Vestergren (S 29,30). Näsby Oct 1912 L. Romell (S 28). Uppsala: Uppsala at Slottet Sep 1884 *Populus*(b) K. Starbäck (S 27, UPS 9). Uppsala 1885 *Populus* K. Starbäck (S 26), 12 Apr 1885 *Populus*(b) L. Romell (S 25). Kiplingeberg 28 May 1968 *Populus tremula*(b) st. con. K. & L. Holm (UPS, S). Vassunda: Ca 1 km Ø of Källbo 20 Apr 1968 *Populus*(b) st. con. K. Holm & L. Holm (UPS 1). Vaxholm: "Bogesundlandet" 10 Apr & 3 May 1966 *Populus*(2b) S. Lundberg (UPS 8,7). - Hls: Ängersjö: Ängersjö May 1898, Mar 1899, 1 Apr 1899, 5 May 1900 (3 coll.), 9 May 1900, 28 Apr 1903 *Sorbus aucuparia*(8b) M. Östman (S 37-S44, UPS 17), 4 Jun 1903 *Betula*(b) M. Östman (S 45). Ängersjö kyrkogård 4 & 5 May 1899 *Sorbus aucuparia*(2b) Fr. Östman (S 48,47). - Ång: Kramfors: Almsjönäs N of Norr-Almsjön 3 Aug 1987 *Salix*(b) GM 5761, 5762, 5677. Sollefteå: Junsele Pustviken 4 Aug 1989 *Salix pentandra*(b) GM 8101. Junsele 5 Aug 1989 *Salix*(b) GM 8101. Lillsele W of Ångermanälven 30 Jul 1990 *Salix*(b) GM 8460, 8462, 5677. Örnsköldsvik: Örnsköldsvik N of Sundaåsen 1 Aug 1987 *Salix* GM 5502. Västerås 2 Aug 1987 *Salix* GM 5594, 5597. Vågefjärden Vikbotten 2 Aug 1987 *Salix* GM 5609. Arnäs E of Älvsjösjön 4 Aug 1987 *Salix* GM 5721, 5722a. Haffstafjärden N of Billstra 9 Jul 1988 *Salix* GM 6050. - Vb: Skellefteå: Skellefteå 1898 *Salix*(b) J. Vleugel (S 50). Umeå: Umeå nedom kyrkan 27 May & 1 Jun 1901 *Salix* C.P. Læstadius (UME 29211,29212). Umeå 1902 *Sorbus aucuparia*(b) J. Vleugel (S 53). Brännland 22 May 1976 Salix (b) O. Eriksson (UME 29109). - Nb: Hietaniemi: Ylikoski at the beach 24 May 1957 *Salix* O. Lönnqvist 276b (UPS). Luleå: Sandö-ören 23 Aug 1915 *Sorbus aucuparia*(b) J. Lind (C). - Hrj: Tännäs: Ljusnedal 25 Mar 1904 *Sorbus aucuparia*(b) M. Östman (S 46). - Jmt: Östersund: Andersön 12 Aug 1982 *Salix caprea* (b) GM 2358, *Sorbus*(b) AG & GM 2356, 2363 (TROM). - ÅsL: Vilhelmina: Strömnäs 19 Jun 1927 *Sorbus aucuparia*(b) G. Nilsson (O 3, UPS). N of Gubbselvforsen 7 Jul 1988 *Salix* GM 5882. Åsele: Gavsele W of Ångermanälven 30 Jul 1990 *Salix* GM 8434. - LL: Jokkmokk: Läddepakte 29 Jul 1901 *Betula*(b) T. Vestergren (S 55). - TL: Abisko: 16 Aug 1903 *Salix*(b) T. Vestergren (S 54). **Finland:** EH: Kangasala: Ohtola 9 Jan 1994 *Salix*(b) U. Söderhölm (H 12). Tammela: Mustiala 9 Dec 1865 (UPS 20), 28 Sep 1868 (H 3), Aug 1877, Mar 1882 (S61,60), Oct 1895 (H 15) all on *Salix*(5b) P.A. Karsten. Near Mustiala Mar 1882 *Salix phylicifolia*(b) P.A. Karsten (H 4). - PS: Kuopio: Kuopio 3 Jul 1903 *Salix*(2b) O.A. Lönnbom (TUR 2, H 8). - KP: Pietarsaari (Jakobstad): 4 Nov 1862 *Salix*(3b) P.A. Karsten (H 5,6,7). - OP: Haukipudas: Martinniemi Ukkolanperä 11 Jun 1967 *Salix phylicifolia*(b) T. Ulvinen (OULU 16). Kalimenojan rantatörmä Tuirahovin NW-puolella 12 Oct 1969 *Sorbus aucuparia*(b) T. Ulvinen (OULU 17). Niemeläntörmä S of Höyhtyä farm 6 Jun 1981 *Salix phylicifolia*(b) Tauno Ulvinen (OULU 22, TUR 1, UPS 18, H 10). Muhos: Poikajoen 1 km from Isterinkosken 18 May 1970 *Salix*(b) T. Ulvinen (OULU 20). Oulu: Uleåborg 20 Aug 1861 *Salix*(b) P.A. Karsten (H 9). Liminka Ala-Kestilä 5m alt. 16 May 1990 *Salix triandra*(b) (OULU 19). - Ks: Posio: Mäntyjärvi 10 km N of village Paruavaari 2 Jul 1955 *Salix*(b) T. Ahti B463 (H 11). - EnL: Kilpisjärvi: Biologinen asema 4 Apr 1965 *Betula pubescens*(b) S. Eurola (OULU 18). - InL: Ivalo: Ivalojuensuu 14 Aug 1802 '*Salix caprea Sphaeria mammilaris* in diar., *rubaeformis* sec. Fries, *mammiformis* Hoffm.' (G. Wahlenberg scrips.) G. Wahlenberg (UPS, LECTOTYPE of *Sphaeria mammata*, selected here). **Russia:** Kola peninsula: Sashejek (Sasheika) 1861 P.A. Karsten (S 59), 27 Jun 1861 *Sorbus aucuparia*(b) P.A. Karsten (UPS 19), id. *Sorbus*(bw) Fungi Fenn. Exs. 776 *Hypoxylon depauperatum* Karst. (s. descr., nom. nud.; SYNTYPE of *H. pauperatum* Karst. (H 14).

Euepixylon udum (Pers.: Fr.) Laessøe & Spooner

Kew Bull. 49 (1): 41 (1994) - *Sphaeria uda* Pers.: Fr., Syst. Mycol. 2: 358 (1823); Pers., Römer's Neues Mag. Bot. 1: 83 (1794), Syn. Meth. Fung.: 33, Tab. 1, Fig. 11-13 (1801) - *Nemania uda* (Pers.: Fr.) Gray, Nat. Arr. Br. Pl. 1: 516 (1821) - *Hypoxylon udum* (Pers.: Fr.) Fr., Summa Veg. Scand. 2: 384 (1849) - *Anthostomella uda* (Pers.: Fr.) P.M.D. Martin, J. S. Afr. Bot. 42: 71 (1976). - Anamorph: *Geniculosporium* (Whalley 1976).

Figs 5 A-C, 7 (map), 17.

Description. *Stromata* 0.1-2 × 0.1-0.3 × 0.02-0.06 cm, uniperitheciate or 2-50 perithecia united in small greyish (in young stage) or black spots or stripes partly immersed in wood, rarely on bark. Ectostroma 100-150 μm, carbonaceous, covering the perithecia like a shield, and continuing down into the wood as a black zone encircling the perithecial group. Entostroma is a

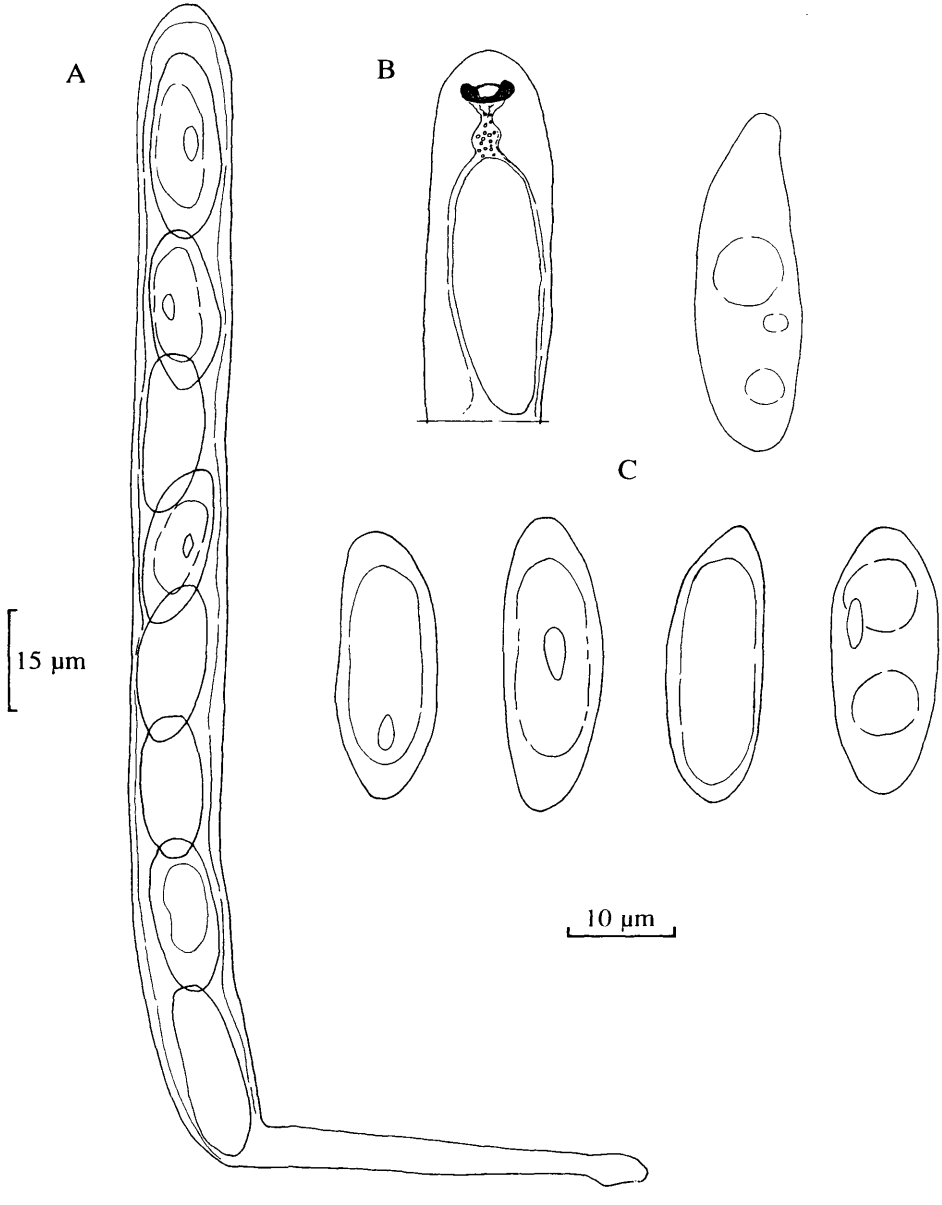
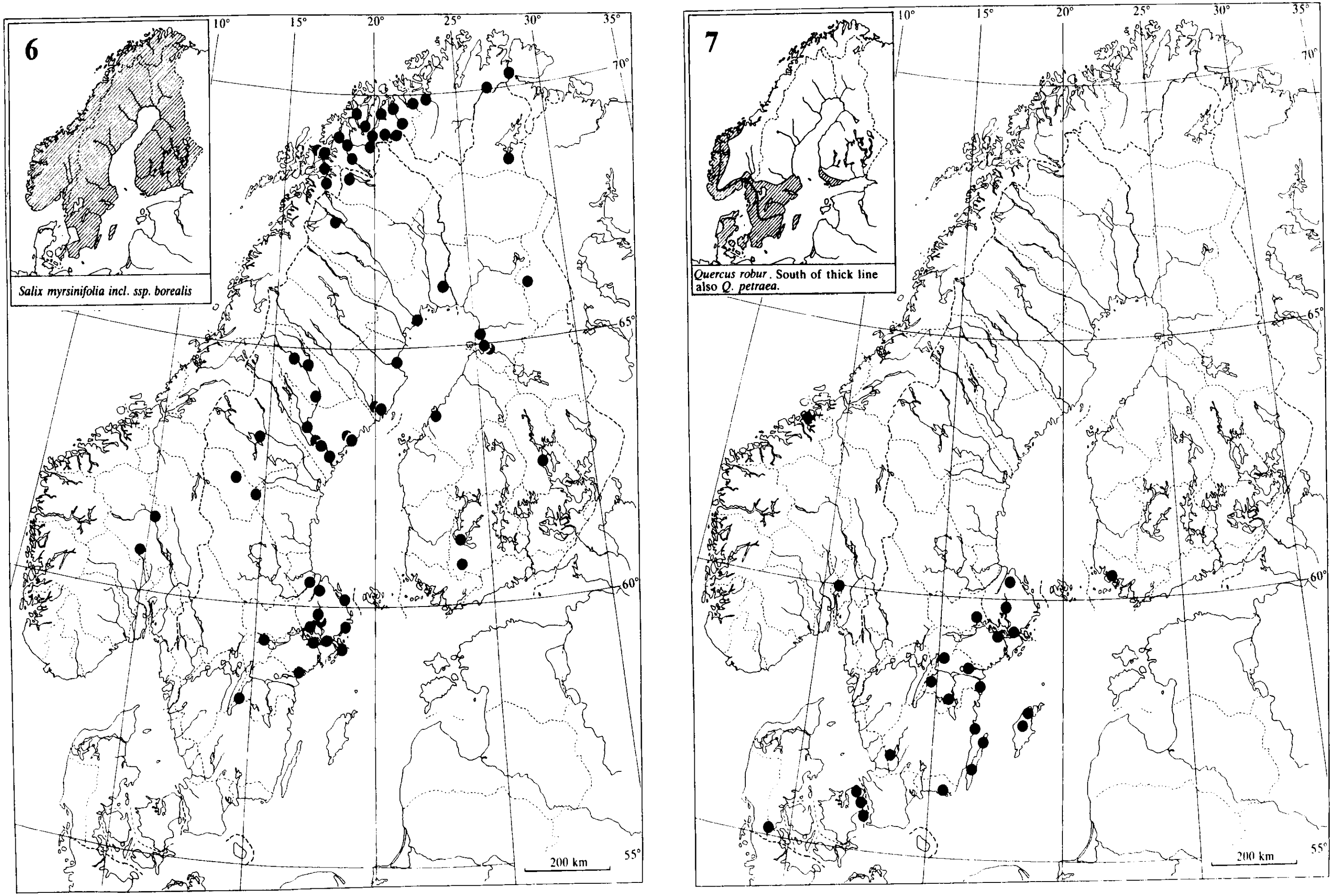


Fig. 5. *Euepixylon udum*. A. Ascus. B. Ascus apex in LG. C. Ascospores. From UPS 29, except for the uppermost and the last spore in the bottom row which are from O 1.

pseudostroma made up of white, decayed wood mixed with hyaline hyphae, to 1.5 mm thick, soft, crumbling with age. *Perithecia* 600-800(-1000) µm high, 480-900 µm broad, ovoid, immersed in the entostroma, the apical part gradually narrows into a long, stout, black ostiolar papilla, strongly



Figs 6-7. Distribution in Norden. Fig. 6. *Entoleuca mammata* and one of its most frequent Nordic hosts. Fig. 7. *Euepixylon udum* and its most common Nordic host.

projecting from the ectostroma. Peridium 40-50 μm, consisting of an innermost hyaline t. porr., ca. 8 μm, followed by a brown t. prism-t. porr., which resembles a bilateral tracery. *Asci* p.sp. 140-200 × 8-19 μm, m. 172 × 15 (n = 6/2) μm, st. 21-58 μm, m. 38 μm (n = 5/2). Ascus annulus amyloid in LG and MZ, disk-shaped in optical section (appearing funnel-shaped when focused also in the depth), 1.5-2 μm high, ca. 4 μm broad. *Ascospores* (23-)25-32(-35) × 8-12 μm, m. 28.2 × 9.6 μm (n = 80/4), oblong, golden brown (5C6, 6C7), evidently with a non-sticky, thin, hyaline perispore at times visible in crushed spores, immature spores with an apical, or basal, hyaline cellular appendage. Germ slit elliptic, poroid, 4-5 × 1-2.5 μm, dark bordered, on the most convex side in case of inequilateral spores.

Taxonomic notes. We have found no specimens in Persoon's herbarium (L) confirming the concept of *Euepixylon udum* (cf. also Ju & Rogers 1996: 329). Persoon's description and drawings of *Sphaeria uda* (Persoon 1801) is, however, indicative of *E. udum*, but not sufficiently detailed to be used as an iconotype. Miller (1932a) designated Fries' Scler. Suec. Exs. 324 in UPS as the 'type', which has been reinvestigated and selected as *lectotype* by us (ICBN art. 7.8). *Hypoxylon sphaeriostomum* (Schwein.) Sacc. seems to be the North American equivalent to *E. udum*, although the ascospores are larger (Miller 1961: 67, Figs. 100, 128). Recently the name *Euepixylon* Füisting (1867), and consequently also *E. udum*, have been claimed invalid according to ICBN, articles 37.1 and 43.1 (Hudson 1996, Eriksson & Hawksworth 1997: 147). This is possibly correct, but we have at present no proposal for another valid name.

In gross morphology *E. udum* may be confused with *Nemania confluens*, which occurs on the same host, but the perithecia in *N. confluens* are more pronounced, with smaller ostioles. The dark stromatic zone line in the wood is a further characteristic of *E. udum*.

Ecology. *Euepixylon udum* is found on decorticated, deteriorated branches of *Quercus*, and less frequently on *Corylus*, or on *Fagus* (two voucher specimens). L. Petrini & Müller (1986) recorded it on *Quercus* and *Castanea sativa*. The wood with the ascomata of *E. udum* is always strongly decomposed by a white rot, which is why the fungus is here designated a tertiary saprobe as is also *Nemania confluens*.

Distribution. *Norway*. Oslo, MR. *Sweden*. Bl, Sm, Öl, Gtl, Ög, Srm, Sth, Upl, Vsm. *Finland*. V. *Denmark*. Sj, Ejy. *Euepixylon udum* was previously reported from Norden by Granmo et al. (1989, as *Hypoxylon udum*). The distribution in southern and western Norway suggests the presence of *Quercus* to be an important factor for the occurrence of *E. udum*. The material on which Hungnes (1982: 137, 249) based his report of *E. udum* from western Norway (MR) seems to have been lost, but undoubtedly represented this species. *Total*. Europe including the British Isles.

Specimens examined. Norway: S.l.d.n.c. (but most likely from the Oslo area) *Quercus*(w) *Hypoxylon crustaceum* det. Rostrup, id. *Hypoxylon fuscum* det. Rostrup (O 1,2). - *Reference*: MR: Tingvoll: Eikrem 16 Sep 1981 *Quercus robur*(w) G. Hungnes (Hungnes 1982: 137). **Sweden:** S.l.d. Fries Scler. Suec. Exs. 324. *S. uda* Pers. (UPS, LECTOTYPE, selected here). - Bl: Ronneby: Ronneby Aug 1887 *Fagus*(2w) L. Romell (S 1, LD 32). - Sm: Femsjö s.d. probably on *Quercus*(w) E. Fries *Sphaeria uda* P. (Fries scrips.) (UPS 34). Misterhult: Jungfrun 11 Jun 1915 *Quercus*(w) G.E. Du Rietz (UPS 16). - Öl: Persnäs: Torslunda 7 Jun 1888 *Quercus*(w) K. Starbäck (S 2,UPS 27). Stenninge S-wards 20 Jul 1953 *Quercus robur*(2w) J.A. Nannfeldt 13020, 13023 (BG 3, UPS 29,31), 25 Jul 1953 *Quercus*(w) J.A. Nannfeldt 13146 (H 3, UPS 30). - Gtl: Ekeby Sep 1895 *Corylus*(w) T. Vestergren (UPS 28). Othem: Near Othemars close to highroad 3 Jun 1992 *Quercus robur*(w) N. Lundqvist 18960 (S 3). - Ög: Gryt: Säterön (ca. 1 km SSE of church) 22 Aug 1944, 20 Jul 1947 *Quercus* J.A. Nannfeldt (UPS 21,22). Kvillinge: Dvardale Sep 1885 *Quercus*(w) E. Haglund (S 4, UPS 17). Korpklev 11 Aug 1891 *Corylus*(w) K. Starbäck (S 7, UPS 19). Simonstorp: Dufhult 15 Jun 1887 *Corylus*(w) E. Haglund (S 5, UPS 18, LD 33, H 4). Västra Tollstad: Omberg 1889 *Quercus*(w) L. Romell (S 6). - Srm: Mariefred: Hedlanda 10 Aug 1941 *Corylus*(b) Th. Arwidsson (S 8). - Sth: Djurgården Rosendal 9 Jan 1890 *Quercus*(w) H. Kugelberg (S 14). Djurgården Manilla Sep 1891

Quercus(w) H. Kugelberg (S 10). - Upl: Bondkyrka: Fäbodarna 1 Aug 1958 *Quercus*(w) L. Holm (UPS 24). Börje: N of Hässleby 9 Aug 1967 *Quercus*(bw) N. Lundqvist 5456 (UPS 25). Dannemora: Between Ekvik and Ralby 5 Jul 1984 K. Holm & L. Holm 3164g (UPS 26). Rasbo: SW of Näset at lake Funbosjön 2.5 km SSE Frötuna 25 Apr 1994 *Quercus*(w) N. Lundqvist 19438 (S 13). Sollentuna: Edsberg Mar 1882 *Quercus*(w) O. Juel (S 9). Uppsala: Uppsala 22 Mar 1885 *Quercus robur*(w) L. Romell (S 11). Uppsala 13 Oct 1895 G. Hellsing (UPS 20). Uppsala Näs: Bärsta lund 10 May 1946 *Corylus*(w) L. Holm 267 (UPS 23). Ärentuna: 3 km SE of Storvreta 11 May 1991 *Quercus robur*(w) N. Lundqvist 18569 (S 12). - Vsm: Västerås-Barkarö: Ridön 1845 *Quercus*(w) M.A. Lindblad (S 15). **Finland:** V: Turku: Ruissalo (Runsala) 13 Apr & 5 May 1861 *Quercus*(2w) P.A. Karsten 2956, 2957 (H 7,6), 14 Apr 1861 *Corylus*(w) P.A. Karsten 2917 (H 8), May 1861 *Quercus*(w) P.A. Karsten F. Fenn. Exs. 561 *Hypoxylon udum* Pers. (H 9), 13 Sep 1866 P.A. Karsten 2958 *Corylus*(w) (H 1), 10 Jun 1867 *Quercus*(2w) P.A. Karsten 2918, 2955 (H 2,5). **Denmark:** Sj: Amager Kongelunden 11 Oct 1996 *Quercus*(w) JHC. Charlottenlund 9 May 1891 *Quercus* (w) O. Rostrup (CP) (Lind 1913: 254, Munk 1957: 131). Grib Skov Strødam 11 Jun 1927 *Quercus*(w) *Anthostoma rhenanum* Fuck. N.F. Buchwald (CP). Jægersborg Dyrehave 13 Sep 1889 *Quercus?* C. Raunkiær. Store Hareskov 24 May 1903 *Quercus*(w) (CP) (Munk 1957: 131). Tokkekøb Hegn 11 Sep 1988 *Quercus* (w) TL-1724. - EJy: Åbenrå Bollerslev Skov 1 Oct 1996 *Quercus* (w) TL-4358.

Nemania aenea (Nitschke) Pouzar

Česká Mykol. 39: 129 (1985) - *Hypoxylon aeneum* Nitschke, Pyren. Germ.: 47 (1867). - Anamorph: *Geniculosporium* (L. Petrini & Rogers 1986: 402).

Figs 8 A-C, 10 (map), 18 (stroma), 25.

Description. *Stromata* 1-3 × 0.5-1.5 × 0.07 cm, in irregular patches on wood, rather woody, or somewhat carbonaceous, brown, young with a silvery veil. Stromatic grooves few, deep, V-shaped. Ectostroma 30-35 μm, carbonaceous. Entostroma greyish white, soft, scanty, sometimes brown at the bottom and around upper part of the perithecia. *Perithecia* (350-)500-600 μm high, (300-)400-800 μm broad, m. 536 × 536 μm (n = 14/3), globose to oblong. Peridium 18-30 μm, consisting of an inner, light brown layer, 7 μm thick, and an outer brown t. prism.-porr. 20-25 μm, without a carbonaceous layer. Perithecial contours low, but distinct, with broadly arched apices. Ostioles small, black. *Asci* p.sp. 77-112 × 8-10 μm, m. 94 × 9μm (n = 23/5), st. 35-88(-112) μm, m. 63 μm (n = 22/5). Ascus annulus deep blue in LG, light blue in MZ, cylindrical or somewhat expanded at the base, at times with thickenings in the middle, ca. 3.5 μm high, 2.5-3.5 μm broad. *Ascospores* 14.5-19.5 × 5-6.5 μm, m. 16.7 × 5.9 μm (n = 38/7), ellipsoid-inequilateral to lunate with usually well rounded ends, sometimes one end slightly elongated, light brown (6C6). Germ slit conspicuous, 5-7.5 μm long, generally in the middle on the least convex side, but also observed on the lateral side, rarely on the more convex side, even from spores in the same perithecium. Judged from recently collected specimens spore deposit on stromata is olive to dark grass green.

Taxonomic notes. Pouzar (1985b) was the first to follow Nitschke (1867) in recognizing *Nemania aenea* as a distinct species close to, but different from, *N. serpens*. We have seen several collections in PRM referred to *N. aenea* by Pouzar (1985b) having ascospores with germ slit consistently on the convex side. For precautionary reasons, these are excluded from the concept of *N. aenea* herein.

Nemania aenea can be distinguished from the *N. serpens* agg. (including *N. serpens* var. *macrospora*) by the larger spores with a relatively long, distinct, pale germ slit and a somewhat deviating shape of the ascus annulus. The distinct germ slit and narrow spores separate it from *N. aureolutea*.

Ecology. *Nemania aenea* produces stromata on deteriorated decorticated trunks and bran-

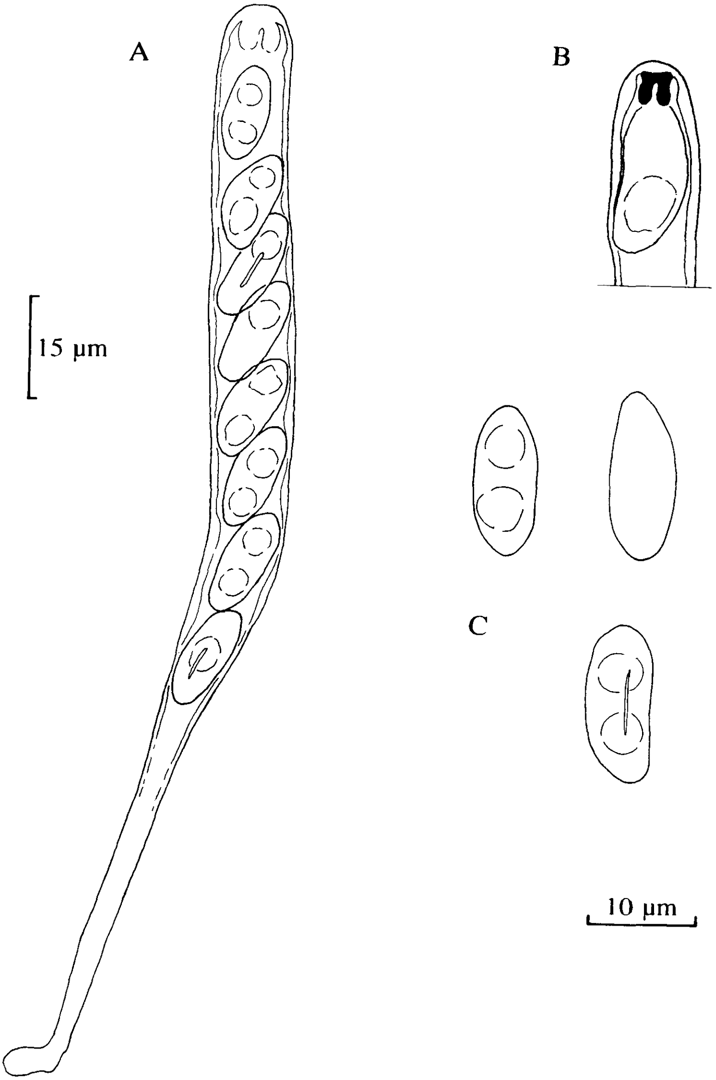


Fig. 8. *Nemania aenea*. A. Ascus. B. Ascus apex in LG. C. Ascospores. (C, TL-2744).

ches of *Alnus*, *Carpinus* and *Fagus*. Additional hosts from Central Europe are *Cornus sanguinea*, *Frangula alnus*, *Populus nigra*, *Quercus robur*, *Salix alba*, *S. cinerea*, *Ulmus* sp. (Pouzar 1985b). From Czechoslovakia Pouzar (1985b) recorded the species from lowland wet forests, near rivers etc., but never on hillsides. Humid, eutrophic habitats are the typical localities for *N. aenea* in Denmark too.

Distribution. *Denmark*. Brh, Sj, Lol, EJy. *Nemania aenea* is here reported for the first time from Norden. We are apt to consider it a typical nemoral fungus in our area. *Total*. Europe including the British Isles.

Specimens examined. Denmark: Brh: Døndalen 12 Aug 1989 *Carpinus*(b) TL-1933. - Sj: Allindelille 30 Oct 1995 *Alnus glutinosa* TL-4055. Store Bøgeskov 18 Oct 1995 *Fagus*(bw) TL-4057. Tokkekøb Hegn 19 May 1986 *Fagus*(w) S.A. Elborne (C 30562). - Lol: Møn: Store Klinteskov Store Geddesø 11 Oct 1994 *Fagus*(b) TL-3726. Store Klinteskov W of Forchhammers Pynt 11 Oct 1994 *Fagus*(w) TL-3715. - EJy: Bollerslev Skov near Åbenrå 1 Oct 1996 hardwood JHC, TL-4370. Høstemark Skov 1 Oct 1995 *Alnus glutinosa*(w) TL-4010. Mols (Strandkjær) 28 Apr 1943 *Corylus*? A. Munk. Over Jels Barsbøl Skov 27 Sep 1996 *Alnus glutinosa(*w) TL-4323. **British Isles, U.K:** Hampshire: Roydon nat. res. Baker's copse 2 Nov 1991 *Quercus*(w) TL-2744 (C, TROM 4). **France(?):** S.l.d. J.B. Mougeot no. 327 as '*Sphaeria uda*? Pers' (UPS (F-03543)56724, herb. E. Fries). **Germany:** Werder zu Schwerin Sep 1850 'Auf Ellernholz' leg. Wüstnei (B, SYNTYPE). Westfalen bei Münster, Wolbeck Aug 1865 *Fagus*(w) Nitschke leg. & det., as '*H. aeneum* n. sp.' (B, LECTOTYPE). **Slovakia:** Šúr ap. Jur prope Bratislava 18 Oct 1979 *Frangula alnus*(w) Z. Pouzar (PRM 821101).

Excluded specimens. Czech Republic: Bučan ap. Hronská Dubrava 23 Oct 1972 *Carpinus b*. Z. Pouzar, as *N. serpens* var. *macrospora* (PRM 815161). Sylva "Cahnov" ap. Lanžhot 4 Oct 1988 *Fraxinus angustifolia* ssp. *danubalis* Z. Pouzar, as *H. aeneum* (PRM 871525). **Slovakia:** Sylva Šúr ap. Jur prope Bratislava 15 Oct 1979 *Salix cinerea* Z. Pouzar, as *H. aeneum* (PRM 821113). Bratislava Peržalka 20 Oct 1979 *Populus nigra* Z. Pouzar, as *N. aenea* (PRM 821102).

Nemania atropurpurea (Fr.: Fr.) Pouzar

Česká Mykol. 39: 19 (1985) - *Sphaeria atropurpurea* Fr.: Fr., Syst. Mycol. 2: 340 (1823), non Tode, Fungi Mecklenb. 2: 32 (1791); Fr., Obs. Mycol. 1: 174 (1815), K. svenska VetenskAkad. Handl., 1816: 144 (1816). - *Hypoxylon atropurpureum* (Fr.: Fr.) Fr., Summa Veg. Scand. 2: 384 (1849). - Anamorph: *Geniculosporium* (L. Petrini & Rogers 1986: 402).

Figs 9 A-D, 11 (map), 19-20 (stromata), 75, 77, 82 (SEM).

Description. *Stromata* 2-8 × 0.5-2 × 0.01 cm, effused in belts or irregular patches on the wood, nearly without exception with deep, narrowly V-shaped stromatic grooves, sometimes areolate owing to large, almost free-standing perithecia; young stromata ash grey to grey brown due to a veil of covering hyphae, mature stromata dark brown to black, sometimes blueish black. Ectostroma 60-170 μm, carbonaceous, hard and brittle. Entostroma white, or white in the lower part and brown in the upper part next to the ectostroma, loose or soft, mostly well developed between the perithecial bases, but scanty or absent below the perithecia. *Perithecia* 550-840 μm high, 540-1100 μm broad, with distinct, broadly arched apex (more conical in case of densely aggregated perithecia). Perithecial contours distinct, to 1/2(-2/3) of perithecial height. Peridium 75-110(-160) μm thick, the innermost layer being a yellow cord, 2 μm, passing into a hyaline to light brown t. prism.-t. porr., 8-15 μm; middle layer a brown t. ang.-t. prism, 17-20μm, and outermost layer 45-120μm, carbonaceous with tissue resembling a reddish dark brown t. epid.-t. ang. Ostioles conspicuous, conical, pointed, mostly 10 (6-14) per 2 × 2 mm. *Asci* p.sp. 58-80 × 5-7 μm, m. 70 × 6.7 μm (n = 60/6), st. 55-120(-135) μm, m. 84 μm (n = 26/5). Annulus amyloid in LG and MZ, 1.5-2 μm high, 1.3-1.8 μm broad below, 1.7-2.2 μm broad above. *Paraphyses* to 300 μm long, 7 μm broad at base, 3.5 μm in the middle, 1.5 μm at the top, septate, branched at base. *Ascospores* 9-11.5(-12.5) × 4-5.5, m. 10 × 4.6 μm (n = 346/18), ellipsoid-inequilateral with narrowly rounded to pointed ends, brown (7F8, 8F6/F8), with 1-2 guttules. Germ slit present in most spores, 4-6 μm long, conspicuous, in the middle on the flat side. Fresh spore-print in daylight black with a slightly blueish tint, which on black, recently collected stromata appears dark green or dark greyish green (25C7) in a binocular.

Taxonomic notes. As demonstrated by Pouzar (1985a: 21), both Shear (1928, 1945) and Miller (1961) wrongly synonymized *Nemania* (as *Hypoxylon*) *atropurpurea* with *Hypoxylon multiforme* based on Fries' material. Fries' specimens of Scl. Suec. Exs. 75 *Sphaeria atropurpurea* in UPS and in K (several specimens) are typical *N. atropurpurea*. However, even Fries at times confused the species with effused forms of *H. multiforme* (as *H. granulosum* s. Fries), as may be seen from a specimen of *N. atropurpurea* (UPS) which he apparently had received from Wahlenberg. The homonym *Sphaeria atropurpurea* Tode is a *nomen ambiguum* (cf. Pouzar 1985a, Ju

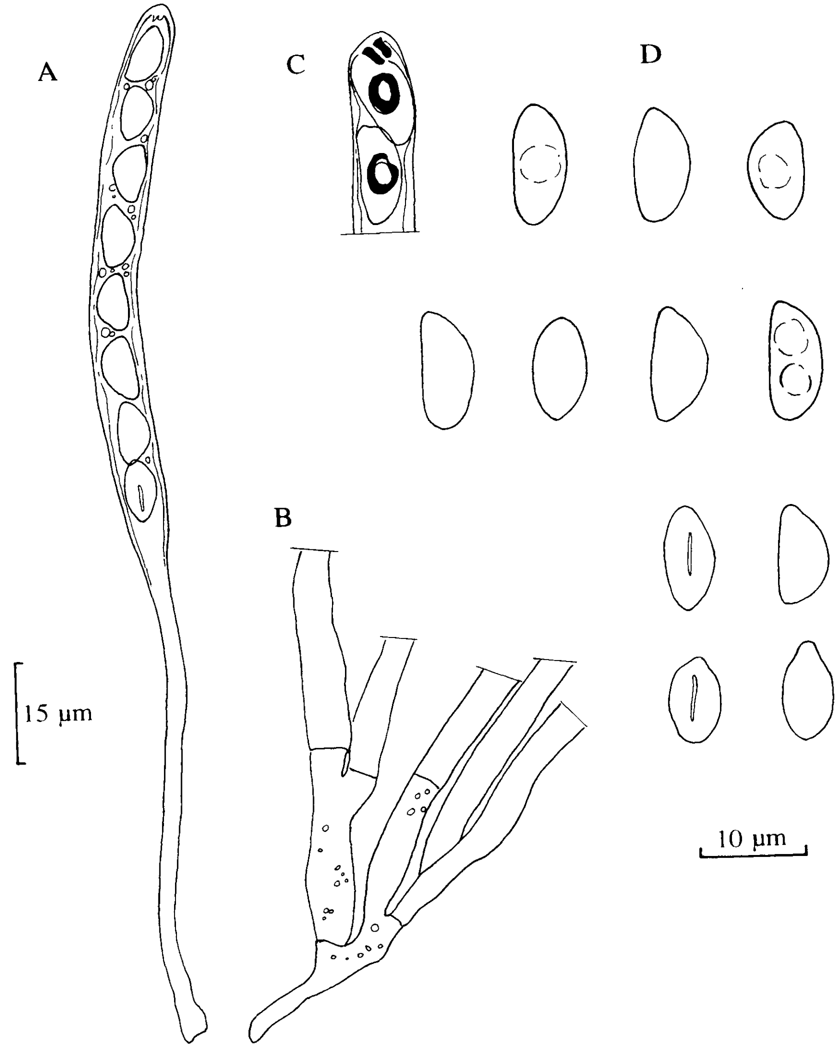


Fig. 9. *Nemania atropurpurea*. A. Ascus. B. Paraphyses, basal parts. C. Ascus apex in LG. D. Ascospores. Spores in the two uppermost rows from lectotype (K), the remainder from BG 9. A, C from BG 9, B from PRM 870442.

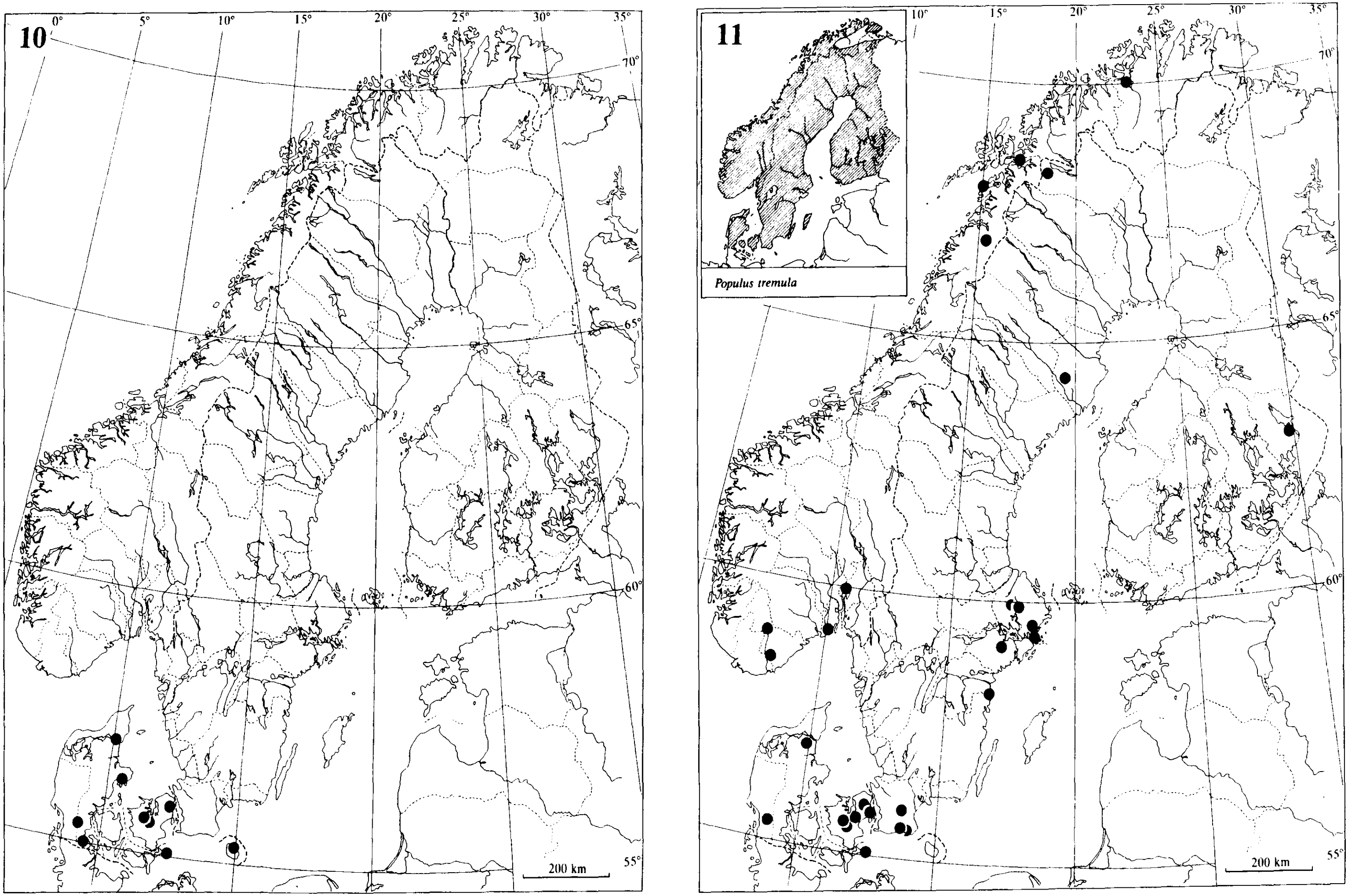
& Rogers 1996).

Nemania atropurpurea is above all characterized by the deep stromatic structures and the large, broadly arched, prominent perithecia. It is separated from effused forms of *H. multiforme* by its scanty, white, or even absent basal entostroma. *N. atropupurea* never possesses false ostioles which otherwise are common in species of the *Nemania serpens* agg.

Ecology. *Nemania atropurpurea* has been found on decaying decorticated trunks and thick branches of *Fagus*, *Populus*, *Salix*. From central Europe Pouzar (1985a) records the additional hosts *Carpinus*, *Tilia* and *Ulmus*. On *Fagus* it is often found on the exposed inner part of split trunks on the ground, indicating an early invasion of the wood. On *Populus* it occurs on the relatively fresh outer part of rotten, hollow trunks.

Distribution. *Norway*. Oslo, Ve, AA, No, Fi. *Sweden*. Sk, Ög, Srm, Upl, Vb, TL. *Finland*. PK. *Denmark*. Sj., Lol, EJy. *Nemania atropurpurea* was reported from Sweden by Fries (1815, 1816, 1823, 1849), from Norway by Sommerfelt (1826, 1827), Rostrup (1904), Jørstad (1928) and Granmo (1977, as *Hypoxylon* cf. *crustaceum*), and probably also from Denmark (as *H. crustaceum*) by Lind (1913) and Munk (1957). The few Finnish records of *N. atropurpurea* are peculiar. We believe it is due to insufficient collecting there as well as in northern Sweden, and not a factual absence of the species. *Total*. Norden and central Europe (Czech Republic, Poland), Canada (Pouzar 1985a, L. Petrini & Rogers 1986). van der Gucht (1995: 318) reported it from Papua New Guinea. However, judging from the pictures, this hardly represents the same species as ours.

Specimens examined. Norway: S.l.d.n.c. 2 coll. (O 2,14), id. *Populus*(3w) (O 4,5,6). - Oslo: Skøyen 1840 *Populus*(w) N.G. Moe (O 3). - Ve: Larvik: Jordstøyp i Kvelde 17 Sep 1995 *Populus*(w) H. Andersen 43-334 (O 22), 17 Oct 1995 *Populus*(w) H. Andersen 130-1130 (TROM 23, O). - AA: Birkenes: Bjorvatn nat.res. 14 Jul 1995 *Populus*(w) AG 109/95 (TROM 19). Bygland: Åraksbø Heddevikji 22 Jul 1974 *Populus*(2w) AG 162/74,168/74 (BG 16,7). - No: Evenes: Forra Lille-Hoggvika 28 Jul 1973 *Populus*(w) AG 189/73, May 1974 *Populus*(w) AG (s.n.) (BG 8,10. TROM). Forra Hoggvik 18 Sep 1995 *Populus*(w) AG 233/95 (TROM 18). Botn S-side of Hallaren 17 Sep 1995 *Populus*(w) AG 225/95 (TROM 17). Saltdal: Saltdalen Sætran s.d. & Oct 1823 *Populus*(2w) S.C. Sommerfelt (O 12,13) (Sommerfelt 1826: 206, 1827: 44 as *Sphaeria atropurpurea* Fr., Rostrup 1904: 19, Jørstad 1928: 439). Steigen: Engeløy Laskestad 7 Aug 1975 *Populus*(w) AG 75/75 (BG 11). - Fi: Alta: Kløftan at Eibyelva 10 km SE of Eiby 5 Aug 1973 *Populus*(w) AG 246/73 (BG 9). **Sweden:** S.l.d. *Hypoxylon atropurpureum* (Tode?) Fr. ex herb. E. Fries (S 4). '*Sphaeria mammala* [sic!] Whlb. Lapp.[onia] Ab auctore, 1824, Est *Hypoxylon granulosum*' (E. Fries scrips.) *Fagus*(w)! (UPS 26, herb. E. Fries). S.l.d. Fries Scler. Suec. Exs. 75 *S. atropurpurea* Tode (K, M. 874 LECTOTYPE, selected here, and M. 880, SYNTYPE). S.l.d. *Fagus sylvatica* Fries Scler. Suec. Exs. 75 *Sphaeria atropurpurea* (UPS 30, SYNTYPE). - Sk: Havgårdssjön 15 Oct 1988 *Ulmus*? TL-4424 (C). Ystad Örups Almskog 23 Sep 1989 *Ulmus* TL-2057 (C). Äsphult Dockarps Kvarn 19 Sep 1996 *Fagus*(w) TL-4278 (C). - Ög: Gryt: Säterön 1 km SSE of the parish church 20 July 1960 *Populus*(w) J.A. Nannfeldt 16275 (UPS 23). - Srm: Hyltinge: Henaredalen *Populus*(w) 1 May 1934 C.I. Malm & J.A. Nannfeldt 8195 (UPS 19). Nacka: Saltsjö-Duvnäs *Populus*(w) 24 Jun 1915 L. Romell (S 3). - Upl: Bondkyrka: Valsätra 8 Sep 1928 *Populus*(w) S. Lundell (UPS 16). Vårdsätra 16 Oct 1929 *Ulmus*(w) S. Lundell & N. Dahlbeck (UPS 15), 18 Sep 1967 *Quercus* N. Lundqvist 5539 (UPS 20), 6 May 1969 *Ulmus*(w) J.A. Nannfeldt 20505 (UPS 17). Nosten S of Läbyvad St. 2 Oct 1931 *Populus*(w) S. Lundell (UPS 13), 16 Sep 1932 *Populus*(2w) J.A. Nannfeldt, M.A. Donk & S. Lundell (UPS 12,14), "Silva Nosten" close to Läbyvad 30 Apr 1934 *Populus*(w) S. Lundell, in Lundell & Nannfeldt (1936): Fungi Exs. Suecici 298 *Hypoxylon serpens* (S 1). Predikstolen 26 May 1963 *Populus*(w) N. Lundqvist 3839 (UPS 7). Boo: Skuru 3 Jun 1900 *Populus*(w) L. Romell (S 2). Uppsala: Uppsala 1853 *Populus*(w) M.A. Lindblad (S 5). Uppsala Storbacken 0.5 km S of Hällby 20 Jun 1953 *Populus*(w) J.A. Nannfeldt 12776 (UPS 22, BG 1). Vänge: Fiby urskog 8 Oct 1930 *Populus*(2w) J.A. Nannfeldt 4097, 4094 (UPS 18,21), 13 Sep 1960 *Populus*(w) N. Lundqvist 2814 (mixed w. *N. serpens* (var. *serpens*)) (UPS 8), 7 Oct 1967 N. Lundqvist 5568 (UPS 25). - Vb: Degerfors: Skatan 1 km N Skällträsk *Populus*(w) L. Huggert (UPS 24). - TL: Jukkasjärvi: Abisko (Njakatjavelk) ca. 1 km SW of the biol. st. 19 Jun 1948 *Populus*(w) J.A. Nannfeldt, A. Pilat & G. Sandberg (UPS 11). **Finland:** PK: Kontiolahti: Koli 29 Aug 1996 underside of fallen *Populus*(w) TL-4261 (TROM). **Denmark:** Sj: Allindelille 2 June 1996 *Fagus*(w) TL-4149. Jægersborg Dyrehave 17 Apr 1986 *Fagus*(w) TL-1292. Jægersborg Dyrehave at Mølleråen 22 Jun 1995 *Fagus*(w)



Figs 10-11. Distribution in Norden. Fig. 10. *Nemania aenea*. Fig. 11. *Nemania atropurpurea* and its most frequent Nordic host.

TL & AG (TROM 21). Lejre 1 km W of Ledreborg 16 May 1996 *Fagus*(w) TL-4096. Store Bøgeskov 18 Oct 1995 *Fagus*(w) TL 4037. Ryegårds Dyrehave 12 May 1986 *Fagus*(w) H.F. Gøtzsche (C-13647). Suserup Skov 9 May 1991 JHC 91-11, 7, 8 & 29 May 1994, 24 Aug 1994 *Fagus*(4w) JHC 94-19, 94-11, 94-62, 94-356, 19 May 1995 *Fagus*(w) TL-3894, 25 Sep 1995 *Fagus* (w) JHC. - Lol: Møn: Høje Møn Jydelejet 25 Jun 1995 *Populus*(w) TL-3911 (C, TROM). - EJy: Rold Skovdistrikt Buderupholm Bjerge Skov 30 Sep 1995 *Fagus*(2w) TL-4008, 4009. - WJy: Lindet Skov 28 Sep 1996 *Fagus*(w) J.H. Petersen TL-4332. **Czech Republic:** Sylva "V Jedli" ap. Přištpo prope Jaroměřice n. Rokyt 15 Sep 1981 *Tilia platyphylla* Z. Pouzar (PRM 831749, ZT). Monte Jezvinec ap. Nyrsko prope Klatovy 28 Sep 1989 *Fagus sylvatica* Z. Pouzar (PRM 871527). Montes Šumava Medvědice in Stožeček ap. Lenora 24 Sep 1990 *Fagus sylvatica* Z. Pouzar (PRM 870442).

Nemania aureolutea (L. Petrini & J.D. Rogers) Granmo comb. n.

Hypoxylon aeneum Nitschke var. *aureoluteum* L. Petrini & J.D. Rogers, Mycotaxon 26: 413 (1986). - Anamorph: *Geniculosporium* (L. Petrini & Rogers 1986: 402).

Figs 12 A-C, 14 (map), 21 (stroma), 26.

Description. *Stromata* 0.2-2 × 0.2-1 × 0.06-0.1 cm, in elliptical spots on bark, or as spots and stripes on wood, dark brown, hard and quite brittle. Young stromata with a vivid brown pruina, in places also with a brown, hirsute covering. Stromatic grooves shallow and widely U-shaped, or lacking. Ectostroma 35-80 μm, carbonaceous, frequently extending down into the wood or beneath the entostroma as a dark zone. Entostroma white, or brown in the upper part and greyish white at the base. *Perithecia* 500-700 μm high, 400-600 μm broad, globose. Peridium with an inner hyaline layer of t. prism. ca. 12 μm thick, and an outer core of brown t. ang. (cells ca. 7 × 3.5 μm), 25-30 μm thick, not carbonized except in the upper part where the peridium adjoins the ectostroma. Ostioles small though distinct. Perithecial contours faint, rarely to 1/4 of perithecial height. *Asci* p.sp. 78-117 × 7-10 μm, m. 93 μm (n = 20/3), st. 35-75 μm, m. 57 μm (n = 11/2). Annulus violet blue or greenish blue in LG, soon darkening, in MZ either no colour or diffusely blue, 3.5-4 μm high, 2.5-3 μm broad. *Paraphyses* longer than the asci, remotely septate, rarely branched, filiform, ca. 2.5 μm thick. *Ascospores* (13-)14-18 × 5.5-7 μm, m. 15.7 × 6.3 μm (n = 79/4), ellipsoid-inequilateral with broadly rounded ends, or one end narrowly rounded and the other broadly rounded, occasionally with one end elongated, light brown (6C7, 7C7/D7). Germ slit inconspicuous, ca. 5 μm long in the middle of the spore on the least convex side. Spore deposit on stroma is suspected to be slightly reddish brown.

Taxonomic notes. According to L. Petrini & Rogers (1986) this taxon was treated as *Hypoxylon (=Nemania) serpens* var. *macrosporum* by L. Petrini & O. Petrini (1985), and L. Petrini & Müller (1986). From the U.S.A. we have seen one collection of *N. serpens* var. *macrospora*, kindly offered by J.D. Rogers. The specimen had inconspicuous ostioles, amyloid asci and narrow-ended, strongly inequilateral ascospores. The taxon is mainly North-American, with only dubious records from Europe. Considering the narrow species concept we are adobting in the *Nemania serpens* agg., it is certainly justified to raise L. Petrini & Rogers' var. *aureolutea* to specific rank, as is here done.

Stromata of *Nemania aureolutea* may easily be confused with *N. serpens*, with which it may be closely associated. The larger ascospores and faintly blueing annulus differ from *N. serpens*. *N. aureolutea* differs from the above-cited specimen of *N. serpens* var. *macrospora* in the presence of distinct ostioles and more rounded, less inequilateral spores.

Ecology. *Nemania aureolutea* occurs on wood and occasionally on outer bark of decaying *Populus*, *Quercus* and *Salix*. *Quercus* was previously the only reported host.

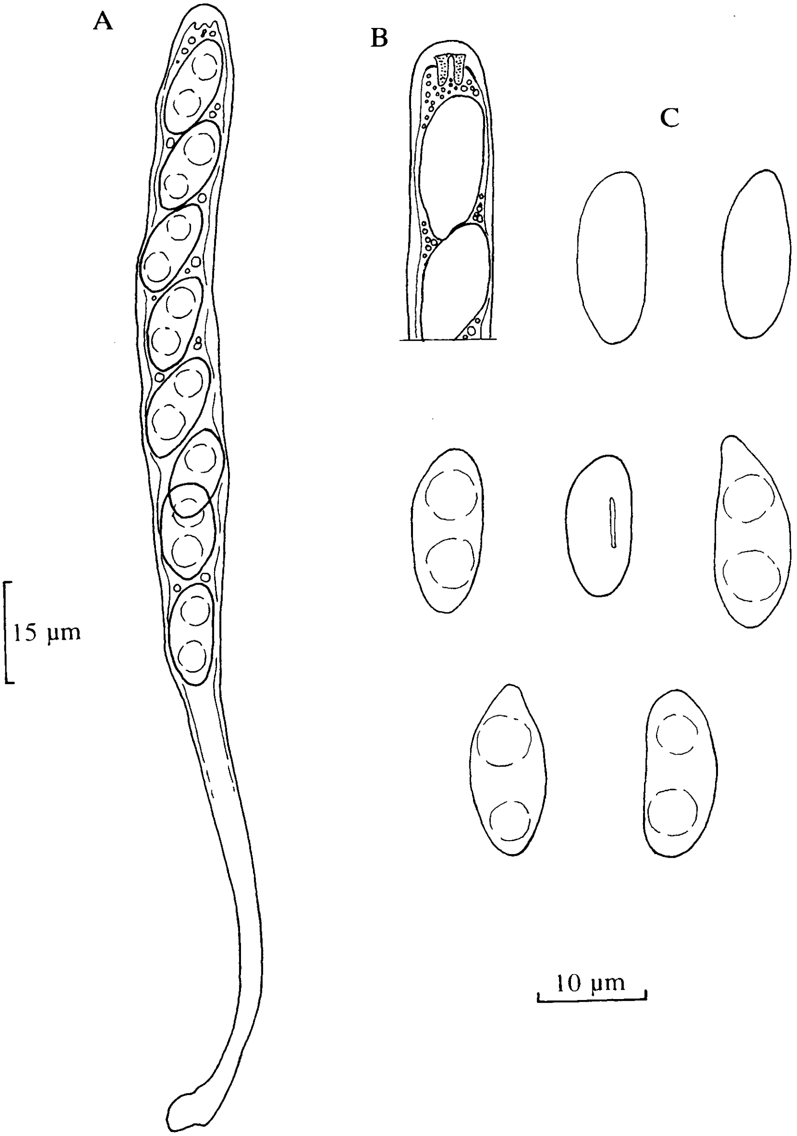


Fig. 12. *Nemania aureolutea*. A. Ascus. B. Ascus apex in LG (faint blue colour). C. Ascospores. (TROM 2).

Distribution. *Norway*. VA. *Denmark*. Lol. *Nemania aureolutea* has not been reported from Norden previously. The Nordic finds are located within the nemoral and boreonemoral regions. *Total*. Europe including the British Isles (L. Petrini & Rogers 1986).

Specimens examined. Norway: VA: Farsund: Gaupeland Havnehagen nat. res. 20 Jul 1995 *Quercus robur*(b) AG 161/95 (no asci) (TROM 1). Lindesnes: Åvik Syrdal nat. res. 22 Jul 1995 *Populus*(w) AG 172b/95 (closely ass. with *N. serpens* AG 172/95) (TROM 2). **Denmark:** Lol: Møn: Høje Møn Jydeleje-faldet 20 May 1995

Salix(w) TL-3870. **British Isles, U.K:** Surrey: Mickleham common 3 March 1991 TL-2274 (C, TROM 3). **Italy:** Piemonte: Valsesia Sopra Scopa 900 m alt. 28 Sep 1983 *Quercus* L. Petrini *Hypoxylon aeneum* var. *aureoluteum* (ZT, (HOLO-?)TYPE). **Switzerland:** Kt. Graubünden: St. Untervaz Heurütenen 540 m alt. 22 Aug 1981 E. Müller & L. Petrini *Hypoxylon aeneum* var. *aureoluteum* (ZT).

Nemania carbonacea Pouzar

Česká Mykol. 39: 22 (1985). - Anamorph: Unknown (cf. L. Petrini & Rogers 1986).

Figs 13 A-C, 15 (map), 22 (stroma), 27.

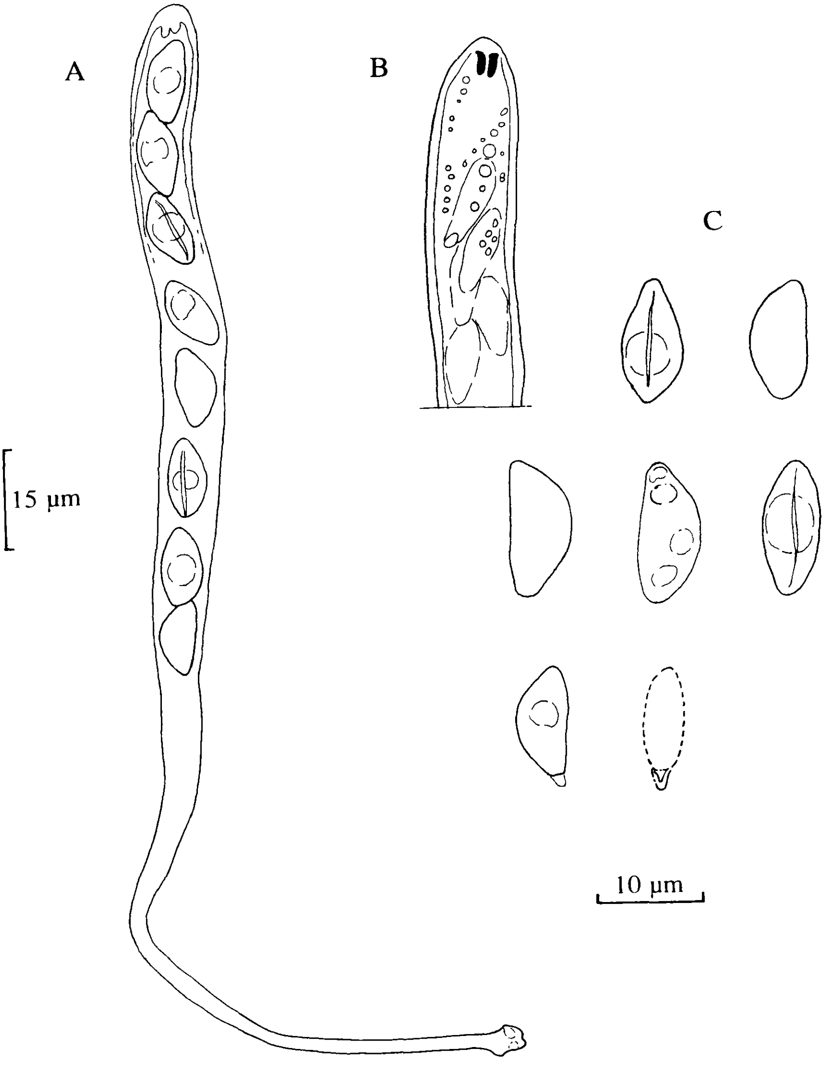
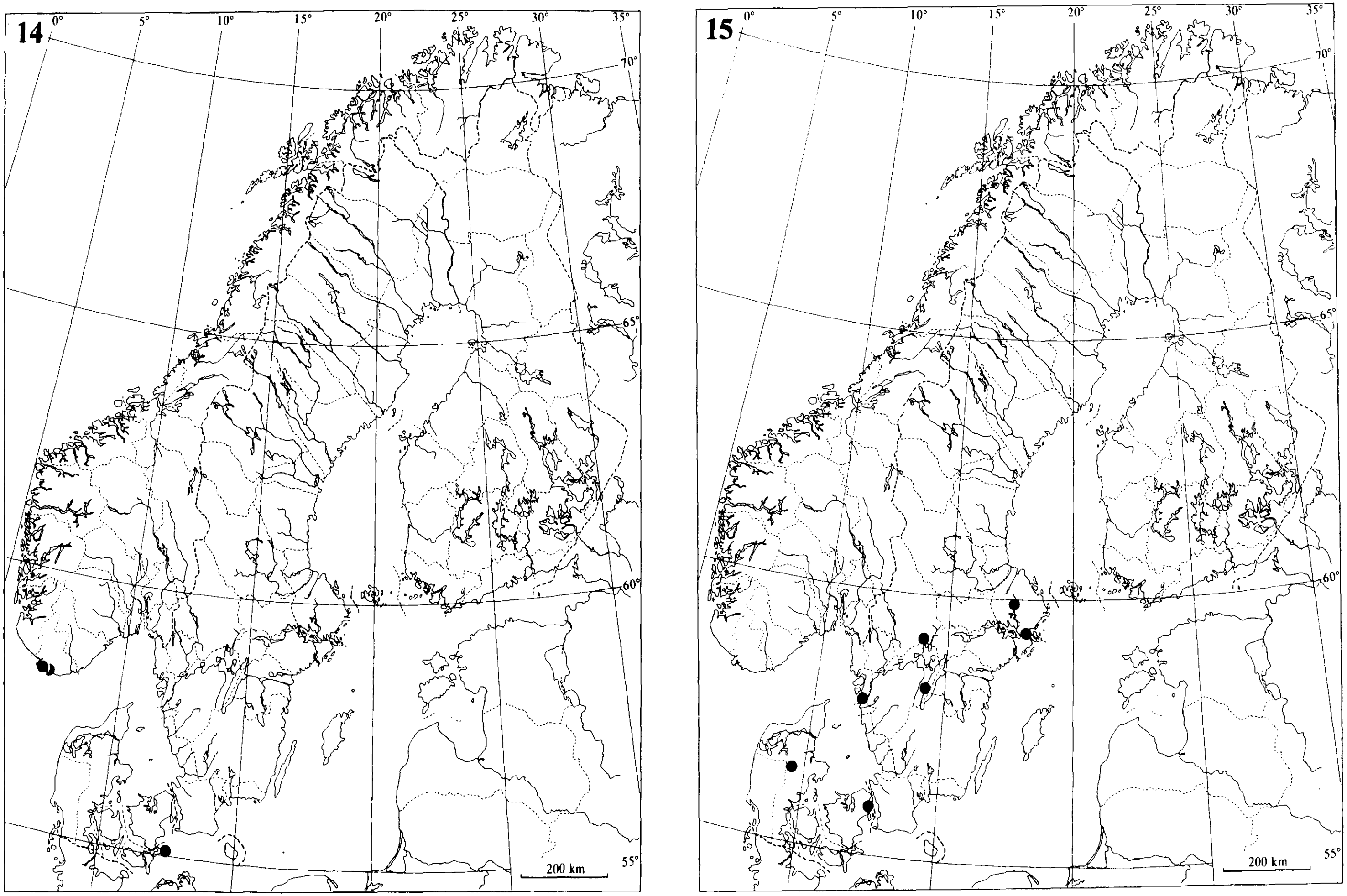
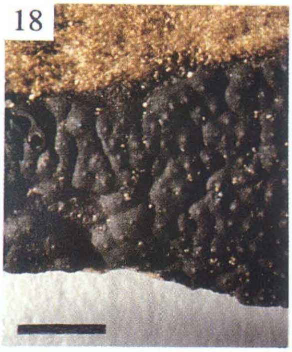
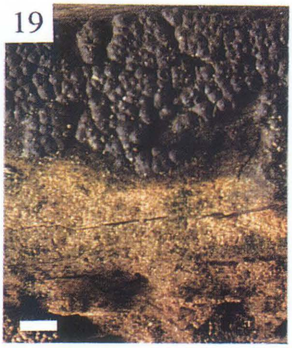


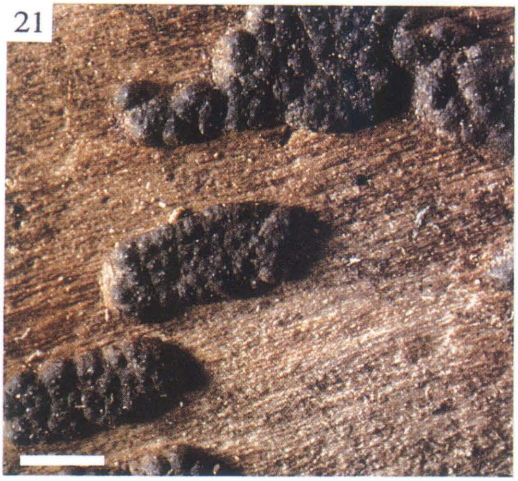
Fig. 13. *Nemania carbonacea*. A. Ascus. B. Ascus apex in LG. C. Ascospores. (S 1).

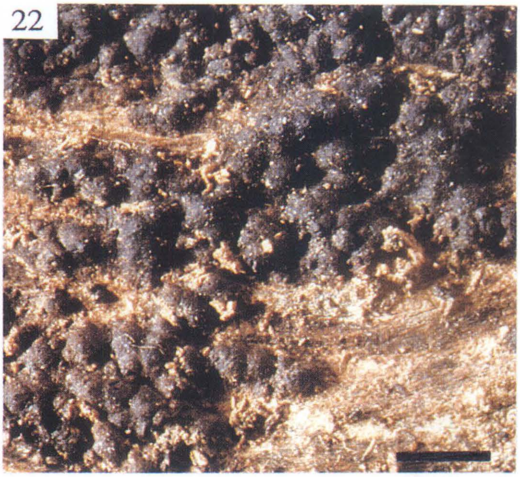


Figs 14-15. Distribution in Norden. Fig. 14. *Nemania aureolutea*. Fig. 15. *Nemania carbonacea*.









Figs 16-22. Photographs of stromata. Fig. 16. *Entoleuca mammata* (TROM 15). Fig. 17. *Euepixylon udum* (O 1). Fig. 18. *Nemania aenea* (TROM, TL-2744). Figs 19-20. *N. atropurpurea* (TROM 19). Fig. 21. *N. aureolutea* (TROM 2). Fig. 22. *N. carbonacea* (S 1). - Rule: 2 mm.

Description. *Stromata* 2-8 × 1-2.5 × 0.04-0.08 cm, brown as young, becoming dull black, with prominent, wide, irregular stromatic grooves. Stromata and surrounding wood are often covered with a conspicuous cream-coloured pruina, which consists of hyaline, angular grains (5-15 µm in diam.) and hyphal fragments. Ectostroma 50-90 µm, carbonaceous, inside dark reddish brown. Entostroma between perithecia yellowish white or grey, at times brown in the upper part, soft. *Perithecia* 450-700 µm high, 450-600 µm in diam., subglobose. Perithecial contours prominent, to 1/2 of perithecial height. Ostioles small, conically papillate, frequently surrounded by a flat, brown or greyish, pruinose area, ca. 150 µm in diam., or a depression. Peridium 30-40 µm thick, with an innermost layer of light yellowish brown t. prism., ca. 12 µm, and an outer, brown t. ang.-t. prism., ca. 20 µm; not carbonized. *Asci* p.sp. 72-93 × 7.5 µm, m. 82 µm (n = 17/3), st. 79-120 µm, m. 87 µm (n = 6/3), with ascus annulus dark blue in LG and MZ, 2-2.5 µm high, 1.5-2 µm broad at base, 2.5-3 µm broad at the top. *Ascospores* 11-13(-14) × 5-6.5, m. 12.2 × 5.5 µm (n = 49/3), partly biseriate in young asci, ellipsoid-inequilateral, often lunate, with narrowly rounded or elongated ends, dark brown (8F7). Remnants of a hyaline cellular appendage and a possible thin, sticky perispore have been observed. Germ slit whole length of spore on the flat side.

Taxonomic notes. *Nemania carbonacea* is distinguished by the black, fragile stromata, often with a cream-coloured covering and by the surface structures. In external morphology it resembles *N. colliculosa*. The dark brown ascospores and the long germ slit along the whole length of the spore are features in common with *N. diffusa*. Judged from our observations of herbarium collections, earlier finds of this species may be hidden among specimens of *N. serpens*.

Ecology. *Nemania carbonacea* has been found on wood of *Betula* and *Corylus*. From Czechoslovakia Pouzar (1985a) records it on *Acer*, *Carpinus*, *Fagus*, *Populus*, *Quercus* and *Tilia*. It belongs to a thermophilic element as does *N. diffusa*. Although its Nordic hosts are rather different from the Czechoslovakian hosts, we assume it to be restricted to the warmer parts of this region too, and the species of *Betula* in question most probably is the thermophilic *B. pendula*.

Distribution. *Sweden*. Vg, Vrm, Upl. *Denmark*. Sj, EJy. *Nemania carbonacea* is new to Norden and certainly a rare species here. *Total*. No previous records outside the former Czechoslovakia are known to us.

Specimens examined. Sweden: Vg: Göteborg Store Amundön 10 km S of Göteborg 1 Aug 1994 *Quercus*(w) B. Nordén (C). - Vrm: Kristinehamn: Niklasdamm Jul 1892 *Betula*(w) H. Hamberg (S 3). - Sth: Stockholm Aug 1887 *Betula*(w) L. Romell (UPS 5, LD 7). - Upl: Bondkyrka: Gottsunda Sep 1885 E. Haglund (UPS 6). Uppsala: Uppsala Oct 1846 *Betula*(w) M.A. Lindblad (S 4), 1884 *Corylus*(w) K. Starbäck (S 2), 19 Apr 1885 *Betula*(w) L. Romell (S 1). **Denmark:** Sj: Jægersborg Dyrehave decorticated hardwood 28 Jan 1989 TL-1893. - EJy: Silkeborg Vesterskov 25 Nov 1995 *Fagus*(w) JHC95-200. **Czech Republic:** Sylva Zámečck ap. Kroměříž 13 Sep 1972 *Acer campestris* Z. Pouzar (PRM 831755, ISOTYPE). Karlicke udoli ap. Dobrichovice prope Praha 6 Oct 1979 *Carpinus betulus* Z. Pouzar (PRM 821117). Hardecká střáři ap. Čížov 20 Aug 1988 *Quercus betulus* Z. Pouzar (PRM876855). **Slovakia:** "Boky" Bukovina ap. Budča prope Zvolen 18 Oct 1972 *Quercus cerris* Z. Pouzar (PRM 874153).

Nemania chestersii (J.D. Rogers & Whalley) Pouzar

Česká Mykol. 39: 24 (1985) - *Hypoxylon chestersii* J.D. Rogers & Whalley, Can. J. Bot. 56: 1346 (1978). - Anamorph: *Geniculosporium* (L. Petrini & Müller 1986).

Figs 23 A-C, 32 (map), 29; 39 (stroma).

Description. *Stromata* 2-6 × 1-2.5 × 0.1 cm, effused, on wood, with abrupt margins, greyish brown to brown (5F4). Stromatal surface with zigzagging narrow, shallow grooves. Ecto-

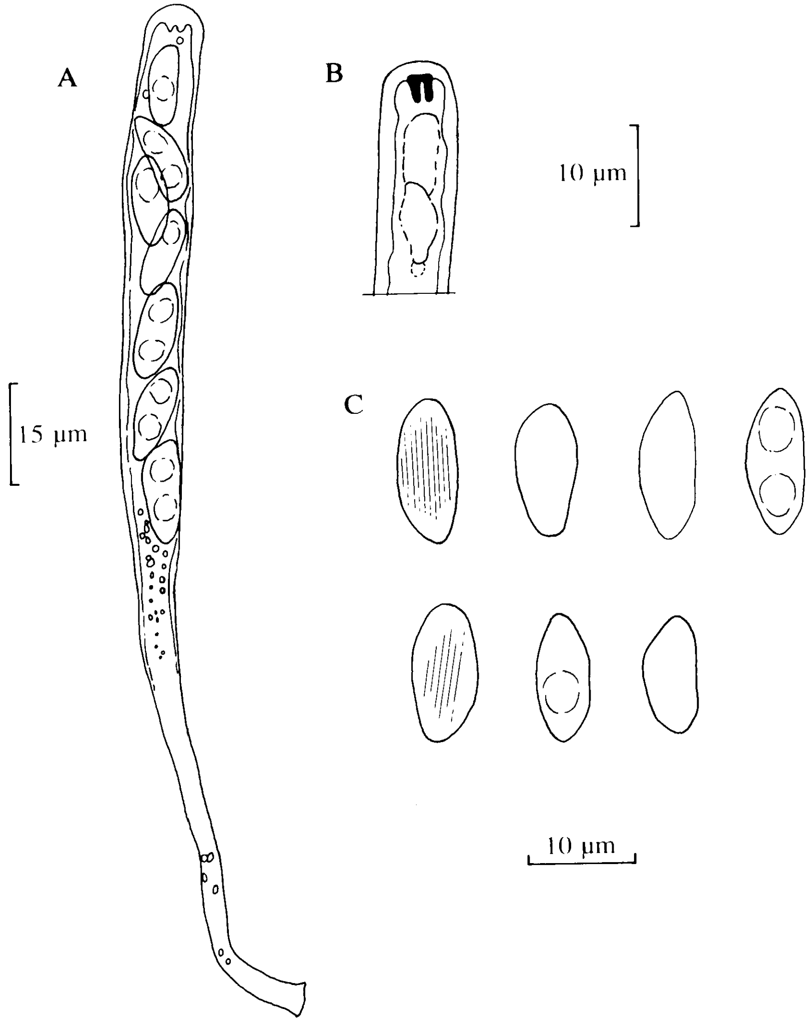


Fig. 23. *Nemania chestersii*. A. Ascus. B. Ascus apex in LG. C. Ascospores. (C, TL-3893).

stroma 50-70 µm, carbonaceous. Entostroma brown, or whitish between the perithecial bases. *Perithecia* 600-900 µm high, 400-900 µm broad, m. 755 × 700 µm (n = 20/4), vertically oblong or ovate. Perithecial contours low. Ostioles small, easily visible only with a lens, conical, black, at times surrounded by a basal groove. Peridium 35-45 µm thick, with an innermost hyaline layer, 8 µm, followed by a light brown layer of t. prism., 35 µm; surrounded by brown entostroma of t. intr. fused with the carbonaceous ectostroma above. *Asci* p.sp. (68-)80-115(-130) × 7-9.5 µm, m. 95 × 8 µm, st. 34-151 µm, m. 84 µm (n = 24/4), ascus annulus blueing in LG and in MZ, ca. 3 µm high and 2.5 µm broad. *Paraphyses* very long, hyaline, septate, probably not branched, 8 µm thick near the base, 2 µm at apex. *Ascospores* (12-)13-17 × 4.5-5.5(-6) µm, m. 14.3 × 5.1 µm (n = 100/5), ellipsoid to navicular or lunate with narrowly rounded, sometimes elongated ends, with

Figs 24-29. Photographs of asci and ascospores. Fig. 24. *Entoleuca mammata* (TROM, GM 1865). Fig. 25. *Nemania aenea* (B, lectotype). Fig. 26. *N. aureolutea* (TROM 2). Fig. 27. *N. carbonacea* (S 1). Fig. 28. *N. colliculosa* (TROM 129, neotype). Fig. 29. *N. chestersii* (TROM, TL-3893). - Rule: 10 μm.

1-2 guttules, smoky brown (6C4, 6D5). Spore wall ornamented with about 20 longitudinal ribs (700-1000×!), no germ slit observed. Spore deposit on stroma dark olive.

Taxonomic notes. *Nemania chestersii* is the only European *Nemania* species which has a sculptured ascospore wall. *Hypoxylon (= Nemania) chestersii* var. *microsporum* from Brazil (Rogers & Samuels 1985) was also recorded with sculptured ascospores. Ornamented ascospores are generally rare in the family *Xylariaceae*. *Camillea* is characterized by having a reticulate ascospore ornamentation. *Biscogniauxia weldenii* (J.D. Rogers) Whalley & Laessøe from the U.S.A. and Honduras, and in particular *B. sinuosa* (Theiss.) Y.-M. Ju & J.D. Rogers from Brazil, have ascospores with ridges and grooves quite similar to *N. chestersii* (Ju et al. 1998).

Several collections of *N. chestersii* had aborted perithecia, giving these parts a deviating morphology. They are sometimes ventrally concave, with one end of the stroma more or less truncate, the other end pointed.

Ecology. *Nemania chestersii* occurs on decorticated, decayed wood of *Fagus*, *Fraxinus* and *Quercus*.

Distribution. *Denmark*. Sj, Lol. New to Norden. The Danish records suggest a southern distribution in Norden, and the species is probably restricted to the nemoral zone. *Total*. Until now known from the British Isles, Czechoslovakia, Germany, France, Switzerland (Rogers & Whalley 1978, Pouzar 1985b, Enderle & Siepe 1985, L. Petrini & Müller 1986).

Specimens examined. Denmark: Sj: Farum Nørreskov Svenskebøgene 7 Mar 1997 *Fagus*(w) JHC 97-001, 97-003, 97-005. Gadevang Strødam Reservatet 21 Sep 1996 *Fagus*(5w) TL-4287, 4288, 4289, 4290; TL-4299 (UME). Næstved Rådmandshaven 15 Sep 1989 *Quercus*(w) TL- 2028. Suserup Skov 10 Jul 1994, 23 Aug 1994, 9 Oct 1994 *Fagus*(4w) JHC 94-140, 94-193, 94-355, 94-162, 29 Nov 1994 *Fagus*(2w) TL-3760, 3761, 19 May 1995 *Fagus*(2w) TL-3893 (C, TROM), 3895, 19 May 1995 *Fraxinus*(w) TL-3896. - Lol: Møn: Store Klinteskov Timmesøbjerg 11 Jun 1996 *Fagus*(w) TL-4162, 24 Jun 1996 *Fagus* (w) TL-4423 (C, TROM).

Nemania colliculosa (Schwein.: Fr.) Granmo comb. n.

Sphaeria colliculosa Schwein.: Fr., Syst. Mycol. 2: 341 (1823); Schwein., Schr. nat. Ges. Leipzig 1: 36 (1822) - *Hypoxylon colliculosum* (Schwein.: Fr.) M.A. Curtis, Geol. Nat. Hist. Surv. N. Carolina, part 3: 140 (1867, n.v.). - Anamorph: *Geniculosporium*.

Figs 30 A-D & 31 A-C, 28; 33 (map), 40-41 (stromata), 68 (culture), 72, 79, 83 (SEM).

Description. *Stromata* 0.5-7 × 0.3-2 × 0.04-0.07 cm, forming small elliptical spots or elongated, often slightly sinuous bands on naked wood. Young stromata sepia brown (5F4), or slightly rusty, with an almost hirsute tomentum consisting of light brown rigid hyphae (ca. 50 × 4 μm), and spherical cells. Fully mature stromata lack tomentum, are bronze brown or dark grey with a discontinuous thin silvery veil, eventually becoming dull black with a scabrous surface. Surface structures as several irregular shallow depressions, and some transversal, short and widely open V-shaped grooves, preferably at the stromal edge. Longitudinal ridges and grooves may form in addition, depending on the wood below. Ectostroma 50-70 μm, carbonaceous, fragile. Entostroma white in young state, later yellowish white to grey brown, soft. A basal, carbonaceous stromatic zone, ca. 80 μm thick, is sometimes present. *Perithecia* 300-450 × 210-510 μm, m. 373 × 362 μm (n = 34/5), globose to ovate, peridium 25-28 μm thick, the innermost layer being a yellow cord, 2.5-3.5 μm, passing into a hyaline to light brown t. prism., 7-10 μm, and an outer layer of light brown t. ang.-t. prism., 12-17 μm, not carbonized. Perithecial contours generally present, to 1/4 of perithecial height, occasionally lacking. Ostioles frequently covered by or just piercing a thin ectostroma, at times fully exposed without ectostroma, continuing smoothly into the rounded-conical perithecial apex (arched at an angle of about 110°). Occasionally false ostioles occur. *Asci* p.sp. 60-91 × 7-8 μm, m. 75 × 7 μm (n = 45/6), st. 45-88(-96) μm, m. 62 μm (n = 41/6), amyloid

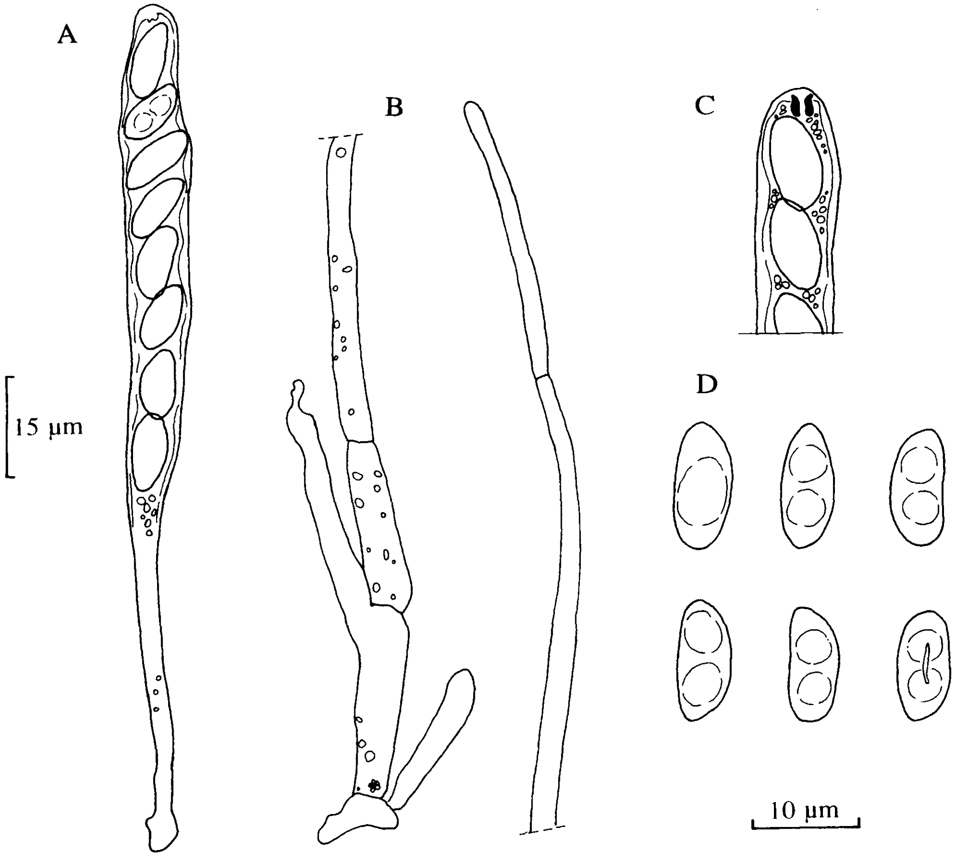


Fig. 30. *Nemania colliculosa*. A. Ascus. B. Paraphysis. C. Ascus apex in LG. D. Ascospores. (TROM 129, neotype).

in LG with ascus annulus 2.5-3 µm high, 1.75-2 µm broad at base, 2.25-2.5 µm broad above. *Paraphyses* to 225 µm long, 8-9 µm broad below, tapering to 2-3 µm beneath the occasionally slightly swollen apex, sparsely branched, septate. *Ascospores* 10-13.5(-14.5) × (4-) 4.5-6 µm, m. 11.7 × 5.1 µm (n = 133/6), brown (6C7-D7), ellipsoid to ellipsoid-inequilateral with narrowly or broadly rounded ends. Germ slit mostly conspicuous, 4-7 µm long, central or slightly displaced towards one end, on the flat side or a little towards the lateral side. In hypochlorite 10-20% of the spores are discoloured in 2 hours. Recent spore deposit on stromata yellowish green or slightly olive green (1B5, 4B5/B6, 4D5).

In culture (neotype; 2% MA, 23 °C) colony reaching a diameter of 7 cm in 3 weeks, whitish with a golden tinge, felt-like, with V-shaped radial furrows and crowded concentric mycelial zones particularly towards the centre. Reverse of plate pale yellow. On PCA several small, black perithecial initials eventually emerged in concentric zones.

Anamorph in culture forming conidiophores 2.5-3 µm broad, branched, pale yellowish brown, with intermittent dark wall sections, in old mycelium abundantly branched, the upper part of the conidiophores appearing almost coral-like. Conidiogenous cells terminal, 40-50 µm long, at times also intercalary, geniculate. Conidia 3-5 × 2.5-3 µm, hyaline, obovoid, with a small indentation scar at the former point of attachment.

Taxonomic notes. *Nemania colliculosa* (*Hypoxylon c.*) has been treated as a synonym of *Nemania serpens* by most authors (Miller 1961, Pouzar 1985b, L. Petrini & Rogers 1986, Ju & Rogers 1996). Schweinitz (1822) recorded *Sphaeria colliculosa* from decayed trunks of '*Quercus lyrata* etc.' without giving any details to facilitate identification. Four original specimens of *Sphaeria colliculosa* (*Hypoxylon colliculosum*) were investigated, and were found to represent

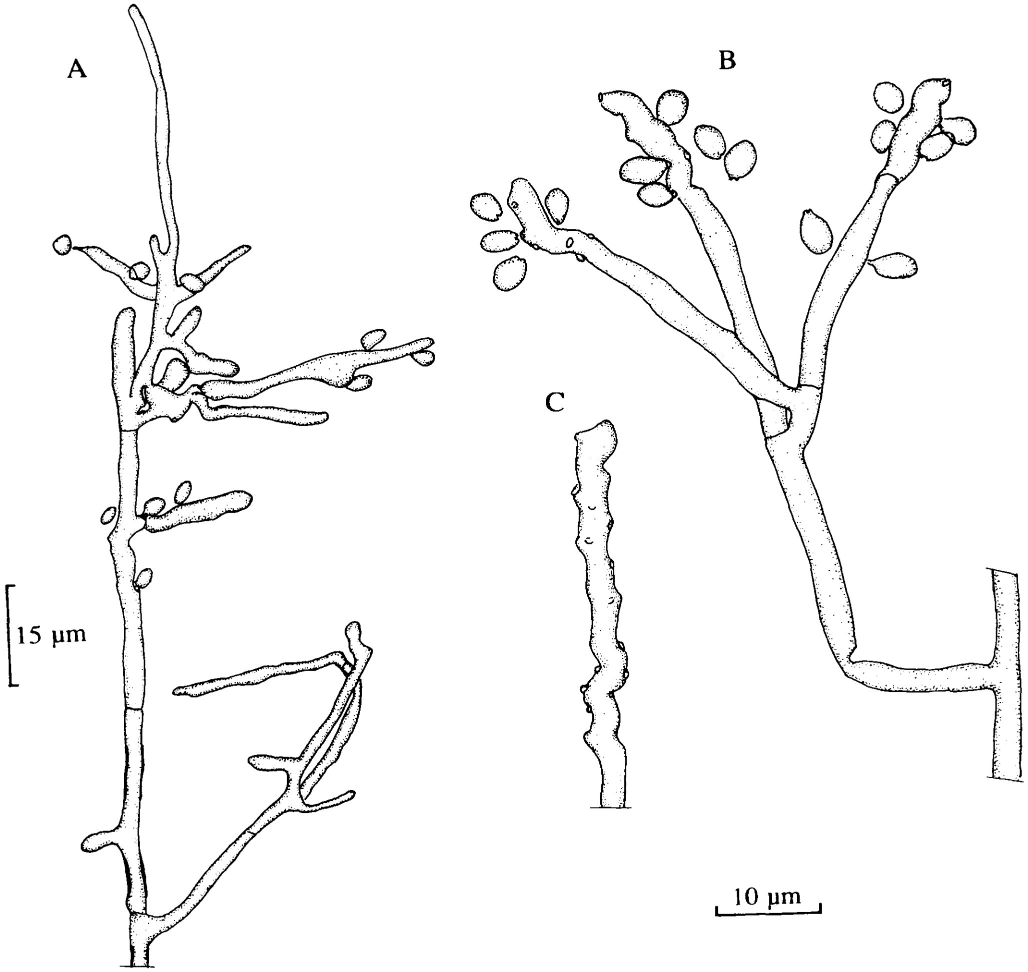
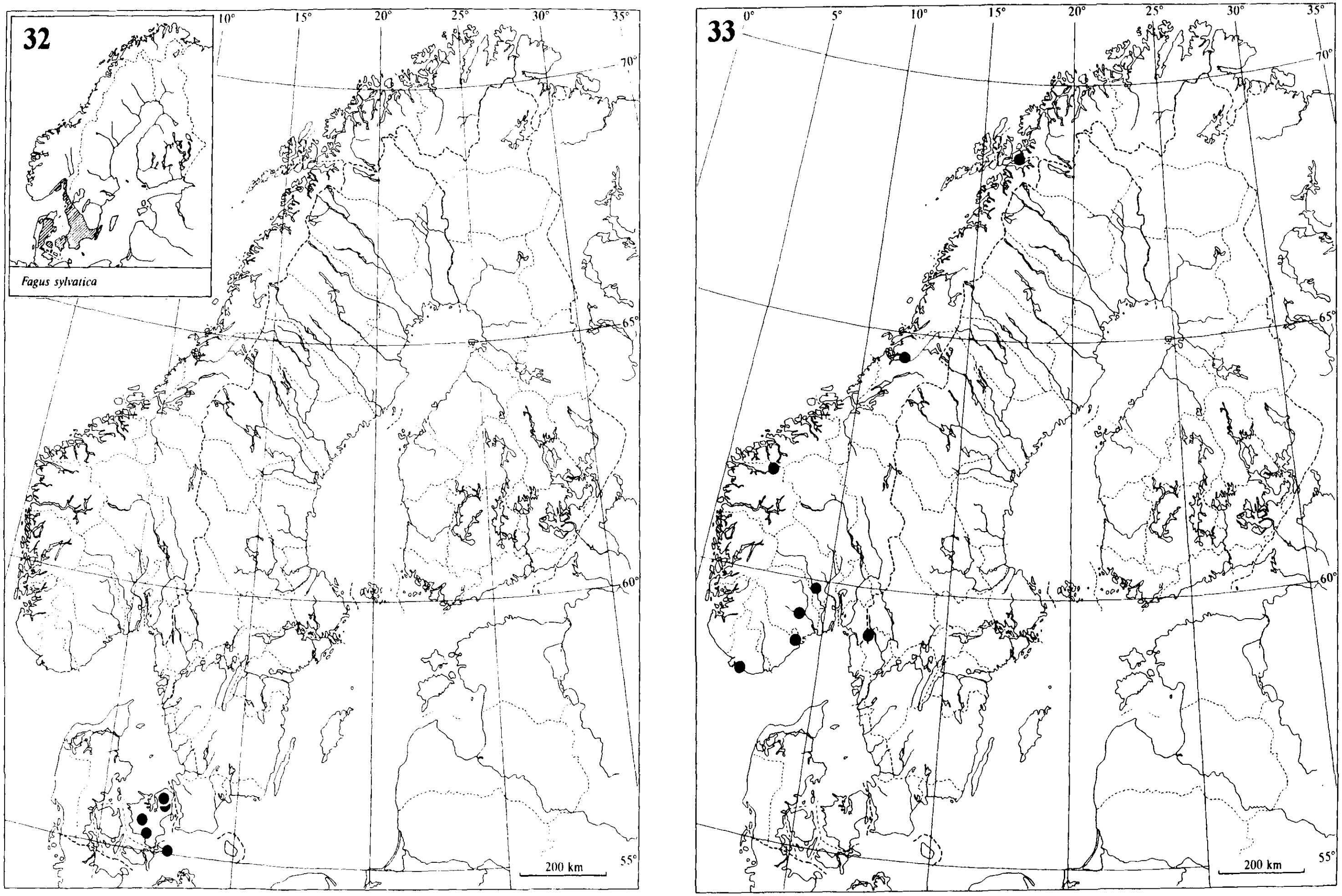


Fig. 31. *Nemania colliculosa.* Anamorph in culture. A-C. Conidiophores with conidia. Note thickened wall sections in A. A. Conidiophore from aged mycelium. Note tendency to coral-like branching. B. Conidiophore with conidia. C. Long, terminal conidigenous cell. (TROM 129, neotype).



Figs 32-33. Distribution in Norden. Fig. 32. *Nemania chestersii* and its most frequent Nordic host. Fig. 33. *Nemania colliculosa* in Norway. The one certain, Swedish locality (in Dls) is also shown.

four different taxa:

(1) A specimen in Kew (ex herb. Schweinitz) labelled 'Type' (cf. Miller 1961: 79) by the herbarium authorities, '*Sphaeria colliculosa* Schw. Salem + Bethlehem', and later '*Hypoxylon colliculosum* (Schwein.) Curt.'; annotated '*Nemania serpens* f. *serpens*' by Pouzar in 1982. It has a stroma 4 × 1 mm on a piece of microporous wood (not indicative of a *Quercus* sp.). The ascal annuli are amyloid. The specimen considerably resembles our material, which we at first considered a variety of *N. serpens* (*N. serpens* var. *reticulata* nom. prov. in herb.).

(2) A specimen in herb. Fries, UPS, probably on *Quercus*, is named in Schweinitz' own handwriting '*Sphaeria colliculosa* LvS'. The specimen contains ascospores but no asci. It may be the specimen on which Fries (1823: 341) accepted the name. The specimen lacks most details, but resembles the lectotype of *Sphaeria caries* Schwein. in PH. It is not conspecific with the Kew specimen cited above.

(3) A specimen in PH designated 'Salem, Bethlehem, 1197-51- Syn. Fung.', evidently having been referred to as 'type' of *S. colliculosa* by some authors (L. Petrini & Rogers 1986, van der Gucht 1995). It was also studied by Pouzar in 1979 and stated to be sterile ('*Hypoxylon* sp. - better type is at Kew', Pouzar's note), which is the case for the stromata on the smaller piece of wood. On the larger piece of wood, however, one out of the four small stromata (each ca. 3 × 1.5 mm) proved to have ascospores (but no asci), 22.5-25 × 8.5-11μm, with short germ slit. This specimen coincides quite well with *Hypoxylon regale* Morgan, s. Miller (1961: 67). *H. regale* Morgan is, according to Ju & Rogers (1996: 311), a synonym for *Sphaeria (= Nemania) quadrata* Schwein.

(4) A specimen in PH from Surinam is designated '*Sphaeria colliculosa* Schw. ms.', and also '*Hypoxylon bipapillatum* B.-C.' It is named 'isotype' of *Hypoxylon bipapillatum* on a slip added by Ju in 1992, and has later been considered holotype by Ju and Rogers (1996: 246; Rogers pers. comm.). The material represents an alien *Nemania* previously unknown to us (v. *N. diffusa*).

Sphaeria colliculosa Schwein. in its original sense evidently is a mixture of different species. There is hardly any authentic, sufficiently well preserved material to show the delicate characters needed to distinguish it from related species. In order to stabilize the concept of *Nemania colliculosa*, we have therefore proposed a *neotype* specimen (AG 228/95), based on ample recent material which to some extent is also comparable with the Schweinitz material in Kew. The ITS nrDNA of the neotype specimen has also been sequenced in the present work.

Nemania colliculosa differs from *N. prava* (and *N. serpens*) in having substantially smaller perithecia, thinner, more fragile ectostroma, more irregular stromatal contours, and less distinct ostioles or ostiolar papillae.

Ecology. *Nemania colliculosa* is found on strongly deteriorated wood of *Populus*, *Quercus* and *Salix*.

Distribution. *Norway*. Bu, Te, AA, VA, SF, NT, No. *Sweden*. Upl.

Specimens examined. Norway: Bu: Flesberg: Flesberg 16 Sep 1974 *Salix*(w) I. Røsberg (BG 49). Hol: Dagali 16 Sep 1974 *Populus*(w) E. Fremstad (BG 91). - Te: Bø: Uvdalsheia above Uvdalstjønn 27 Jul 1974 *Populus* (bw) AG 250/74 (incl. a piece of *N. serpens*) (BG 47). - AA: Grimstad: Skiftenes nat. res. 10 Jul 1995 *Acer*(w) AG 53/95 (TROM 113). Risør: Jostadvt. at road E18 ca. 3 km S of Holt 23 Jul 1974 *Populus*(bw) *Salix*(w) AG 190/74, 184/74 (BG 38,39). - VA: Lindesnes: Åvik Syrdal nat. res. 22 Jul 1995 *Quercus*(w) AG 170/95 (ass. w. *N. serpens* AG 171/95) (TROM 120). - SF: Stryn: Strynsvatn Flostranda nat. res. 20 Jul 1994 *Salix*(2w) AG 6/94, 10/94 (TROM 105,97). - NT: Overhalla: Near Heiabakken 6 Sep 1978 *Populus*(w) S. Sivertsen (TRH 89). - No: Evenes: Botn S-side of Hallaren 17 Sep 1995 *Populus*(2w) AG 228/95 NEOTYPE; 229/95 (TROM 129;130). **Sweden:** Dls: Fröskog: Sörknatten nat. res. Husdalsbergen 13 Sep 1990 *Populus*(bw) TL-3074 (C, K). **U.S.A:** Salem [North-Carolina] + Bethlehem [Pennsylvania] *Sphaeria colliculosa* Schw. (later: '*Hypoxylon colliculosum* (Schw.) Curt.)'. (K).

Specimens with affinity to N. colliculosa: **Sweden:** Upl: Dannemora: W of Andersby 3 Oct 1972

Quercus(bw) N. Lundqvist 8105 (UPS 71). - Ång: Junsele: Junsele 5 Aug 1989 *Salix pentandra*(w)GM 8109 (was closely ass. w. *N. serpens* TROM 186) (TROM 133).

Nemania confluens (Tode: Fr.) Laessøe & Spooner

Kew Bull. 49 (1): 40 (1994) - *Sphaeria confluens* Tode: Fr., Syst. Mycol. 2: 342 (1823); Tode, Fungi Mecklenb. 2: 19-20 & 63, Tab. 10, Fig. 87 (1791) - *Hypoxylon confluens* (Tode: Fr.) Westend., Bull. Acad. roy. Sci. Brux. 12: 242 (1845) - *Hypoxylon semiimmersum* Nitschke, Pyren. Germ.: 50 (1867). - Anamorph: *Geniculosporium* (Chesters & Greenhalgh 1964).

Figs 34 A-C, 35 (map), 42 (stroma).

Description. *Stromata* 0.1-1.5 × 0.1-0.2 × 0.1-0.15 cm, in small elliptical spots (0.1-0.5 cm diam.) or as short stripes on bare wood, black, consisting of 1-25 perithecia. Young stromata have remains of a brownish grey pruina. Ectostroma 70-100 μm thick, carbonaceous and very hard, at the stromal border penetrating into the wood and circumscribing the perithecia as a carbonized zone. Entostroma brown grey, scanty, crumbled away in old stromata. *Perithecia* 700-1000 μm high, 700-1000(-1500) μm broad, globose or ovoid, often apically depressed, usually with the base immersed in the wood. Ostioles small, conical. Perithecial contours prominent, or lacking. Peridium ca. 50 μm thick, the innermost layer being a yellow cord, ca. 3 μm, continuing as a yellowish to light brown t. porr., 10-15 μm, the outer layer a brown t. ang., 25-35 μm, mixed with wood elements and with some carbonaceous spots. *Asci* p.sp. 85-124 × 13-15 μm, m. 102 × 14 μm (n = 13/3), st. 62 μm (n = 9/3). Ascus annulus amyloid in LG, sometimes with diffusely blueing material above its upper margin, ca. 3 μm high and 4 μm broad, in immature asci slightly higher than broad. *Paraphyses* filiform to ribbon-shaped, to 610 μm long, 3.5-5 μm broad in the middle, tapering to 2-2.5 μm at the top, septate, rarely branched. *Ascospores* (13-)14-20 × 7-10 μm, m. 16.3 × 8.1 μm (n = 103/4), ellipsoid to ellipsoid-inequilateral, with one end broadly rounded, the other end pointed or citriform, or both ends broadly rounded, with 1-2 guttules, dark brown (7F8). Germ slit whole spore length on least convex side, straight or somewhat winding.

Taxonomic notes. *Nemania confluens* is an atypical *Nemania* deviating in the shape of ascus annulus and in its innate growth habit. It should probably be removed from *Nemania*. *Rosellinia salicum* Fabre (= *Byssonectria salicum* (Fabre) Cooke) from France with subglobose spores is said to resemble *N. confluens* (Rappaz 1995: 163).

We are not sure if *Nemania confluens* occurs outside Europe, though it might have been recorded under other names (cf. Ju & Rogers 1996: 258). Schweinitz (1832: 192) reported *Sphaeria confluens* from Pennsylvania, U.S.A., but Miller (1961) regarded *N. confluens* (as *Hypoxylon c.*) as European and mentioned *Hypoxylon regale* Morgan as its American counterpart. In gross morphology *Nemania confluens* may be easily confused with *Euepixylon udum*. It lacks, however, the coarse ostiolar papilla and the distinct black substratal zone line typical of the latter.

Ecology. Strongly deteriorated wood of *Quercus* appears to be the common substrate for *Nemania confluens* wherever found, and it is proper to designate it a tertiary saprobe. Dennis (1981, 1986) also reports it on *Fagus*, *Fraxinus*, *Fuchsia* and *Ulmus* in the British Isles. In Denmark it often occurs together with *Nemania serpens* in marshy localities.

Distribution. *Norway*. AA, VA. *Sweden*. Sk. *Denmark*. Sj, Lol, Fyn, EJy, WJy. Rare. *Nemania confluens* has previously been reported from Sweden (Fries 1849: 389, *Sphaeria c.*), Denmark (Munk 1957: 133, as *H. semiimmersum*), Norway (Granmo 1977: 116), and the Nordic countries (Granmo et al. 1989). The species has a southern and western distribution in the Nordic countries, showing a preference for the oceanic parts of the oak region. *Total*. Europe, including

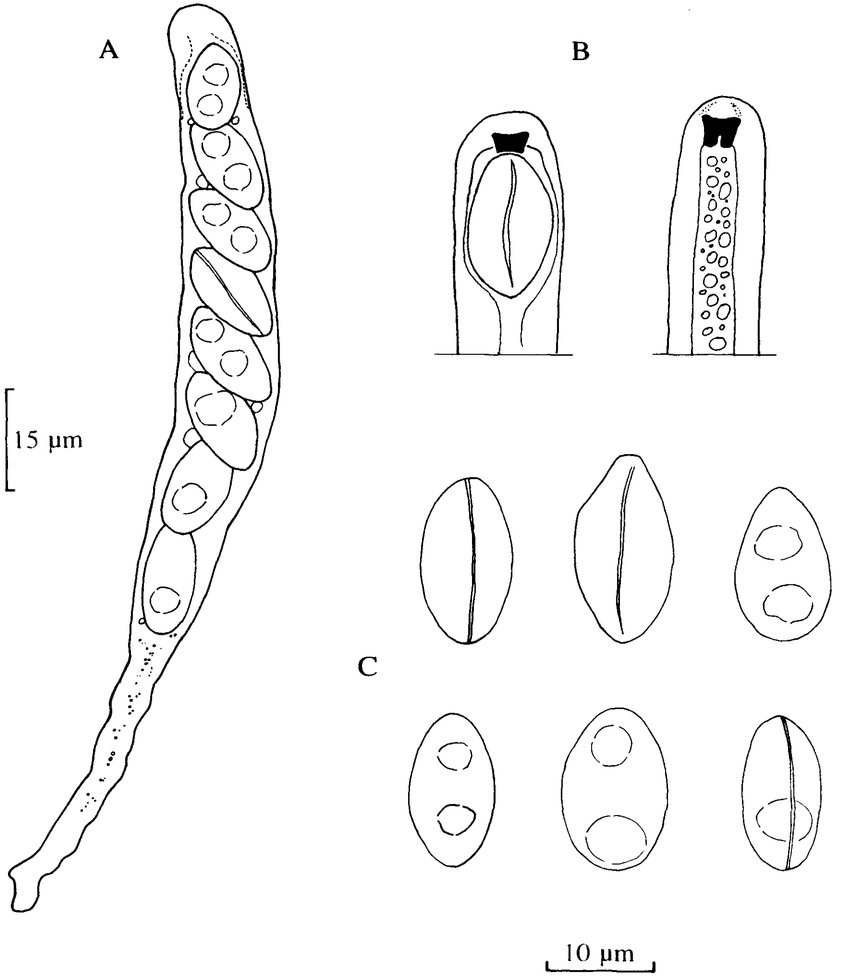
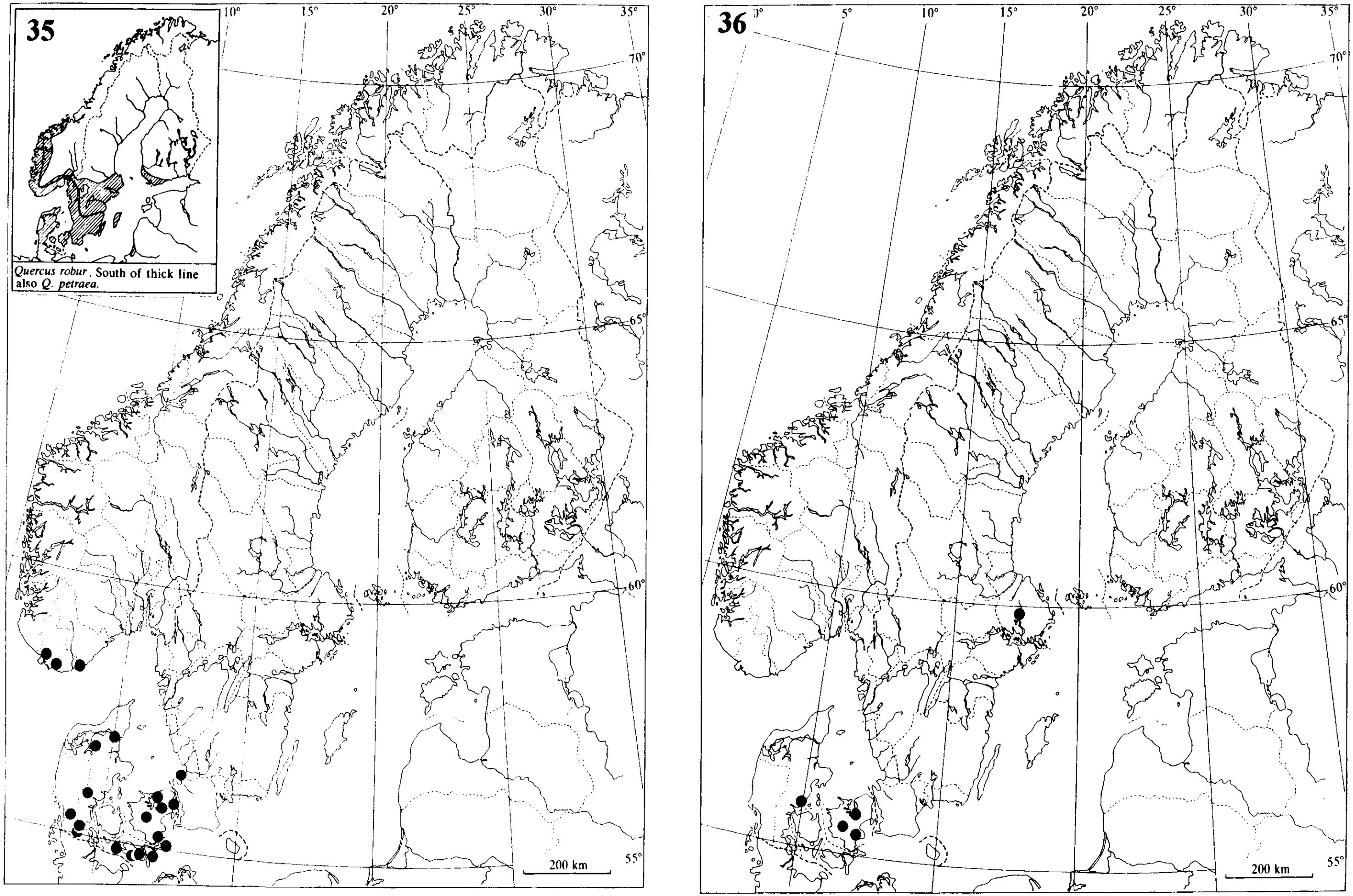


Fig. 34. *Nemania confluens*. A. Ascus. B. Ascus apices in LG; mature ascus (left) and immature ascus (right). C. Ascospores. (BG 1).

the British Isles. U.S.A.(?)

Specimens examined. Norway: AA: Lillesand: Kvåse W of Toretjørn 15 Jul 1995 *Quercus*(w) AG 127/95 (TROM 3). - VA: Flekkefjord: Hidra Rasvåg 16 Jul 1974 *Quercus*(w) AG 91/74 (BG 1). Lindesnes: Åvik Syrdal nat. res. 22 Jul 1995 *Quercus*(2w) AG 173/95, 177/95 (TROM 4,5). **Sweden:** Sk: Hallands Väderö Tångokärret 1 Oct 1994 *Quercus*(w) K. Bergelin (UME 1). **Denmark:** Sj: Allindelille 15 Jun 1996 *Fagus*(w) TL-4168. Fredriksdal Apr 1884 *Fagus*(w) Raunkiær. Jægersborg Dyrehave Mar 1884 *Fagus*(w) C Raunkiær. Jægerspris Nordskov 7 Sep 1985 *Quercus*(w) TL-1133. - Lol: Falster: Donne Mose 13 Apr 1962 L. Døssing. Lolland: Krenkerup Haveskov 24 Oct 1986 *Fagus*(w) S.A. Elborne 1672, 15 Jan 1989 *Carpinus*(w) S.A. Elborne, 15 Jan 1989 *Quercus*(w) TL- 1901. Kristiansæde Skov 23 Apr 1992 *Quercus*(w) H. Knudsen. Møn: Store Klinteskov Jydelejefaldet 11 Oct 1995 *Fagus*(w) *Quercus*(w) TL-4042, 4047. Ulvshale 21 May 1995 *Tilia cordata*(w) *Quercus*(w) TL-3874, 3873. - Fyn: Langeland: Vester Gulstav 15 Apr 1989 *Quercus*(w) TL-1923. - EJy: Bollerslev Skov near Åbenrå 1 Oct 1996 *Fagus*(w) J.H. Petersen TL-4372. Frøslev Vesterkrat W of Padborg 2 Jan 1990 *Quer-*



Figs 35-36. Distribution in Norden. Fig. 35. *Nemania confluens* and its most frequent Nordic host. Fig. 36. *Nemania diffusa*.

cus(w) R. Toft 90-0021. Gasse Skrøp E of Skærbøk 20 Sep 1991 *Quercus*(w) J. Vesterholt. Høstemark Skov 26 Dec 1994 *Fagus*(w) TL-3770. Lovns 2 Oct 1995 *Tilia*(w) J.H. Petersen. - WJy: Billund Krat 6 Apr 1993 *Quercus*(w) R. Toft JV89-2797. Lindet Skov 29 Apr 1989 *Quercus*(w) R. Toft 89-367. **British Isles, U.K.:** Somersetshire s.d. *Quercus*(w) C.E. Broome (O 2). N. Wales: Gwynedd Glynwood Bangor 30 Dec 1982 *Quercus*(w) A.J.S. Whalley (UME 2).

Nemania diffusa (Sowerby) Gray

Nat. Arr. Br. Pl. 1: 517 (1821) - *Sphaeria diffusa* Sowerby, Engl. Fungi 3: Pl. 373, Fig. 10 (1803, n.v.), non Schwein. (1832) - (?)*Sphaeria unita* Fr.: Fr., El. Fung. 2: 67 (1828) - *Hypoxylon unitum* (Fr.: Fr) Nitschke, Pyren. Germ.: 44 (1867) - *Nemania unita* (Fr.: Fr.) Krieglst. & Enderle, Mittbl. AG Pilzk. Niederrhein 7: 1: 64 (1989) - *Hypoxylon irregulare* Cooke, Grevillea 11: 133 (1883) - *Hypoxylon lilacinofuscum* Bres., Fungi Trid. 2: 43, Tab. 149, Fig. 1 (1892). - Anamorph: *Geniculosporium* (L. Petrini & Rogers 1986: 402 sub *Hypoxylon bipapillatum*).

Misapplied names: *Hypoxylon bipapillatum* Berk. & M.A. Curtis, s. L. Petrini & Rogers, Mycotaxon 26: 406 (1986), non s. orig. - *Nemania bipapillata* (Berk. & Curtis) Pouzar, s. Pouzar, Česká Mykol. 39: 24 & 133 (1985), non s. orig.

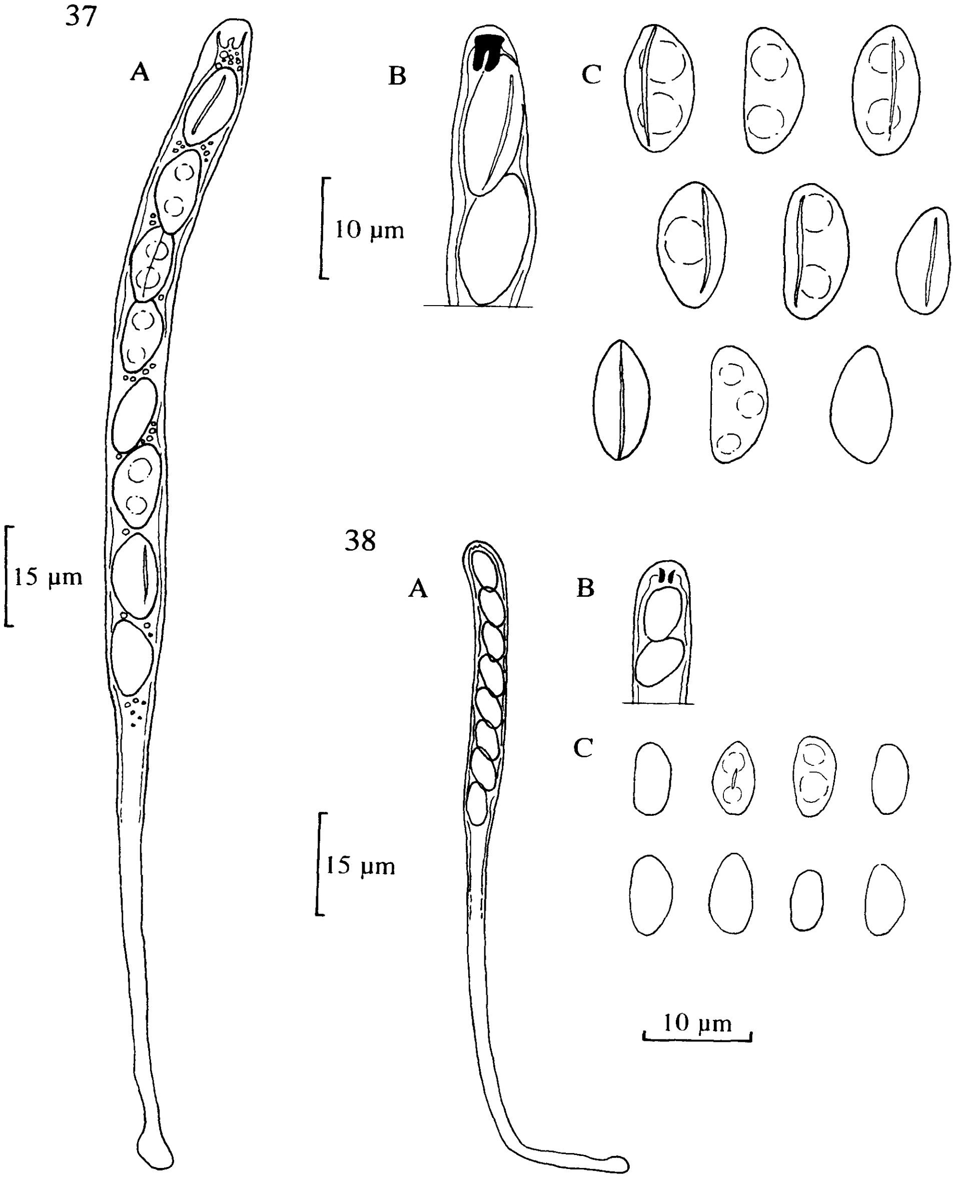
Figs 36 (map), 37 A-C, 43 (stroma), 52.

Description. *Stromata* on wood 1-5 × 0.5-1.5 × 0.06 - 0.08 cm, effused, or on bark 2-4 mm diam. and 1-2 mm high, pulvinate, confluent, surface even, brown to dark brown. Stromatal grooves scanty, wide, or none. Ectostroma 150 μm or more, carbonaceous, dense and hard, extending about half way down to the perithecial base. Entostroma up to 500 μm, corky soft, brown, rarely greyish white and loose. Basal entostroma 50-200 μm, tissue a t. ang. of isodiametric cells (3-4 μm diam). *Perithecia* 500-800 μm high, 400-700(-800) μm broad, m. 670 × 640 μm (n = 15/3). Ostioles black, conical, barely visible to the naked eye, occasionally annulate. Perithecial contours lacking, or pronounced only at stromal margin, where the perithecial apex may widen to a flat, often slightly oblique area. Peridium with a hyaline or yellowish inner layer of t. prism., 10-15 μm (individual cells ca. 5 × 2 μm), a brown middle layer, 15-20 μm of t. prism., and a strongly carbonaceous outer layer, 35 μm thick or more. The outer layer is sometimes lacking at the very bottom of the perithecia. *Asci* p.sp. 67-112 × 6.5-7.5 μm, m. 86 μm (n = 35/5), st. 50-140 μm, m. 90 μm (n = 24/4). Ascus annulus amyloid in LG and MZ, (2-)3.5-5 μm high and 2.5-3 μm broad. *Paraphyses* exceeding the asci in length, up to 200 μm above ascal layer, at base 6 μm broad, tapering to ca. 1 μm at the top, sparsely branched. *Ascospores* 9.5-13.5(-14.5) × 4.5-6.1 μm, m. 12 × 5.5 μm (n = 91/5), ellipsoid-inequilateral or navicular, with predominantly narrowly rounded ends, brown (7D7, 8E8). Germ slit distinct on the least convex side, centrally or from one end of the spore, somewhat dark-bordered, extending 3/4 to whole spore length (and even over one of the ends).

Taxonomic notes. When Nitschke (1867) treated *Hypoxylon unitum*, he referred to Fries' *Sphaeria unita* but had no Fries' material at hand. It has not been possible to find any *S. unita* in Swedish herbaria. Fries (1823, 1832 index) erroneously considered *Sphaeria diffusa* Sowerby a synonym of *S. nummularia* (= *Biscogniauxia n.*).

Hypoxylon bipapillatum s. orig. (holotype from Surinam in PH) is a *Nemania* species somewhat different from *N. diffusa*, which for instance is seen from its peculiar peridial tissue and regularly annulate ostioles. According to Ju & Rogers (1996) *H. bipapillatum* is the same as *S. diffusa* Schwein. (*nom. illeg.*) and *Hypoxylon subannulatum* P. Henn. & E. Nyman s. Miller (1961: 93). This is mainly a tropical/subtropical species, though Dennis (1995: 143) reported the latter (as *Nemania subannulata*) from Southeast England. We accept *Nemania diffusa* on the authority of Ju & Rogers (1996: 265), who state that the holotype (in K) is the same as *Nemania* *bipapillata* s. Pouzar.

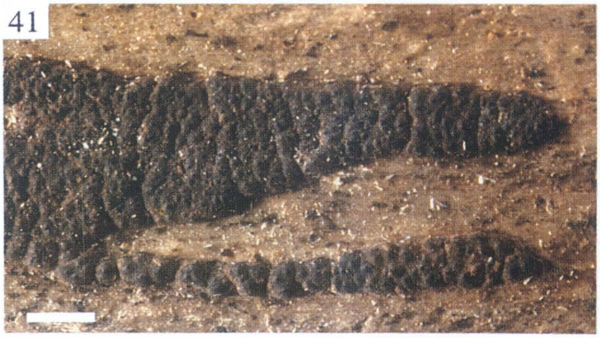
The very thick and hard ectostroma with an even surface is characteristic of *Nemania*



Figs 37-38. *Nemania diffusa* and *N. effusa*. Fig. 37. *Nemania diffusa*. A. Ascus. B. Ascus apex in LG. C. Ascospores. A, B and spores in the uppermost row, and the two leftmost spores in the second row, from TL-3852 (C), the remaining spores from PRM 870428. Fig. 38. *Nemania effusa*. A. Ascus. B. Ascus apex in LG. C. Ascospores. (TROM 8).

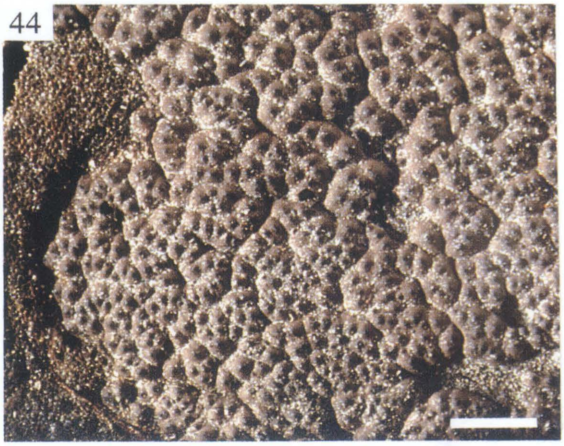

39


40


41


42


43


44

Figs 39-44. Photographs of stromata. Fig. 39. *Nemania chestersii* (C, TL-3893). Figs 40-41. *N. colliculosa* (TROM 129, part of neotype). Fig. 42. *N. confluens* (TROM 4). Fig. 43. *N. diffusa* (UPS 1). Fig. 44. *N. effusa* (TROM 6). - Rule: 2 mm.

diffusa and will often be sufficient to distinguish it from the other species treated here. It differs from *N. carbonacea* in a long-lasting brown stroma colour, and somewhat smaller spores without pointed ends.

Ecology. *Nemania diffusa* occurs on corticated and decorticated wood of *Corylus*, *Fraxinus* and *Quercus*. It has also been recorded on *Acer*, *Castanea* and *Ulmus* in Europe (L. Petrini & Müller 1986: 556, as *Hypoxylon serpens* var. II). Typical localities for *N. diffusa* in Denmark are eutrophic deciduous forests with e.g. *Corylus*.

Distribution. *Sweden*. Upl. *Denmark*. Sj, EJy. *Nemania diffusa* is new to Norden. The few Nordic finds are located in the relatively warm boreonemoral region. The record from a greenhouse in Uppsala, Sweden (at 60 °N) is apt in this case. Pouzar (1985b: 133, as *N. bipapillata*) recorded the species in six localities in Czechoslovakia, all located in the warmer part of the country. *Total*. Europe including the British Isles; U.S.A.(?), Brazil, Mauritius.

Specimens examined. Sweden: Upl: Uppsala in the greenhouse on a wooden tub 26 Mar 1915 *Fraxinus*(w) H. Oswald (UPS 1). **Denmark:** Sj: Boserup Skov at Roskilde 4 May 1995 *Corylus*(bw) B.G. Olsen TL-3852 (C, TROM 1). Sorø Sønderskov near railway st. 16 May 1995 *Fraxinus*(w) TL-3879. Suserup Skov 19 May 1995 *Quercus*(w) TL-3885.Trondhjems Huse Skov S of Vråby (at Tryggeælde å) 28 Mar 1965 A. Munk. - EJy: Munkebjerg Strandskov SE of Vejle 15 May 1990 *Corylus*(b) J. Vesterholt 90-120. Trelde Næs 26 Sep 1996 *Quercus* (bw) S.A. Elborne 2186. **Brazil:** S. Leopoldo 1929 leg. Braun, det. Rick (PACA). **Czech Republic:** Bučan ap. Hronska Dubrava 23 Oct 1972 *Carpinus betulus* Z. Pouzar (PRM 815161 (one out of the three inner capsules). Between Velkahora and Drinovahora 2 Oct 1981 *Corylus avellana* Z. Pouzar (PRM 831753). **Germany:** Westfalen '..an der Mauer im Schlossgarten zu Cappenberg', Aug 1866 *Corylus* Nitschke leg. & det. as *Hypoxylon unitum* (B). No. 16. 'Oder ist ... v. *Hypoxylon udum?*', Nitschke det. as *Hypoxylon unitum* (Fr.) Nitschke (B). **Italy:** Tirol Trient in cortice *Ulmi suberosae* Mar 1890 I. Bresadola leg. as *Hypoxylon lilacino-fuscum* Bres. (UPS). **Mauritius:** Mauritius 1861 Pouce, as *Hypoxylon irregulare* Cooke (K, M 1344. HOLOTYPE of *Hypoxylon irregulare* sec. Ju & Rogers 1996). **Slovakia:** Sylva Háj ap. Pravice 24 Sep 1984 *Quercus petraea* Z. Pouzar (PRM 870428).

Nemania effusa (Nitschke) Pouzar

Česka Mykol. 39: 24 (1985) - *Hypoxylon effusum* Nitschke, Pyren. Germ.: 48 (1867) - *Hypoxylon serpens* (Pers.: Fr.) J. Kickx f. var. *effusum* (Nitschke) J.H. Mill., Monogr. World Species Hypoxylon: 80 (1961) - *Hypoxylon albidum* Romell (ined.; material in S). - Anamorph: *Geniculosporium* (L. Petrini & O. Petrini 1985: 222).

Figs 38 A-C, 44 (stroma), 46 (map), 53; 76, 78, 84 (SEM).

Description. *Stromata* 1-6 × 1-2.5 × 0.07-0.12 cm, effused on wood, rarely on bark and then restricted and circular to oblong. Young stromata greyish white, older stromata bronze to black. Stromatal grooves short, distinct, mostly V-shaped, at times U-shaped. Ectostroma 100 μm, carbonaceous. Entostroma up to 1 mm, basal part 100-500 μm, soft, white, or pale brown. The wood under the stroma is discoloured to a yellowish hue. *Perithecia* 540-650 μm high, 650-800 μm broad, globose to broadly cylindrical. Perithecial contours usually prominent. Perithecial apices narrowly arched when situated near the centre of the stromata, broadly arched at the stromatal margins. Ostioles conspicuous, conical. Peridium 40-55 μm thick, consisting of an inner hyaline layer, ca. 10 μm, which starts with 2-3 cells t. ang. and turns into a t. prism.-t. porr.; a brown middle layer, 12-15 μm, of t. prism.-t. porr., and an outer, moderately carbonized dark reddish brown layer, 20-30 μm, of t. ang.-t. epid. *Asci* p.sp. (35-)45-65 × 4-5 μm, m. 52 × 4.8 μm (n = 49/6), st. 55-120 μm. Ascus annulus amyloid in LG and MZ, 1.5-2 μm high, 1.2-1.5 μm broad. *Paraphyses* lash-like, ca. 150 μm long, 5 μm broad at the base, 1.5-2 μm at the apex, septate, both unbranched and sparsely branched. *Ascospores* 6-9.5 × 3-4.5 μm, m. 7.9 × 3.4 μm (n = 136/6), oblong-ellipsoid to slightly navicular, with 1-2 guttules, pale brown to brown (7C7/C8). Germ slit mostly inconspicuous, short, central.

Taxonomic notes. *Nemania effusa* is well distinguished in its external and internal morphology. Macromorphologically the most characteristic feature is the mixture of large, dome-shaped and small, cone-shaped perithecia. In combination with small ascospores this will be diagnostic. The species has commonly been confused with *Hypoxylon multiforme*, *N. atropurpurea* and *N. serpens*, as seen from our examination of herbarium specimens. In external morphology *Nemania effusa* is easily mistaken for *N. atropurpurea*. However, microanatomy and nr ITS DNA sequences prove the separate status of these closely related taxa. Miller (1961) included *Nemania effusa* as a mere variety of *N. serpens* in his very broad concept of *N. serpens*.

Ecology. *Nemania effusa* is a lignosaprobe and a mycosaprobe as well. It grows on decorticated branches and trunks of *Betula*, *Populus*, *Salix* and *Quercus*, and on old *Phellinus igniarius*, *P. populicola* and *P.* cf. *ferruginosus*. *Salix*, *Populus* and *Phellinus* are the hosts mentioned for the few other European records (Nitschke 1867, Munk 1957: 134, Dennis 1974: 171, 1995: 143).

Distribution. *Norway*. Oslo, Op, NT, No, Tr. *Sweden*. Sth, Upl. *Finland*. EH, PK. *Denmark*. Sj, EJy. *Nemania effusa* is a rather rare species in Norden. Rostrup (1904) recorded *Hypoxylon effusum* from Norway, but the material (in O) is in fact *H. multiforme*. From Denmark, however, the species was unambiguously described by Munk (1957). From Sweden the only record has been that of Miller (1961: 81) of *Hypoxylon albidum*. The Finnish finds were made recently and are not previously reported. *Total*. Europe (British Isles, Germany), Georgia (Grusija) (sec. Bondarceva 1975). U.S.A. (sec. Miller 1961).

Specimens examined. Norway: S.l.d.n.c *Salix*(2w) (O 3,4). - Oslo: Bogstadåsen 1840 s.n.c. *Salix*(w) (O 2) (ass. with *N. serpens* O 11) (Rostrup 1904: 19 as *H. crustaceum*). - Op: Ringebu: Ringebu s.d. *Salix caprea*(w) S.C. Sommerfelt *Hyp. atropurpureum* Fr. det. C.L. Shear 1923 (O 7) (Rostrup 1904: 19 as *H. serpens*). Vestre Toten: Toten Museum 13 Sep 1984 *Phellinus* F.-E. Eckblad (O 10). Steinberg slope at Toten Museum 13 Sep 1984 *Phellinus igniarius* J.Z. Yue & O.E. Eriksson (TROM 9). - NT: Namsskogan: At Namsskogan railway st. 20 Jul 1973 *Betula*(w) AG 127/73 (BG 5). - No: Rana: Holmen Skuggheia 23 Jul 1989 *Salix borealis*(bw) GM 7641/7650a (TROM 8). Saltdal: Saltdalen Feb 1824 *Salix caprea*(w) S.C. Sommerfelt (O 1) (Sommerfelt 1826: 206, 1827: 45 as *Sphaeria serpens* Fr., Jørstad 1928: 448 as *Hypoxylon crustaceum*). - Tr: Bardu: Setermoen on the riverbank of Barduelva 31 Jul 1973 partly on *Betula*(w) partly on healthy, living *Phellinus* cf. *ferruginosus* AG 195/73 (BG 6, UPS 6). **Sweden:** Sth: Stockholm Aug 1887 *Betula*(w) L. Romell (S 4). Djurgården 21 Jan 1894 *Salix*(w) L. Romell M.A.3326, as *Hypoxylon albidum* Romell coll.orig. (nom. ined.!) (S 1(15017)). - Upl: Bondkyrka: Vårdsätra 19 Apr 1885 *Salix*(w) L. Romell (S 2). Gottsunda Sep 1885 *Salix*(w) E. Haglund (S 3). Harbo: Kalvnäset 6 km NE Harbo 5 May 1980 pores of *Phellinus* N. Lundqvist 12579 (UPS 5). Uppsala: Uppsala 19 Apr 1885 L. Romell (LD 7). **Finland:** EH: Hollola: Kukkila Karjusaari 17 Aug 1984 *Populus tremula*(w) V. Haikonen 4816 (H 1). - PK: Kontiolahti: Koli 29 Aug 1996 *Phellinus populicola* and *Populus tremula*(b) TL-4260 (C, TROM). **Denmark:** Sj: Luknam s.d. *Populus canescens*(w) A. Munk leg. & det. (CP) (Munk 1957:133). - EJy: Skindbjerglund near Gammel Skørping 1 Aug 1988 *Quercus*(w) with *Armillaria*-rhizomorphs TL-1673.

Nemania prava Granmo, Laessøe & T. Schumach.

Hypoxylon atropurpureum (Fr.: Fr.) Fr. var. *brevistipitatum* L. Petrini & J.D. Rogers, Mycotaxon 26: 415 (1986) - *Nemania serpenoides* Granmo, T. Schumach. & Laessøe, non r. publ. (Granmo 1998). - Anamorph: *Geniculosporium*.

Stromata 0.3-4 × 0.1-2 × 0.07-0.1(-0.14) cm, in ligno aggregata, ut maculae oblongata vel rigae irregularibus distantiis positae. Stromata juvenilia partim pruina tenuissima cineraceo-alba contecta, matura fusca, demum nigrescentia, vix scabridiuscula. Sulci superficiei aliquando V-formes, transversim undulati, aliter lati non profundi. Ectostroma carbonaceum, durum, 80-100 *μm crassum, entostromate propinquo fusco, aliter albido, ceraceo. Perithecia 390-600 μm alta, 260-680 μm lata, in medio 470 × 436 μm, structurae nullae vel raro usque ad tertiam partem altitudinis peritheciorum. Peridium 28-32 μm crassum, non carbonaceum. Ostiola papillata, nigra, valida, saepe verruciforma. Asci p.sp. 62-96 × 7-9 μm, in medio 76 × 8 μm (n = 58/5), stipitibus 60-101 μm, in medio 77 μm (n = 51/5), annulo apicali in liquido iodato Lugoli cyaneo, paullo altiore quam latiore. Paraphyses usque ad 250 μm longae, ad basin 5 μm crassae, sursum tenuiores. Ascosporae 9.5-13(-14) × (4-)4.5-6 μm, in medio 11.5 × 5.1 μm (n = 71/5), ellipsoideo-inaequilaterales, apicibus maxima ex parte angustatis, rarius acutae, colore hepatico, rima germinativa brevi, conspicua. - Holotypus: AG 50/94 (TROM 104) (v.i.).*

Figs 45 A-F, 47 (map), 54 & 59; 62-63 (stromata), 69 (culture), 73, 80, 85 (SEM).

Description. *Stromata* 0.3-4 × 0.1-2 × 0.07-0.1(-0.14) cm, crowded on wood in small ovate or oblong spots and stripes or more distantly in belts or irregular patches. Parts of the young stromata may have a very thin, greyish pruina. Mature stromata brown and eventually black, with a slightly scabrous surface. Surface of stromata with some undulating, mostly transverse, V-shaped grooves, and shallow, widely U-shaped grooves. Ectostroma 80-100 μm, carbonaceous, moderately hard. Entostroma just beneath ectostroma usually brown, otherwise greyish white or greyish brown, waxy, in old stromata often becoming brown throughout. Sometimes a thin (to 100 μm thick), whitish basal entostroma is seen, consisting of hyphae and wood elements. *Perithecia* 390-600 μm high, 260-680 μm broad, m. 470 × 436 μm (n = 40/5), oblong, ovate or subglobose. Ostioles black, stout, mostly fully exposed on the ectostroma as definite broadly conical warts, 40-50 μm high, 150-160 μm broad, occasionally with a ring-like depression at the base. Perithecial contours none, or rarely to 1/3 of perithecial height, with apex broadly arched (180° > angle > 110°). Peridium 28-32 μm thick, the innermost layer being a yellow cord, 3.5 μm, passing into a hyaline t. prism, 5-8 μm, next and outermost layer a brown t. prism.-t. ang., 18-22 μm, often enclosing scattered dark brown to black carbonaceous spots. *Asci* p.sp. 62-96 × 7-9 μm, m. 76 × 8 μm (n = 58/5), st. 60-101 μm, m. 77 μm (n = 51/5). Ascus annulus amyloid in LG, 2.75-3 μm high, 2 μm broad below, 2.5 μm broad above. *Paraphyses* to 250 μm long, 5 μm broad at base, 2-3 μm at the top, unbranched, or sparsely branched from the middle section. *Ascospores* 9.5-13(-14) × (4-)4.5-6 μm, m. 11.5 × 5.1 μm (n = 71/5), ellipsoid-inequilateral, the majority with narrowly rounded or even acute ends, or with one end narrow and the other broadly rounded, occasionally approaching a pyriform shape, in a small proportion of the spores both ends are broadly rounded; oak brown (5D6). Germ slit 5-6 μm long, conspicuous, located towards the narrowest end of the spore. Recent spore deposit on stroma brownish to faintly reddish brown (6D7).

Culture (holotype; 2% MA, 23 °C). After 10 days velvety, 4 cm in diam., after 3 weeks thick felt-like and greyish white, with greyish white, fan-shaped radial growth. Reverse of plate greyish yellow. The culture produced water abundantly. Older cultures with a distinct odour of curry or 'Cenofix' (a spice mixture), or reminiscent of dry *Lactarius helvus*. On WA at length several small perithecia formed at the periphery of the culture. They contained immature asci with blueing annulus and a few ascospores, 12 x 5.5 μm.

Anamorph forming conidiophores 2-2.5 μm broad, branched, completely hyaline. Conidiogenous cells both terminal and intercalary; geniculate. Conidia 4-5 × 2.5-3 μm, hyaline, obovoid to ovoid, with a small indentation scar at the former point of attachment.

Taxonomic notes. *Nemania prava* was recognized by L. Petrini & Rogers (1986) as a variety of *Nemania atropurpurea* (as *Hypoxylon atropurpureum* var. *brevistipitatum*). It was stated to differ from the main type by a shorter ascus stipe, a characteristic which could not be

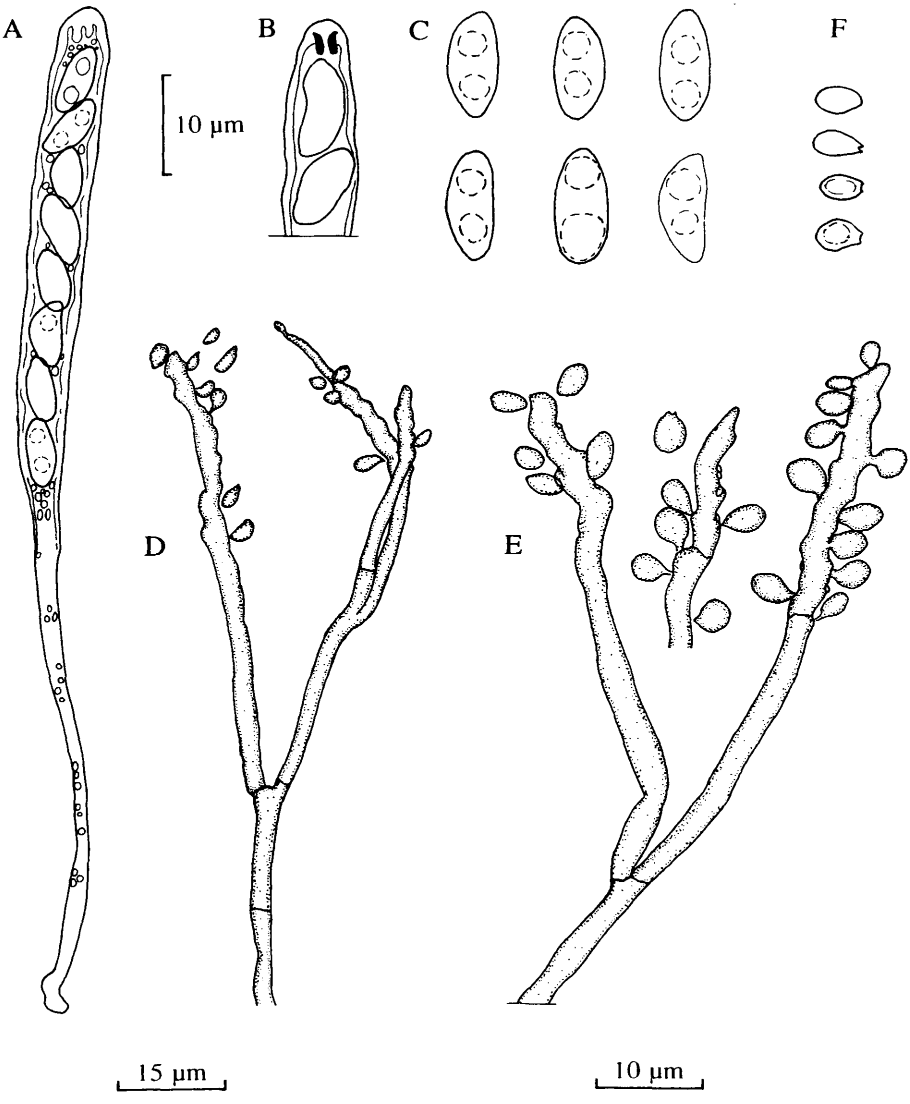
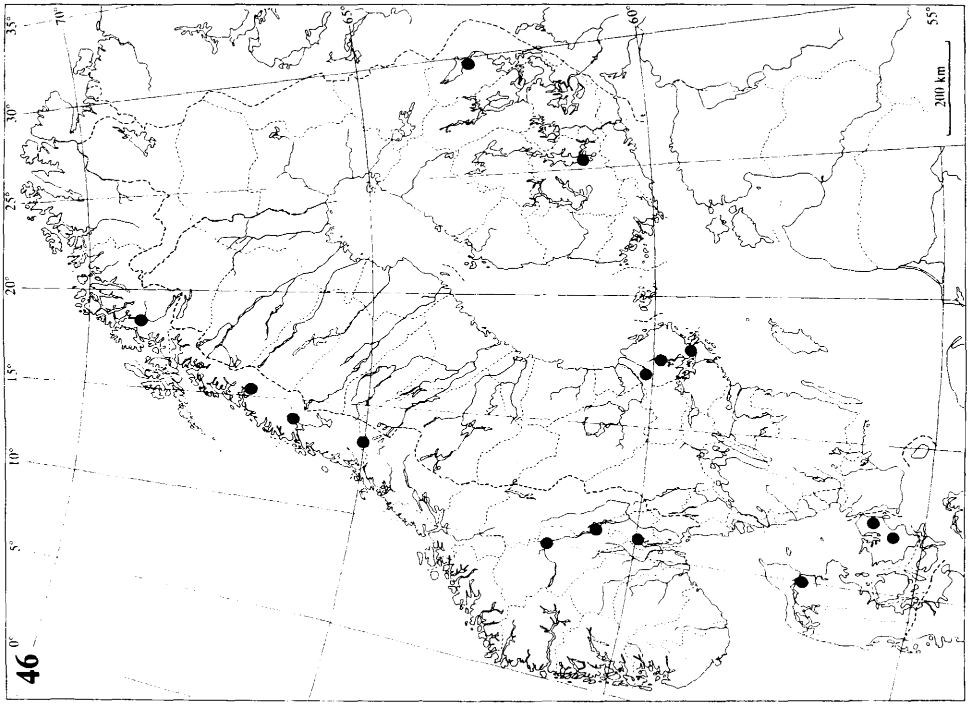


Fig. 45. *Nemania prava* n. sp. A. Ascus. B. Ascus apex in LG. C. Ascospores. D-F. Conidiophores and conidia in culture. (TROM 104, holotype).

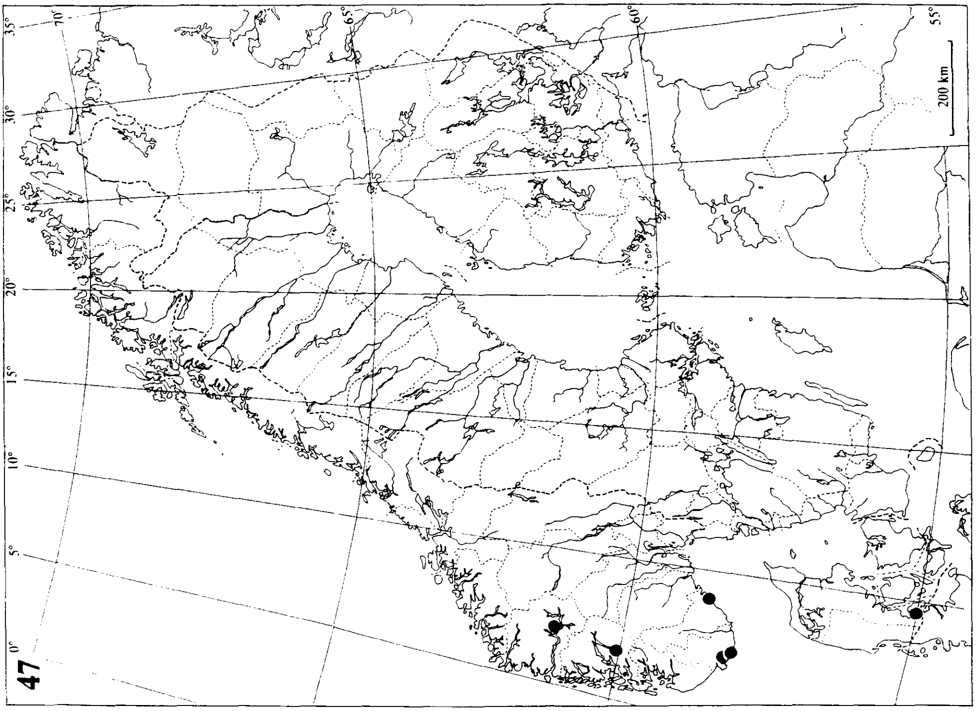
confirmed in the present study. In stromatal gross morphology it is more similar to *N. serpens*, a relationship which is also supported by the nr ITS DNA phylogeny (Fig. 3). The larger perithecia and light reddish brown spore deposit will help to separate *Nemania prava* from *N. colliculosa* and *N. reticulata*.

Some of the specimens mentioned in the locality list have not been sufficiently scrutinized to establish their identity unequivocally. Their affinity to *N. prava* has been judged from external

46



47



Figs 46-47. Distribution in Norden. Fig. 46. *Nemania effusa.* Fig. 47. *Nemania prava.*

morphology (mostly lacking perithecial contours, arch of perithecial apex etc.), in addition to having a blueing annulus.

Ecology. *Nemania prava* has been recorded on fresh or strongly deteriorated wood of *Betula*, *Corylus*, *Fraxinus* and *Quercus*.

Distribution. *Norway*. AA, VA, Ho, SF. *Denmark*. EJy. Distributional data are incomplete due to the intermixing of taxa at an earlier stage.

Specimens examined. Norway: AA: Grimstad: Between Tønnesølvt. and Kvernvt. 11 Jul 1995 *Quercus*(w) AG 58/95 (TROM 114). - VA: Lindesnes: Åvik Syrdal nat. res. 22 Jul 1995 *Quercus*(w) AG 175/95 (TROM 121). Lyngdal: Skolandsvt. Skoland nat. res. 19 Jul 1995 *Betula*(w) AG 155/95 (TROM 119). - Ho: Odda: Hildal 24 Jul 1994 *Fraxinus*(w) AG 50/94 HOLOTYPE (TROM 104). - SF: Sogndal: Stedje Skjernes 29 Jul 1995 *Corylus*(2w) AG 192a/95, 193a/95 (both closely ass. w. *N. serpens* AG 192b & 193b/95) (TROM 127,128). **Denmark:** EJy: Kollund Skov E of Konså 19 Sep 1988 *Fraxinus*(w) TL-1739 (C, TROM 135). **France:** Haute Savoie bei Thonon, Bois de Goudrée 4 Jul 1981 L. Petrini *Hypoxylon atropurpureum* var. *brevistipitatum* (ZT). **Switzerland:** Kt. Graubünden: Dischmatal Teufi 20 May 1981 *Betula* L. Petrini *Hypoxylon atropurpureum* var. *brevistipitatum* (ZT). Davos Stillberg 1900 m alt. 2 Sep 1982 *Alnus viridis* L. Petrini *Hypoxylon atropurpureum* var. *brevistipitatum* (PRM 869039). Kt. Neuenburg: Creux-dú-Van 1 Jun 1985 *Fagus sylvatica* L. Petrini *Hypoxylon atropurpureum* var. *brevistipitatum* (ZT, (HOLO-?)TYPE). Argau Erlinsbach Egg 20 May 1992 *Quercus* B. Erb, L. Petrini det. *Hypoxylon atropurpureum* var. *brevistipitatum* (ZT).

Specimens with affinity to N. prava: **Norway:** Ve: Nøtterøy: Hella 13 Nov 1982 *Corylus*(w) S. Aase (O 82). - AA: Grimstad: Søm at Fevik 12 Jul 1995 *Fagus*(w) AG 74/95 (TROM 112). - VA: Kristiansand: Hemmingsvt. Murtetjønn nat. res. 17 Jul 1995 *Acer*(w) AG 138/95 (TROM 115). - Ro: Hå: Ogna 14 Jul 1974 *Quercus*(w) AG 75/74 (BG 45). - MR: Sande: Breivik Larsnes 2 Jul 1975 *Corylus*(bw) O. Balle (BG 55). **Sweden:** Vg: Göteborg: Billdal: Årekärrslunden 1992(?) B. Nordén 920500(p.p.) (C). - Upl: Uppsala: Kvarnbo 19 Sep 1965 *Prunus*(w) N. Lundqvist 4743 (UPS 72). **Finland:** EH: Vehkalahti: Pyhältö 25 Sep 1977 *Salix*(w) L. Fagerström (H 1).

Nemania reticulata (P. Karst.) Granmo comb. n.

Hypoxylon reticulatum P. Karst., F. Fenn. Exs. 773 (1868), Not. Sällsk. Fauna Fl. fenn. Förh. 13: 238 (1873) - *Hypoxylon crustaceum* (Sowerby) Nitschke var. *reticulatum* (P. Karst.) P. Karst., Acta Soc. Fauna Fl. fenn. 2: 6: 74 (1885) - (?)*Sphaeria hydnicola* Schwein., J. Acad. nat. Sci. Philad. 5: 14 (1825).

Figs 48 A-B, 50 (map), 64 (stroma), 86 (SEM).

Description. *Stromata* 0.5-2 × 0.5-1.5 × 0.05-0.08 cm, in small patches or in a reticulate manner on dead polypores, brown to dark brown. A greyish brown to vivid brown, pruinose to villose covering may occur, and is probably confined to younger stromata. Stromatal grooves short, widely U-shaped, shallow, or as smooth shallow depressions. Ectostroma 60-85 μm, carbonaceous but of woody consistence. Entostroma soft, yellowish brown to brown. Basal entostroma lacking or up to 150 μm thick, occasionally with a basal carbonaceous zone about 80 μm. *Perithecia* 360-480 μm high, 300-500 μm broad, m. 413 × 386 μm (n = 16/3), globose. Perithecial contours faint or none. Ostioles small, covered with a thin ectostroma almost to the pore, 15-23 (mostly 17) ostioles per 2 x 2 mm. Peridium 35-45 μm, the innermost layer being a yellow cord, 3 μm, passing into a hyaline t. prism.-t. porr., 5-7 μm, the middle layer a light brown t. prism., 12-15 μm, and the outermost layer a thick-walled, brown t. ang.-t. glob. mixed with some long cells, 24-28 μm, without carbonization; the adjoining entostroma is a light yellowish brown t. intr. *Asci* p.sp. 60-86 × 7-9.5, m. 76 × 8 μm (n = 24/4), st. (24-)34-74(-82), m. 52 (n = 29/4). Ascus annulus amyloid in LG and MZ, almost square, 2.5 μm high, 1.7-2 μm broad below, 2.5-2.75 μm broad above. Immature asci in some of the long stored specimens were seen to react dextrinoid. *Ascospores* 9-13 × 4-5(-6), m. 10.7 × 4.8 μm (n = 123/6), ellipsoid-inequilateral with

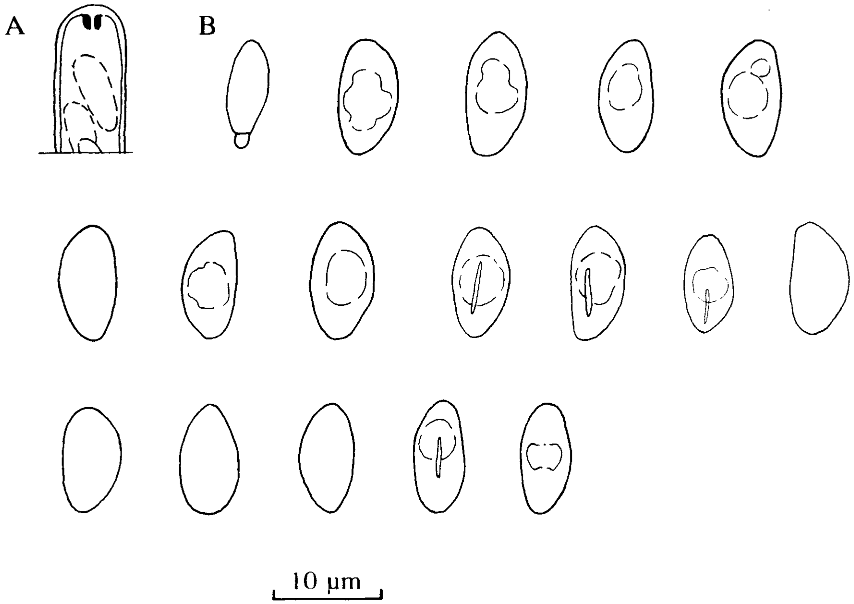


Fig. 48. *Nemania reticulata*. A. Ascus apex in LG. B. Ascospores. Uppermost row and the three leftmost spores in the second row from lectotype (K), the remainder in the second row from S 23, and the spores in the bottom row from O 15.

narrowly rounded ends, light brown (6D7). Germ slit conspicuous, 5-7 µm, central or slightly towards one end on the least convex side of the spores. The spore deposit is suspected to be greyish green as that for *N. serpens*.

Taxonomic notes. Karsten eventually considered *Hypoxylon reticulatum* a variety of *Hypoxylon crustaceum* (Sowerby) Nitschke (Karsten 1885). Nitschke's material (in B) of the latter is in fact *H. multiforme*. Nitschke's description and comments on *H. crustaceum* (Nitschke 1867: 49) are again indicative of *Hypoxylon (= Nemania) atropurpureum*. We were at first apt to consider *N. reticulata* a variety of *N. serpens*, although preceding authors have often synonymized *Nemania reticulata* with *N. atropurpurea*. However, though the ascospores of *N. reticulata* have a form much resembling those of *N. atropurpurea*, the affinity of *N. reticulata* clearly lies with *N. colliculosa*, not with *N. atropurpurea*. *Nemania reticulata* differs from *N. colliculosa* and *N. prava* in having indistinct perithecial contours, almost lacking stromatal grooves, and in occurring on polypores. A reticulate stroma or growth habit, which probably is the source for its name, was seen in only one specimen, a collection from herb. Karsten (H) (see Fig. 64).

Rosellinia mycophila has sometimes been erroneously used as a herbarium name for *N. reticulata*. According to L. Petrini (1993: 233) *Sphaeria mycophila* of Fries is *Rosellinia mycophila* (Fr.: Fr.) Sacc., which occurs on polypores and coniferous remains also in Norden.

Sphaeria hydnicola Schwein. is a somewhat doubtful taxon which was investigated by Pouzar (type specimen in PH) and synonymized with *N. serpens* (Pouzar 1985b: 134), a disposition concurred by L. Petrini & Rogers (1986). Miller (1961: 77) assumed that *S. hydnicola* is a synonym of the North American *Nemania albocincta* (Ellis & Everh.) Pouzar, which is untenable when considering the dark brown ascospores with a long germ slit in the latter.

Ecology. Nearly all voucher specimens of *Nemania reticulata* were on old, deteriorated *Fomitopsis (= Polyporus) pinicola* (Schwartz: Fr.) P. Karst., both on the pores and on the pileus surface. This host is common in Norden on dead *Picea* and *Pinus*, and on some hardwoods (Ryvarden & Gilbertson 1993). One Finnish specimen was on *Phellinus igniarius*. No unambiguous finds on woody hosts have been established.

Distribution. *Norway*. Oslo, Bu. *Sweden*. Sth. *Finland*. V, EH.

Specimens examined. Norway: S.l.d.n.c. on old *Fomitopsis pinicola* 2 coll. as *Hypoxylon reticulatum* det. Rostrup (O 15,16), id. on *Fomitopsis pinicola* as *Rosellinia mycophila* (Fr.) Sacc. det. Rostrup (O 56) (Rostrup 1904: 18). - Oslo: Kristiania on *Polyporus* as *H. reticulatum* det. Rostrup (O 14) (Rostrup 1904: 19). - *Reference*: Bu: Hurum: Mølen ult. Jun 1935 on *Polyporus* (Hagen 1950: 54 as *Hypoxylon reticulatum* Karst.). **Sweden:** Sth: Djurgården 1 May 1904 on *Polyporus pinicola* L. Romell (S 23). **Finland:** V: Elimäki: Mustila 10 Aug 1908 on *Fomitopsis pinicola* C.G. Tigerstedt leg. & det. *Hypoxylon crustaceum* (H 20, 21). Merimasku: Aug 1860 on *Polyporus pinicola* P.A. Karsten 3570 *Hypoxylon reticulatum* Karst. (H 22, w. reticulate stroma). - EH: Tammela: Mustiala s.d. on *Polyporus pinicola* P.A. Karsten *Hypoxylon reticulatum* Karst. (S 24). Mustiala Sep (s.a.) on *Polyporus pinicola* P.A. Karsten Fungi Fenn. Exs. 773 *Hypoxylon reticulatum* Karst. (K, LECTOTYPE, selected here; H 23, SYNTYPE). Mustiala 23 Aug 1872 on *Phellinus igniarius* P.A. Karsten *Hypoxylon crustaceum* (Sow.) (UPS 73). **U.S.A.:** North Carolina: Salem, *Sphaeria hydnicola* L. v. Schw. 1207-61-Syn. Fung. (on *Radulum*(?) upon thin bark) (PH, HOLOTYPE sec. Ju & Rogers 1996).

Nemania serpens (Pers.: Fr.) Gray

Nat. Arr. Br. Pl. 1: 516 (1821) - *Sphaeria serpens* Pers: Fr., Syst. Mycol. 2: 341 (1823); Pers., Usteri's Annln Bot. 15: 18 (1795), Syn. Meth. Fung.: 20 (1801) - *Hypoxylon serpens* (Pers.: Fr.) J. Kickx f., Fl. Crypt. Env. Louv.: 115 (1835).

Figs 49 A-D, 51 (map), 55-56, 58; 65-66 (stromata), 70-71 (cultures), 74, 81 (SEM).

Description. *Stromata* 0.5 - 7 × 0.2 - 2.5 × 0.06 - 0.08 cm, irregularly effused or in more or less confluent spots. Young stromata greyish brown (8F3) to dark brown (8F4), becoming brownish grey (8F2) and lastly dark grey to black, covered in part by an appressed pubescent whitish mycelial web, which merges with the stroma and eventually becomes silvery white (seen under a binocular), and finally brown, occasionally with reddish tints in the stromatal grooves. Stromatal grooves widely U-shaped, and as irregular depressions. Ectostroma 70-90 μm, carbonaceous, hard. Entostroma 250-500 μm, white throughout, or brown in the upper half and white below. *Perithecia* 400-700(-800) μm high, 400-800 μm broad, m. 548 × 550 μm (n = 66/10), at times with the bases slightly immersed in wood. Perithecial contours either prominent, 1/4 - 1/3 of perithecial height, with broadly bulging apices, or contours absent. Ostioles conical, blunt, 7-20 per 2 × 2 mm, mostly 10-15. Peridium 60-130 μm, the innermost hyaline layer being a yellow cord, 3-5 μm, passing into a t. prism-t. porr., 18-25 μm; the middle layer a brown t. prism/t. ang.-t. porr., 10-22 μm, and the outermost layer a t. epid., 30-80 μm, distinctly carbonized. *Asci* p.sp. 65-96 × 6-9 μm, m. 78 × 7.5 μm (n = 91/8), st. (35-)45-120(-132) μm, m. 71 μm (n = 71/6). Ascus annulus dextrinoid (golden, orange, rusty, reddish brown) in LG, none or a barely discernible dextrinoid reaction in MZ, diffusely delimited, 3-5 μm high, 1.8-2.5 μm broad, after 5% KOH-pretreatment strongly amyloid in LG as well as in MZ. A divergent amyloid reaction (turquoise, dark) may occur in some asci in LG (but not in MZ), particularly in material which has been stored for a long time. *Ascospores* 10-14.5(-16.5) × 4-6 μm, m. 12.5 × 4.8 μm (n = 241/12), oblong-ellipsoid or ellipsoid-inequilateral to navicular or reniform, with broadly rounded ends or one end broadly rounded, the other narrowly rounded or attenuate; with (1-)2 guttules, and evidently a thin hyaline, indehiscent non-sticky perispore (disclosed in crushed spores). In fresh material the ascospores are greyish olive brown, becoming light brown (5C5/D5,

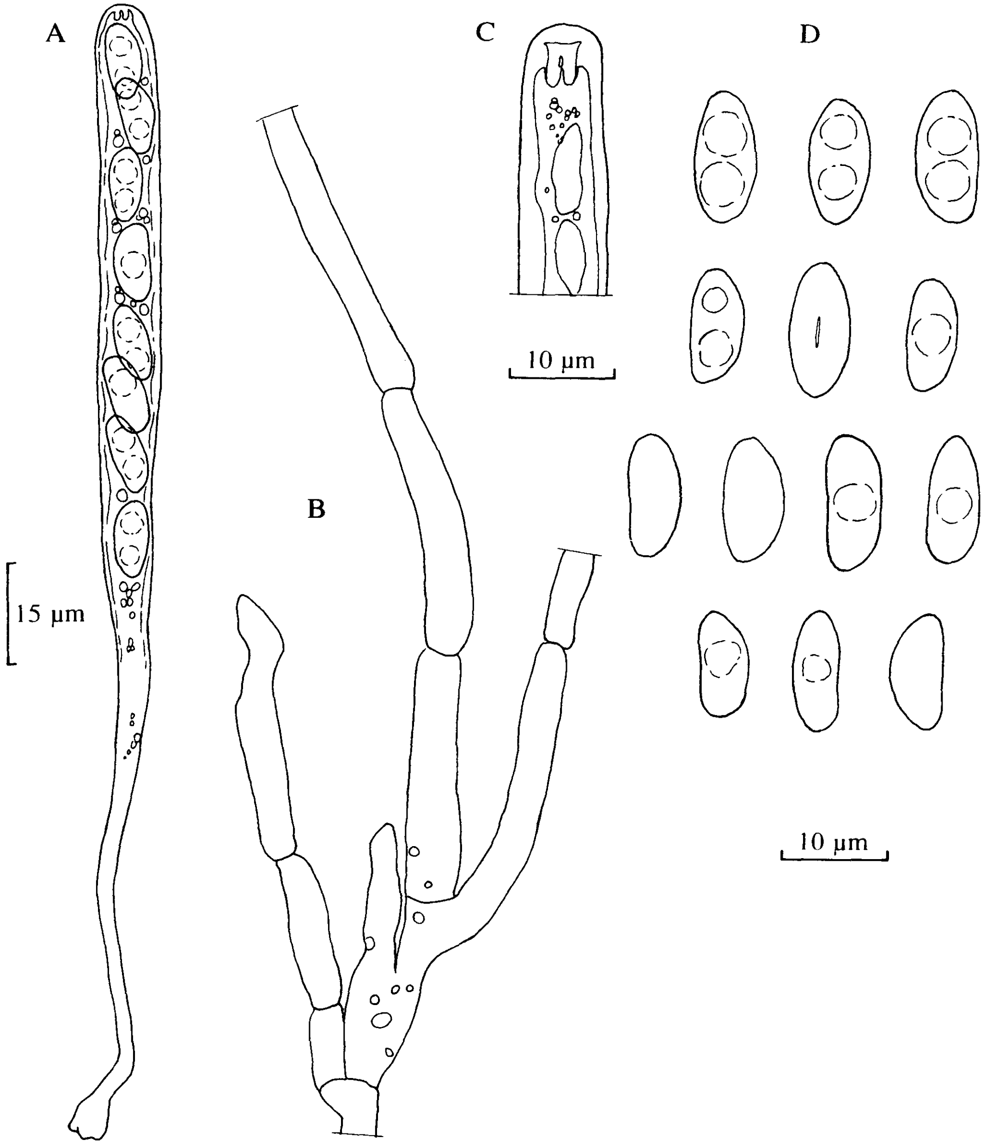
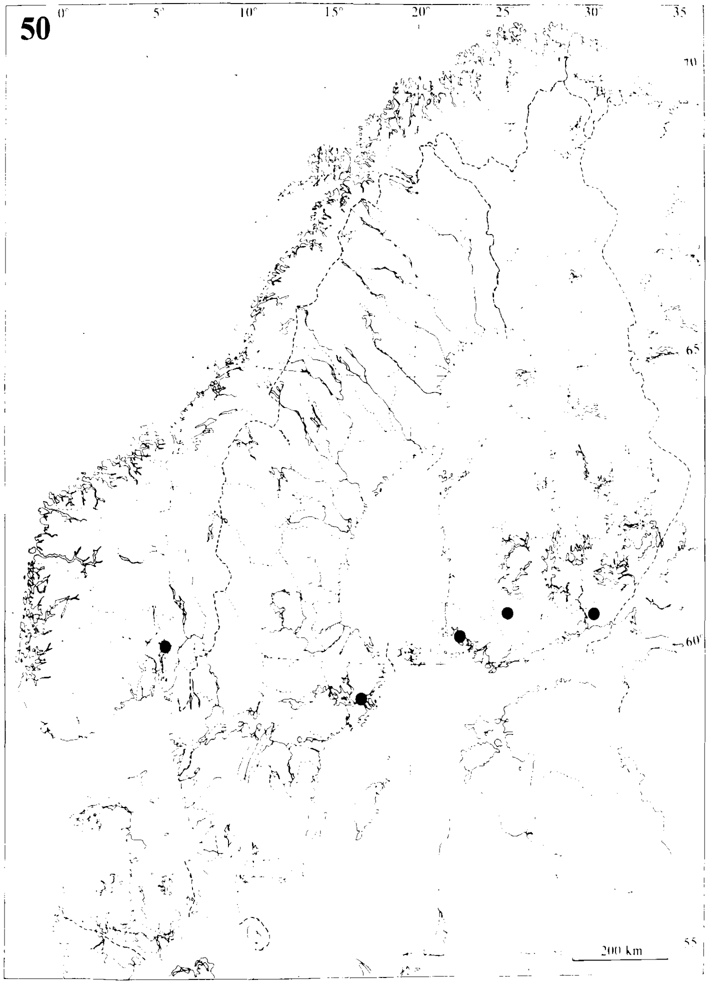
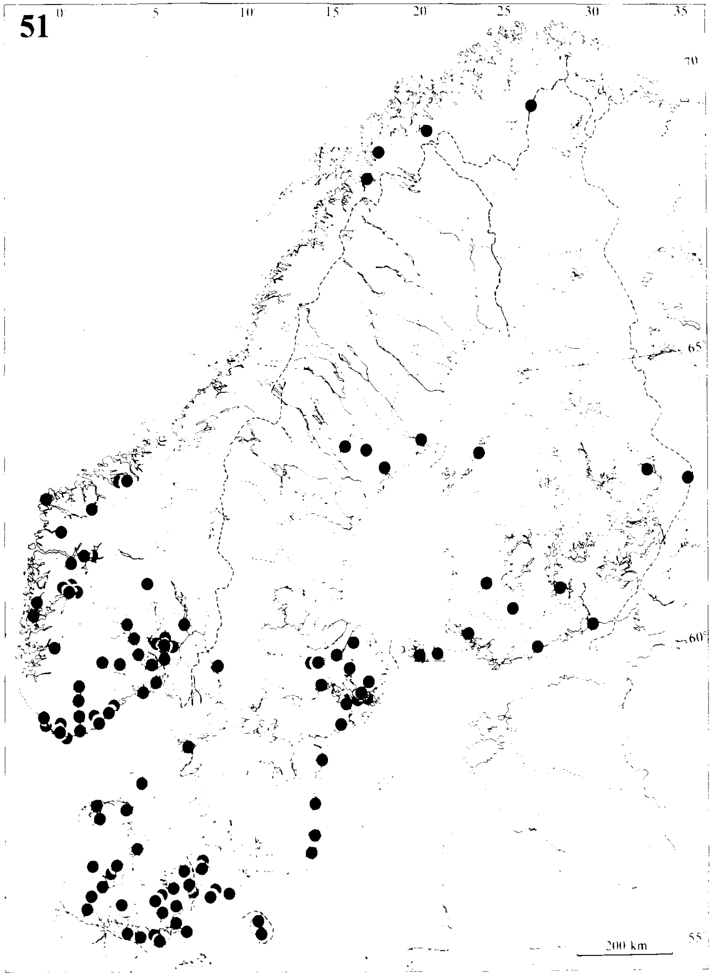


Fig. 49. *Nemania serpens*. A. Ascus. B. Basal parts of paraphyses. C. Ascus apex in LG (annulus dextrinoid). A-C from neotype (TROM 174). D. Ascospores. Spores in the two uppermost rows, and the two leftmost in the third row, from neotype (TROM 174), the remainder from BG 48. The broadest spores have been suspended in water for a much longer time than the others.

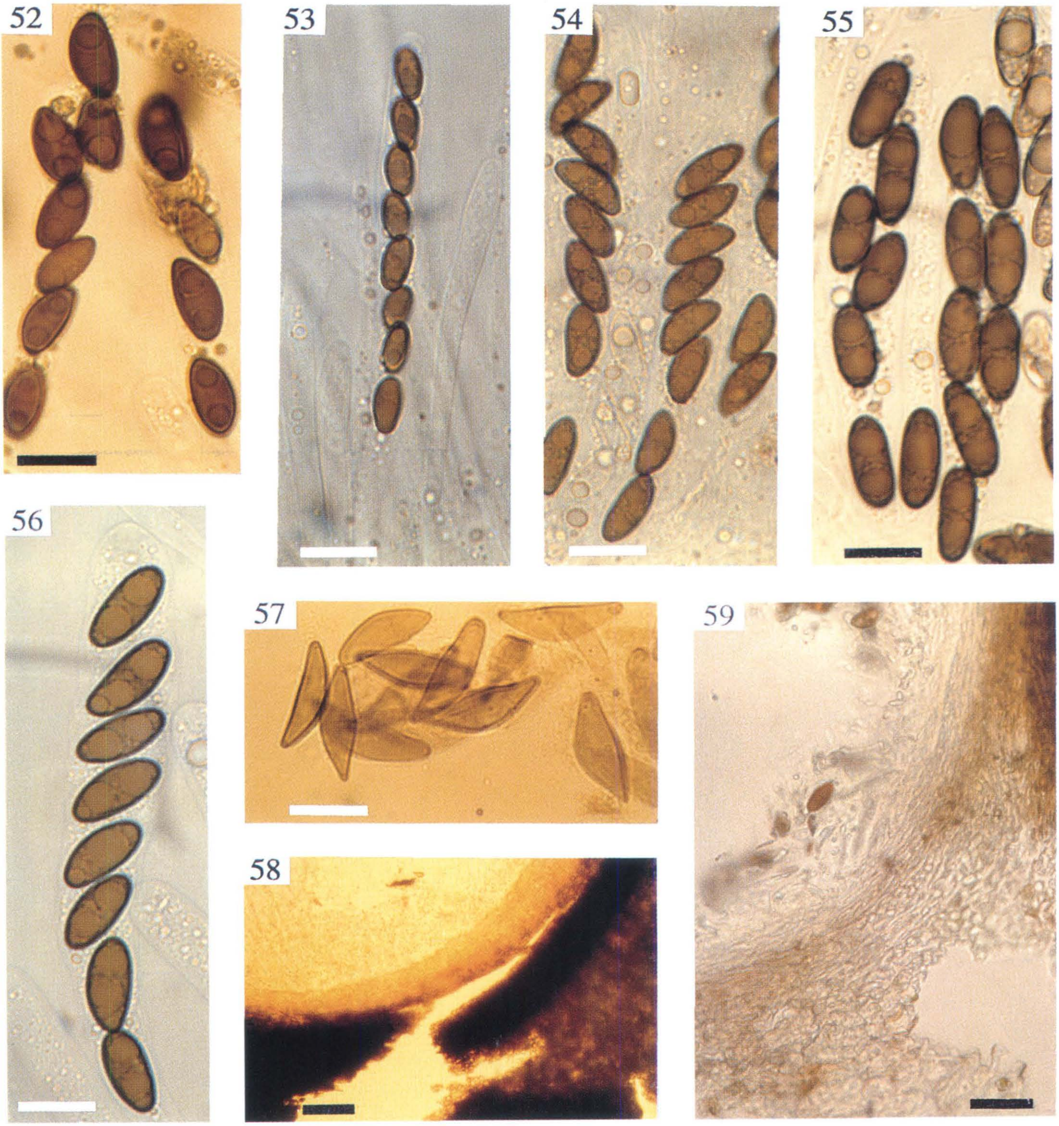
50



51



Figs 50-51. Distribution in Norden. Fig. 50. *Nemania reticulata.* Fig. 51. *Nemania serpens.*



Figs 52-59. Photographs of asci, ascospores and peridia. Figs 52-57. Asci and ascospores. Fig. 52. *Nemania diffusa* (TROM 1). Fig. 53. *N. effusa* (TROM 8). Fig. 54. *N. prava* (TROM, holotype). Figs 55-56. *N. serpens*, from TROM 162 and TROM 174 (neotype), respectively. Fig. 57. *Nemania* sp. B (UPS). Figs 58-59. Photographs of vertical, median sections of perithecia. Fig. 58. *Nemania serpens*. Bottom of perithecium to the right. Note outer carbonaceous layer of peridium. Part of the carbonaceous ectostroma is seen at the bottom of the picture. Fig. 59. *Nemania* cf. *prava*. Section at the junction bottom-side. Note the pale brownish peridium without carbonacous layer passing into pale entostroma. A few green algae may possibly be seen in the entostroma as tiny green spots. - Rules: 52-57: 10 μm, 58: 50 μm, 59: 20 μm.

6B7, 6D7/D8) in material which has been stored for some time. Germ slit 3-4 μm long, inconspicuous, in the centre of the spore on the least convex side.

Hypochlorite treatment discolours 60-70% of the spores in 2 hours. Spore deposit on recently collected stromata is typical greyish green (27C7-D7, 28D8-E8), changing to brownish after some time (months), probably dependent on drying procedures and storing conditions.

Cultures (from neotype) on (1) PDA for 24 days at 19 °C formed a mycelial mat 5 cm diam., chalk-white, dense, ca. 2 mm thick, surface finely velvety; with radial, shallow grooves. Reverse of agar plate honey yellow. Incubated on (2) 2% MA for 3 weeks at ca. 23 °C to 7.2 cm diam., felt-like, greyish brown, with dense, slow-growing and loose fast-growing zones making up concentric rings, and some radial zones of compact mycelial growth. Reverse of agar plate golden or yellow brown.

Anamorph from culture (2) consists of pale yellow brown, smooth conidiophores, ca. 3 μm broad, branches 2-3 μm wide. Terminal conidiogenous cells 30-50 μm long, geniculate. Conidia 3-5 × 2-3 μm, pale yellow, with a small indentation scar. In nature anamorph ash grey, bushy, fertile conidiophores habitually resembling miniature trees, covering stromata and nearby wood.

Taxonomic notes. Miller (1961: 79) referred to a specimen in herb. Persoon in Leiden as 'type' of *Hypoxylon (Nemania) serpens* (L 910.269-703, *Sphaeria serpens*), which has been accepted by subsequent authors, and some have even considered it a reference to the lectotype, which is certainly not correct. Miller's 'types' are rather references to authentic material in his opinion, or at the best potential lectotypes (cf. also *Hypoxylon quisquiliarum* and *Sphaeria smilacicola*; Miller 1961: 72). Thus previously he (Miller 1930: 141) had referred to Fries' Scler. Suec. 47 *Sphaeria serpens* at Harvard as 'type', and to another *S. serpens* in herb. Persoon (L 910.269-887) as well (Miller 1932b: 143).

There are many specimens of '*Sphaeria serpens*' in herb. Persoon, some representing other taxa, and Persoon's description of *Sphaeria serpens* is of little use to guide us. In fact we do not know if Persoon had any of those specimens at hand or in mind when describing his species. According to D. Korf (pers. comm.) most of Persoon's material originates from his Paris period (1803-1836). Moreover, if the actual Leiden specimen (910.269-703) is in fact 18th century material, it rather points to Persoon's *Sphaeria serpens* β. *lumbricoides* (Persoon 1801: 20) due to the handwritten inscription on the label: 'In hohlen Weidenbäumen', which corresponds to the protologue for this variety: 'in salicibus cauis interdum occurit' (Persoon l.c.). The specimen in question is small (0.5 × 0.5 cm) and depauperate.

Evidently there is also a possibility to lectotypify on material from the sanctioning author (ICBN art. 7.8, cf. Korf 1982: 253). Although we have not scanned through all Fries' Scler. Suec. Exs. 47 *Sphaeria serpens* Pers. we have studied the exsiccat-specimen in UPS, where at least one of the two pieces of stromata had ascospores ((10-)11-14 × 4.8-5.5 μm, m. 12 × 5 μm) and perithecial size comparable with typical *N. serpens*. However, the asci were disintegrated and the material is fragile. Even if the specimens mentioned above (Leiden 'type'; UPS) correspond to our *N. serpens* in features possible to verify, the material is scanty and poor, without interpretable peridial anatomy and asci. Consequently we feel justified to *neotypify N. serpens* on the basis of well preserved recent material (AG 171/95 (TROM 174)), which also has been DNA-analysed.

The conception of *Sphaeria crustacea* Sowerby has always been based on a drawing by Sowerby (1803), and no authenthic specimen of his fungus is known. Neither do we know about any material from Gray of *Nemania crustacea* (Sowerby) Gray (Gray 1821). It is tempting to accept Fries' (1823) synonymy of Sowerby's taxon with *Sphaeria serpens*.

Nemania serpens is different from *N. prava* and *N. colliculosa* in its larger perithecia, dextrinoid ascus annulus, mostly broadly rounded spore-ends, and distinct culture morphology.

Ecology. *Nemania serpens* produces ascomata on strongly decayed, mostly decorticated wood on a number of hosts belonging to several plant families, of which members of *Fagaceae* and *Salicaceae* are particularly susceptible in Norden. Stromata of *N. serpens* may grow close to stromata of *N. atropurpurea, N. aureolutea, N. colliculosa* or *N. prava* on the same trunk.

Distribution. *Norway*. Ak, Oslo, Op, Bu, Ve, Te, AA, VA, Ro, Ho, SF, MR, No, Tr, Fi. *Sweden*. Sk, Sm, Öl, Ög, Vg, Vrm, Srm, Sth, Upl, Vsm, Ång, Vb. *Finland*. A, V, U, EK, St, EH, PK, KP. *Denmark*. Brh, Sj, Lol, Fyn, EJy.

It is not possible to tell to what extent previous records of *Nemania serpens* from the Nordic countries - or any other country - represent *N. serpens* in our restricted sense. Most of them probably represent *N. serpens*, because the records of *N. serpens* in this study are about three times the number of specimens with amyloid ascus annulus in the aggregate species.

Specimens examined. Norway: S.l.d.n.c. (O 25), id. *Quercus*(w) *H. crustaceum* det. Rostrup (O 26). - Ak: Asker: Semsvatnet Tveter gård 21 Nov 1993 *Sorbus*(w) AG & A. Often (TROM 108). Bærum: Haslum 28 May 1933 *Salix*(w) A. Hagen (O 83). Eidsvoll: 0.5 km W of Eidsvoll church 13 Oct 1968 *Sorbus*(bw) A. Pedersen (O 21). Frogn: N of Drøbak 10 Sep 1961 *Acer*(w) M. Geesteranus & F.-E. Eckblad (O 24). Håøya 4 May 1991 *Populus*(w) A.-E. Torkelsen 8/91 (O 86). Ås: Ås Sep 1885 *Populus*(w) F. Werenskiold (O 4, TRH 27). - Oslo: Linderud s.d. *Populus*(w) N.G. Moe (O 2), 1840 *Populus* N.G. Moe (O 10). Tøyen s.d.n.c. *Sorbus aucuparia*(w) (O 12), 1840 *Salix*(w) N.G. Moe (O 13) (Rostrup 1904: 19). Mærradalen s.d. *Ulmus*(w) Blytt (O 6). Bogstadåsen 1840 *Populus*(w) *H. crustaceum* (Sow.) Nits. det. Rostrup (O 11, mixed with *N. effusa* O 2) (Rostrup 1904: 19). Ullern s.d.n.c. *Acer*(w) (O 23), 1840 N.G. Moe (O 9,19), 12 Oct 1879 A. Blytt (O 20). - Op: Etnedal: Bruflat s.d. *Salix caprea*(w) (O 7), s.d. *Salix caprea*(w) N.G. Moe (O 5). - Bu: Flesberg: Flesberg 16 Sep 1974 *Betula*(b) E. Fremstad (BG 90). Kongsberg: Stengelsrud 3 km N of Kongsberg 16 Sep 1974 *Salix*(w) A. Bertelsen (BG 48). Rollag: Kulelia Solhaug *Populus*(w) 16 Sep 1974 A. Bertelsen (BG 50). - Ve: Larvik: Larvik Beech forest 29 Jul 1974 *Fagus*(w) AG (BG 28). Sande: The screes at Holm railway st. 26 Sep 1922 *Sorbus aucuparia*(w) O.A. Høeg (O 8). Tønsberg: Gullkrona 1 Oct 1983 *Fraxinus*(w) S. Aase (O 84). - Te: Bø: Uvdalsheia above Uvdalstjønn 27 Jul 1974 *Sorbus aucuparia*(w) AG 232/74 (BG 32). Kviteseid: River valley above main road 26 Jul 1974 *Fraxinus*(w) AG 212/74 (BG 46). - AA: Birkenes: Bjorvatn nat. res. 14 Jul 1995 *Populus*(4w) AG 99/95, 100/95, 108/95, 111/95 (TROM 149,150, 155, 157), *Sorbus*(w) AG 102/95 (p.p. LG amyloid!) (TROM 125), *Salix*(w) *Quercus*(2w) AG 101/95, 103/95, 110/95 (TROM 151,152,156), *Fraxinus*(w) *Tilia*(w) AG 105/95, 106/95 (TROM 153,154). Håbbesland 16 Jul 1995 *Fraxinus*(w)AG 130/95 (TROM 166). Bygland: Åraksbø Heddevikji 22 Jul 1974 AG 156/74, *Betula*(w) AG 166/74 (BG 33,35). Grimstad: Skiftenes nat. res. 10 Jul 1995 *Acer*(2w) AG 49/95, 50/95 (TROM 140,141). Between Tønnesølvt. and Kvernvt. 11 Jul 1995 *Populus*(4w) AG 56/95, 55/95, 59/95, 60/95 (TROM 124,142,144,145), *Quercus*(3w) AG 57/95, 61/95, 68/95 (TROM 143,146,147). Fevik 12 Jul 1995 *Fagus*(w) AG 73/95 (TROM 148). Lillesand: Kvåse 0.5 km W of Toretjørn 15 Jul 1995 *Sorbus aucuparia*(w) *Fraxinus*(w) *Populus*(w) AG 118/95, 121/95, 122/95 (TROM 158,161,162). Kvåse 0.8 km W of Toretjørn 15 Jul 1995 *Tilia*(w) *Populus*(w) AG 119/95, 125/95 (TROM 159,164). Kvåse Røyrmyråsen NW-slope 15 Jul 1995 *Populus*(2w) AG 120/95, 124/95 (TROM 160,163). Vallesvær-Hofsvt. 15 Jul 1995 *Populus*(w) AG 128/95 (TROM 126). Risør: Jostadvatn at road E18 3 km S of Holt 23 Jul 1974 *Populus*(w) AG 193/74 (BG 37). - VA: Farsund: Farsund 20 Jul 1995 *Salix*(w) AG 157/95 (TROM 172). Gaupeland 20 Jul 1995 *Tilia*(w) AG 163/95 (TROM 173). Flekkefjord: Hidra Rasvåg 16 Jul 1974 *Ulmus*(w) O. Larsen & AG 88/74 (BG 42). Kristiansand: Dvergsnes 19 Jul 1974 *Betula*(w) K. Halvorsen & AG 108/74 (BG 40). Korsvikkilen 19 Jul 1974 K. Halvorsen & AG 112/74 (BG 41). Lindesnes: Åvik Syrdal nat. res. 22 Jul 1995 *Quercus*(2w) AG 171/95 NEOTYPE (ass. with *N. colliculosa* AG 170/95) (TROM 174), AG 174/95 (TROM 176), *Populus*(w) AG 172/95 (closely ass. with *N. aureolutea* AG 172b/95), *Tilia*(w) AG 176/95 (TROM 175,177). Lyngdal: Skolandsvatnet 19 Jul 1995 *Tilia*(w) AG 154/95 (TROM 171). Mandal: S-end of Nomevt. 18 Jul 1995 *Populus*(2w) AG 141/95, 144/95 (TROM 122,170), *Acer*(3w) AG 140/95 (ass. with *Hypoxylon multiforme*), 142/95, 143/95 (TROM 167,168,169). Vennesla: Kile 23 Jul 1995 *Sorbus* AG 182/95, *Salix*(w) AG 183/95 (TROM 178,179). - Ro: Suldal: Hylsfjorden Hylen 25 Jul 1994 *Fraxinus excelsior*(w) AG 57/94 (TROM 101). - Ho: Granvin: Granvin E-side of the river at Eide railway st. 8 Jul 1974 *Fraxinus*(w) AG 11/74 (BG 30). Os: Hattvik 13 May 1973 *Fraxinus*(w) K. Halvorsen (BG 17). Tysnes: Onarheim 18 Aug 1974 *Corylus*(w) F.-E. Eckblad (BG 92). Ulvik: Ulvik at the river 200 m NW of Ulvik Camping 9 Jul 1974 *Ulmus*(w) AG (BG 31). Voss: Voss above railway st. 8 Jul 1974 *Fraxinus*(w) AG 1/74 (BG 29). Voss Mølster 1 Aug 1995 *Fraxinus*(w) AG 241/95 (TROM 183). - SF: Førde: Kussli 6 Jun 1973 *Ulmus*(w) O. Balle (BG 94). Leikanger: Leikanger Hallandsberget 20 Mar 1975 *Fraxinus*(w) O. Aas (BG 18). Kvinna 3 km E of Hella 22 Jul 1994 *Tilia*(w) AG 28/94 (TROM 107). Sogndal: Norum hillside under Sitjaren 22 Jul 1994 *Ulmus*(2w) *Fraxinus*(w) AG 30/94, 32/94, 31/94 (TROM 99,103,100), 28 Jul 1995 *Fraxinus*(w) AG 187/95 (TROM 180). Norum hillside 0.6 km N of church 29 Jul 1995 *Ulmus*(w) AG 197/95 (TROM 182). Stedje Skjersnes 29 Jul 1995 *Corylus*(2w) AG 192b/95, 193b/95 (both closely ass. w. *N. prava*) (TROM 189,188). Stryn: Strynsvatn Flostranda nat. res. 20 Jul 1994 *Ulmus*(w) *Salix*(w) *Tilia*(w) AG 2/94, 9/94, 11/94 (TROM 96,106,98). Vik: Arnafjord W-slope of Krokegga 30 Jul 1995 *Sorbus*(w) AG 200/95 (TROM 181). Vågsøy: Måløy 30 Sep 1976 AG 133/76 (BG 80). - MR: Nesset: Øverås 14 Jul 1973 *Corylus*(w) AG 67/73 (BG 51). Rauma: Åndalsnes 13 Jul 1973 *Populus*(w) AG 55/73 (BG 52). - No: Evenes: Forra Hoggvik 17 May 1974 *Populus*(w) AG (BG 54), (100 m alt.) 4 Aug 1996 *Populus*(2w) AG 11/96, 12/96 (TROM 191,192). - Tr: Salangen: Skårvika at Sjøvegan 11 Jul 1989 *Salix nigricans*(w) GM 337a (TROM 109). Storfjord: Skibotn Lullesletta 19 Aug 1992 *Salix*(w) N. Lundqvist 19147 (TROM 81, S) (Mathiassen & Granmo 1996: 45). - Fi: Karasjok: Tanaelv Seilnes ('Seglnæs') s.d. *Populus*(w) J.M. Normann (O 22). **Sweden:** S.l.d. *Salix*(w) *H. atropurpureum* ex herb. E. Fries (S 12). Fries Scler. Suec. Exs. 47 *S. serpens* Pers. (on wood of either *Populus* or *Salix*) (UPS). - Sk: Dalby: Dalby - Söderskog 16 Apr 1946 *Ulmus*(w) J.A. Nannfeldt 8212 (UPS 49). Kropp: Rosendal 2 Jan 1994 *Quercus*(bw) S.-Å. Hanson 13140 (LD 64). Ottarp: Bälteberga 1 May 1995 *Quercus* S.-Å. Hanson. Skarhult: Skarhults kronopark 6 Mar 1993 *Sorbus*(w) B. Hägg (LD 66). Välinge: Bjarbolund 4 Apr 1992 *Fagus*(w) S.-Å. Hanson 2176 (LD 65). Äsphult Dockarps Kvarn 19 Sep 1996 *Fagus* (w) TL-4283 (C). - Sm: Misterhult: Jungfrun at Stensliperiet 11 Jun 1915 *Populus*(w) G.E. Du Rietz & H. Osvald (UPS 50), Jun 1915 G.E. Du Rietz & H. Osvald (UPS 51), 25 May 1917 G.E. Du Rietz (UPS 58). Jungfrun Sydskogen Jun 1915 G.E. Du Rietz & H. Osvald (UPS 57), Jun 1916 *Populus*(w) G.E. Du Rietz (UPS 56), 25 May 1917 *Quercus*(w) G.E. Du Rietz (UPS 55). - Öl: Halltorps Haga *Carpinus?* TL-4196 (C). St. Dalby Aug 1969 O. Vevle (BG 95). - Ög: Gryt: Säterøn ca. 1 km SSE of church 22 Aug 1944 *Quercus*(w) J.A. Nannfeldt 7313 (UPS 46). Strømmen 21 Apr 1946 *Quercus*(w) J.A. Nannfeldt 8268 (UPS 48). Stenbacka ca. 500 m E of Glåpbo 15 Jul 1947 *Quercus*(w) J.A. Nannfeldt 9327 (UPS 52). - Vg: Göteborg: St. Änggården Naturparken 2 Dec 1936 *Fagus*(w) T. Nathorst-Windahl 33 (UPS 45). Billdal Årekärrslunden 1992(?) B. Nordén 920500(p.p.) *Salix*(w) (C). - Vrm: Arvika: Arvika Jul 1886 *Populus*(w) E. Holmgren (S 7). - Srm: Höiö: Näsudden peninsula 2 km E of Tullgarn Castle 24 Apr 1992 *Quercus*(bw) N. Lundqvist 18900 (S 10). Nacka: Östervik 26 May 1892 L. Romell (S 9). Tveta: Tvetaberg 22 Dec 1858 *Salix*(w) C.P. Laestadius (BG 93, S 8, UME 60). - Sth: Stockholm Skuggan 11 May 1891 *Ulmus*(w) L. Romell (S 3). - Upl: Alsike: 1 km N of Fredrikslund near Åsen 26 Oct 1991 *Quercus robur*(w) N. Lundqvist 18874 (S 4). Bondkyrka: Forest E of Vårdsätra naturpark 13 May 1915 *Alnus*(w) H. Osvald (UPS 44). Gottsundabergen 16 May 1929 *Populus*(w) S. Lundell & J.A. Nannfeldt (UPS 37). Nosten ca. 1 km S of Läbyvad st. 19 Jun 1931 *Populus*(w) S. Lundell & J.A. Nannfeldt (UPS 28). Fäbodarna 17 May 1946 *Ulmus*(w) L. Holm (UPS 25). Dalby: Brunna (the *Fraxinus*-grove N of the farm) 5 Mar 1987 *Sorbus intermedia*(w) K. Holm & L. Holm 4394 (UPS 42). Dannemora: W of Andersby "Andersby ekbackar" 3 Oct 1972 N. Lundqvist (UPS 38, a quite aberrant specimen!). Ekerö: Ekebyhof Aug 1890 *Fagus*(w) H. Hamberg (O 85), Aug 1893 *Fagus*(w) H. Hamberg (S 5, UPS 41), M.A. Lindblad (S 6). Harbo: Kalvnäs at lake Tämnaren 4 Jul 1974 *Corylus*(w) N. Lundqvist (UPS 35). Kårsta: Kårsta 19 Oct 1947 *Populus*(w) B. Cortin (S 19). Täby: Täby 4 May 1911 *Populus*(w) T. Vestergren (S 20). Uppsala: Uppsala 1846 *Picea abies*(w) M.A. Lindblad (S 2, UPS 36), Oct 1846 *Picea abies*(w) M.A. Lindblad (S 16), 1853 *Populus*(w) M.A. Lindblad (S 17, UPS 40), 19 Apr 1885 L. Romell (UPS 27, LD 63, ass. w. *N. effusa*), 25 Apr 1885 *Fraxinus*(w) L. Romell (S 18,UPS 34). Vänge: Fiby urskog 17 May 1932 *Salix*(w) J.A. Nannfeldt 4416 (UPS 54), 13 Sep 1960 *Populus*(w) N. Lundqvist 2814 (mixed w. *N. atropurpurea*) (UPS 39). Ärentuna: 3 km SE of Storvreta 1 Oct 1972 *Populus*(w) N. Lundqvist 8093 (UPS 43). - Vsm: Rytterne: Åholmen 18 Oct 1972 *Fraxinus*(w) I. Nordin (UPS 26). Sala: Skuggan 7 Jul 1946 R. Morander (UPS 53). Västerås-Barkarö: Ridön s.d. *Populus*(w) & *Betula*(w) M.A. Lindblad (S 11), May 1845 *Betula*(w) *Quercus*(w) M.A. Lindblad (S 14,UPS 30). - Ång: Anundsjö: Seltjern 29 Jul 1898 *Salix*(w) Rob. E. Fries (S 1). Junsele: Junsele 5 Aug 1989 *Salix pentandra*(w) GM 8109 (was closely ass. w. *N.* aff. *colliculosa*) (TROM 186). Själevad: Haffstafjärden N of Billsta 8 Jul 1988 *Salix nigricans*(2w) GM 5985, 5989 (TROM 184,185). - Vb: Umeå: Brännland (riverside near outlet of Smörbäcken) 12 May 1984 *Salix*(w) O. Eriksson (UME 59). Brännland 2 Jul 1995 *Salix phylicifolia*(w) GM & O. Eriksson (closely ass. with amyloid taxon of uncertain affinity) (TROM 187). **Finland:** A: Lemland: Slätholmen 18 Sep 1976 *Sorbus*(w) L. Fagerström (H 15). Sottunga: Storsuttunga 7 Jun 1976 *Fraxinus*(w) G. Kvist (H 16). - V: Merimasku: 1860 P.A. Karsten 2950 (H 24). Turku: Ruissalo (Runsala) 5 May 1861 & Jun 1869 *Quercus*(2w) P.A. Karsten 2948, 3344 (H 11,12). Ruissalo Onnelan tienhaara (crossroads) 1 Nov 1967 *Betula*(w) S. Puolamäki (TUR 18). - U: Espoo 13 Oct 1908 *Betula*(w) C.G. Tigerstedt (H 3). - EK: Vehkalahti: Turkia 10 Oct 1980 *Betula*(w) L. Fagerström (H 2). - St: Vammala: Atyrvää (Tyrvis) 1859 *Alnus*(w) P.A. Karsten (H 17). - EH: Asikkala: Viitaili Pellosniemi 26 Apr 1986 *Salix caprea*(w) V. Haikonen 7074 (H 4). Tammela: Mustiala 8 May 1866 *Betula*(w) P.A. Karsten (? F. Fenn. Exs. 772) (S 21, H 10), 8 May 1869 *Sorbus aucuparia*(w) P.A. Karsten (UPS 33), 9 Oct 1869 *Sorbus*(w) P.A. Karsten 2959 (H 6), Nov 1892 *Populus*(w) P.A. Karsten 2947 (H 5), s.d. *Populus*(w) P.A. Karsten 2951 (H 7). Kytö 16 May 1866 *Alnus*(w) P.A. Karsten 2952 (H 8). Pähkijärvi 16 Jun 1868

Salix(w) P.A. Karsten 2946 (H 9). - PK: Ilomantsi: Niemijärvi Tapionhu 28 Aug 1996 *Betula*(w) J. Heilmann-Clausen TL-4253 (C). Palosenvaara 29 Aug 1996 *Populus/Betula* TL-4266 (C). Kontiolahti: Koli 23 Aug 1996 *Populus*(w) TL 4214 (C). - KP: Pietarsaari (Jakobstad) 7 Aug 1870 *Sorbus*(2w) P.A. Karsten 2949, 2954 (H 13,14). **Denmark:** Brh: Døndalen 12 Oct 1964 A. Munk. Hammerskoven 14 May 1911 *Crataegus oxyacantha* J. Lind (CP) (Lind 1913: 253). Paradisbakkerne 27 Sep 1985 *Salix*(w) TL-1183. - Sj: Boserup Skov 18 Apr 1957 *Fagus*(w) A. Munk. Charlottenlund Forsthaven Jun 1890 Rützou (C 30565), Forsthaven 13 Jun 1890 *Populus*(w) Rützou (Lind 1913: 253). Faxe Kalkbrud 17 Oct 1985 *Salix* TL-1162. Gentofte Sø Insulinmosen 14 Aug 1983 *Fraxinus*(w) TL-0565. Grib Skov Store Grib Sø 4 Sep 1996 *Fagus*(w) TL-4272. Gundsømagle Sø 23 Oct 1988 TL-1882. Holbæk Ryegard Zoo SE of Holbæk 12 Oct 1986 *Salix*(w) GM (TROM 110). Jægersborg Dyrehave S of Eremitaget 18 Mar 1953 J.A. Nannfeldt (UPS 32). Jægersborg Dyrehave 6 Nov 1994 *Ulmus*(w) TL-3766, 22 Jun 1995 *Fagus*(5w) TL & AG (TROM 197,199,200,202,203), *Fagus*(w) TL-3920, *Ulmus*(w) AG (TROM 201). København Bernstorffsparken on a stump 23 Mar 1965 A. Munk. København Botanisk Have 30 May 1985 TL & A. Whalley. Nørreskov E of Lille Værløse 6 May 1924 *Sorbus aucuparia*(w) O. Rostrup (CP) (Munk 1957: 131). Rådmandshaven Næstved s.d. *Quercus*(w) S.A. Elborne 1818. Saltholm 16 Jun 1984 TL-0810. Sorø Sønderskov Runde Mose 16 May 1995 *Alnus glutinosa*(bw)TL-3880. Store Bøgeskov 18 Oct 1995 *Fagus*(w) TL-4036. Strandegårds Dyrehave TL-1154. Suserup Skov 24 Apr 1993 *Corylus*(w) H.F. Gøtzsche 93-3, 23 Aug 1994 *Fagus*(w) *Quercus*(w) JHC 94-354, 94/357, 29 Nov 1994 *Fagus*(w) TL-3762, 19 May 1995 *Fagus*(w) *Fraxinus*(w) *Quercus*(w) TL-3888, 3887, 3891, 15 Dec 1995 *Fraxinus*(w) *Malus*(w) TL-4058, 3886. Tokkekøb Hegn 11 Sep 1988 *Fagus*(w) TL-1725. Vallø Storskov Sep 1953 *Fagus*(w) A. Munk. - Lol: Falster: Fiskebæk Skov 15 Jan 1989 *Quercus* (b) TL-1914. Lolland: Frejlev Skov 22 Oct 1986 TL-1409. Krenkerup Haveskov 15 Jan 1989 H.F. Gøzsche TL-1905. Roden Skov 22 Oct 1986 TL-1413. Vindeholme Skov 15 Jan 1989 *Tilia*(w) H.F. Gøtzsche. Møn: Klinteskoven Jydeleje-faldet 20 May 1995 *Salix*(w) *Fraxinus*(w) TL-3859, 3869, 11 Oct 1995 *Fagus*(bw,w) TL-4049, 4043. Liselund 20 May 1995 *Aesculus* (w) TL- 3865. Store Klinteskov 26 Nov 1963 *Fagus*(w) A. Munk. Store Klinteskov Kærlighetsstien near hotel 25 Jun 1995 *Fagus*(w) TL-3915. Timmesø Bjerg 24 Jun 1996 *Fagus*(w) TL-4187, at Klintehotellet 24 Jun 1996 *Lonicera xylosteum*(bw) TL-4179. Ulvshale Skoven 26 May 1985 *Carpinus*(2w) TL-3872, 3876, *Fagus*(w) & hardwood indet. TL-1126, 3871, 21 May 1995 *Quercus*(bw) TL-3877. - Fyn: Fyn: Snarup W of Kværndrup Loddeniung 11 Mar 1995 J. Vesterholt JV95-101. Langeland: Lunden at Keldsnor 15 Oct 1984 *Corylus*(w) H. Knudsen (C-12658). - EJy: Gærum (Vejrhøj) S of Fredrikshavn 17 Oct 1985 *Populus*(w) TL-1268. Haderslev Pamhule Skov 22 Sep 1988 *Alnus glutinosa*(w) TL-1773, 29 Sep 1996 *Fagus*(w) TL-4343. Høstemark 26 Dec 1994 *Fagus* (w) TL-3774. Livø 29 Sep 1995 *Corylus*(bw) TL-3971. Lovns 2 Oct 1995 *Tilia*(w) J.H. Petersen (C-32091). Mols Bjerge Strandkjær 28 Apr 1943 *Quercus*(w) A. Munk. Rold Skov Bjergeskov at Buderupholm 8 Oct 1989 *Fagus*(w) TL-2077. Staksrode Juelsminde 12 Oct 1963 *Fraxinus*(w) A. Munk. Staksrode Skov 10 Sep 1991 *Fraxinus*(bw) J. Vesterholt 91-333. Stenderup Skovene Midtskov 27 Sep 1996 *Fagus*(w) TL-4308. Tolne Bakker 15 Oct 1985 K. Hauerslev. Trelde Skov 29 May 1995 *Alnus*(w) *Fagus*(w) *Salix*(w) JHC. Vorsø 23 Oct 1980 TL-Vorsø 406, 12 Nov 1980 TL-Vorsø 552, 15 Jun 1981 *Sambucus nigra*(w) TL-Vorsø 640, 9 Nov 1983 TL-Vorsø 913, 22 Jun 1984 TL-Vorsø 951, 31 Mar 1986 *Quercus* (2w) TL-Vorsø 1063, 1064, 31 Mar 1986 TL-Vorsø 1066, 30 Aug 1988 TL-Vorsø 1123, 17 Jul 1994 *Ulmus*(w) TL-3588, 27 May 1996 *Ulmus* TL-4102. Åbenrå Bollerslev Skov 1 Oct 1996 *Tilia*(w) M. Christensen TL 4371, *Fagus*(w) J.H. Petersen TL-4373. Åbenrå Rise Skov 1 Oct 1996 *Fagus*(w) TL-4364, *Fagus*(w) M. Christensen TL-4365. **Czech Republic:** Cahnov ap. Lanžhot 4 Oct 1977 *Quercus robur* Z. Pouzar (PRM 869185). Boři les ap. Valtice "Tři Grácie" 6 Oct 1977 *Prunus* Z. Pouzar (PRM 869007). **France:** Gallia meridion. s.d. Persoon No. 8 *Sphaeria atropurpurea* Fr.?, *Sphaeria granulosa* (L 910.270-338, herb. Persoon). Rhone Lyon s.d. ex herb Montagne '*S. uda*? Pers. vix' (UPS (F-03797) 56078, herb. E. Fries). **Germany:** Westfalen bei Münster, bei Erdmanns Aug 1865 Nitschke leg. & det. *H. aeneum* Nitschke (B). **Country unknown:** S.l.d.n.c. *Sphaeria serpens* 'in hohlen Weidenbäumen' (L 910.269-703, herb. Persoon).

Nemania serpens *agg. - amyloid specimens not at present arranged as to species*: **Norway:** Øs: Hvaler: Søndre Sandøy 25 Apr 1975 F.-E. Eckblad (O 58). Råde: Tomb agricultural school 4 Jul 1973 L. Ryvarden 11895 (O 87). - Ak: Bærum: Tjernsrudtjern (Kjensrudtjern), 27 May 1879 *Populus*(w) A. Blytt (O 3). - Oslo: Ve: Larvik: Jordstøyp i Kvelde 20 Sep 1995 *Populus*(w) H. Andersen 75-661 (O 137). - Te: Drangedal: Drangedal 1 km S of rifle range 25 Jul 1974 *Populus*(bw) AG 207/74 (BG 36). - AA: Birkenes: Bjorvatn nat. res. 14 Jul 1995 *Populus*(w) AG 104/95 (TROM 111). Bygland: Åraksbø Heddevikji 26 Jul 1994 *Sorbus aucuparia*(w) AG 62/94 (TROM 102). Grimstad: Søm at Fevik 20 Jul 1974 *Fagus*(w) AG 132/74 (BG 43), 12 Jul 1995 *Fagus*(w) AG 75/95 (TROM 118). Vegårshei: 3 km W of Akland 19 May 1977 *Salix*(w) A.-E. Torkelsen 17/77 (O 88). - VA: Kristiansand: Hemmingsvt. Murtetjønn nat. res. 17 Jul 1995 *Populus*(w) *Tilia*(w) AG 136/95, 135/95 (TROM 116,117). - Ro: Gjesdal: Dirdal 13 Jul 1974 *Corylus*(w) AG 71/74 (BG 44). - Ho: Austevoll: Møkster at *Phyllitis*-locality May 1968

Corylus(w) P.M. Jørgensen & D.O. Øvstedal (BG 1). Lindås: Seim Vollom 17 Sep 1974 *Populus*(w) AG (BG 57). - SF: Stryn: Strynsvatn Flostranda nat. res. 20 Jul 1994 *Corylus*(w) AG 4/94 (TROM 134). - MR: Smøla: Kuli 13 Oct 1995 *Populus*(w) S. Sivertsen S-95-8 (TRH 132). - NT: Snåsa: Bergsåsen 13 Sep 1978 *Salix*(w) S. Sivertsen (TRH 136). - Fi: Alta: Kløftan at Eibyelva 5 Aug 1973 *Sorbus aucuparia*(w) I. Granmo & AG 242/73 (BG 53). **Sweden:** Ög: Västra Tollstad: Omberg (Mullskräerna) 12 Jul 1889 *Sorbus aucuparia*(b) L. Romell (S 22, UPS 47). - Bh: Ljung: Korsviken 1 Jul 1888 *Rosa*(w) A.G. Eliasson (S 13). - Upl: Bälinge: Gullögla 8 May 1971 *Corylus*(w) J.A. Nannfeldt (UPS 29). - Vsm: Västerås-Barkarö: Ridön 1845 M.A. Lindblad (UPS 31). - Dlr: Säter: Nordalen (the ravine N of Kvarn) 29 Mar 1964 *Salix*(w) O. Eriksson 2274a (UME 61). - Vb: Umeå: Umeå 1909 *Salix*(w) J. Vleugel (S 15). Vännäs: Fällfors near road betw. Fällfors and Önskanäs 25 Jun 1976 *Juniperus communis*(bw) O. Eriksson (UME 62, impoverished material). **Denmark:** Sj: Vallø Storskov Sep 1953 *Fagus*(w) (mixed w. *N. serpens*) A. Munk. - Lol: Knuthenborg 13 Sep 1894 E. Rostrup. - EJy: Livø 29 Sep 1995 *Salix(w)* TL-4007. Rustrup Skov at Gjessø Silkeborg 21 Jan 1954 A. Munk. Skanderborg Dyrehave *Salix* (w) (C 26278). Trelde Skov 30 May 1995 (mixed w. *N. serpens*) JHC. - WJy: Billund Båstlund Krat 30 Sep 1996 *Quercus*(w) J.H. Petersen TL- 4354. **Czech Republic:** Soběslavská Blata pr. Soběslav 1 Sep 1950 *Salix aurita* M. Svrček (PRM 688225). Cahnov ap. Lanžhot 4 Oct 1988 *Ulmus*(w) Z. Pouzar (PRM 871869). **France(?):** S.l.d. '*ad lignum*' ex herb. J.B. Mougeot *Sphaeria uda* (UPS (F-03545)56726, herb. E. Fries).

Nemania sp. A

Fig 60 A-B.

Description. *Stromata* 0.3-3 × 0.5-1 × 0.09 cm, on wood, dark brown with scabrous surface. Stromatal grooves pronounced, broadly U-shaped. Ectostroma carbonaceous, ca. 60 µm. Entostroma mostly whitish. *Perithecia* 460-550 µm high, 300-420 µm broad, pyriform. Peridium 40-45 µm, carbonaceous in the apical part only. Ostioles stout, conical, shiny black. Perithecial contours mostly distinct, to 1/2 of perithecial height, with conical to broadly arched apices. *Asci* p.sp. 108-132 µm, st. 96 µm. Ascus annulus dark in LG, blue in MZ, 3.5-4 µm high, 3.25-4 µm broad at apex, 2.25-3 µm broad at base. *Ascospores* 15.5-19.5 × 6.5-9 µm, m. 17.3 × 7.6 µm (n = 19/1), ellipsoid to ellipsoid-inequilateral, with narrowly rounded to acute ends, frequently with remnants of a hyaline cellular appendage, brown to copper coloured (7C8). Germ slit inconspicuous, ca. 4 µm long, on the least convex side.

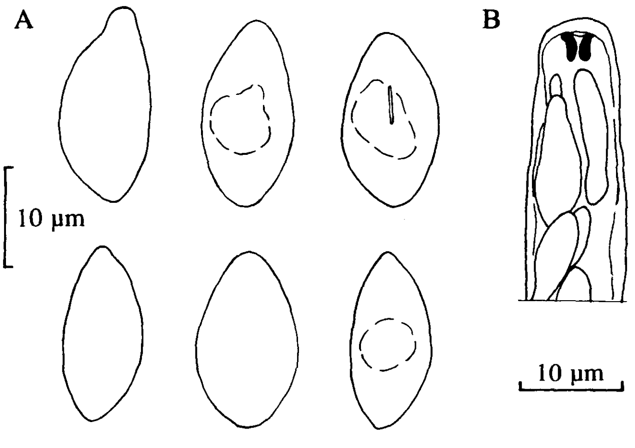


Fig. 60. *Nemania* sp. A. A. Ascospores. B. Ascus apex in LG. (S 1).

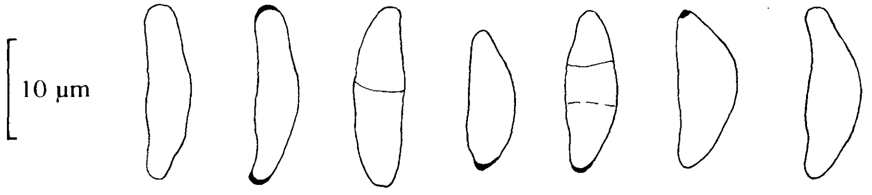


Fig. 61. *Nemania* sp. B. Ascospores (UPS, herb. E. Fries).

Taxonomic notes. This probably undescribed taxon resembles *Hypoxylon (=Nemania) serpens* var. *macrospora*, judged from the one North American specimen we have seen. *Nemania* sp. A has, however, larger and somewhat differently shaped ascospores. The pronounced perithecia and strong ostioles are striking features. The old sample from Sweden consists of two small and two larger stromata. The material was mixed with *N. serpens* on *Picea* (S 16) and *N. carbonacea* on *Betula* (S 4). More material, and also a closer study of *N. serpens* var. *macrospora*, is needed in advance of a possible formal description. One should thereby also reconsider some of the strains known from culture only (L. Petrini & Rogers 1986), for instance the 'Barron-isolate', referred to as *Hypoxylon serpens* in several laboratory studies.

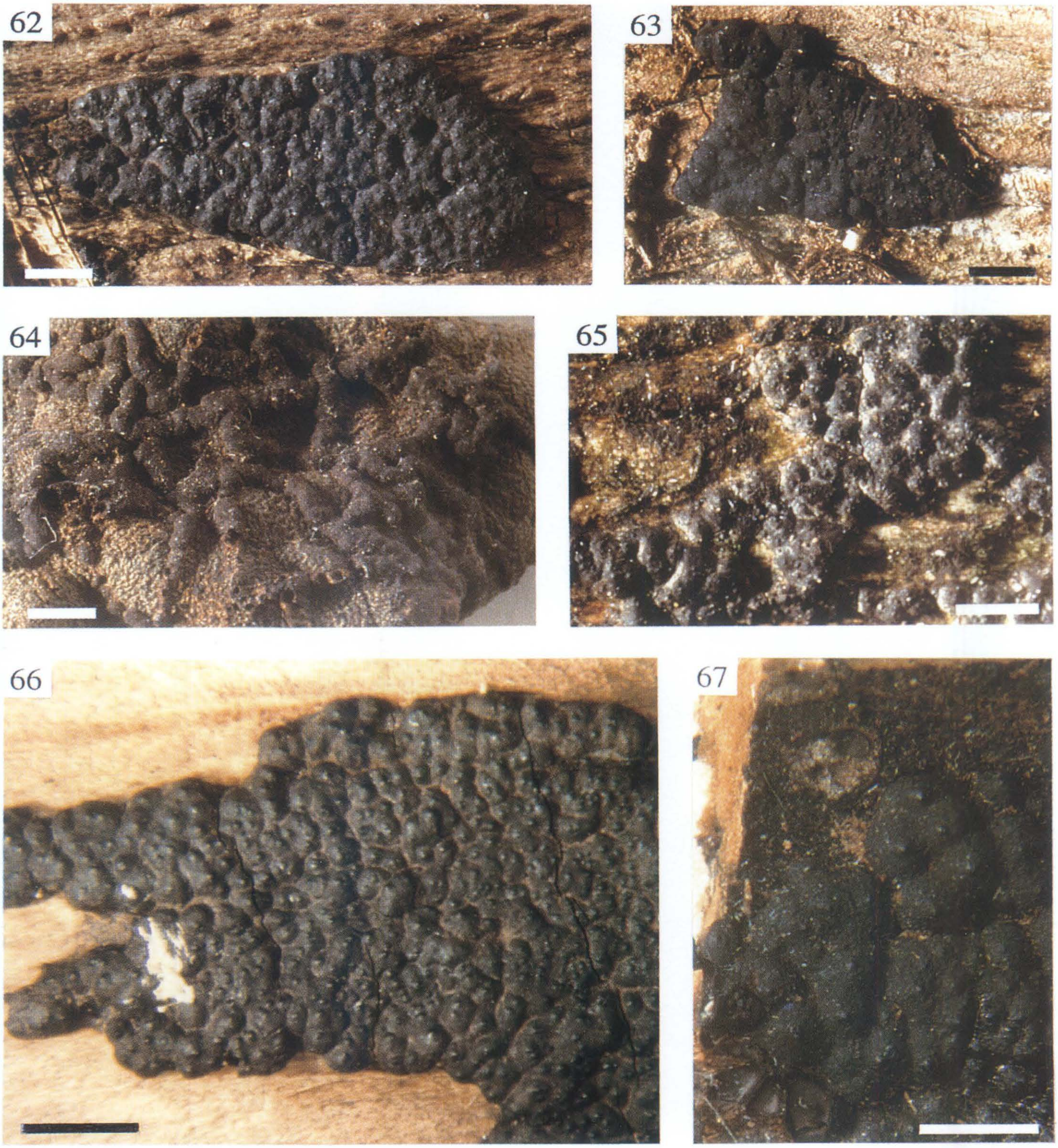
Specimen examined. Sweden: Upl: Uppsala Oct 1846 *Picea*(w) M.A. Lindblad (S 1).

Nemania sp. **B**

Figs 57, 61; 67 (stroma).

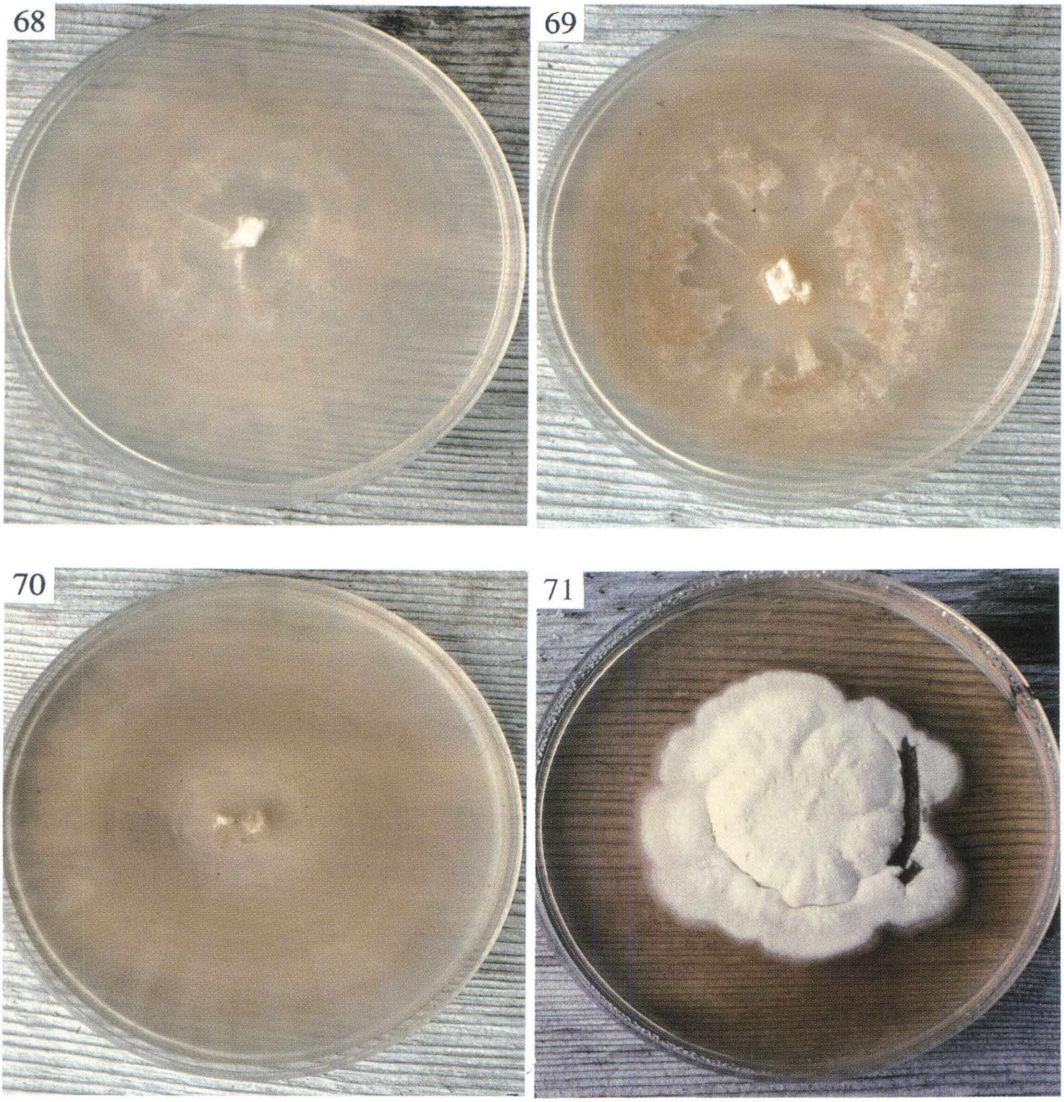
Description. *Stroma* totally 3.5 × 0.7 × 0.12 cm (glued on paper and broken in three pieces), very fragile, scabrous, dull black. Stromatal grooves deep, narrowly V-shaped due to irregularly aggregated groups of perithecia. Ectostroma ca. 60 µm, carbonaceous, continuous with a 30-50 µm thick, black, sterile crust on the surrounding wood. Entostroma has probably crumbled. *Perithecia* (600-)900-1100 µm high, 450-1350 µm in diam., globose to ovoid, sometimes a little rough due to faint concentric thickenings. Ostioles conspicuous, conical, pointed, black, mostly surrounded by a ring-like margin delimiting an area 240-300 µm in diam. Perithecial contours prominent, but absent in some parts of the stroma. Peridium 30 µm thick, carbonaceous. A very thin, yellowish red tissue (remnants of an entostroma?) covers both the peridium, and the wood beneath the black crust. An orange pigment is extracted when soaking free perithecia in 2% KOH. *Asci* dissolved. *Ascospores* (12.5-)13.5-18 × 3.5-4.5 µm, m. 15.4 × 4.5 µm (n = 18), ellipsoid and navicular, or lunate, with narrowly rounded ends which often appear to be somewhat thickened, aseptate, but occasionally with 1, rarely 2 septa, pale greyish brown, smooth (by LM). No guttules seen in any media. Germ slit inconspicuous, ca. 4 µm long in the middle of the spore (not possible to tell on which side of the spore).

Taxonomic notes. This probably undescribed taxon is named *Sphaeria incrustans* P. in herb. Fries (v.i.), almost certainly in Fries' handwriting. *Sphaeria incrustans* Pers. (Persoon 1796: 70, 1801: 82) was studied by Ju & Rogers (1996: 283) in herb. Persoon (L). They found it to represent different taxa, thus being a *nomen confusum*. Fries (1823: 343) sanctioned Persoon's name, but evidently his description deviates somewhat from that of Persoon. He did not cite any particular specimen, but added: '*Ad truncos populinos, acerinos & c. rarior.* (v.s.)'. Fries in 1849



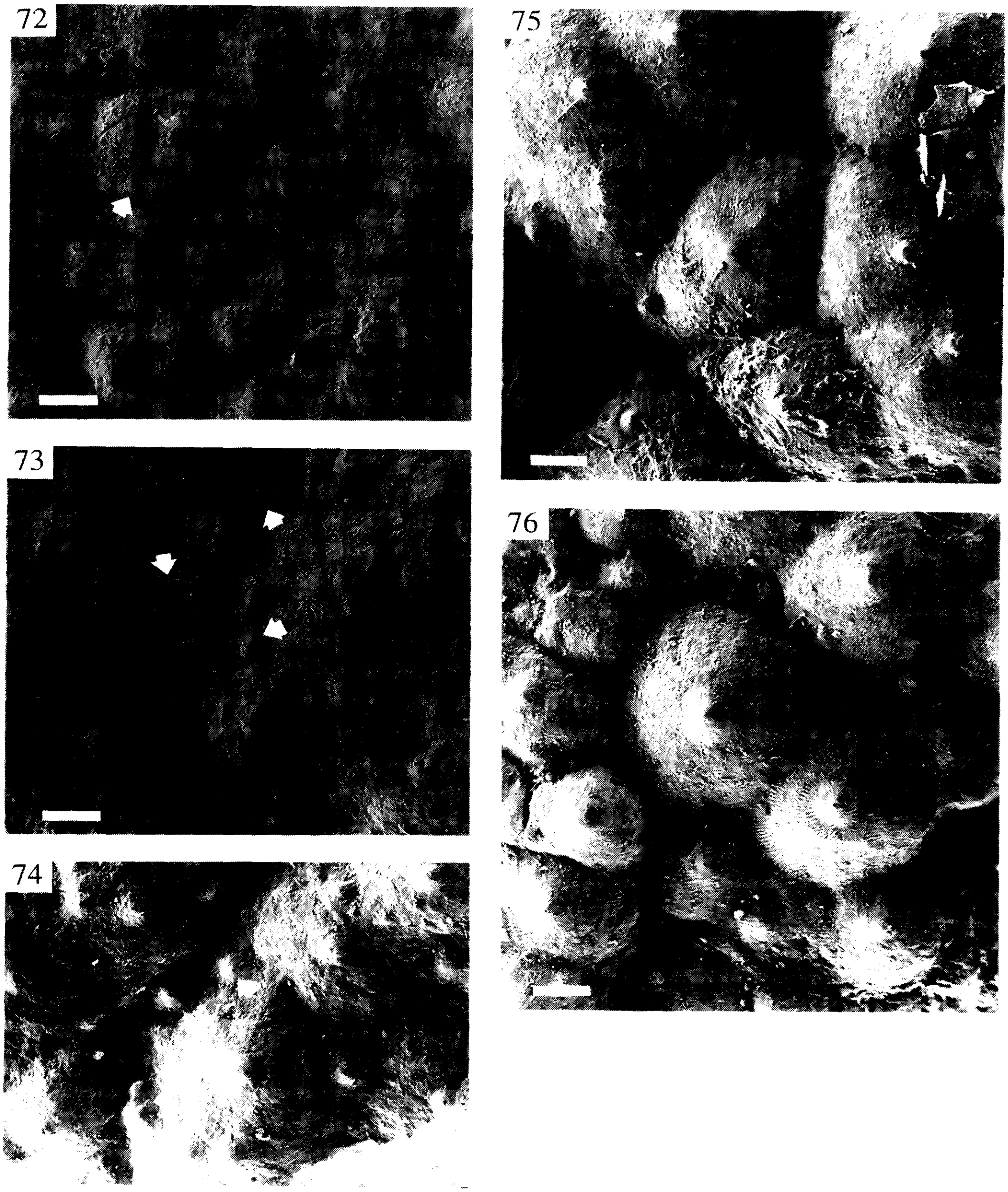
Figs 62-67. Photographs of stromata. Figs 62-63. *Nemania prava*. Fig. 62. Type of *Hypoxylon atropurpureum* var. *brevistipitatum* (ZT). Fig. 63. TROM 114. Fig. 64. *N. reticulata* (H 22). Figs 65-66. *N. serpens*, from TROM 168 and TROM 174 (neotype), respectively. Fig. 67. *Nemania* sp. B (UPS). - Rule: 2 mm.

still cited *S. incrustans* Pers. as 'r.[rare] 1.' (1 = regio campestris) (Fries 1849: 389). In herb. Fries in UPS there are three capsules labelled *Sphaeria incrustans* Pers. One is from herb. J.F. de Chaillet and revised - possibly in Fries' hand - to *Sphaeria obducens*. This is an *Ohleria*, fitting

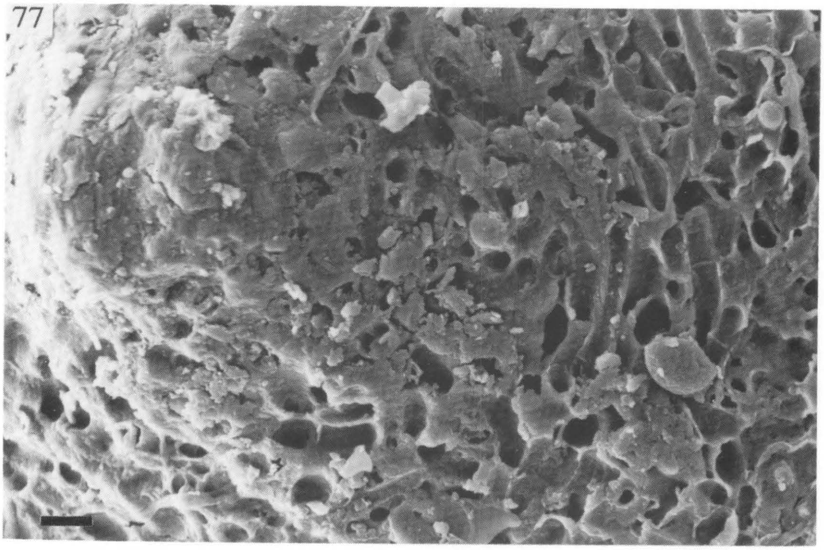


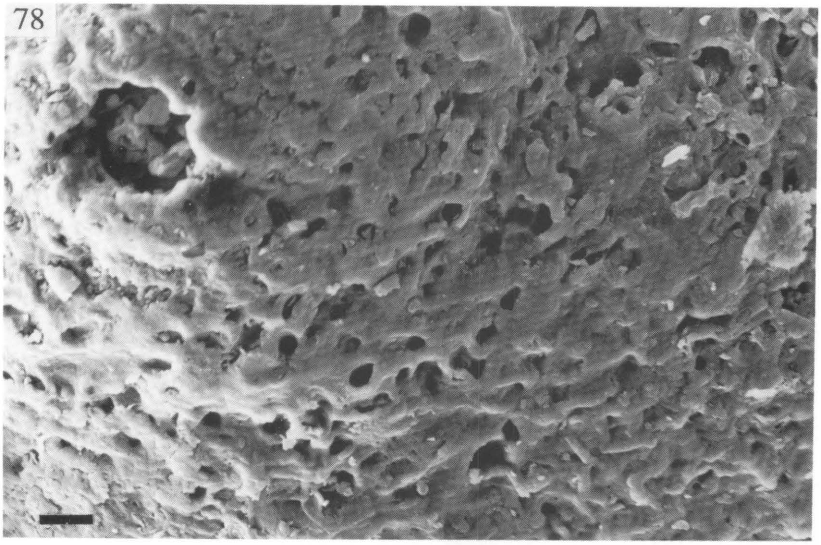
Figs 68-71. Cultures of *Nemania* species in Petri dishes. Fig. 68. *Nemania colliculosa* (TROM 129, neotype). Fig. 69. *N. prava* (TROM 104, holotype). Figs 70-71. *N. serpens* (TROM 174, neotype). - Figs 68-70. After 4 weeks on 2% MA at ca. 21° C. Fig. 71. After 24 days on PDA at 19° C.

reasonably well with *O. obducens* Winter. The second is from herb. L. Dufour no. 568. It has no annotations by Fries and seems to be a coelomycete with innumerable small, allantoid spores. The third is our fungus, which Fries ostensibly got from Acharius, according to the inscription in Fries'



Figs 72-76. Surface of stromata as seen by SEM. Arrows: False ostioles. Fig. 72. *Nemania colliculosa* (TROM 130). Fig. 73. *N. prava*. Part of a stroma with faint stromatal grooves and almost lacking perithecial contours (TROM 119). Fig. 74. *N. serpens*, with one distinct stromal groove (TROM 154). Fig. 75. *N. atropurpurea*. Note distinct, V-shaped stromatal grooves (TROM 18). Fig. 76. *N. effusa*. Note mixture of large and small perithecia; stromatal grooves as by *N. atropurpurea*. The faint scratching in the perithecial surface is probably caused by feeding snails (TROM 8). - Rule: 200 μm.

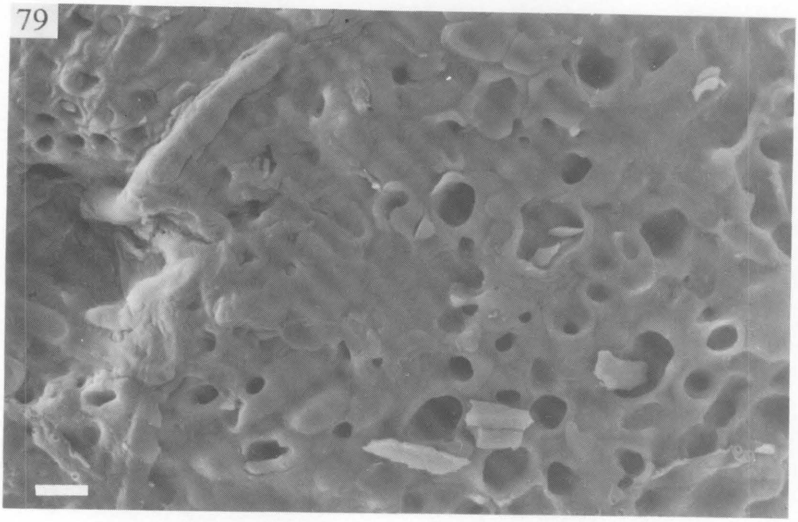




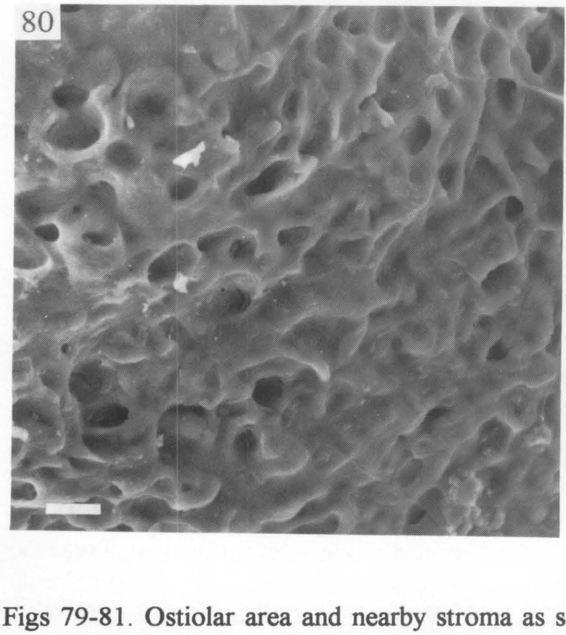
Figs 77-78. Ostiolar area and nearby stroma as seen by SEM. Fig. 77. *Nemania atropurpurea*. Ostiolar pore on the left side is still plugged. Note the concentrically elongated openings in the stroma surface at the ostiolar base (TROM 18). Fig. 78. *N. effusa*. Ostiolar pore at left (TROM 8). - Rule: 5 μm.

hand. It does not fit with Persoon's description of *S. incrustans*, but to some extent agrees with that of Fries (Fries 1817: 259, 1823: 343). Fries, however, consistently accepted Persoon's

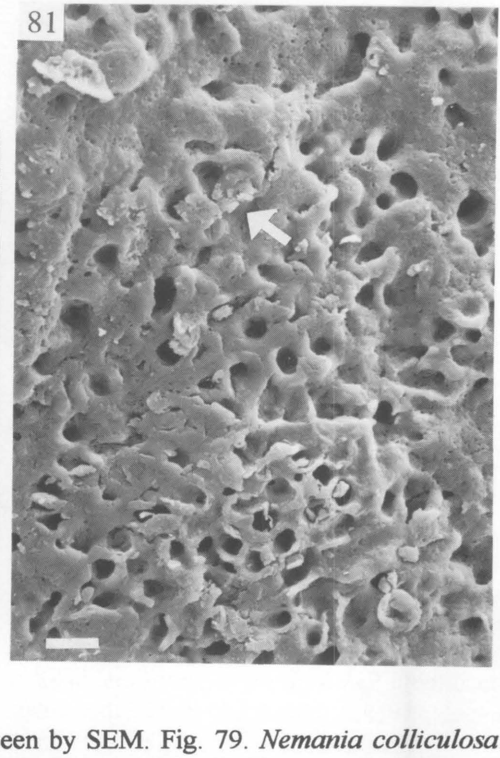
79



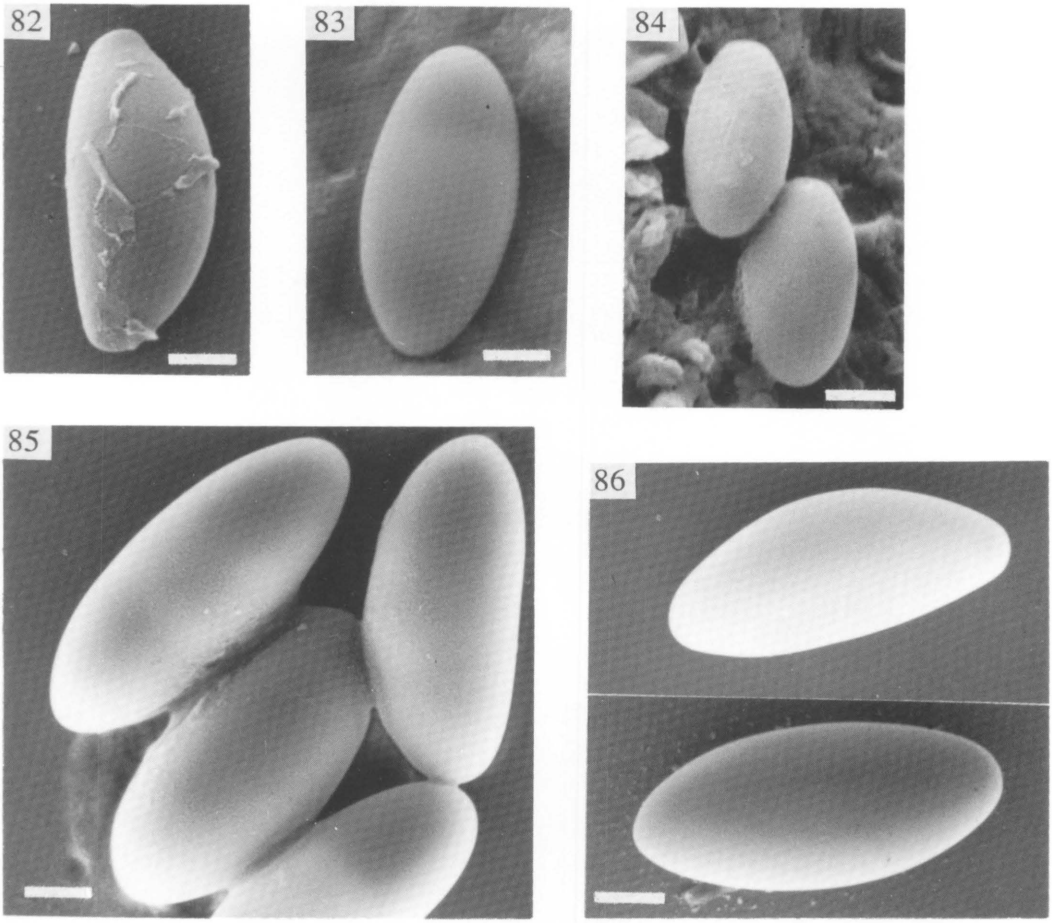
80



81



Figs 79-81. Ostiolar area and nearby stroma as seen by SEM. Fig. 79. *Nemania colliculosa*. Ostiolar pore with protruding ascus on the left side (TROM 130). Fig. 80. *N. prava*. Ostiolar pore in the upper left corner (hidden by the number label) (TROM 119). Fig. 81. *N. serpens*. The ostiolar base approximately in the area of the arrow, the ostiolar pore being in the direction of the upper left corner (TROM 154). - Rule: 5 μm.



Figs 82-86. Ascospores as seen by SEM. Fig. 82. *Nemania atropurpurea*. Ascospore in lateral view (K, lectotype). Fig. 83. *N. colliculosa*. Ascospore in frontal view (TROM 130). Fig. 84. *N. effusa* (TROM 8). Fig. 85. *N. prava*. Two ascospores in frontal view (to the left), and one(-two) in lateral view (TROM 121). Fig. 86. *N. reticulata*. The upper spore in lateral view, the lower spore in frontal view (K, lectotype). - Rule: 2 µm.

authorship of the name, and we have no indication that he had our species in hand or in mind when describing *Sphaeria incrustans* Pers. We refrain from naming this species formally until we have more, preferably fresh material of the taxon.

Nemania sp. B is obviously related to *Nemania illita* (Schwein.) Pouzar. The occurrence of septa in the ascospores is, however, unique. *Nemania illita* has aseptate ascospores with the germ slit on the most convex side, as seen from a specimen in PRM (Saccardo Mycotheca Italica 629, as *Hypoxylon multiforme*, PRM 688140) with ascospores 10.8-13.2 × 3.5-5 µm (L. Petrini & Müller 1986: ascospores of *Hypoxylon illitum* 12-14 × 3-4 µm).

Ecology. The host is *Salix* (by wood anatomy).

Distribution. *Sweden*. Ög (only known record). The species should be searched for, principally in localities in Östergötland, for instance near Vadstena, where Acharius stayed most of his life until his death in 1819.

Specimen examined. Sweden: Ög: Ostrogothia s.d. Acharius *Salix*(w), *Sphaeria incrustans* P. (UPS, herb. E. Fries).

ACKNOWLEDGEMENTS

Ove E. Eriksson, Umeå, and Klaus Høiland, Oslo, are acknowledged for comments on the manuscript. Nomenclatural problems have been discussed with Dick Korf. Zdeněk Pouzar, Liliane Petrini and Orlando Petrini have kindly answered and discussed relevant questions on taxonomy, and commented some specimens.

The following persons have offered help in various ways: Geir Mathiassen at the Botanical Department, Tromsø Museum is thanked for engaging discussions on taxonomy, Kirsti Eidsmo for running technical assistance, particularly with SEM-photography; Gro Rundfloen, Guri Reibo and May-Britt Eriksen Norberg have checked the colour notations. Mari Karlstad, Tromsø Museum, has photographed the stromata. The DNA analyses were performed at the DNA Laboratory for Biosystematics and Ecology, Department of Biology, University of Oslo, and we thank T. Kolpus for technical assistance. Riise Taylor and Rob Barrett have improved the English language, and Synnøve des Bouvrie (all Tromsø) the Latin description. My colleagues at Tromsø Museum, Torstein Engelskjøn and Torbjørn Alm, have read several chapters for the final version, and proposed linguistic revisions.

Finally, the first author want to express his gratitude to Liv and Isak for their patience and benevolence during the work.

The study was supported financially by the University of Tromsø and the University of Oslo.

REFERENCES

Baral, H.O. 1987. Lugol's solution/IKI versus Melzer's reagent: hemiamyloidity, a universal feature of the ascus wall. - Mycotaxon 29: 399-450.

Berbee, J.G. & Rogers J.D. 1964. Life cycle and host range of Hypoxylon pruinatum and its pathogenesis on poplars. - Phytopathology 54: 257-261.

Bier, J.E. 1940. Studies in forest pathology. 3. Hypoxylon canker of poplar. - Can. Dept. Agr. tech. Bull. 27: 1-40.

Bondarceva, M.A. 1975. Fungi generis Hypoxylon Fr. in URSS. - Novit. Syst. Pl. Vasc. 12: 185-191.

Bremer, K. 1988. The limits of amino acid sequence data in angiosperm phylogenetic reconstruction. - Evolution 42: 795-803.

Cannon, P. F., Hawksworth, D.L. & Sherwood-Pike, M.A. 1985. The British Ascomycotina: an annotated checklist. - Commonwealth mycological Institute, Kew, London.

Chesters, C.G.C. & Greenhalgh G.N. 1964. Geniculosporium serpens gen. et sp. nov., the imperfect state of Hypoxylon serpens. - Trans. brit. mycol. Soc. 47: 393-401.

Dahl, E., Elven, R., Moen, A. & Skogen, A. 1986. Vegetasjonsregionkart over Norge 1: 1 500 000. Nasjonalatlas for Norge, kartblad 4.1.1. - Statens Kartverk, Hønefoss.

Dennis, R.G.W. 1974. New or interesting British microfungi, 2. - Kew Bull. 29: 157-179.

- 1981. British Ascomycetes, ed. 2, with suppl. - Cramer-Gantner, Vaduz.

- 1986. Fungi of the Hebrides. - Royal botanic Gardens, Kew.

- 1995. The fungi of Southeast England. - Royal botanic Gardens, Kew.

Donk, M.A. 1964. Nomina conservanda proposita. I. Proposals in fungi. Pyrenomycetes. - Regn. Veg. 34: 16-31.

Eckblad, F.-E. 1968. The genera of the operculate Discomycetes: a re-evaluation of their taxonomy, phylogeny and nomenclature. - Nytt Mag. Bot. 15: 1-191.

- 1969. The genera Daldinia, Ustulina and Xylaria in Norway. - Norw. J. Bot. 16: 139-145.

Enderle, M. & Siepe, K. 1985. Hypoxylon chestersii Rogers & Whalley 1978 - Erstnachweis für die Bundesrepublik Deutschland. - Z. Mykol. 51: 157-160.

Eriksson, O. 1966. On Anthostomella Sacc., Entosordaria (Sacc.) Höhn. and some related genera (Pyrenomycetes). - Svensk bot. Tidskr. 60: 315-324.

- 1989. NaClO, sodium hypochlorite, a powerful agent in studies of ascospore morphology. - Syst. Ascomycet. 8: 1: 29-57.

- & Hawksworth D.L. 1997. Notes on ascomycete systematics - Nos 2140-2245. - Syst. Ascomycet. 15: 139-173.

Eriksson, T. 1995. Autodecay version 3.0. Dept Bot., Univ. Stockholm, Sweden. - Computer program for Macintosh distributed by the author.

Fangan, B.M., Stedje, B., Stabbetorp, O.E., Jensen, E.S. & Jakobsen, K.S. 1994. A general approach for PCR-amplification and sequencing of choloroplast DNA from crude vascular plant and algal tissue. - BioTechniques 16: 484-494.

Felsenstein, J. 1985. Confidence limits on phylogenies: an approach using the bootstrap. - Evolution 39: 783-791.

Fries, E. 1815. Observationes mycologicae, 1. - Bonnier, Copenhagen.

- 1816. Uppställning af de i Sverige funne Vårtsvampar (Scleromyci). - K. svenska

VetskAkad. Handl. 1816: 126-157.

- 1817. Uppställning af de i Sverige funne Vårtsvampar (Scleromyci). - K. svenska VetskAkad. Handl. 1817: 245-271.

- 1823. Systema mycologicum, 2. - Lund.

- 1828. Elenchus fungorum, 2. - Greifswald.

- 1832. Systema mycologicum, 3. - Greifswald.

- 1849. Summa vegetabilium Scandinaviae, 2. - Uppsala.

Füisting, W. 1867. Zur Entwicklungsgeschichte der Pyrenomyceten. - Bot. Z. 39: 305-311.

Gilbert, D.G. 1993. SeqApp, version 1.9a169. Computer program distributed via Internet (ftp.bio.indiana.edu/molbio/seqapp.hqx).

Ginns, J. H. 1986. Compendium of plant disease and decay fungi in Canada 1960-1980. - Res. Branch Agric. Can. Publ. 1813: 1-416.

Granmo, A. 1977. Slekten Hypoxylon i Norge. - Cand. real. Thesis, Univ. Bergen, Bergen, (unpubl.).

- 1998. A critical study of Biscogniauxia, Hypoxylon and Nemania (Xylariaceae) in Norden. - Dr scient. Thesis, Univ. Tromsø, Tromsø (unpubl.).

- 1999. Morphotaxonomy and chorology of the genus Hypoxylon (Xylariaceae) in Norway. Sommerfeltia 26: 1-81.

- , Hammelev, D., Knudsen, H., Læssøe, T., Sasa, M., & Whalley, A.J.S. 1989. The genera Biscogniauxia and Hypoxylon (Sphaeriales) in the Nordic countries. - Opera bot. 100: 59-84.

Gray, S.F. 1821. A natural arrangement of British plants, 1. - London.

Greuter, W., Barrie, F.R., Burdet, H.M., Chaloner, W.G., Demoulin, V., Hawksworth, D.L., Jørgensen, P.M., Nicholson, D.H., Silva, P.C., Trehane P. & McNeill, J. (eds) 1994. International code of botanical nomenclature (Tokyo code). - Koeltz, Königstein.

Griffin, D.H., Quinn, K.H., Gilbert, G.S., Wang, C.J.K. & Rosemarin, S. 1992. The role of ascospores and conidia as propagules in the disease cycle of Hypoxylon mammatum. - Phytopathology 82: 114-119.

van der Gucht, K. 1995. Illustrations and descriptions of xylariaceous fungi collected in Papua New Guinea. - Bull. Jard. bot. nat. Belg. 64: 219-403.

Holmgren, P.K., Holmgren, N.H. & Barnett, L.C. (eds) 1990. Index herbariorum 1: The herbaria of the world, ed. 8. - N. Y. bot. Gdn, New York.

Hudson, K. 1996. - Index of fungi 6: 595-653.

Hultman, T., Ståhl, S., Hornnes, E. & Uhlén, M. 1989. Direct solid phase sequencing of genomic and plasmid DNA using magnetic beads as solid support. - Nucl. Acids Res. 17: 4937-4946.

Hungnes, G. 1982. Ascomyceter (Coronophorales, Sphaeriales, Hysteriales og Pleosporales) på Quercus i Norge. Systematikk og økologi. - Cand. real. Thesis, Univ. Oslo, Oslo (unpubl.).

Jørstad, I. 1928. Nord-Norges skogsykdommer. - Tidsskr. Skogbr. 36: 365-456.

Ju, Y.-M & Rogers, J.D. 1996. A revision of the genus Hypoxylon. - Mycol. Mem. 20: 1-365.

- , Rogers, J.D., San Martin, F. & Granmo, A. 1998. The genus Biscogniauxia. - Mycotaxon 66: 1-98.

Karsten, P.A. 1885. Revisio monographica atque synopsis Ascomycetum in Fennia hucusque detectorum. - Acta Soc. Fauna Fl. fenn. 2: 6: 1-174.

Korf, R.P. 1982. Citation of author's names and the typification of names of fungal taxa published between 1753 and 1832 under the changes in the code of nomenclature enacted in 1981. -

Mycologia 74: 250-255.

Kornerup, A. & Wanscher, J.H. 1967. Methuen handbook of colour, ed. 2. - Politiken-Methuen, London.

Krieglsteiner, G.J. 1993. Verbeitungsatlas der Grosspilze Deutschlands (West) 2: Schlauchpilze. - Ulmer, Stuttgart.

Krieglsteiner, G.J. & Enderle, M. 1989. Über Vorkommen, Verbreitung und Ökologie einiger Arten der Gattungen Biscogniauxia O. Kuntze 1891, Nemania S.F. Gray 1821 emend. Pouzar 1986 und Hypoxylon Bulliard 1791 s.str. in der Bundesrepublik Deutschland und einingen Nachbarländern. - Mittbl. ArbGemein. Pilzk. Niederrhein 7: 46-89.

Lind, J. 1913. Danish fungi as represented in the herbarium of E. Rostrup. - Gyldendalske Boghandel-Nordisk Forlag, København.

Mathiassen, G. 1993. Corticolous and lignicolous Pyrenomycetes s.lat. (Ascomycetes) on Salix along a mid-Scandinavian transect. - Sommerfeltia 20: 1-180.

- & Granmo, A. 1996. The 11th Nordic mycological congress in Skibotn, North Norway 1992. - Univ. Trondheim VitenskMus. Rapp. bot. Ser. 1995: 6: 1-77.

Miller, J.H. 1930. British Xylariaceae. - Trans. br. mycol. Soc. 15: 134-154.

- 1932a. British Xylariaceae. 2. - Trans. br. mycol. Soc. 17: 125-135.

- 1932b. British Xylariaceae. 3. A revision of specimens in the herbarium of the Royal Botanic Gardens, Kew. - Trans. br. mycol. Soc.: 136-146.

- 1961. A monograph of the world species of Hypoxylon. - Univ. Georgia Press, Athens, Georgia.

Munk, A. 1957. Danish Pyrenomycetes. - Dansk bot. Ark. 17: 1: 1-491.

Nitschke, T. 1867. Pyrenomycetes germanici. - Trewendt, Breslau.

Påhlsson, L. & Danielsson, M. 1984 (eds). Naturgeografisk regionindelning av Norden, ed. 2. - Nordiska Ministerrådet, Arlöv, Sweden.

Persoon, C.H. 1796. Observationes mycologicae - seu discriptiones tam novorum quam notabilium fungorum exhibitae. Pars prima cum tabulis VI aeneis pictis. - Usteri's Annln Bot. 20: 15: 115-130.

- 1801. Synopsis methodica fungorum. - Göttingen.

Petrini, L. & Petrini, O. 1985. Xylariaceous fungi as endophytes. - Sydowia 38: 216-234.

Petrini, L.E. 1993. Rosellinia species of the temperate zone. - Sydowia 44: 169-281.

- & Müller, E. 1986. Haupt- und Nebenfruchtformen europäischer Hypoxylon-Arten (Xylariaceae, Sphaeriales) und verwandter Pilze. - Mycol. helv. 1: 501-627.

- & Rogers, J.D. 1986. A summary of the Hypoxylon serpens complex. - Mycotaxon 26: 401-436.

Petrini, O. 1982. Notes on some species of Chloroscypha endophytic in Cupressaceae of Europe and North America. - Sydowia 35: 206-222.

Pinon, J. 1975. Présence en France du "chancre" du tremble (Hypoxylon mammatum (Wahl.) Mill.). - C. R. Seances Acad. Agric. Fr. 61: 703-706.

Pouzar, Z. 1985a. Reassessment of Hypoxylon serpens-complex 1. - Česká Mykol. 39: 15-25.

- 1985b. Reassessment of the Hypoxylon serpens-complex 2. - Česká Mykol. 39: 129-134.

Rappaz, F. 1995. Anthostomella and related Xylariaceous fungi on hard wood from Europe and North America. - Mycol. Helv. 7: 99-168.

Rogers, J.D. & Ju, Y.-M. 1996. Entoleuca mammata comb. nov. for Hypoxylon mammatum and the genus Entoleuca. - Mycotaxon 59: 441-448.

- & Samuels, G. J. 1985. New taxa of Hypoxylon. - Mycotaxon 22: 367-373.

- & Whalley, A.J.S. 1978. A new Hypoxylon species from Wales. - Can. J. Bot. 56: 1346-1348.

Rostrup, E. 1904. Norske Ascomyceter i Christiania universitets botaniske museum. - Skr. VidenskSelsk. Christiania. I. math.-naturvid. Klasse 1904: 4: 1-44.

Rudi, K., Kroken, M., Dahlberg, O.J., Deggerdal, A., Jakobsen, K.S: & Larsen, F. 1997. Rapid universal method to isolate PCR-ready DNA using magnetic beads. - BioTechniques 22: 506-511.

Ryvarden, L. & Gilbertson, R.L. 1993. European polypores, 1. - Synopsis fung. 6: 1-387.

de Schweinitz, L.D. 1822. Synopsis fungorum Carolinae superioris. - Schr. nat. Ges. Leipzig 1: 20-131.

- 1832. Synopsis fungorum in America boreali media degentium. - Trans. am. phil. Soc. Philad. N.S. 4: 141-316.

Shear, C.L. 1928. Notes on the synonymy of some species of Hypoxylon. - Mycologia 20: 83-87.

- 1945. Studies of types and authentic specimens of Hypoxylon – 1. - Lloydia 8: 245-262.

Sommerfelt, S.C. 1826. Supplementum florae lapponicae. - Christiania [Oslo].

- 1827. Physisk-oeconomisk Beskrivelse over Saltdalen i Nordlandene. - K. norske Vidensk. Selsk. Skr. 19 Aarh. 2: 2: 1-148.

Sowerby, J. 1803. Coloured figures of English fungi, 3, part 25 (n.v.). - J. Davis, London.

Swofford, D.L. 1993. PAUP (Phylogenetic analysis using parsimony) version 3.1.1. Distributed by the Illinois Natural History Survey, Champaign, Ill.

Whalley, A.J.S. 1976. Notes on conidial state of Hypoxylon udum. - Trans. br. mycol. Soc. 67: 515-517.

- & Edwards, R.L. 1987. Xylariaceous fungi: use of secondary metabolites. - In: Rayner, A.D.M., Brasier, C.M. & Moore, D. (eds), Evolutionary biology of fungi, Cambridge Univ. Press, Cambridge, pp. 423-434.

- & Edwards, R.L. 1995. Secondary metabolites and systematic arrangement within the Xylariaceae. - Can. J. Bot. 73 Suppl. 1: 802-810.

- & Watling, R. 1980. Hypoxylon udum Pers. ex Fr. - Trans. bot. Soc. Edinburgh 43: 217-220.

White, T.J., Bruns, T., Lee, S. & Taylor, J. 1990. Amplification and direct sequencing of fungal ribosomal RNA genes for phylogenetics. - In: Innis, M.A., Gelfand, D.H., Sninsky, J.J. and White, T.J. (eds), PCR Protocols: Chapter 38. A guide to methods and applications, Academic Press, San Diego, Cal., pp. 315-322.

APPENDICES

APPENDIX 1: PROVINCES OF NORDEN

Norway
1. Øs - Østfold
2. Ak - Akershus
(including Oslo on Fig. 1)
3. He - Hedmark
4. Op - Oppland
5. Bu - Buskerud
6. Ve - Vestfold
7. Te - Telemark
8. AA - Aust-Agder
9. VA - Vest-Agder
10. Ro - Rogaland
11. Ho - Hordaland
12. SF - Sogn og Fjordane
13. MR - Møre og Romsdal
14. ST - Sør-Trøndelag
15. NT - Nord-Trøndelag
16. No - Nordland
17. Tr - Troms
18. Fi - Finnmark

Sweden
1. Sk - Skåne
2. Bl - Blekinge
3. Sm - Småland
4. Öl - Öland
5. Gtl - Gotland
6. Ög - Östergötland
7. Vg - Västergötland
8. Hl - Halland
9. Bh - Bohuslän
10. Dls - Dalsland
11. Vrm - Värmland
12. Nrk - Närke
13. Srm - Södermanland
(including Sth - Stockholm on Fig. 1)
14. Upl - Uppland
15. Vsm - Västmanland
16. Dlr - Dalarna
17. Gst - Gästrikland
18. Hls - Hälsingland
19. Mpd - Medelpad
20. Ång - Ångermanland
21. Vb - Västerbotten
22. Nb - Norrbotten
23. Hrj - Härjedalen
24. Jmt - Jämtland
25. ÅsL - Åsele lappmark
26. LyL - Lycksele lappmark
27. PL - Pite lappmark
28. LL - Lule lappmark
29. TL - Torne lappmark

Finland
1. A - Ahvenanmaa (Åland)
2. V - Varsinais-Suomi
3. U - Uusimaa
4. EK - Etelä-Karjala
5. St - Satakunta
6. EH - Etelä-Häme
7. ES - Etelä-Savo
8. LK - Laatokan Karjala
9. EP - Etelä-Pohjanmaa
10. PH - Pohjois-Häme
11. PS - Pohjois-Savo
12. PK - Pohjois-Karjala
13. KP - Keski-Pohjanmaa
14. Kn - Kainuu
15. OP - Oulun Pohjanmaa
16. PeP - Perä-Pohjanmaa
17. Ks - Koillismaa
18. KiL - Kittilän Lappi
19. SoL - Sompion Lappi
20. EnL - Enontekiön Lappi
21. InL - Inarin Lap

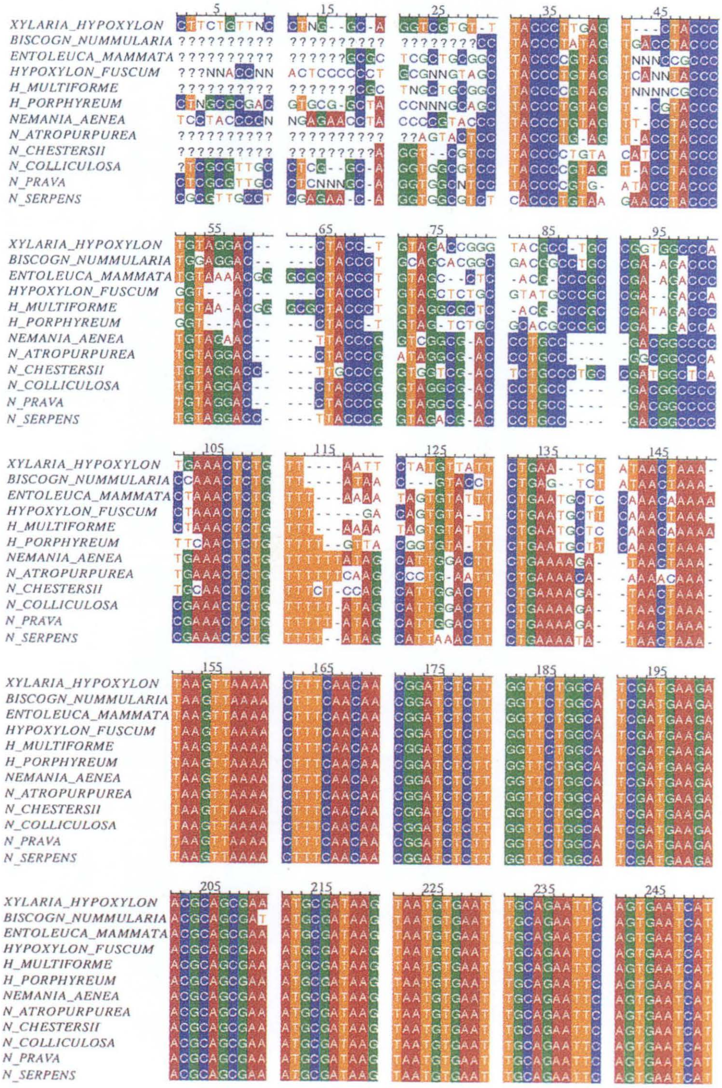
Denmark
1. Brh - Bornholm
2. Sj - Sjælland
3. Lol - Lolland, Falster, Møn
4. Fyn - Fyn, Langeland, Ærø
5. EJy - eastern and northern parts of Jylland
6. WJy - western part of Jylland

APPENDIX 2: ABBREVIATIONS AND SYMBOLS

AAS - Afdeling for alger og svampe (for cultures at C)
AG - A. Granmo (locality lists)
GM - G. Mathiassen (locality lists)
JHC - J. Heilmann-Clausen (locality lists)
LM - light microscopy
LG - Lugol's solution
m. - mean (measurements)
MZ - Melzer's reagent
(n = ../..) - number in measurements: total/number of collections
s.l. - sensu lato (in a broad sense); sine loco (without locality)
s.l.d.n.c. - sine loco, die (et) nomine collectoris (lacking locality, date and collector's name)
st. con. - status conidicus (conidial state)
t. - textura (tissue types): ang. - angularis, epid. - epidermoidea, glob. - globulosa, intr. - intricata, porr. - porrecta, prism. - prismatica
TL - T. Læssøe (locality lists)
● - localities of investigated specimens (distribution maps)
◆ - localities according to literature records (distribution maps)

APPENDIX 3: SEQUENCE MATRIX OF THE ITS nrDNA FOR PHYLOGENETIC ANALYSES.

Printed with the 'pretty print' option in SeqApp. - The matrix consists of 498 characters, and spans from the 3' end of the internal transcribed spacer 1 (ITS 1; positions 1-157), the 5.8S rRNA gene (positions 158-317), and the ITS 2 (positions 318-498). Gaps are indicated by hyphens (-), and missing characters by question marks.



	5	15	25	35	45
XYLARIA_HYPOXYLON	CTTCTGTTNC	CTNG--GC-A	GGTCGTGT-T	TACCCTTGAG	T---CTACCC
BISCOGN_NUMMULARIA	??????????	??????????	????????CC	TACCCTATAG	TGACCTACCC
ENTOLEUCA_MAMMATA	??????????	??????GCGC	TCGCTGCGGC	TACCCCGTAG	TNNNCCGCCC
HYPOXYLON_FUSCUM	???NNACCNN	ACTCCCCCCT	GCGNNGTAGC	TACCCTGTAG	TCANNTACCC
H_MULTIFORME	??????????	???????CGC	TNGCTGCGGC	TACCCCGTAG	TNNNNCGCCC
H_PORPHYREUM	CTNGCGCGAC	GTGCG-GCTA	CCNNNGCAGC	TACCCTGTAG	T--CGTACCC
NEMANIA_AENEA	TCCTACCCCN	NGAGAACCTA	CCCCGTACCC	TACCCTGTAG	TT-CCTACCC
N_ATROPURPUREA	??????????	??????????	??AGTACTCC	TACCCTG-AG	T-ACCTACCC
N_CHESTERSII	??????????	?????????A	GGT--CGTCC	TACCCCTGTA	CATCCTACCC
N_COLLICULOSA	?TCGCGTTGC	CTCG--GC-A	GGTGGCGTCC	TACCCCGTAG	T-ACCTACCC
N_PRAVA	CTCGCGTTGC	CTCNNNGC-A	GGTGGCNTCC	TACCCCGTG-	ATACCTACCC
N_SERPENS	CGCGTTGCCT	CGAGAA-C-A	GGTGGCGTCT	CACCCTGTAA	GAACCTACCC

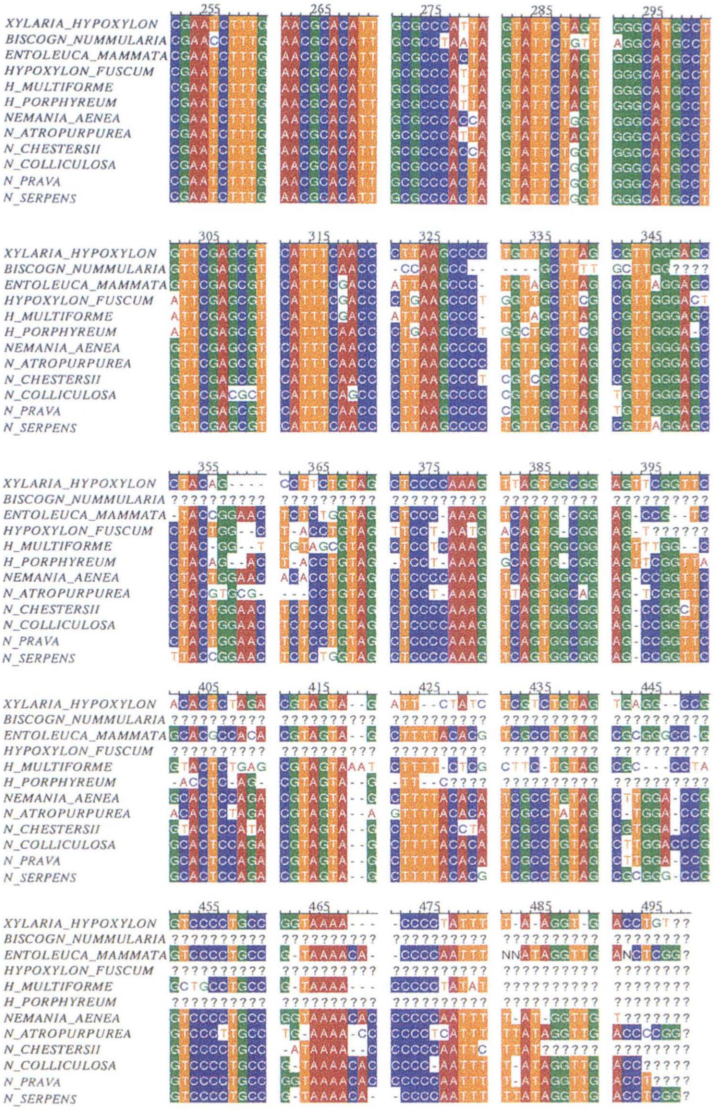
	55	65	75	85	95
XYLARIA_HYPOXYLON	TGTAGGAC--	---CTACC-T	GTAGACCGGG	TACGCC-TGC	CGGTGGCCCA
BISCOGN_NUMMULARIA	TGGAGGAC--	---CTACCCT	GCAGCACGGC	GACGGCCTGC	CGA-AGACCC
ENTOLEUCA_MAMMATA	TGTAAAACGG	GCGCTACCCT	GTAGC--CTC	-ACG-CCCGC	CGA-AGACCC
HYPOXYLON_FUSCUM	GGT---AC--	---CTACCCT	GTAGCTCTGC	GTATGCCCGC	CGA--GACCA
H_MULTIFORME	TGTAA-ACGG	GCGCTACCCT	GTAGGCGCTC	-ACG-CCCGC	CGATAGACCC
H_PORPHYREUM	GGT---AC--	---CTACC-T	GTAG-TCTGC	GCACGCCCGC	CGA--GACCA
NEMANIA_AENEA	TGTAGAAC--	---TTACCCG	GTCGGCG-AC	CCTGCC----	-GACGGCCCC
N_ATROPURPUREA	TGTAGGAC--	---CTACCCG	ATAGGCG-AC	CCTGCC----	-GGCGGCCCA
N_CHESTERSII	TGTAGGACC-	---TTGCCCG	GTGGTCG-AC	TCTGCCCTGC	CGATGGCTCA
N_COLLICULOSA	TGTAGGAC--	---CTACCCG	GTAGGCG-AC	CCTGCC----	-GACGGCCCC
N_PRAVA	TGTAGGAC--	---CTACCCG	GTAGGCG-AC	CCTGCC----	-GACGGCCCC
N_SERPENS	TGTAGGACC-	---TTACCCG	GTAGACG-AC	CCTGCC----	-GACGGCCCC

	105	115	125	135	145
XYLARIA_HYPOXYLON	TGAAACTCTG	TT----AATT	CTATGTTATT	CTGAA--TCT	ATAACTAAA-
BISCOGN_NUMMULARIA	CCAAACTCTG	TT----ATAA	C---GTACCT	CTGAG--TCT	ATAACTAAA-
ENTOLEUCA_MAMMATA	CTAAACTCTG	TTT---AAAA	TAGTGTATTT	CTGAATGCTC	CAAACAAAAA
HYPOXYLON_FUSCUM	CTAAACTCTG	TTT-----GA	CAGTGTA--T	CTGAATGCTT	CAAACTAAA-
H_MULTIFORME	CTAAACTCTG	TTT---AAAA	TAGTGTATTT	CTGAATGCTC	CAAACAAAAA
H_PORPHYREUM	TTCAACTCTG	TTTT--GTTA	CGGTGTA-TT	CTGAATGCTT	CAAACTAAA-
NEMANIA_AENEA	TGAAACTCTG	TTTTTTATAG	CATTGGACTT	CTGAAAAGA-	-TAACTAAA-
N_ATROPURPUREA	TGAAACTCTG	TTTTTTCAAG	CCCTG-AATT	CTGAAAACA-	-AAAACAAA-
N_CHESTERSII	TGCAACTCTG	TTTCT-CCAG	CATTGGACTT	CTGAAAAGA-	-TAACTAAA-
N_COLLICULOSA	CGAAACTCTG	TTTTT-ATAG	CATTGGACTT	CTGAAAAGA-	-TAACTAAA-
N_PRAVA	CGAAACTCTG	TTTTT-ATAG	CATTGGACTT	CTGAAAAGA-	-TAACTAAA-
N_SERPENS	CGAAACTCTG	TTTT--ATAG	CATTAAACTT	CTGAAAATA-	-TAACTAAA-

	155	165	175	185	195
XYLARIA_HYPOXYLON	TAAGTTAAAA	CTTTCAACAA	CGGATCTCTT	GGTTCTGGCA	TCGATGAAGA
BISCOGN_NUMMULARIA	TAAGTTAAAA	CTTTCAACAA	CGGATCTCTT	GGTTCTGGCA	TCGATGAAGA
ENTOLEUCA_MAMMATA	TAAGTTAAAA	CTTTCAACAA	CGGATCTCTT	GGTTCTGGCA	TCGATGAAGA
HYPOXYLON_FUSCUM	TAAGTTAAAA	CTTTCAACAA	CGGATCTCTT	GGTTCTGGCA	TCGATGAAGA
H_MULTIFORME	TAAGTTAAAA	CTTTCAACAA	CGGATCTCTT	GGTTCTGGCA	TCGATGAAGA
H_PORPHYREUM	TAAGTTAAAA	CTTTCAACAA	CGGATCTCTT	GGTTCTGGCA	TCGATGAAGA
NEMANIA_AENEA	TAAGTTAAAA	CTTTCAACAA	CGGATCTCTT	GGTTCTGGCA	TCGATGAAGA
N_ATROPURPUREA	TAAGTTAAAA	CTTTCAACAA	CGGATCTCTT	GGTTCTGGCA	TCGATGAAGA
N_CHESTERSII	TAAGTTAAAA	CTTTCAACAA	CGGATCTCTT	GGTTCTGGCA	TCGATGAAGA
N_COLLICULOSA	TAAGTTAAAA	CTTTCAACAA	CGGATCTCTT	GGTTCTGGCA	TCGATGAAGA
N_PRAVA	TAAGTTAAAA	CTTTCAACAA	CGGATCTCTT	GGTTCTGGCA	TCGATGAAGA
N_SERPENS	TAAGTTAAAA	CTTTCAACAA	CGGATCTCTT	GGTTCTGGCA	TCGATGAAGA

	205	215	225	235	245
XYLARIA_HYPOXYLON	ACGCAGCGAA	ATGCGATAAG	TAATGTGAAT	TGCAGAATTC	AGTGAATCAT
BISCOGN_NUMMULARIA	ACGCAGCGAT	ATGCGATAAG	TAATGTGAAT	TGCAGAATTC	AGTGAATCAT
ENTOLEUCA_MAMMATA	ACGCAGCGAA	ATGCGATAAG	TAATGTGAAT	TGCAGAATTC	AGTGAATCAT
HYPOXYLON_FUSCUM	ACGCAGCGAA	ATGCGATAAG	TAATGTGAAT	TGCAGAATTC	AGTGAATCAT
H_MULTIFORME	ACGCAGCGAA	ATGCGATAAG	TAATGTGAAT	TGCAGAATTC	AGTGAATCAT
H_PORPHYREUM	ACGCAGCGAA	ATGCGATAAG	TAATGTGAAT	TGCAGAATTC	AGTGAATCAT
NEMANIA_AENEA	ACGCAGCGAA	ATGCGATAAG	TAATGTGAAT	TGCAGAATTC	AGTGAATCAT
N_ATROPURPUREA	ACGCAGCGAA	ATGCGATAAG	TAATGTGAAT	TGCAGAATTC	AGTGAATCAT
N_CHESTERSII	ACGCAGCGAA	ATGCGATAAG	TAATGTGAAT	TGCAGAATTC	AGTGAATCAT
N_COLLICULOSA	ACGCAGCGAA	ATGCGATAAG	TAATGTGAAT	TGCAGAATTC	AGTGAATCAT
N_PRAVA	ACGCAGCGAA	ATGCGATAAG	TAATGTGAAT	TGCAGAATTC	AGTGAATCAT
N_SERPENS	ACGCAGCGAA	ATGCGATAAG	TAATGTGAAT	TGCAGAATTC	AGTGAATCAT

Appendix 3 (continued).



```
                        255        265        275        285        295
XYLARIA_HYPOXYLON    CGAATCTTTG AACGCACATT GCGCCCATTA GTATTCTAGT GGGCATGCCT
BISCOGN_NUMMULARIA   CGAACCTTTG AACGCACATT GCGCCTAATA GTATTCTGTT AGGCATGCCT
ENTOLEUCA_MAMMATA    CGAATCTTTG AACGCACATT GCGCCCACTA GTATTCTAGT GGGCATGCCT
HYPOXYLON_FUSCUM     CGAATCTTTG AACGCACATT GCGCCCATTA GTATTCTAGT GGGCATGCCT
H_MULTIFORME         CGAATCTTTG AACGCACATT GCGCCCATTA GTATTCTAGT GGGCATGCCT
H_PORPHYREUM         CGAATCTTTG AACGCACATT GCGCCCATTA GTATTCTAGT GGGCATGCCT
NEMANIA_AENEA        CGAATCTTTG AACGCACATT GCGCCCACCA GTATTCTGGT GGGCATGCCT
N_ATROPURPUREA       CGAATCTTTG AACGCACATT GCGCCCATTA GTATTCTAGT GGGCATGCCT
N_CHESTERSII         CGAATCTTTG AACGCACATT GCGCCCACCA GTATTCTGGT GGGCATGCCT
N_COLLICULOSA        CGAATCTTTG AACGCACATT GCGCCCACTA GTATTCTGGT GGGCATGCCT
N_PRAVA              CGAATCTTTG AACGCACATT GCGCCCACTA GTATTCTGGT GGGCATGCCT
N_SERPENS            CGAATCTTTG AACGCACATT GCGCCCACTA GTATTCTGGT GGGCATGCCT

                        305        315        325        335        345
XYLARIA_HYPOXYLON    GTTCGAGCGT CATTTCAACC CTTAAGCCCC TGTTGCTTAG CGTTGGGAGC
BISCOGN_NUMMULARIA   GTTCGAGCGT CATTTCAACC -CCAAGCC-- ----GCTTTT GCTTGG????
ENTOLEUCA_MAMMATA    GTTCGAGCGT CATTTCGACC ATTAAGCCC- TGTAGCTTAG CGTTAGGAGC
HYPOXYLON_FUSCUM     ATTCGAGCGT CATTTCGACC CTGAAGCCCT GGTTGCTTCG CGTTGGGACT
H_MULTIFORME         ATTCGAGCGT CATTTCGACC ATTAAGCCC- TGTAGCTTAG CGTTGGGAGC
H_PORPHYREUM         ATTCGAGCGT CATTTCAACC CTGAAGCCCT GGCTGCTTCG CGTTGGGA-C
NEMANIA_AENEA        GTTCGAGCGT CATTTCAACC CTTAAGCCCC TGTTGCTTAG CGTTGGGAGC
N_ATROPURPUREA       GTTCGAGCGT CATTTCAACC CTTAAGCCCC TGTTGCTTAG CGTTGGGAGC
N_CHESTERSII         GTTCGAGCGT CATTTCAACC CTTAAGCCCT CGTCGCTTAG CGTTGGGAGC
N_COLLICULOSA        GTTCGACGCT CATTTCAGCC CTTAAGCCCC CGTTGCTTAG TGTTGGGAGC
N_PRAVA              GTTCGAGCGT CATTTCAACC CTTAAGCCCC CGTTGCTTAG TGTTGGGAGC
N_SERPENS            GTTCGAGCGT CATTTCAACC CTTAAGCCCC TGTTGCTTAG CGTTAGGAGC

                        355        365        375        385        395
XYLARIA_HYPOXYLON    CTACAG---- CCTTCTGTAG CTCCCCAAAG TTAGTGGCGG AGTTCGGTTC
BISCOGN_NUMMULARIA   ?????????? ?????????? ?????????? ?????????? ??????????
ENTOLEUCA_MAMMATA    -TACCGGAAC TCTCTGGTAG CTCCC-AAAG TCAGTG-CGG AG-CCG--TC
HYPOXYLON_FUSCUM     CTACTGG--C T-ACCTGTAG TTCCT-AATG ACAGTG-CGG AG-T??????
H_MULTIFORME         CTAC-GG--T TGTAGCGTAG CTCCTCAAAG TCAGTGGCGG AGTTTGG--C
H_PORPHYREUM         CTACAG--AC T-ACCTGTAG -TCCT-AAAG GCAGTG-CGG AGTTCGGTTA
NEMANIA_AENEA        CTACTGGAAC ACACCTGTAG CTCCCCAAAG TCAGTGGCGG AG-CCGGTTC
N_ATROPURPUREA       CTACGTGCG- ---CCTGTAG CTCCT-AAAG TTAGTGGCAG AG-TCGGTTC
N_CHESTERSII         CTACTGGAAC TCTCCTGTAG CTCCCCAAAG TCAGTGGCGG AG-CCGGCTC
N_COLLICULOSA        CTACTGGAAC TCTCCTGTAG CTCCCCAAAG TCAGTGGCGG AG-CCGGTTC
N_PRAVA              CTACTGGAAC TCTCCTGTAG CTCCCCAAAG TCAGTGGCGG AG-CCGGTTC
N_SERPENS            TTACCGGAAC TCTCTGGTAG CTCCCCAAAG TCAGTGGCGG AG-CCGGTTC

                        405        415        425        435        445
XYLARIA_HYPOXYLON    ACACTCTAGA CGTAGTA--G ATT--CTATC TCGTCTGTAG TGAGG--CCG
BISCOGN_NUMMULARIA   ?????????? ?????????? ?????????? ?????????? ??????????
ENTOLEUCA_MAMMATA    GCACGCCACA CGTAGTA--G CTTTTACACG TCGCCTGTAG CGCGGGCC-G
HYPOXYLON_FUSCUM     ?????????? ?????????? ?????????? ?????????? ??????????
H_MULTIFORME         GTACTCTGAG CGTAGTAAAT CTTTT-CTCG CTTC-TGTAG CGC---CCTA
H_PORPHYREUM         -ACCTC-AG- CGTAGTA--G -TT--C???? ?????????? ??????????
NEMANIA_AENEA        GCACTCCAGA CGTAGTA--G CTTTTACACA TCGCCTGTAG CTTGGA-CCG
N_ATROPURPUREA       ACACTCTAGA CGTAGTA--A GTTTTACACA TCGCCTATAG C-TGGA-CCG
N_CHESTERSII         GTACTCCATA CGTAGTA--G CTTTTACCTA TCGCCTGTAG CGTGGA-CCG
N_COLLICULOSA        GCACTCCAGA CGTAGTA--G CTTTTACACA TCGCCTGTAG CTTGGACCCG
N_PRAVA              GCACTCCAGA CGTAGTA--G CTTTTACACA TCGCCTGTAG CTTGGA-CCG
N_SERPENS            GCACTCCAGA CGTAGTA--G CTTTTACACG TCGCCTGTAG CGCGGG-CCG

                        455        465        475        485        495
XYLARIA_HYPOXYLON    GTCCCCTGCC GGTAAAA--- -CCCCTATTT T-A-AGGT-G ACCTGT??
BISCOGN_NUMMULARIA   ?????????? ?????????? ?????????? ?????????? ????????
ENTOLEUCA_MAMMATA    GTCCCCTGCC G-TAAAACA- -CCCCAATTT NNATAGGTTG ANCTCGG?
HYPOXYLON_FUSCUM     ?????????? ?????????? ?????????? ?????????? ????????
H_MULTIFORME         GCTGCCTGCC G-TAAAA--- CCCCCTATAT ?????????? ????????
H_PORPHYREUM         ?????????? ?????????? ?????????? ?????????? ????????
NEMANIA_AENEA        GTCCCCTGCC GGTAAAACAC CCCCCAATTT T-AT-GGTTG T???????
N_ATROPURPUREA       GTCCCTTGCC TG-AAAA-CC CCCCTCATTT TTATAGGTTG ACCCCGG?
N_CHESTERSII         GTCCCCTGCC -ATAAAA--C CCCCCAATTC TTAT?????? ????????
N_COLLICULOSA        GTCCCCTGCC G-TAAAACAC CCCC-AATTT T-ATAGGTTG ACC?????
N_PRAVA              GTCCCCTGCC GGTAAAACAC CCCCCAATTT T-ATAGGTTG ACCT????
N_SERPENS            GTCCCCTGCC G-TAAAACA- -CCCCAATTT TTATAGGTTG ACCTCGG?
```

SOMMERFELTIA AND SOMMERFELTIA SUPPLEMENT

Vol. 1. A. Hansen & P. Sunding: Flora of Macaronesia. Checklist of vascular plants. 3. revised edition. 167 pp. NOK 140. (Jan. 1985; out of stock).

Vol. 2. R.H. Økland & E. Bendiksen: The vegetation of the forest-alpine transition in Grunningsdalen, S. Norway. 224 pp. NOK 170. (Nov. 1985).

Vol. 3. T. Halvorsen & L. Borgen: The perennial Macaronesian species of Bubonium (Compositae-Inuleae). 103 pp. NOK 90. (Feb. 1986).

Vol. 4. H.B. Gjærum & P. Sunding: Flora of Macaronesia. Checklist of rust fungi (Uredinales). 42 pp. NOK 50. (Dec. 1986).

Vol. 5. J. Middelborg & J. Mattsson: Crustaceous lichenized species of the Caliciales in Norway. 71 pp. NOK 70. (May 1987).

Vol. 6. L.N. Derrick, A.C. Jermy & A.C. Paul: Checklist of European Pteridophytes. xx + 94 pp. NOK 95. (Jun. 1987).

Vol. 7. L. Malme: Distribution of bryophytes on Fuerteventura and Lanzarote, the Canary Islands. 54 pp. NOK 60. (Mar. 1988).

Vol. 8. R.H. Økland: A phytoecological study of the mire Northern Kisselbergmosen, SE. Norway. I. Introduction, flora, vegetation, and ecological conditions. 172 pp. NOK 140. (Oct. 1989).

Vol. 9. G. Mathiassen: Some corticolous and lignicolous Pyrenomycetes s. lat. (Ascomycetes) on Salix in Troms, N Norway. 100 pp. NOK 85. (Oct. 1989).

Vol. 10. T. Økland: Vegetational and ecological monitoring of boreal forests in Norway. I. Rausjømarka in Akershus county, SE Norway. 52 pp. NOK 55. (June 1990).

Vol. 11. R.H. Økland (ed.): Evolution in higher plants: patterns and processes. Papers and posters presented on a symposium arranged on occasion of the 175th anniversary of the Botanical Garden in Oslo, June 5-8, 1989. 183 pp. NOK 150. (Dec. 1990).

Vol. 12. O. Eilertsen: Vegetation patterns and structuring processes in coastal shell-beds at Akerøya, Hvaler, SE Norway. 90 pp. NOK 85. (June 1991).

Vol. 13. G. Gulden & E.W. Hanssen: Distribution and ecology of stipitate hydnaceous fungi in Norway, with special reference to the question of decline. 58 pp. NOK 110. (Feb. 1992).

Vol. 14. T. Tønsberg: The sorediate and isidiate, corticolous, crustose lichens in Norway. 300 pp. NOK 330. (May 1992).

Vol. 15. J. Holtan-Hartwig: The lichen genus *Peltigera*, exclusive of the *P. canina* group, in Norway. 77 pp. NOK 90. (March 1993).

Vol. 16. R.H. Økland & O. Eilertsen: Vegetation-environment relationships of boreal coniferous forests in the Solhomfjell area, Gjerstad, S Norway. 254 pp. NOK 170. (March 1993).

Vol. 17. A. Hansen & P. Sunding: Flora of Macaronesia. Checklist of vascular plants. 4. revised edition. 295 pp. NOK 250. (May 1993).

Vol. 18. J.F. Ardévol Gonzáles, L. Borgen & P.L. Péres de Paz: Checklist of chromosome numbers counted in Canarian vascular plants. 59 pp. NOK 80. (Sept. 1993).

Vol. 19. E. Bendiksen, K. Bendiksen & T.E. Brandrud: *Cortinarius* subgenus *Myxacium* section *Colliniti* (Agaricales) in Fennoscandia, with special emphasis on the Arctic-alpine zones. 37 pp. NOK 55. (Nov. 1993).

Vol. 20. G. Mathiassen: Corticolous and lignicolous Pyrenomycetes s.lat. (Ascomycetes) on *Salix* along a mid-Scandinavian transect. 180 pp. NOK 180. (Nov. 1993).

Vol. 21. K. Rydgren: Low-alpine vegetation in Gutulia National Park, Engerdal, Hedmark, Norway, and its relation to the environment. 47 pp. NOK 65. (May 1994).

Vol. 22. T. Økland: Vegetation-environment relationships of boreal spruce forests in ten monitoring reference areas in Norway. 349 pp. NOK 230. (May 1996).

Vol. 23. T. Tønsberg, Y. Gauslaa, R. Haugan, H. Holien & E. Timdal: The threatened macrolichens of Norway - 1995. 258 pp. NOK 220. (June 1996).

Vol. 24. C. Brochmann, Ø.H. Rustan, W. Lobin & N. Kilian: The endemic vascular plants of the Cape Verde islands, W Africa. 356 pp. NOK 230. (Dec. 1997).

Vol. 25. A. Skrindo & R.H. Økland: Fertilization effects and vegetation-environment relationships in a boreal pine forest in Åmli, S Norway. 90 pp. NOK 90. (Dec. 1998).

Vol. 26. A. Granmo: Morphotaxonomy and chorology of the genus *Hypoxylon* (Xylariaceae) in Norway. 81 pp. NOK 120. (Sept. 1999).

Vol. 27. A. Granmo, T. Læssøe & T. Schumacher: The genus *Nemania* s.l. (Xylariaceae) in Norden. 96 pp. NOK 135 (Sept. 1999).

Supplement Vol. 1. R.H. Økland: Vegetation ecology: theory, methods and applications with reference to Fennoscandia. 233 pp. NOK 180. (Mar. 1990).

Supplement Vol. 2. R.H. Økland: Studies in SE Fennoscandian mires, with special regard to the use of multivariate techniques and the scaling of ecological gradients. (Dissertation summary). 22 pp. NOK 35. (Dec. 1990).

Supplement Vol. 3. G. Hestmark: To sex, or not to sex... Structures and strategies of reproduction in the family Umbilicariaceae (Lecanorales, Ascomycetes). (Dissertation summary). 47 pp. NOK 55. (Dec. 1991).

Supplement Vol. 4. C. Brochmann: Polyploid evolution in arctic-alpine *Draba* (Brassicaceae). 37 pp. NOK 60. (Nov. 1992).

Supplement Vol. 5. A. Hansen & P. Sunding: Botanical bibliography of the Canary Islands. 116 pp. NOK 130. (May 1994).

Supplement Vol. 6. R.H. Økland: Boreal coniferous forest vegetation in the Solhomfjell area, S Norway: structure, dynamics and change, with particular reference to effects of long distance airborne pollution. 33 pp. NOK 43. (May 1995).

Supplement Vol. 7. K. Rydgren: Fine-scale disturbance in an old-growth boreal forest - patterns and processes. 25 pp. NOK 40. (May 1997).

INSTRUCTIONS TO AUTHORS:

SOMMERFELTIA accepts scientific papers of 32 printed pages or more, in English. The abstract must not exceed 300 words. The author is responsible for ensuring that the English is linguistically correct.

Manuscripts to SOMMERFELTIA must not have been published or accepted for publication elsewhere.

Manuscripts are subjected to peer reviewing by at least two reviewers, before acceptance or rejection is decided.

Authors of planned contributions to SOMMERFELTIA are recommended to contact the editor early in the writing process: manuscripts should, as far as possible, be prepared by the author to fit the layout of the series. Relevant WordPerfect codes on a discette, as well as further instructions, are obtained from the editor. The manuscript should be submitted in three copies, accompanied by one copy on discette upon request from the editor.

Figures (incl. line drawings) should preferably be 16.0 cm broad and not higher than 23.6 cm -the type area. They are reduced to 87 % during the printing process. Narrower and broader figures may be accepted. Legends to figures should be included as a separate file. Tables (including headings) should be enclosed on a separate file. Tabulator stops should be used for vertical alignment of columns. One open line should be left between the table heading and the table proper. Tables placed at right angles to normal text should be 23.6 cm broad and not more than 16.0 cm high. Tables divided on more pages can be accepted; on the second and later pages the table heading should be Tab. x (continued).

Figures and tables should be numbered separately and consecutively with Arabic numerals. Black and white photographs can be accepted after agreement with the editor. Coloured illustrations are normally accepted only when paid for by the author. Taxonomic keys should have right margins and be based on dichotomies. References should be written according to current practice in SOMMERFELTIA. SOMMERFELTIA prefers abbreviations of titles in accordance with the World List of Scientific Periodicals. Recent issues of SOMMERFELTIA (Vols 22-27) should be consulted for details of layout.

An author is supplied with ten copies free of charge. When there are more than one author, each receives eight copies free of charge. Additional copies may be ordered at subscription cost.

Trykk: GCS AS, Oslo