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T. Tønsberg

The sorediate and isidiate, corticolous, crustose lichens in Norway

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128 species in 45 genera of sorediate and isidiate, crustose, corticolous lichens are recorded from Norway. Accounts of their morphology, chemistry, and substratum preferences are presented, and a discussion of their distribution in Norway is supported by maps for a number of taxa. With few exceptions, the taxa can be distinguished on thallus characters alone. Several taxa, especially those with brown or blue-pigmented soralia, have soredia with a distinct cortex. New species are: *Buellia arborea* Coppins & Tønsb. (from Norway and Scotland), *Fuscidea arboricola* Coppins & Tønsb. (from Norway, Sweden, and Scotland), *F. pusilla* Tønsb. (from Norway, Sweden, and Scotland), *Lecanora flavoleprosa* Tønsb. (from Norway and Austria), *L. flavopunctata* Tønsb. (from Norway and Sweden), *L. norvegica* Tønsb. (from Norway), *Lecidea gyrophorica* Tønsb. (syn. *L. epizanthoidiza* auct., non Nyl.), *L. praetermissa* Tønsb. (from Norway and Sweden), *L. subcinnabarina* Tønsb. (from Norway), *L. vacciniicola* Tønsb. (from Norway, Sweden, and Spain), *Lecidella subviridis* Tønsb. (from Norway and Sweden), *Lepraria elobata* Tønsb. (from Norway), *L. jackii* Tønsb. (from Norway), *L. obtusatica* Tønsb. (from Norway), *L. umbricola* Tønsb. (from Norway, England, and Scotland), *Micarea coppinsii* Tønsb. (from Norway and Scotland), *Rinodina flavosoralifera* Tønsb. (from Norway), *R. disjuncta* Sheard & Tønsb. (from Norway and the pacific coast of U.S.A. and Canada), and *Schaereria corticola* Muhr & Tønsb. (from Norway, Sweden and Scotland). *Ochrolechia androgyna* s. lat. is shown to comprise at least four distinct species.

New combinations are: *Cliostomum leprosum* (Räsänen) Holien & Tønsb., *Lepraria rigidula* (B. de Lesd.) Tønsb., *Mycoblastus caesius* (Coppins & P. James) Tønsb., *Placynthiella dasaea* (Stirton) Tønsb., and *Ropalospora viridis* (Tønsb.) Tønsb. *Lecidea turgidula* var. *pulveracea* Fr. is raised to specific level with the new name *Lecidea leprarioides* Tønsb. *Mycoblastus sterilis* Coppins & P. James is reduced to synonymy with *M. fucatus* Stirton.

Pertusaria borealis is new to Europe. *Halecania viridescens, Lecanora farinaria, Lepraria caesioalba* Laundon ined., *L. eburnea* Laundon ined., *Megalospora tuberculosa, Opegrapha multipuncta*, and *Scoliciosporum gallurae* are new to Scandinavia. *Mycoblastus caesius, Lecidella elaeochroma* "f. *soralifera*", *L. flavosorediata, Micarea granulans* (saxicolous, not treated), *Opegrapha sorediifera*, and *Rinodina degeliana* are new to Norway.

In some cases, Poelt's species pair concept can be applied to this group of lichens. Additional secondary substances, not occurring in the primary species, sometimes occur in the soralia of the secondary species. In this case, presence of the additional substance cannot be regarded as an independent taxonomic character, and the species pair concept is still useful. However, morphologically indistinguishable specimens with different chemistry may represent different secondary species.

The term consoredia is introduced to denote diaspores composed of aggregated soredia.

Keywords: Ascomycetes, Distribution, Isidia, Lichens, Lichen substances, Norway, Soredia, Substratum ecology, Taxonomy.

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CONTENTS

INTRODUCTION

Lichenized ascomycetes employ two main divergent strategies of reproduction, a sexual strategy through ascospores and an asexual strategy through dispersal of specialized vegetative diaspores or thallus fragments. Lichens which produce structures for vegetative reproduction commonly occur without apothecia. When apothecia occur, they are often sparse or immature. Classification of lichens is based primarily on the ontogeny and anatomy of the ascocarps. Assigning sterile species to the correct genus is therefore often conjectural until fruiting specimens have been found.

Fortunately, most sorediate and isidiate lichen specimens can be recognized on characters of the thallus. Morphology may in many cases provide sufficient information for determination. However, sterile crustose lichens belonging in widely different genera may have very similar appearances due to convergence and parallel evolution. In such cases characters of chemistry, mostly secondary product chemistry, may be indispensable.

Sorediate and isidiate corticolous crustose lichens have mostly been neglected by collectors of Norwegian lichens. Many widespread and common species were totally lacking or represented by only a few specimens in the herbaria prior to the start of the present investigations. This is apparently due to the fact that sorediate and isidiate species are often sterile and inconspicuous. Among the most comprehensive collections of Norwegian sorediate and isidiate corticolous crustose lichens were those made, mainly in Vestfold, by Ove Arbo Høeg for his study of the Norwegian corticolous Pertusariaceae and "Thelotremaceae" (Høeg 1923). His material is deposited in TRH. Other extensive and important herbarium collections include those made by G. Degelius, T. M. Fries, J. J. Havaas, N. C. Kindt, B. Lynge, N. G. Moe, A. H. Magnusson, and J. M. Norman.

Annotated keys to sterile corticolous lichens, containing many species also occurring in Norway, have been compiled for South Sweden (Almborn 1952) and the British Isles (Laundon 1963). These keys contain about 50 and 40 taxa of the groups treated here, respectively. In the recent Swedish crustose lichen flora by Foucard (1990), the corresponding number amounts to about 90 taxa. Although these works cover different geographical areas and therefore different lichen floras, they indicate that the number of known taxa is increasing in northwest Europe. This increase is probably largely due to the extended general knowledge of lichens during the last few decades. Particularly important is the use of chemical characters which was greatly facilitated by the standardized thin-layer chromatographic techniques (Culberson & Kristinsson 1970), making accurate and reproducible determinations of chemical substances possible.

Recent papers of special importance for the study of Scandinavian corticolous crustose lichens are Santesson's (1984) checklist of the lichens of Norway and Sweden, and works on British lichens carried out by, e.g., Coppins & James (1978, 1979a,b, 1984), James (1971), and Laundon (1981, 1989). Many of the species recently described from Scotland and other parts of the British Isles, have subsequently been found in Scandinavia.

Although taxonomic problems are usually best solved by monographic treatments of genera, this study was carried out partly in order to discover sterile species which have remained overlooked by monographers.

CHOICE OF TAXA

According to their growth form, lichens are often classified as crustose, foliose or fruticose. The limits between these three main groups are not sharp and numerous intermediates occur. Squamulate and squamiform taxa are intermediate between distinctly crustose and distinctly foliose lichens, but were classified as crustose in a wide sense by Henssen & Jahns (1973). In the present account most taxa are distinctly crustose, but several subsquamulate taxa and one distinctly squamulate taxon are also included. Taxa belonging to genera included in Krog et al. (1980), a Norwegian flora mainly treating foliose and fruticose species, are omitted. In deciding which species should be included, I admit to being somewhat arbitrary. I have, e.g., decided to exclude all species of *Bacidia* s. lat. and *Lopadium* with a (sub-)isidiate thallus. Also not included were some species, most of which are apparently new, of which the available material is sterile and too scanty for an exhaustive description. I have, on the other hand, included *Chaenotheca furfuracea* which is usually esorediate. The corticolous material of *Psilolechia lucida* included in this study is not sorediate, but that species is included because saxicolous specimens are often sorediate. *Trapeliopsis glaucolepidea* (Nyl.) G. Schneider, a lignicolous species, was left out, although some corticolous areolae spreading onto bark from adjacent wood have been found.

AIMS

The study had five principle aims: (1) To make a synopsis of the sorediate and isidiate, corticolous, crustose lichens in Norway, (2) to elucidate and, when possible without carrying out monographic treatments of genera, solve taxonomic problems at the species level, (3) to find, if possible, diagnostic thalline characters of the taxa, (4) to prepare descriptions of and keys to the taxa, based on thalline characters, and (5) to discern local distributions and substratum preferences of the taxa.

The present account should be regarded as a first step towards a better understanding of the Norwegian corticolous flora of sterile lichens, as they are still far from being well-known.

MATERIALS, METHODS AND TERMINOLOGY

MATERIALS

The present account is based on about 4800 specimens collected by the author and about 1800 collections, mainly herbarium material, received on loan from or studied in the following institutional herbaria (abbreviations according to Holmgren et al. 1990): BG, C, LD, NLH, O, S, TRH, TROM, and UPS, and from the private herbarium of G. Degelius (Göteborg). Material from outside Norway, e.g., type specimens and other specimens which were used for the purpose of comparison, were borrowed from the herbaria mentioned above and from BM, BP, CANL, E, GZU, H, MICH, TUR, UBC, and WIS, and from the private herbaria of P.P.G. van. den. Boom (Netherlands: Son), M. Dietrich (Switzerland: Bern), McCune (U.S.A.: Corvallis), J.E. Salazar (Spain: Navarra), J. Sheard (Canada: Saskatoon), and R. Türk (Austria: Salzburg). Many recent collections of relevant material have been placed at my disposal, especially by J. E. Anonby (Leikanger), A. Botnen (Bergen), B.J. Coppins (Edinburgh), G. Gaarder (Lena), L.-E. Muhr (Karlskoga), A. Orange (Cardiff), D. O. Øvstedal (Bergen), and H. Holien (Trondheim); these collections belong to BG and to E (Coppins), TRH (Holien) and UPS (Muhr). Most of the author's collections, including all specimens referred to by collection number, are deposited in BG unless otherwise stated.

No attempts were made to recognize duplicates in the herbarium material, and for all calculations, duplicates of herbarium specimens collected prior to the present study, were regarded as distinct collections. Occasional esorediate specimens of species which are usually sorediate are included.

METHODS

Field work

The author's field work, comprising a total of about 500 days, was carried out during 1977-1991. All Norwegian counties (fylker), were visited. Parts of the counties Hordaland, Sør-Trøndelag, Nord-Trøndelag, and Nordland were more thoroughly investigated than the other parts of Norway. The vertical distribution of the investigated sites ranged from about sea-level to 1550 m; by far the most sites were in the lowlands. The sites for the author's collections are mapped in Fig. 1. All the taxa have been collected and studied in the field by the author.

It is evident from Fig. 1 that parts of coastal Norway (in a broad sense) have been more intensively studied than the inland (Oppland, Hedmark). This concentration on coastal lowland habitats is partly due to fact that the richest flora of deciduous trees and shrubs is found in a broad belt along the southern and westernmost coast. This unevenness in collecting frequency should be kept in mind when considering the types of distribution discussed below.

Field work was carried out in natural or semi-natural habitats, as well as habitats more

Fig. 1. Map of sites where the author has collected specimens of the taxa in this study.

strongly influenced by man. The former type of habitats included most alpine habitats and the few existing virgin forests; the second type of habitat included most of the deciduous broad-leaved groves and coniferous forests, churchyards, parks, and gardens. The localities were selected subjectively by searching for sites which were likely to contain interesting species or to be species-rich.

The total number of studied individuals of the different phorophytes varied greatly. Trees have been more frequently investigated than shrubs and dwarf shrubs, and trunks much more frequently than their branches and twigs. The phorophytes on which the lichen specimens were collected are listed in Tab. 1.

Fertile specimens were especially sought for, and the given percentages of fertility are therefore merely rough indications. The percentage is calculated on the basis of the presence at least one ascocarp in a collection. As fertile specimens are usually particularly sought for in the field, they are - compared with the sterile ones - usually highly over-represented in the herbaria; thus the % numbers given do not reflect nature.

Preparation of the specimens. Fresh bark pieces of many phorophytes will cure when allowed to dry, sometimes ultimately forming a tube. In order to make flat pieces, the samples were usually dried in a plant press.

Mixed stands method

If two or more morphologically dissimilar forms are species specific, they are believed to be able to grow under the same environmental conditions without the existence of intermediates (see, e.g., Esslinger 1977: 71). In the present account, taxa growing side by side on a uniform surface of a small piece of bark were regarded as having been subjected to the same environmental conditions. Study of such mixed stands has been important in deciding the morphological differences between some taxa, especially of *Lepraria.*

The mixed stand method should be used with great caution and not mechanically (see, e.g., Wyatt et al. 1982). Individuals of a mixed stand should ideally be of the same age. Individuals of a single species, even of sterile species, may differ morphologically and chemically due to slight differences in their genetical constitution. The mixed stands method was not applied on taxa which were regarded as representing pairs of primary and secondary taxa.

Microscopy

All specimens were examined with the aid of a binocular Leitz dissecting microscope (DM), usually at 10× or 25×. Measurements given in mm are DM measurements on dry material. The standard spot tests applied to thalli were performed using DM.

Sizes of areolae were measured under the dissecting microscope. The measurements given refer to esorediate areolae or to sorediate areolae where the size was not considered to have been altered by expansion of the soralia.

Examination and measurements of anatomical preparations were carried out utilizing a binocular Zeiss light microscope (LM) at up to 1000× magnification. Soredia were mounted in water and the preparations were treated gently in order not to crush the framework formed by the hyphae. Examination of soredia and consoredia usually required a droplet of 10% KOH

Tab. 1. The phorophytes. Phorophytes marked with an asterisk (*) have only occasionally been collected from.

Category		Species
Coniferous trees and shrubs	*	*Abies alba* Mill.
		Juniperus communis L.
	*	*Larix decidua* Mill.
		Picea abies (L.) Karst. (*Picea abies* subsp. *abies*)
	*	*P. abies* (L.) Karst. subsp. *obovata* (Ledeb.) Hultén
		Pinus sylvestris L.
	*	*Pinus mugo* Turra
	*	*P. ponderosa* Dougl.
	*	*Taxus baccata* L.
	*	*Thuja* sp.
Deciduous trees		*Acer platanoides* L.
		A. pseudoplatanus L.
		Aesculus hippocastanum L.
		Alnus glutinosa (L.) Gaertn.
		A. incana (L.) Moench.
	*	*A. incana* (L.) Moench. subsp. *kolaensis*
		Betula pubescens/pendula (*B. pubescens* Ehrh. and/or, more rarely, *B. pendula* Roth.)
	*	*Carpinus betulus* L.
		Fagus sylvatica L.
		Fraxinus excelsior L.
		Malus domestica Borckh.
		Populus tremula L.
	*	*Populus simonii* Carr.
	*	*Prunus avium* L.
	*	*P. cerasus* L.
		P. domestica L.
		P. padus L.
	*	*Pyrus communis* L.
		Quercus (*Q. petraea* (Matt.) Liebl. and/or *Q. robur* L.)
		Salix caprea L.
		Sorbus aucuparia L.
	*	*S. hybrida* L.
		Tilia (*T. cordata* Mill., rarely *T. platyphyllus* Scop.)
		Ulmus glabra Huds.
Deciduous or evergreen shrubs (incl. dwarf shrubs and small trees)		*Betula nana* L.
		Calluna vulgaris (L.) Hull
		Corylus avellana L.
	*	*Crataegus calycina* Peterm.
	*	*Erica cinerea* L.
	*	*Empetrum* (*E. nigrum* L. or *E. hermaphroditum* Hagerup.)
	*	*Frangula alnus* Mill.
	*	*Ilex aquifolium* L.
	*	*Loiseleurea procumbens* (L.) Desv.
	*	*Mespilus germanicus* L.
	*	*Rhamnus catharticus* L.
	*	*Rhododendron catawbiense* Michx.
		Salix aurita L.
	*	*S. nigricans* Sm.
		Salix sp(p). (low-alpine/subalpine shrubs, mainly *S. glauca* L. and *S. lapponum* L.)
	*	*Sambucus nigra* L.
	*	*Syringa vulgaris* L.
		Vaccinium myrtillus L.

added under the cover-slip in order to dissolve crystals of lichen substances obscuring the details. Conidia, asci, spores, paraphyses and photobiont cells were studied in squash preparations. Routine examination of apothecial tissue was carried out on hand-cut sections; detailed anatomical studies required 8-15 µm thick sections cut on a freezing microtome. The preparations were mounted in one or several of the following solutions: water, 50% HNO_3 (N), diluted lactophenol-cotton-blue (LCB), and a modified Lugol's solution in which H_2O was replaced by lactic acid (I). Microscope measurements were made in water or in water with drops of 10% KOH (K) added under the coverslip.

The iodine reaction (I) was studied with and without pretreatment with K; the former reaction is denoted K/I. The standard spot test reagents K and C (see below) were also applied to microscopical preparations mounted in water by adding a drop of the reagent to the edge of the cover slip. For the PD reaction, a dry preparation was needed. Tests of colour reaction of pigments in prothallus hyphae, soredia, and apothecia were made in LM. Polarized light was used to locate crystals. Colours of the soralia were observed on dry specimens using DM, whereas those of the soredia were observed in LM. Thallus thickness was measured (DM) through the thickest thallus parts, such as tuberculae and soralia.

Microphotography was performed with a Zeiss Axiomat (LM) and a Jeol JSM-T200 (SEM). Photography (LM) of soredia and consoredia was based on gently squashed preparations mounted in water with a drop of K. The microscope light was incidental if not otherwise stated. Macrophotography was performed with a Wild Leitz Makroskop.

Descriptions

The descriptions are based on my own examinations of Norwegian corticolous material unless otherwise stated.

Chemistry

Thin-layer chromatography

Thin-layer chromatography (TLC) was carried out in accordance with the standardized methods of Culberson & Kristinsson (1970) and Culberson (1972), modified by Menlove (1974) and Culberson & Johnson (1982). On the plates, extracts of up to 18–23 lichens were spotted. By routine TLC, the solvent front was allowed to run high up on the plates, especially in solvent C in which the entire plate was often used.

The basic solvent systems were:
Solvent A. Toluene/dioxane/acetic acid (180:45:5).
Solvent B. Hexane/methyl tert.-butyl ether/formic acid (140:72:18).
Solvent C. Toluene/acetic acid (200:30).

All specimens, except a few which were too scanty, were run in all the three basic solvent systems. Aluminum plates were used in solvent A and B, glass plates in solvent C. Specimens found to contain fatty acids were re-chromatographed on glass plates in all solvent systems. Two-dimensional chromatograms were prepared by the standardized methods of Culberson & Johnson (1976) and Culberson et al. (1981).

In order to obtain an adequate separation of difficult mixtures of related compounds which do not separate in the standard A-B-C solvent systems, several additional systems were used:

Solvent D (Dibben 1980, Hanko 1983). Butanol/acetone/water (75:15:30). This solvent was useful for separation of protocetraric acid-type β-orcinol depsidones. A number of specimens of most species containing fumarprotocetraric acid or succinprotocetraric acid (including about 70 specimens of *Pertusaria borealis*) were analysed in this system.

Solvent G (Culberson et al. 1981). Toluene/ethyl acetate/formic acid (139:83:8). This solvent was particularly useful for improved resolution of mixtures of low R_F β-orcinol depsidones. Satellites of fumarprotocetraric acid (protocetraric acid, succinprotocetraric acid, and the unknowns cph-1 and cph-2) and of stictic acid (cryptostictic and constictic acids) were distinguished in this solvent system. For all species containing stictic acid (except *Porpidia* sp. A, which was too scanty) two-dimensional GxA chromatography of one specimen and one-dimensional chromatography in solvent G of several specimens were performed. The results were compared with one- and two-dimensional chromatograms of *Parmelia (Parmotrema) crinita* and *Menegazzia terebrata* (see Culberson et al. 1981). Several unknown substances (probably including Pcr-1, Pcr-2, Pcr-3, or Pcr-4; see Culberson et al. 1981) occurred, but no effort was made to identify these substances.

All specimens of *Pertusaria borealis* were analysed in solvent G.

Solvent H (J. Santesson 1967). Cyclohexane/chloroform/ethyl methylketone (60:30:40). This solvent separates atranorin and chloroatranorin, as well as usnic- and isousnic acids. *Hypogymnia physodes*, which contains both atranorin and chloroatranorin (Ohlsson 1973), was used as a control. Selected specimens (up to 20) of all species found to contain atranorin by chromatography in the standard A, B, and C solvents, were re-run in solvent H. The corticolous material of *Lecania baeomma* was sparse; the recorded chloroatranorin was based on results obtained by analyses of three saxicolous specimens.

Solvent J (Hanko 1983). Dichloromethan/aceton (4:1). This solvent was useful for separation of xanthones. The colour of the spots in long wave UV-light before acid-charring varied greatly from yellowish to orange-red and brown and proved to be compound specific.

Solvents L and M (J. Elix, pers. comm. to P.M. Jørgensen). L: Acetic acid/toluene (15:85); M: Ethylacetate/cyclohexane (25:75).

Solvent L and M were used once to confirm the presence of norargopsin. Norstictic acid and atranorin were used as standards. The spots were sorted by R_F-classes defined on each chromatogram by the standards according to Culberson & Kristinsson (1970). It proved convenient also to have several other control substances present. A lichen mixture containing large amounts of atranorin and norstictic acid, as well as of fumarprotocetraric acid, divaricatic acid, usnic acid, and zeorin, was usually collectively extracted and spotted on the chromatograms.

Some groups of compounds, e.g., fatty acids and xanthones, are not exhaustively treated in the standardized accounts of TLC data for lichen products (see Culberson & Kristinsson 1970, Culberson 1972, and White & James 1985). In such cases, pure samples, if available, were used to verify the presence of a particular substance. The following pure samples were put at my disposal by S. Huneck (Halle): Argopsin, arthothelin, dihydropertusaric acid, pannarin, parietin, thiophanic acid, thiophaninic acid, and thuringione.

Fatty acids were located by spraying the plates with water after acid treatment. Spots representing fatty acids turned opaque on wetted plates. By two-dimensional chromatography of extracts containing fatty acids, the plates were wetted with water twice, firstly after the plates had been run in the first direction and secondly after acid charring of the two-dimensional chromatogram.

The material was usually run shortly after it had been collected and dried. During the first chemical analysis of the material a number of different species in different genera were often run simultaneously. When conspecific specimens were subsequently filed together, they were often chromatographed at least one additional time. Co-chromatography of conspecific specimens proved particularly useful and led to the detection of several minor, but significant substances which during routine chromatography of occasional specimens had been overlooked or regarded as a possible contamination.

The detection of a 'new' spot on the chromatograms often led to a thorough chemical reinvestigation of all specimens of the species or species-complex in order to ascertain if the spot had previously been overlooked or not. In fact, a large number of specimens were run many times. Unidentified substances were compared to known control substances run alongside the unknowns. The frequency of a trace substance was difficult to establish as it was often uncertain when a spot representing such substances was present or not. A substance which has been cited as accessory, might actually prove to be constant by the application of more sensitive methods. Terpenoids in trace amounts were particularly easy to overlook as their occurrence on the plates was often obscured by terpenoids from the substratum. Detailed two-dimensional chromatography was not carried out for trace terpenoids. If the presence of a particular substance was established by TLC of only a selection of specimens, this has been indicated in the text.

Terpenoids were often difficult to distinguish from contaminating terpenoids from the bark of the phorophyte; usually no effort was made to identify or characterize terpenoids other than zeorin. Usually only major terpenoids were characterized chromatographically. An exception was the terpenoids of *Lecanora impudens* which were compared chromatographically with those of *Lecanora allophana* "f. *sorediata*". It was important to compare the terpenoid patterns of the lichens with that of the pure bark of the phorophyte. For species which also may occur on stone, corticolous and saxicolous material were compared, as the substratum of the latter did not contain any confusing organic substances such as terpenoids.

In species producing gyrophoric and/or lecanoric acids a number of unidentified substances often occurred. These substances, including a substance giving a pinkish spot in day-light on untreated plates, were not usually studied further.

Chromatography of occasional specimens of various lichens growing on *Juniperus communis*, and more rarely on other phorophytes, often yielded a spot indicative of a fatty acid(s) (R_F-classes: A (4-)5, B 5, C 5) which was absent on chromatograms based on specimens of the same species growing on other substrates. Comparisons of chromatograms of extracts of 1) lichen + substratum and 2) naked substratum (from the same piece of bark, or at least in the same collection) proved that the substance came from the substratum.

Similarly, chromatography of some collections of *Rinodina colobina*, a species of rich-bark trees such as, e.g., *Fraxinus excelsior*, showed the presence of spots resembling those of fatty acids. Extracts containing 1) the lichen with all or nearly all the substratum removed, 2) the lichen with substratum present, and 3) naked bark from the herbarium packet were analysed. No (or possible faint traces of) fatty acids were discovered in the extracts from the lichen with the substratum removed and in the naked bark. Fatty acids were only present in the extracts containing bark and the lichen. It is possible that the fatty acids were produced by the lichen only in the endosubstratal part of the thallus, or that they were synthesized by the phorophyte in response to fungal infection, possibly acting as a defence against the growth of the invading hyphae of the lichen.

When several unidentified substances were present, they were usually given a number. The numbers are according to the positions on the plate developed in solvent A with the uppermost spot given the number 1.

Some specimens which by the TLC methods and solvents described above proved to contain unknown substances or substances whose identities were not conclusively settled, were analysed by specialists in chemistry. C. F. Culberson (Durham) kindly analysed material of the following species, using TLC or high power liquid chromatography (HPLC): *Lecanactis latebrarum* (Tønsberg 7099; saxicolous; TLC), *Lecidea pullata* (Tønsberg 6436a, 7050a; TLC, HPLC), *Lepraria obtusatica* (Tønsberg 8832; TLC, HPLC), *Leproloma vouauxii* (Tønsberg 5998; saxicolous; TLC), *Micarea coppinsii* (Tønsberg 10613; TLC), *Mycoblastus affinis* (Tønsberg 5437; TLC), *M. caesius* (Tønsberg 6780; TLC), *Ropalospora viridis* (several specimens, including the holotype; TLC, HPLC), and *Rinodina disjuncta* (Tønsberg 6697; TLC, HPLC).

S. Huneck (Halle) kindly analysed specimens of *Lecidea efflorescens* (Tønsberg 5654; TLC, spectroscopy) and *Pertusaria albescens* (Tønsberg 8863; TLC, mass spectrophotometry).

J.-G. Knoph (Berlin) analysed by mass spectrometry and/or TLC specimens of *Lecidella flavosorediata* (Tønsberg 13365), *L. scabra* (Tønsberg 8729b, 13670), *L. subviridis* (Tønsberg 11390, 11477), *Lecidella* sp. A (Tønsberg 8729a, 8741), *Pyrrhospora quernea* (Tønsberg 7869), as well as some esorediate taxa of *Lecidella elaeochroma* s. lat. By comparing chromatograms of these specimens with chromatograms placed at my disposal by J.-G. Knoph and with chromatograms of pure xanthones, the main xanthones of the specimens were identified.

The chemistry of some species, including detailed accounts of the methods used, has been published by Huneck & Tønsberg (1982), Culberson et al. (1984), and Huneck et al. (1986).

Spot tests

The standard lichen spot-test reagents PD (a saturated solution of paraphenylenediamine in 96% ethanol), K (10% KOH), and C (commercial hypochlorite solution) were applied directly on the thallus (cortex, soralia, medulla) using pointed glass rods. K following C is denoted the KC reaction. As a general rule, the best non-cortical reactions on sorediate specimens were obtained on the soralia.

UV-light

Some specimens of all taxa were examined under short wave (254 μm) and long wave (350 μm) UV-light.

Substratum

Phorophytes with a high number of species belonging to such genera as, e.g., *Candelaria*, *Phaeophyscia*, *Physcia*, *Physconia*, and *Xanthoria* (see James et al. 1977 for a more detailed list) usually have a nutrient-rich or nutrient-enriched bark (Du Rietz 1945, James et al. 1977, see also Barkman 1958). Such phorophytes are referred to below as rich-bark trees and the bark is referred to as eutrophic. Phorophytes lacking or having a poorly developed flora of these genera are referred to as acid-bark trees or as intermediates; the barks are referred to as acidic or intermediate.

In the present study, no chemical analyses of bark Ph were carried out, and the judgement of richness was based on the entire lichen flora of the phorophyte. Among the main phorophytes, *Acer platanoides*, *A. pseudoplatanus*, *Fraxinus excelsior*, *Populus tremula*, *Tilia*, and *Ulmus glabra* usually had eutrophic barks; *Alnus incana*, *Betula*, *Calluna vulgaris*, *Prunus padus*, *Sorbus aucuparia*, and the bark of all conifers were usually acidic, whereas *Alnus glutinosa*, *Quercus* and *Salix caprea* were usually intermediate.

The bark surface may be divided into smooth and rough. It should be noted, however, that bark of rough-barked trees, e.g., *Picea abies* and *Alnus glutinosa*, also have smooth facets, and that bark of smooth-barked trees, e.g., *Betula*, also have rough facets. It is also important to note that most deciduous trees are smooth-barked when young, even those which become markedly rough-barked when older.

Identification of bark pieces. Old herbarium material usually lacked written information about the substratum. In such cases, no effort was made to determine phorophytes, unless its identity was immediately evident. Bark pieces of *Betula pubescens/pendula*, *Picea abies*, *Pinus sylvestris*, and *Juniperus communis* were usually easily identified by the morphological characteristics of their bark surfaces.

Distribution

For selected species a distribution map is provided. These maps may also include sites for lignicolous specimens. Sites for terricolous and saxicolous specimens, if included, are indicated by an asterisk. Figures showing vertical distributions are based solely on collections from southern Norway south of Trondheimsfjorden (central Norway). To the north of that fjord, alpine plants often descend to sea-level. For the purpose of these figures, only specimens with an indication of altitude on the label were taken into account. Most herbarium specimens lacked information about altitude.

Maps showing the Norwegian distribution of the main phorophytes are included in, e.g., Hultén (1971). It should be noted that many phorophytes, due to the activity of man, occur far outside their natural range.

Classification into phytogeographical elements

The species are classified into main phytogeographical elements according to Økland (1989) who distinguished five main elements in the Fennoscandian flora: Western, southern, south-eastern, eastern, and northern. I largely adopt this scheme, but place the taxa into the groups mainly according to their distribution in Norway and Sweden, using Santesson (1984) regarding the Swedish distributions, as well as some recently published floristic papers (e.g. Muhr 1987, Arvidsson et al. 1988, Arup & Ekman 1991a). An additional group comprising widespread species is included, as well as a group consisting of species with an insufficiently known distribution. Some predominately saxicolous species have been omitted from the classification.

The subordinate phytogeographical elements largely follow Økland (1989). Within the western element a sub-element comprising species which, in Scandinavia, are mainly restricted to Trøndelag and adjacent areas is recognized. A subordinate element of strongly continental species is assigned to the south-eastern main element. Some predominately saxicolous species have been left unclassified. For many taxa knowledge of the distribution is too scanty for a conclusive classification.

Western element

(1) *Markedly western species*. The species of this distributional group occur on the outermost coast between Vest-Agder: Lista and Møre og Romsdal. They are unknown further east in Scandinavia.

(2) *Species occurring mainly in central Norway*. This distributional group is not included in the scheme of Økland (1989). Species belonging to this group have their centre of distribution in central Norway, mainly Nord-Trøndelag and adjacent parts of Nordland, Sør-Trøndelag and Sweden (Jämtland).

(3) *Western species*.The species of this distributional group occur in Østfold: Hvaler and in a broad belt along the coast from Telemark - Nordland (- Troms). In Sweden the species occur on the western coast only.

(4) *Slightly western species*.This distributional group includes species occurring in a broad belt along the coast, but that are sparse or absent inland. It is largely confined to the western half of south Sweden, rarely reaching the eastern coast.

(5) *Widespread species with a western tendency*. The species of this group are more widely distributed extending further inland than the preceding group. In south Sweden they occur also on the eastern coast. The range of some species also includes Finland.

Southern element

(1) *Markedly southern*. The species of this distributional group occur on the outermost coast from Telemark to Vest-Agder. In Sweden they occur on the southern and south-eastern coasts, and more sparsely on the west coast.

(2) *Southern species*.The species of this distributional group occur in a broad belt along the coast from Akershus to Hordaland. In Sweden they occur as far north as "limes norrlandicus". Phorophytes belonging to this element include *Alnus glutinosa*, *Corylus avellana*, *Fraxinus excelsior*, *Quercus robur*, and *Tilia cordata*.

(3) *Slightly southern species*.The species of this distributional group occur in a broad belt along the coast from Østfold - Trøndelag (- Nordland). In Sweden they occur occasionally north of "limes norrlandicus".

(4) *Widespread species with a southern tendency*. The species of this distributional group are sparingly present also in Troms and Finnmark. In Sweden they are more widespread than the preceding group, but still infrequent north of "limes norrlandicus". Phorophytes belonging to this element include *Ulmus glabra*.

Southeastern element

Species listed here are mainly confined to broad-leaved trees.

(1) *Species restricted to central parts of southern Norway*. The species of this

distributional group occur in central parts of southern Norway. They may extend as far west as the innermost part of Sogn and Fjordane. This distributional group was not distinguished by Økland (1989).

(2) *Strongly south-eastern species.* The species of this distributional group occur in a broad belt along the south-eastern coast west to Telemark. In Sweden the species occur in the south-easternmost part as far north as Vänern, and in the eastern part of Denmark.

(3) *South-eastern species.*The species of this distributional group occur in Østlandet east of the water divide, southwest to Vest-Agder: Kristiansand. They are absent in Vestlandet and in Trøndelag. In other parts of Fennoscandia the species are somewhat more widely distributed than the preceding element reaching, e.g., Jämtland in Sweden.
Phorophytes: *Acer platanoides.*

(4) *Slightly south-eastern species.*The species of this distributional group occur in SE Norway, the inner part of Vestlandet, Trøndelag (around the inner part of Trondheimsfjorden), and are sparingly present in northern Norway as far north as the border between Nordland and Troms.

(5) *Widespread species with a south-eastern tendency.* The species of this distributional group are widespread, but with a southeastern centre of gravity, reaching further west and north than the preceding group.

Eastern element

(1) *Eastern species.* The species of this distributional group are completely absent in westernmost Norway (Vestlandet) and from Denmark.

(2) *Slightly eastern.* The species of this distributional group are more widely distributed than the preceding group extending W to Vestlandet where they are most frequent in the eastern part, and to Denmark.
Phorophytes: *Picea abies.*

Northern element

Within this distributional element, Økland (1989) distinguishes three distributional groups: the arcto-alpine species, the boreal-alpine species, and the hemiboreal-alpine species which have their main occurrences in the alpine zone, the middle boreal zone, and the northern boreal zones, respectively. In the present account species have not been assigned to these distributional groups within the northern element. *Betula nana*, *Salix glauca*, and *S. lapponum* are phorophytes belonging to the northern element (Økland 1989). The terms subalpine and low-alpine are used in accordance with Gjærevoll (1990). The widespread phorophytes *Juniperus communis* and *Betula pubescens* commonly occur up to the low-alpine belt. According to Gjærevoll (1990) an alpine species is "one that has its main distribution above the birch forest limit and north of the polar birch forest".

Ubiquitous species

No true corticolous species is ubiquitous in the strict sense. Widespread species occurring throughout the country in sites where a phorophyte is available, are here denoted ubiquitous. No phorophytes are available along the northernmost coast and above the dwarf shrub limit.

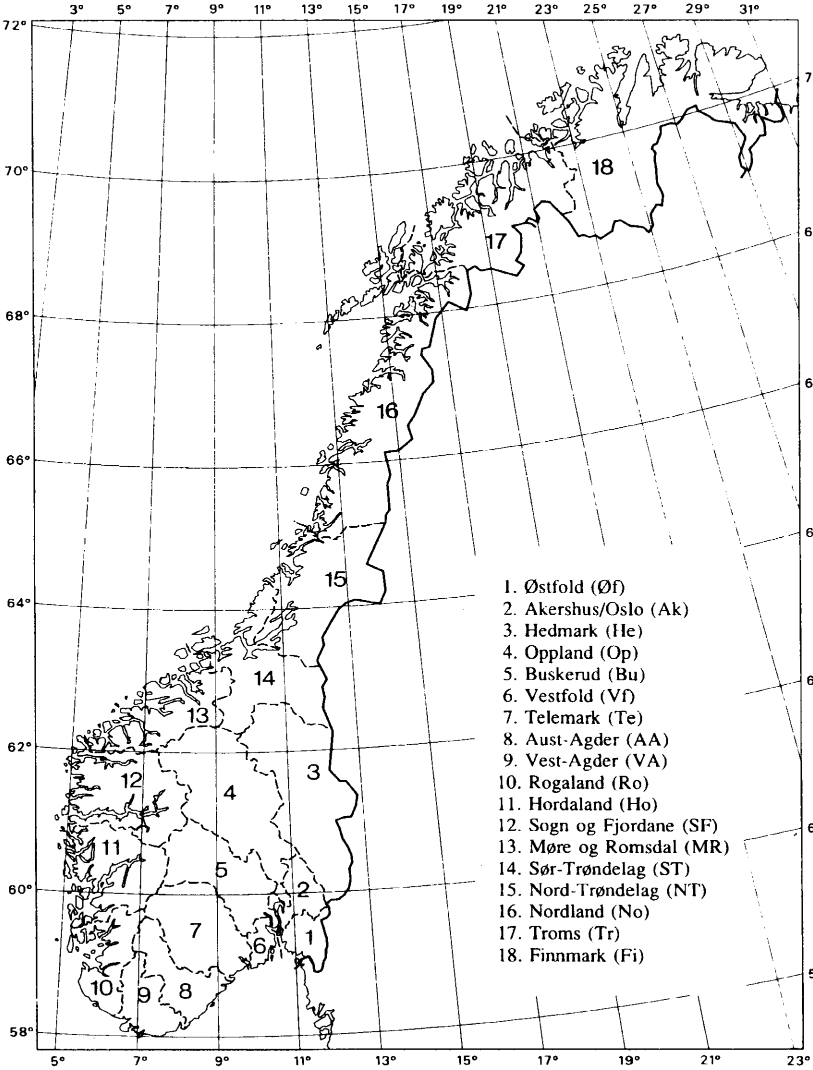


Fig. 2. Norwegian counties and their abbreviations.

NOMENCLATURE AND TERMINOLOGY

Nomenclature of phorophytes

The nomenclature of phorophytes (i.e., host trees or shrubs) follows mainly Lid (1985). The phorophytes and their abbreviations are listed in Tab. 1.

Nomenclature of lichens

The nomenclature of lichen species not treated in detail mainly follows Santesson (1984). For recent segregates of *Parmelia* s. lat. the new generic names are referred to in brackets. Names and authors of genera are those accepted by Eriksson & Hawksworth (1991b) with the addition of *Lepraria* Ach. and *Loxospora* Massal. Abbreviations of authors are mainly according to the list provided by Laundon (1979) and/or the principles he recommended. In the treatment of the different species in the taxonomic part, the basionym is cited only for recently published names (i.e., for names that are not included in the checklist for Sweden and Norway (Santesson 1984)) and for names where a type specimen has been studied.

Abbreviations of counties. Geographical terms

In the treatment of the species, a rough sketch of the distribution is given by listing the counties (see Fig. 2). These are recorded in a strict order in accordance with Fig. 2, which also gives the abbreviated form used in 'Specimens seen'. The counties from Østfold to Nord-Trøndelag are collectively referred to as southern Norway (Sør-Norge), and the counties from Nordland to Finnmark as northern Norway (Nord-Norge). Central Norway is here defined as the counties Sør-Trøndelag and Nord-Trøndelag, whereas westernmost Norway (Vestlandet) includes the counties from Rogaland to Møre og Romsdal.
For terminology referring to plant geographical elements and to properties of the bark of the phorophytes, see under distribution and substratum above.

RESULTS AND DISCUSSION

MORPHOLOGY

Thallus

A thallus is defined as the vegetative lichen body. The species were represented by one or more thalli on each small piece of bark. In some species, e.g. *Enterographa zonata*, *Fuscidea pusilla*, *Lecanora conizaeoides*, *Lepraria neglecta* s. lat., *Ropalospora viridis*, *Schismatomma umbrinum*, *Scoliciosporum gallurae*, and *S. sarothamni*, the ability to develop colonies (numerous discernible, often small thalli growing side by side) appeared to be a constant feature. *Lecanora conizaeoides* often occurred in colonies when young. When older, however, thalli of that species often fuse and form a morphologically uniform thallus up to several dm in diameter. In irregularly spreading, indeterminate, areolate or leprose species with no distinct prothallus, it is probably a common feature that large thalli are the result of fusion of numerous smaller neighbouring, previously discernible thalli that have originated from several diaspores.

In sorediate species, the thallus was endo- or episubstratal in esorediate parts. No distinct episubstratal, esorediate parts occurred in *Chrysothrix* species, *Lecidea leprarioides* and in unstratified specimens of *Lepraria* species, sometimes with the exception of a poorly developed pro- or hypothallus.

In a number of other species, esorediate episubstratal thallus parts were absent, poorly developed or soon became dissolved into soredia, e.g., in *Haematomma ochroleucum*, *Japewia subaurifera*, *Lecanora expallens*, *L. farinaria*, *Lecidea nylanderi*, *L. porphyrospoda*, *L. praetermissa*, *L. pullata*, *L. subcinnabarina*, *L. vacciniicola*, *Lecidella subviridis*, *Placynthiella dasaea*, *Rinodina flavosoralifera*, *R. griseosoralifera* and *Rimularia fuscosora*. In *Pertusaria pupillaris*, distinct esorediate episubstratal thallus parts were sometimes developed, but most specimens were endosubstratal in esorediate parts. Although many specimens of *Catillaria pulverea* had no distinct esorediate parts, others had well-developed, esorediate areolae.

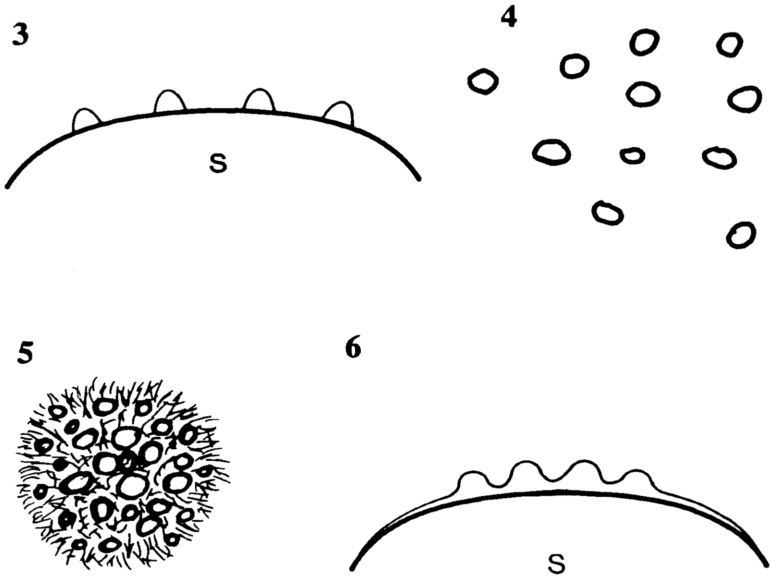
Species with distinct episubstratal thallus parts in addition to soredia included, e.g., *Hypocenomyce leucococca*, *H. scalaris*, and most species of *Ochrolechia* and *Pertusaria*.

In isidiate species, non-isidiate thallus parts were usually well-developed. In *Placynthiella icmalea*, however, the isidia were developed directly from an endosubstratal thallus.

The thalli were rosette forming or more or less irregularly spreading.

The over-all colours of the thalli were whitish, grey, green, yellow, bluish, brown, orange, or shades of these colours. The colour of the soralia usually contrasted to that of the esorediate parts. This feature was most striking in species which have pigments restricted to the soralia, e.g., in *Lecidella elaeochroma* "f. *soralifera*" and *Mycoblastus alpinus*. In leprose species, the thallus surface was uniformly coloured throughout. Tips of isidia and prothallus hyphae often differed in colour from other thallus parts, sometimes markedly. The thallus was glossy or dull.

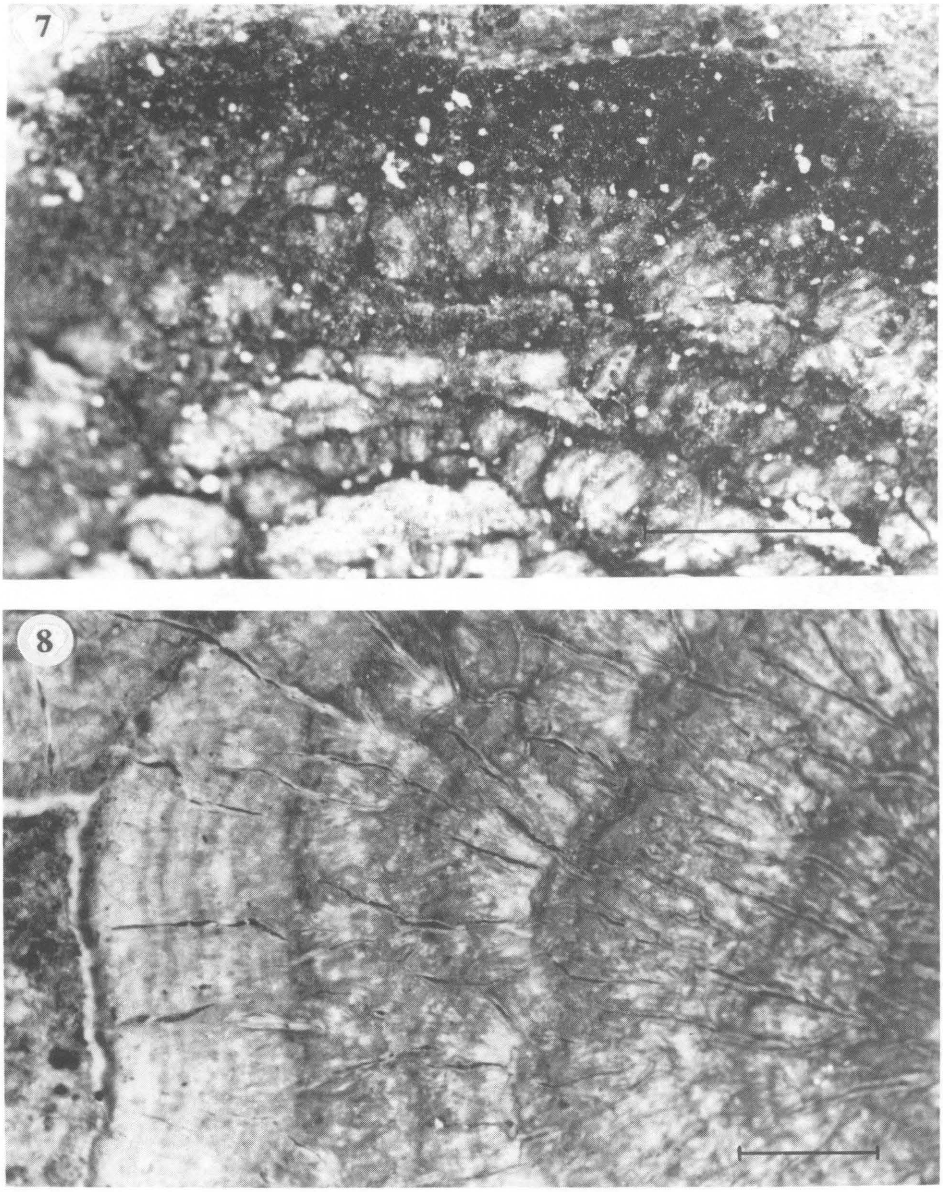
The thallus was (a) indeterminate, i.e. with areolae and/or soralia spreading over the



Figs 3-6. Sketches of some thallus types. Fig. 3. Areolate. Fig. 4. Areolate, indeterminate, widespread. Fig. 5. Areolate, determinate (bounded by a distinct prothallus), rosette-formed. Fig. 6. Continuous, tuberculate. Figs 3, 6. In sections; Figs 4, 5. Surface view; S. Substratum.

substratum without a delimiting prothallus (Figs 3-4); (b) delimited, i.e. areolate with a well-developed delimiting border of a distinct prothallus (Fig. 5) (e.g. in *Fuscidea* spp.) or, when continuous, either with a sharply cut marginal edge (e.g. in most species of *Ochrolechia* and *Pertusaria*) (see Fig. 8), or with a distinct prothallus (e.g. in *Phlyctis argena*); or (c) indistinctly delimited, i.e. intermediate between indeterminate and delimited.

The thallus was usually either areolate (Figs 3-5) or continuous (Fig. 6). The areolate thallus consisted of more or less discrete to contiguous (or sometimes partly fused) areolae. The term areolae are here defined as the small, rounded thallus portions developing on an endo- to episubstratal prothallus. The often angular thallus portions resulting from the cracking of a continuous thallus are here not denoted areolae. The areolae were (a) persistently discrete (Figs 3, 4), (b) contiguous, (c) fused, or (d) imbricate (in *Hypocenomyce scalaris* only). The areolae often became fused towards the thallus centre, whereas the marginal parts were persistently discrete or contiguous. Crustose areolae were usually roundish when viewed from above, more or less convex and up to 0.2-0.3 mm in diameter. Globose crustose areolae were constricted below, and occurred in, e.g., *Micarea coppinsii*. In most species the areolae were adnate, i.e., with the entire underside attached to the substratum. In *Baeomyces rufus*, *Candelariella reflexa*, *Fuscidea pusilla*, *Hypocenomyce leucococca*, *Lecidea efflorescens*, *L. gyrophorica*, *L. porphyrospoda*, *Rinodina degeliana*, *R. efflorescens* and *Rinodina* sp. A, the areolae were more or less subsquamiform, i.e., with marginal parts of the underside free from



Figs 7-8. Zoned thallus margin. Fig. 7. *Fuscidea praeruptorum*. Tønsberg 10264. Scale 1 mm. Fig. 8. *Pertusaria albescens*. Tønsberg 8863. Scale 2 mm.

the substratum. However, in species with predominately subsquamiform areolae, the areolae often varied from being crustose (adnate) to subsquamiform or almost squamiform and edge on to the substratum, but the thallus was never uniformly squamulose throughout.

In *Hypocenomyce scalaris*, the thallus was distinctly and uniformly squamulose; the squamiform areolae were edge on to the substratum, with a corticate, convex upper side and a whitish, ecorticate, concave lower side (see Timdal 1984).

In *Hypocenomyce leucococca* (Fig. 40), *Rinodina flavosoralifera* and in forms of *Caloplaca chlorina* with a well-developed esorediate thallus, the areolae were more or less incised and minutely lobed. In thalli which were endosubstratal in esorediate parts, areolae were usually absent. More or less hollow and blister-like areolae were denoted bullate, and occurred, e.g., in *Fuscidea pusilla* and *Lecanora conizaeoides*.

A continuous thallus covers the substratum completely, although young specimens were sometimes only partly episubstratal. The episubstratal thallus portions of such thalli may superficially resemble areolae, but differ in being very irregular in size and circumference and in tending to be interconnected; obviously they represent a poorly developed, incompletely continuous thallus and are therefore not denoted areolae. A continuous thallus was (a) film-like (very thin and engulfing the substratum, as in e.g. *Gyalideopsis anastomosans*), (b) even (flat), (c) tuberculate (i.e., with irregularly to regularly rounded protuberances here denoted tuberculae (Fig. 6), as e.g. in many species of *Ochrolechia* (Figs 82, 89) and *Pertusaria*), or (d) folded (as often in, e.g. *Ochrolechia androgyna* B and *Pertusaria albescens*). Regular tuberculae were mostly slightly convex to hemiglobose or, more rarely, subglobose as e.g. in *Ochrolechia androgyna* C. Bullate tuberculae were hollow and blister-like (cfr. bullate areolae) and occurred e.g., in a form of *Loxospora elatina* and in *Ochrolechia frigida* "f. *lapuensis*". The surface of a continuous thallus was sometimes cracked. Some species with typically continuous thalli sometimes had a few marginal areolae.

Within a single specimen, an even thallus was more or less uniform in thickness, whereas a tuberculate or plicate thallus often varied extensively in thickness. The thickness of the thallus also often varied considerably from specimen to specimen within a species. The thinnest thallus observed was found in *Gyalideopsis anastomosans*, and the thickest thallus in *Ochrolechia androgyna* B (up to 4 mm), *O. androgyna* D (5 mm), *Pertusaria albescens* (4 mm), and *P. amara* (4 mm).

Certain species of *Fuscidea*, *Ochrolechia* and *Pertusaria* often had a concentrically zoned margin. In species with an areolate thallus, e.g. *Fuscidea praeruptorum* (Fig. 7), the zones were composed of concentrically arranged areolae bordered with prothallus alternating with pure prothallus, whereas in species with a continuous thallus, e.g. in *Pertusaria albescens* (Fig. 8) the zoned margin consisted of concentric bands of different colour (shades of grey or green; the marginal part of the outermost band was often a distinct prothallus). Hale (1974, 1983), discussing species with a continuous thallus, stated that each band in a zoned thallus corresponds to growth in the summer (pale and wide) and in the winter (dark and narrow).

Prothallus

In several species a prothallus was usually evident. Three types may be distinguished:

(1) This type occurred between discrete areolae and as a marginal thallus border in many areolate species (Figs 5, 7, 34, 37). The prothallus was composed of a thin layer of hyphae ramifying on, between, or below the uppermost bark cells of the substratum. In the marginal thallus border, the prothallus hyphae were mostly radiating, whereas between the areolae, the hyphae formed a network. The prothallus hyphae were discrete or formed a continuous cover on the substratum. The colour, which was often bluish or brownish, may vary within a species. This type of prothallus occurred in, e.g., *Buellia griseovirens*, *Fuscidea* spp., *Mycoblastus caesius*, *Ropalospora viridis*, and *Rinodina disjuncta*. In *Fuscidea*

praeruptorum the outermost prothallus band was up to 0.7 mm wide.

(2) In other species, mostly those with a continuous thallus, the prothallus was white (composed of colourless hyphae) and felty, with radiating hyphae. This type occurred in, e.g., *Haematomma ochroleucum*, where it was up to 0.2 mm thick and to 1-2 mm wide, and in *Phlyctis argena*, where it was up to 7 mm wide. In this species the prothallus often displayed particularly vigorous growth in places where mosses were growing in front of the thallus.

(3) In many *Pertusaria* and some *Ochrolechia* species a third prothallus type occurred. Here the prothallus hyphae were more or less conglutinated in the uppermost part and formed a whitish somewhat glossy marginal zone of the thallus up to 2 mm wide. In a few specimens of *Pertusaria coccodes* and *P. coronata* the prothallus was composed of two bands: outside the glossy band there was a dull, felty band of free, radiating, non-conglutinated hyphae.

When abutting adjacent specimens of the same or of a different species, the thalli of many species were delimited by a dark brown to blackish border line. The dark pigment is probably composed of melanins which may have a detoxifying effect (see Deacon 1988: 165). This line should not be denoted a prothallus (see also Brodo 1984a).

In *Leproloma* spp. and, occasionally in species of the *Lepraria neglecta* group, a hypothallus was present as a brown, lax mat of hyphae in the lowermost part of the thallus. The hypothallus differed from the hyphae of the medulla in being pigmented and devoid of crystalline deposits.

Soralia

The soralia were whitish, greyish, greenish, yellowish, brownish, or bluish, and usually differed in colour from the esorediate thallus parts. In species with brown, bluish or aeruginose soralia, only the external soredia were pigmented (see below). In eroded soralia, where most of the external soredia had recently been shed, a mixture of pigmented and unpigmented soredia giving the soralia a mottled appearance was sometimes observed. In *Japewia subaurifera* the external soredia were brown whereas the internal ones were yellow, giving well-developed soralia a mixture of brown and yellow colours.

On a continuous thallus, the soralia were located on the upper side and were more or less rounded (Fig. 80), linear, or irregular (Fig. 104). The surface was concave (e.g. in *Caloplaca obscurella*), flat (Fig. 103), or more or less convex. Strongly convex soralia were hemiglobose to capitate (Fig. 77). On an areolate thallus, the soralia were located on the upper surface, along the margin, or on the underside. Minute soralia (up to 0.2 mm in diameter) are denoted punctiform. Convex to more or less flat soralia confined to margins of the areolae are denoted marginal (Fig. 113). Distinctly concave, marginal soralia are denoted labriform. Soralia covering the underside of subsquamiform to squamiform areolae are denoted sublabriform and labriform, respectively. Frequently the soralia expanded to a size beyond the width of the areola from which they had arisen.

Persistently discrete soralia were rare. In most species, at least some soralia became contiguous (touching each other without becoming fused) or fused. In species where soralia tended to become fused, the entire thallus or thallus surface could eventually become leprose (i.e., completely dissolved into soredia). Distinctly delimited soralia occurred in, e.g., *Caloplaca sorocarpa* (Fig. 29) where they often are doliiform (barrel-like), in *Ochrolechia alboflavescens* (Fig. 80) and in *Pertusaria hemisphaerica*. In *Caloplaca sorocarpa* and *Ochrolechia alboflavescens*, the soralia were surrounded by a prominent ring formed by esorediate parts of the thallus. In *Pertusaria hemisphaerica*, where no such ring was formed, the soralia were compact and firm and their shape was retained even on old specimens. Diffuse (i.e., poorly delimited) soralia occurred in, e.g., *Lecidea leprarioides*. Many species had soralia which were intermediate between delimited and diffuse.

The largest soralia were observed in species with large, thick and continuous thalli. In *Pertusaria albescens*, *P. amara* and *P. borealis*, circular soralia up to 3-4 mm in diameter occurred. On a single continuous thallus, the soralia were usually of unequal size, indicating that new soralia were developed continuously. Most often, the soralia stopped their growth in width when a certain size was achieved. However, in *Phlyctis argena*, a species with flat, irregularly spreading soralia, the expansion of each single soralium seemed to continue throughout much of the lifespan of the thallus. The soralia of that species often reached one cm or more in diameter.

Soredia

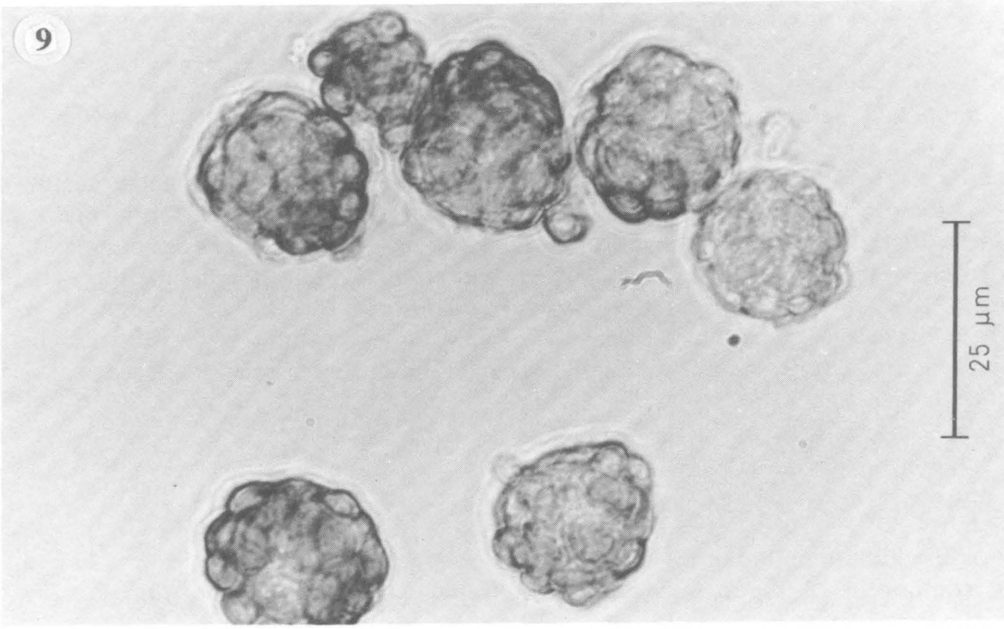
All more or less globose, more or less free diaspores produced in soralia-like patches or being the main component of the thallus are here referred to as soredia (or, sometimes, as consoredia).

Well-developed soredia were usually episubstratal. However, in occasional specimens of several taxa, e.g. *Hypocenomyce sorophora*, *Lecanora farinaria* and *Pertusaria pupillaris*, fully developed soredia were observed beneath the uppermost cell layers of the phorophyte which formed a convex cup over the soralia.

The soredia were usually globose, rarely ellipsoid or irregular. The soredia usually consisted of clusters of algal cells surrounded by a more or less distinct wall of fungal cells. In many taxa, and especially in those with brown or aeruginose pigmented soredia, e.g., in *Caloplaca chlorina*, *C. sorocarpa*, *Japewia subaurifera*, *Rimularia fuscosora* and *Schaereria corticola*, the wall was a distinct, well-developed, continuous envelope, usually one cell-layer thick. In *Rimularia fuscosora* the wall was 1-2(-3) cell layers thick. The cells of a pigmented, continuous cortex were usually more or less isodiametric (diameter usually about 3.5-6 µm) and formed a true paraplectenchyma (Figs 9-10); hyphal filaments were hardly evident. Such soredia were firm and not easily damaged in squash preparations. In soredia with a less distinct, more or less continuous wall, the cells usually varied from subglobose to shortly subcylindrical (usually less than about 6 µm long), and hyphal filaments were sometimes discernable. Sometimes the wall was a network, one cell layer thick, of filamentous hyphae. Such soredia were often fragile and easily damaged in squash preparations. Sometimes the wall had small projections, usually in the form of one single fungal cell, giving the soredium a papillate surface. Long projections (Fig. 11-12) occurred, e.g., in species of *Lepraria* and *Leproloma*, most pronounced in *Lepraria rigidula* (projections up to 120 µm long). Long hyphal projections probably facilitate the anchoring of a soredium to the substratum surface. Literature provides further examples of lichens with papillae on the soredia, e.g., they occur in *Agonimia tristicula* (Coppins & Bennell 1979) and *Vezdaea* (Poelt & Döbbler 1975). Apparently they are not uncommon among lichens with a more or less leprose thallus.

In a few species the wall was poorly developed or apparently absent, e.g., in *Micarea prasina*, *Halecania viridescens*, and *Opegrapha multipuncta*.

In some species, a distinct difference in pigmentation between the soredia at the surface and those of the inner part of the soralium was observed (Fig. 13); the former are denoted



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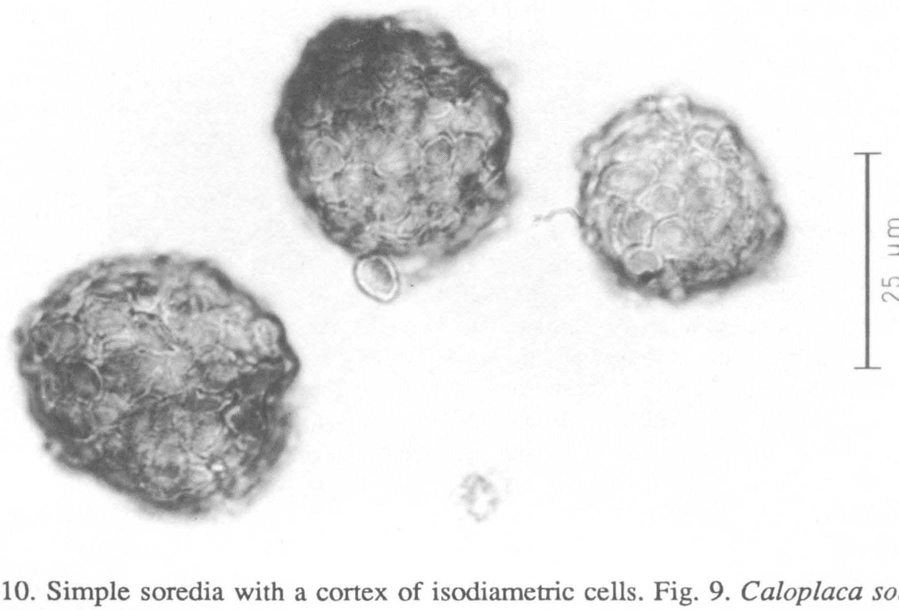
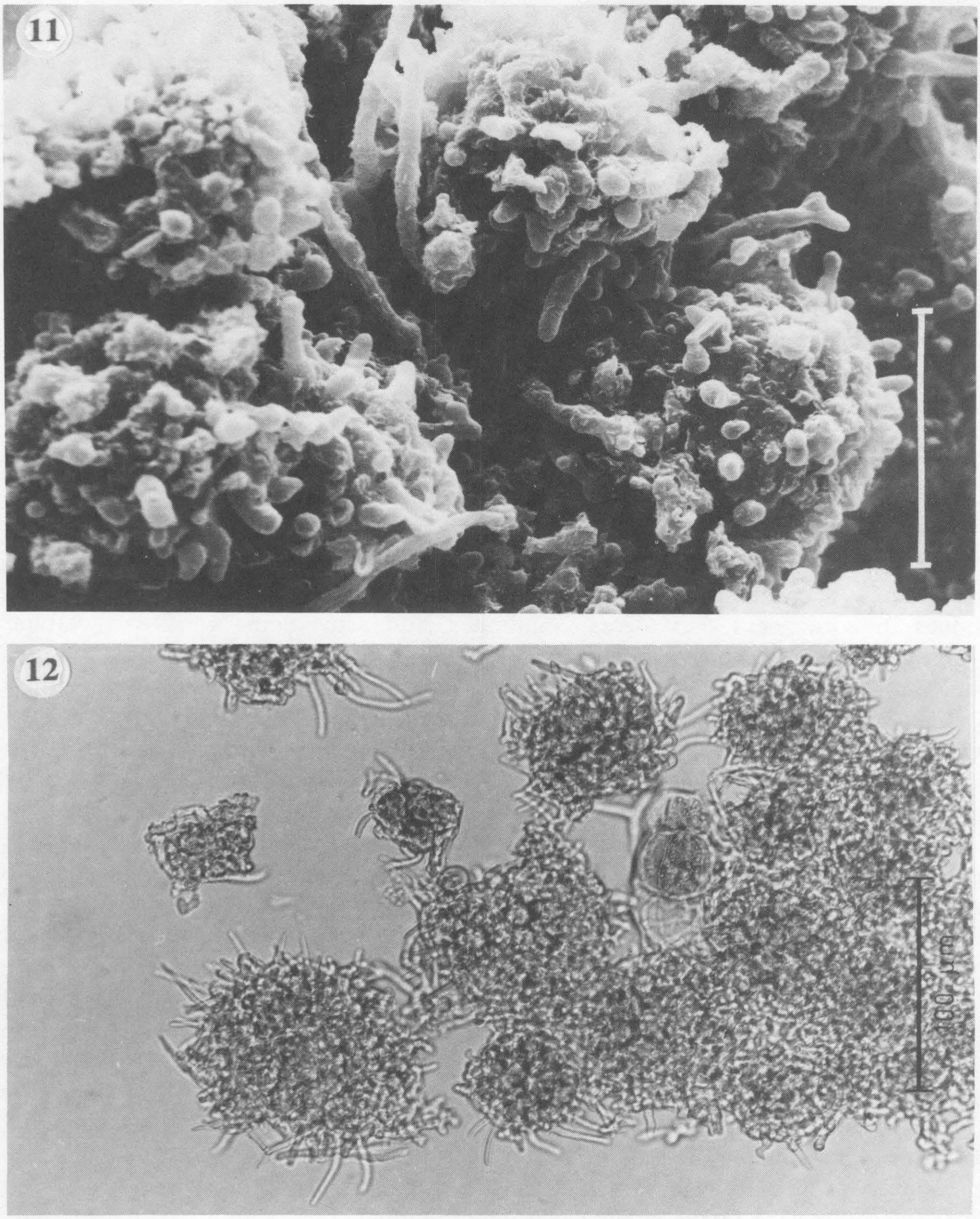


Figs 9-10. Simple soredia with a cortex of isodiametric cells. Fig. 9. *Caloplaca sorocarpa*. Tønsberg 7258. Fig. 10. *Rimularia fuscosora*. Tønsberg 11186.

external soredia, the latter internal soredia.

In taxa containing lichen substances, the hyphae of the soredia were often heavily encrusted with crystals. Projecting hyphae were, however, usually devoid of crystals. Soredia with non-crystalline pigments in the wall of the cortical hyphae were not incrusted with crystals, even where the internal soredia were incrusted. Brown or aeruginose pigmentation of the cell wall was exclusively a feature of the external soredia and was confined to or most pronounced in the exposed part of the wall of the soredia. In some species pigmentation was



Figs 11-12. Soredia with hyphal projections. Fig. 11. *Lepraria jackii*. Holotype. SEM. Fig. 12. *Lepraria rigidula*. Tønsberg 13002.

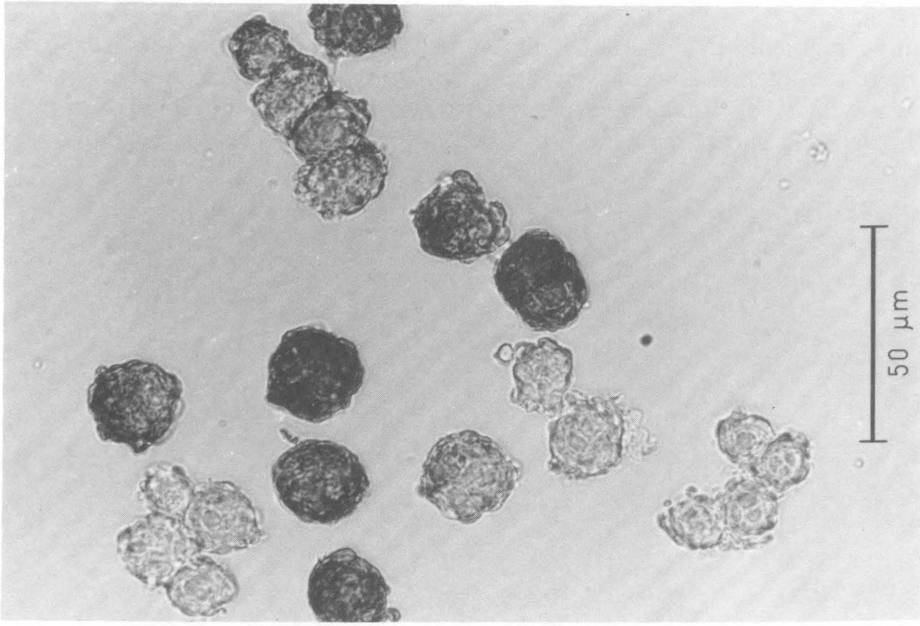


Fig. 13. *Rimularia fuscosora*. Tønsberg 11186. Squash of soralia showing external (dark) and internal (light) soredia.

a constant feature, in other species pigmentation occurred in occasional specimens. Anthraquinones, pulvinic acid derivatives, xanthones, and usnic acids were extracellular crystalline pigments deposited on the hyphae of external as well as internal soredia.

Pigmentation of the soredia, both the non-crystalline wall components and extracellular crystals, probably confers a high degree of protection against UV-radiation by screening the fungal protoplasm (see Deacon 1988) as well as the algal cells (see Hawksworth & Hill 1984: 127). The non-crystalline pigmentation of the walls of the soredia is apparently induced by exposure to light as it was never observed in the walls of the internal soredia. As soralia are sites with no protective cover such as a cortex, they represent vulnerable areas. Pigments, such as usnic acid, probably also act to protect not only the parent lichen from attack through the soralia, but also the released diaspore when trying to establish itself in a suitable habitat.

The soredia are denoted as fine if most of them are less than 30 µm in diameter, and coarse if most of them are more than 30 µm in diameter. In most species, the soredia were fine. The smallest soredia were about 10-12 µm, and composed of a single algal cell enveloped by hyphae. Soredia larger than 15-20 µm usually contained several algal cells. The soredia were simple (Fig. 9-10), loosely aggregated (i.e., contiguous and becoming more or less free when squashed or mounted in K), or occurred in aggregations denoted *consoredia* (Figs 14-17, 107). This term is introduced here, and refers to more or less compact, rounded, elongate to somewhat irregular aggregations of soredia encrusted with crystals of lichen substances. When mounted in water consoredia are reminiscent of coarse soredia. When mounted in K (dissolving the lichen substances) the individual soredia are usually discerned, however. Individual soredia in a consoredium are here referred to as part-soredia. Consoredia composed of few part-soredia were fine to coarse, whereas those with many part-soredia were

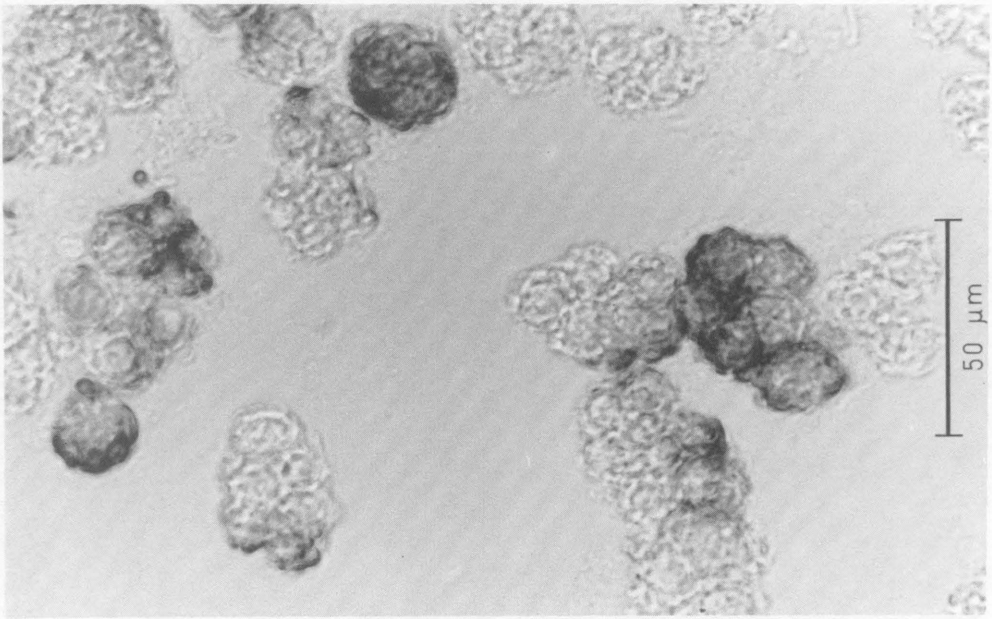


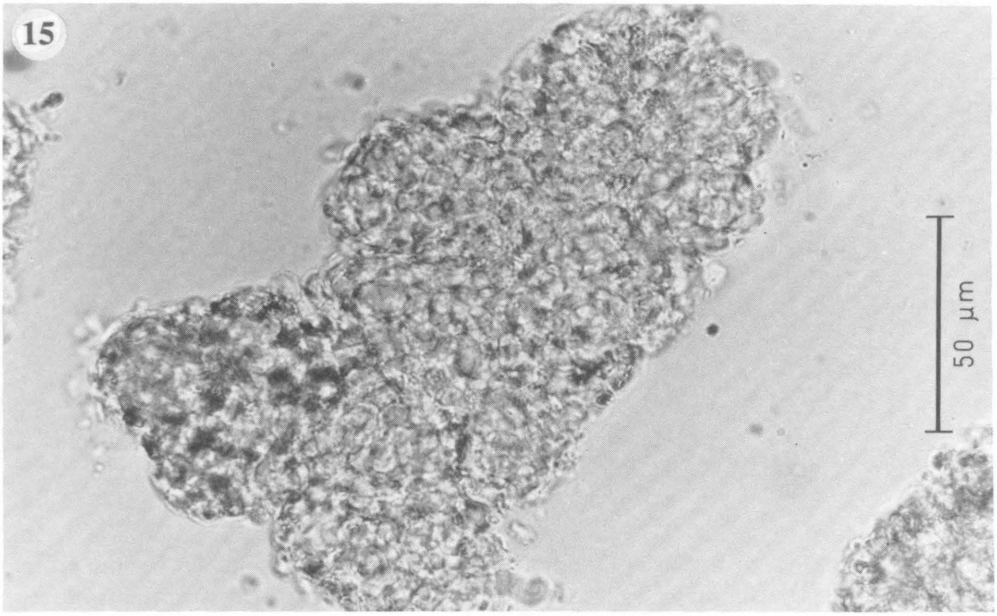
Fig. 14. *Buellia arborea*. Holotype. External (partly pigmented) and internal consoredia.

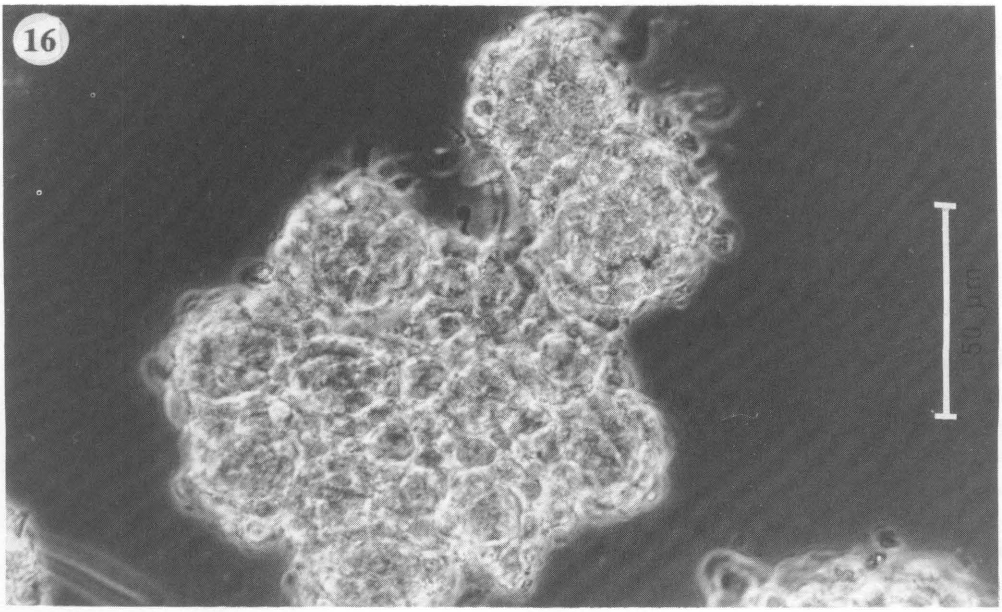
always coarse. In *Micarea leprosula* the thallus is consorediate throughout. As for the simple soredia, the external consoredia may be pigmented (Fig. 14). In occasional specimens of, e.g., *Lepraria* and *Ochrolechia*, large consoredia were sometimes observed to be fastened below by a few hyphae. Consoredia probably originate by division of soredia rather than through aggregation of originally simple and free soredia. Both the simple soredia and the consoredia act as dispersal units. Soralia with an abundance of consoredia may be superficially mistaken for aggregations of isidia.

According to Jahns (1988), soredia are usually developed in the upper parts of the algal layer or at the border line between the medulla and the algal layer, become pushed outwards and ultimately released by the formation and growth of new soredia. The production of soredia continues until the entire algal layer is used up. However, in the present material new soredia were apparently commonly formed also by division of mature soredia into two or more smaller soredia with only one or a few algal cells; this was followed by repeated division and growth of the algal cells as well as growth of the hyphae. The consoredia probably arise from soredia where the division of the parent soredium is incomplete. Production of consoredia seems to be of taxonomic importance.

Globose, soredia-like structures with a more or less well-developed cortex have recently been discussed in detail by Serusiaux (1985) and Walker (1985), see, e.g., also Tibell (1976) and Esslinger (1977). The globose, corticate diaspores found in the soredia-like structures of *Thelomma ocellatum* are denoted isidia by Tibell (1976). Similar diaspores in *Usnea* subgen. *Neuropogon* are referred to as pseudoisidia by Walker (1985), and in the brown *Parmeliae* as isidioid soredia by Esslinger (1977). The term goniocysts was introduced by Norman (1871) to describe thalli entirely composed of clusters of cyanobacteria enveloped by hyphae forming a complete wall. If the wall was incomplete, the thalline elements were denoted goniocystula.

The term goniocyst has been adopted by many authors. Coppins (1983a) used this term to describe the globose elements constituting the thallus of, e.g., *Micarea prasina*. Coppins (1983a) deliberately used the term soredia, however, for similar structures in other species which are not entirely composed of such structures. Serusiaux (1985) concluded that the term





Figs 15-16. Consoredia in *Catillaria pulverea*. Tønsberg 6823. Fig. 16 with phase contrast.

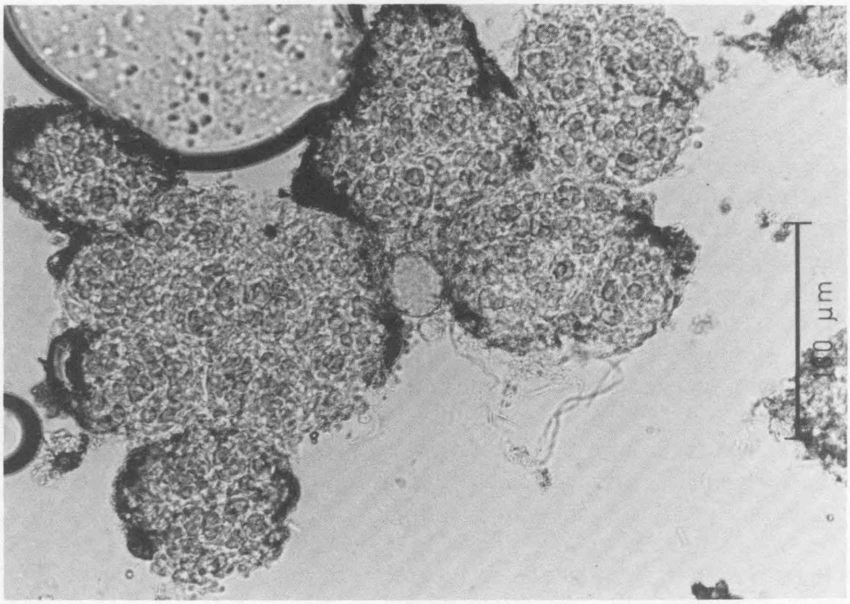


Fig. 17. Consoredia in *Pertusaria hemisphaerica*. Tønsberg 9358.

goniocysts in literature had been used for different structures by different authors. For the time being, he decided to restrict the use of the term goniocyst to the diaspores produced in some foliicolous *Opegrapha* species (a decision adopted by Hawksworth & Hill 1984).

No species considered here contained a cyanobacterium as the photobiont (i.e., the photobiont of goniocysts in the original sense) and none of the *Opegrapha* species considered had the structures referred to by Serusiaux (1985). I have also avoided the term goniocyst in the sense of Coppins (1983a) partly because of the diverse meaning of the term and partly because of the impossibility of distinguishing this structure from true soredia. In several of the species treated here, a partly sorediate thallus may become entirely dissolved into soredia when old, and in some specimens of usually areolate species, areolae are occasionally not developed even when young, and such thalli may be composed entirely of soredia.

Isidia

All globose to elongate, usually projecting, corticate diaspores with a basal point of attachment are here referred to as isidia. Seven types of isidia and isidia-like structures occurred:

(1) The development of the isidia was initiated below the upper cortex. Young isidia apparently burst through the cortex of the thallus which cracked and formed a more or less lacerated sheet around the isidium or, more commonly, group of isidia. Isidia were developed continuously, and the uppermost isidia were probably pushed out by the younger isidia arising below. The differentiation of a cortex was secondary (not being derived from the cortex of the thallus). Isidia developed in this way were homoiomerous (i.e., the interior of the isidium was filled with hyphae and algae; no medullar central core was developed). The mature isidia were surrounded basically by ecorticate tissue forming rounded patches. These patches were often

located at the apices of tuberculae. This type of isidium development occurred in *Pertusaria flavida*, *P. coccodes*, and *P. coronata*, possibly also in *Ochrolechia subviridis* (at least in some specimens). The ecorticate patches may superficially resemble soralia (see e.g. Høeg 1923), but well-developed, typical soredia were only rarely observed in these patches.

(2) The cortex of the isidia was continuously connected with the surrounding thallus cortex and seemed to be derived from that. This mode of development occurred in *Pertusaria corallina*, *P. oculata*, and *P. dactylina*, and the isidia were heteromerous (i.e., with a whitish medullary core surrounded by an algal layer). According to Jahns (1974, 1988), dealing with examples from foliose lichens (e.g. *Lasallia pustulata* and *Parmelia tiliacea*), isidia derived from the thalline cortex may be developed from a protuberance of the thalline cortex and become filled with tissue growing upwards from the algal layer, or be developed exclusively from cortical hyphae by trapping free-living algae. However, the isidia of both *Lasallia pustulata* and *Parmelia tiliacea* are in my opinion homoiomerous and thus anatomically different from the cortex-derived isidia of *Pertusaria corallina*, *P. oculata* and *P. dactylina*.

(3) In a few areolate species, the entire areola was isidiiform, i.e., globose to cylindrical, simple to branched, fragile, and easily detached from the substratum or broken. Such isidia occurred in *Caloplaca herbidella* and *Placynthiella icmalea* (Fig. 108). The term *blastidia* was proposed by Poelt (1980a) to denote segmented, disintegrating propagules budding off the thalli in a yeast-like manner. The isidia-like areolae of *Placynthiella icmalea*, seem to fit this definition and may be referred to as blastidia. The areolae of this species are very fragile, being built up of globular elements and each segment is probably acting as a diaspore. These isidia-like areolae (Fig. 108) resemble consoredia, but, unlike consoredia, they are projecting and basically fastened to the substratum. However, in *Placynthiella icmalea* the whole areola constitutes the blastidium, i.e., the thallus is entirely blastidiate.

(5) The term *schizidia*, which was first proposed by Poelt (1965), denotes flattened diaspores formed by upper layers of a lichen thallus splitting off as scale-like, often rounded portions (see also Poelt 1980a and Codogno et al. 1989). Schizidia occurred in *Baeomyces rufus*.

(6) The term *thlasidia* was proposed by Poelt (1986) to denote the isidia-like structures of *Gyalideopsis anastomosans* described by Vězda (1979). These were more or less cylindrical, flattened, colourless, sometimes spathulately widening in upper part, and pointed at the tips. The thlasidia were fragile and became easily detached. They probably act as diaspores.

(7) In some taxa, e.g. *Ochrolechia androgyna* B (Fig. 83), *O. microstictoides*, *Pertusaria albescens*, *P. amara*, and *Phlyctis argena*, irregular to somewhat flattened, more or less eroded cortical fragments were in some specimens developed from the tuberculae. These structures probably act as diaspores.

The colour of the isidia, especially the apex, often deviated somewhat from the colour of non-isidiate parts. The isidia were simple to more or less branched, and globose, cylindrical, club-shaped, verruciform, or more or less irregular. The surface of the isidia was even to knobby and glossy to mat. The isidia were up to 3 mm long (*Pertusaria oculata*) and up to 0.7 mm wide (*P. dactylina*).

Schizidia, thlasidia, and heteromerous isidia were always episubstratal. Young homoiomerous isidia were usually episubstratal, but occasionally endosubstratal in taxa with thin thalli; when well-developed they were always episubstratal.

Photobiont

All the species contained green algae. In most of the species they were usually coccoid (unicellular and globular) and 10-15(- 20) µm in diameter. In all species of *Micarea* they were micareoid (see Coppins 1983a). *Stichococcus* occurred in *Chaenotheca furfuracea* and *Psilolechia lucida*, possibly also in *Chaenotheca gracilenta*. *Trentepohlia* occurred in *Enterographa zonata, Lecanactis latebrarum, Opegrapha* spp., and *Schismatomma umbrinum*. However, other types also occurred, e.g., in *Lecidea vacciniicola*, for details (see that species).

Species with a similar morphology

Most of the species could usually be recognized on the basis of morphology alone. Groups of species not always easily separated by morphology included, e.g.: *Bacidia epixanthoides/Lecidea gyrophorica, Lecanora allophana* "f. *sorediata/L. impudens, Lecanora expallens/L. flavoleprosa, Fuscidea arboricola/F. praeruptorum/F. pusilla/Ropalospora viridis, Rimularia fuscosora/Schaereria corticola*, as well as certain forms of *Buellia arborea/B. griseovirens/Mycoblastus fucatus, Pertusaria coccodes/P. coronata*, and *Trapeliopsis flexuosa/T. granulosa.*
Fortunately, several of these species are distinct chemically (see also under chemistry below).

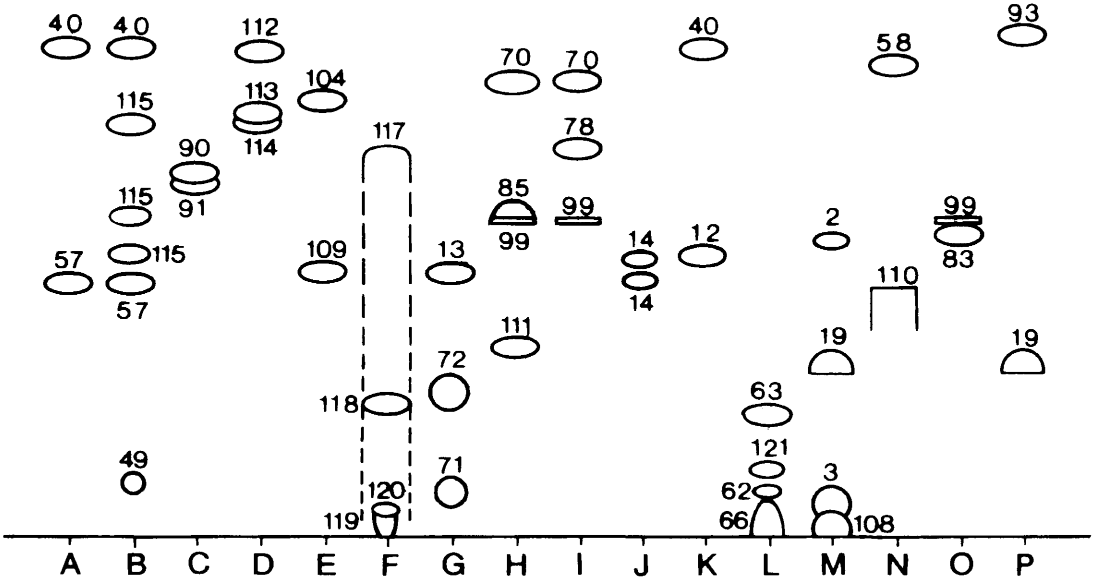
CHEMISTRY: ACETONE SOLUBLE SUBSTANCES

Chemical properties are regarded as being of invaluable importance in the taxonomy of lichens (see e.g. Culberson 1969, 1970, Culberson et al. 1977, Brodo 1978, 1986, Hawksworth et al. 1980) and any taxonomic paper not including chemical data is accordingly incomplete (Brodo 1986). In the present study, about 75 taxa contained substances or a combination of substances that were conclusive for the identification of the lichen species without considering other characters.

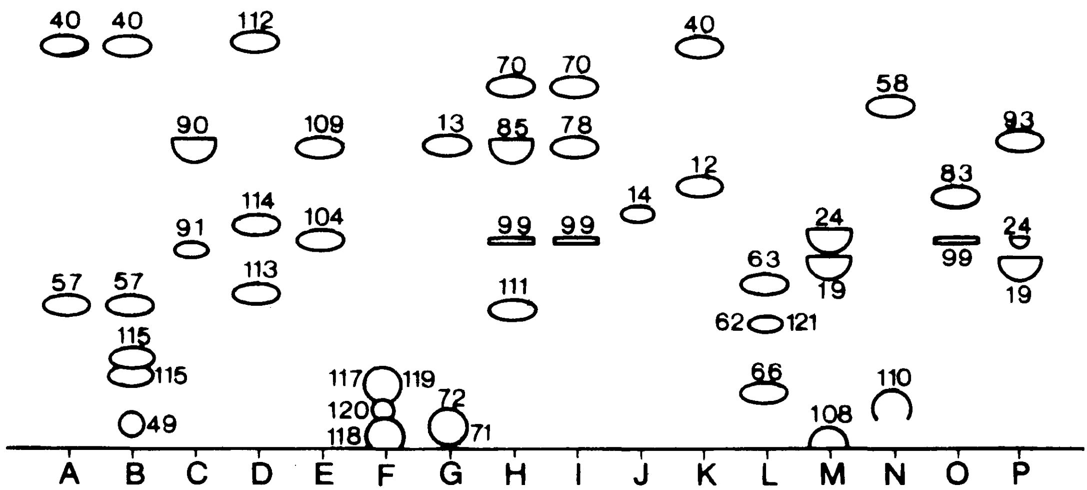
Although most specimens, when well-developed, could be identified by morphology alone, others were only conclusively identified by chemistry. Convergence and parallel evolution have led to morphologically more or less similar thalli of species belonging to quite different genera. Sterile specimens of, e.g., *Rimularia fuscosora* and *Schaereria corticola* may be morphologically very similar, if not identical. Fortunately they can be separated by their chemistry. Other examples of morphologically similar taxa where chemistry is invaluable, at least in order to deal with every specimen, include *Bacidia epixanthoides/Lecidea gyrophorica, Lecanora expallens/L. flavoleprosa, Fuscidea arboricola/F. praeruptorum/F. pusilla/Ropalospora viridis*, as well as certain forms of *Mycoblastus fucatus/Buellia griseovirens/B. arborea*, and *Pertusaria coccodes/P. coronata*.

For most taxa the major constituent(s) were diagnostic. However, in some taxa minor substances proved to be of particular diagnostic value. According to Culberson et al. (1987) the knowledge of the chemistry of satellite substances is essential for phylogenetic reconstructions.

Of the 129 taxa included only five or six were acid deficient: *Bacidia epixanthoides*, Solvent A



Solvent B



Solvent C

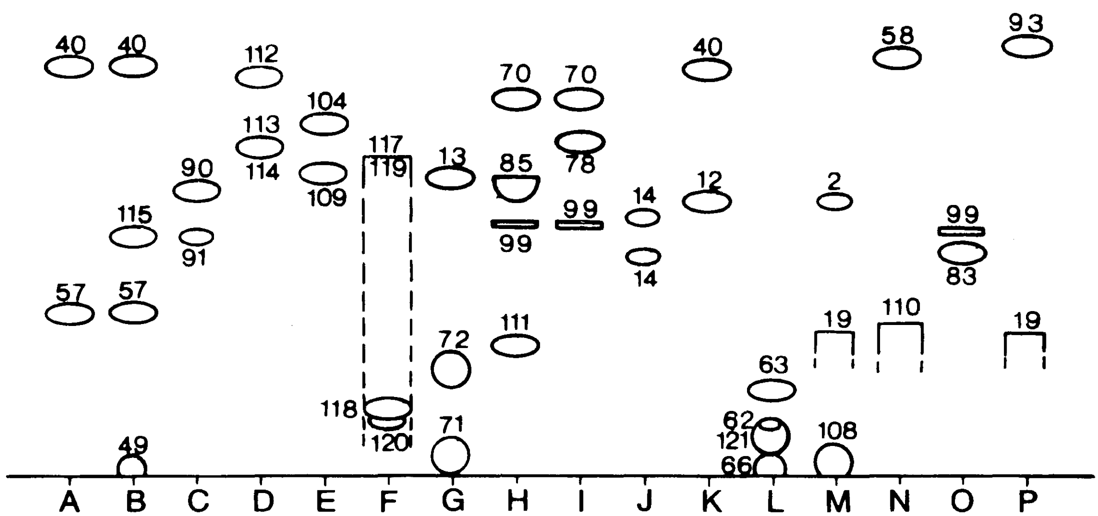


Fig. 18. Chromatogram in solvent systems A, B and C of the major diagnostic unknown secondary substances encountered. The numbers refer to those in the text. A - References. B - *Buellia griseovirens*. C - *Caloplaca herbidella*. D - *Chaenotheca gracilenta*. E - *Chrysothrix chrysophthalma*. F - *Japewia subaurifera*. G - *Lecanactis latebrarum*. H - *Lecanora expallens*. I - *Lecanora flavoleprosa*. J - *Lecidea subcinnabarina*. K - *Lepraria rigidula*. L - *Leproloma vouauxii*. M - *Ochrolechia androgyna* B. N - *Rinodina efflorescens*. O - *Rinodina* sp. A. P - *Trapeliopsis pseudogranulosa*.

Caloplaca chlorina, *C. obscurella*, *Gyalideopsis anastomosans*, *Opegrapha multipuncta*, and possibly *Rinodina colobina*.

The list below gives an account of the main substances, omitting many unidentified substances in trace amounts which were not studied or were found to be of no taxonomic importance. For more complete information, see the treatment of the species. The substances are listed and grouped mainly in accordance with Culberson et al. (1977). For compounds characterized chromatographically by Coppins (1983a), Culberson (1972), Culberson & Kristinsson (1970), Culberson et al. (1981, 1984, 1987), Leuckert & Knoph (in press), and White & James (1985), no chromatographic data are given, unless of special interest. The TLC characteristics of the major, unidentified (and previously presumably uncharacterized) substances, are set out in Tab. 2. The appearances of the major unidentified substances and of some rare substances on TLC chromatograms developed in solvents A, B and C are shown in Fig. 18 and 19, respectively. Tab. 3 summarizes the occurrence of the main substances of the species as listed below.

Tab. 2. One-dimensional TLC characteristics of the main unidentified diagnostic substances. The numbers of the substances correspond to those in the text. LW - Long wave UV-light. SW - short wave UV-light. Untreated: before acid charring and heat. Treated - after acid charring and heat. * - uppermost substance in a range of substances/front of trailing substance. # - Spot visible, but colour indistinct or not evident. - - Spot not evident or hardly visible.

		R_F-classes			Spot colour in daylight	
		A	B	C	Untreated plates	Treated plates
119	Subaurifera unknown 3	1(-2)	2-3	6	pale yellow/brown	(#)
108	Androgyna B unknown 3	1-2	1-2	1-2	-	greyish violet
66	Vouauxii unknown 2	2	2	1-2	-	-
120	Subaurifera unknown 4	2	2	2	-	-
3	Androgyna B unknown 2	2	1-2	1-2	-	-
71	Latebrarum unknown	2	1-2	1-2	-	pale brown
121	Vouauxii unknown 1	2	3	2	-	-
118	Subaurifera unknown 2	2(-3)	2	2(-3)	pale yellow/brown	(#)
111	Expallens unknown	3	4	3	pale yellow	-
110	Efflorescens unknown	(3-)4*	2	3(-4)	-	pale brown
14	Subcinnabarina unknowns	(4-)5	5	5	-	-
109	Chrysophthalma unknown	5	6	6	-	brown
12	Rigidula unknown	5	5-6	5	-	-
83	Rinodina sp. A unknown	5	5(-6)	5	-	pale yellow/orange
91	Herbidella unknown 2	5	5	5	pale yellow	pale yellow
90	Herbidella unknown 1	5	6	5-6	orange	yellow
117	Subaurifera unknown 1	5-6	2-3	6	pale yellow/brown	(#)
115	Griseovirens unknowns	5-6	2-3	5	-	-
78	Flavoleprosa unknown	6	6	6	-	-
96	Allophana unknown 2	6	3	5	-	pale violet
114	Gracilenta unknown 3	6	5	6	-	-
113	Gracilenta unknown 2	6	(4-)5	6	-	-
95	Allophana unknown 1	6	5	6	-	violet
112	Gracilenta unknown 1	7	7	7	-	-
93	Pseudogranulosa unknown	7-8	6	(7-)8	yellow	yellow

Tab. 2 (continued).

		Spot colour in UV-light			
		Untreated plates		Treated plates	
		SW	LW	SW	LW
119	Subaurifera unknown 3	#	brown	brown	brown
108	Androgyna B unknown 3	-	#	#	grey
66	Vouauxii unknown 2	grey	#	#	grey
120	Subaurifera unknown 4	-	±bluish white	-	-
3	Androgyna B unknown 2	-	-	-	-
71	Latebrarum unknown	pale blue	#	#	grey
121	Vouauxii unknown 1	-	yellow	#	grey
118	Subaurifera unknown 2	#	brown	brown	brownish
111	Expallens unknown	#	brown	#	grey
110	Efflorescens unknown	#	brown	#	grey
14	Subcinnabarina unknowns	-	-	-	-
109	Chrysophthalma unknown	blue	-	#	orange
12	Rigidula unknown	-	-	dull bluish	-
83	Rinodina sp. A unknown	blue	reddish brown	#	dull reddish brown
91	Herbidella unknown 2	#	yellowish brown	-	#
90	Herbidella unknown 1	#	brown	orange	orange to brown
117	Subaurifera unknown 1	#	brown	brown	brownish
115	Griseovirens unknowns	#	brown	#	#
78	Flavoleprosa unknown	#	pale brown	#	#
96	Allophana unknown 2	-	-	brown	brown
114	Gracilenta unknown 3	#	-	greyish blue	greyish blue
113	Gracilenta unknown 2	blue	±blue	greyish blue	blue
95	Allophana unknown 1	-	-	brown	brown
112	Gracilenta unknown 1	whitish blue	ice-blue	blue	vivid blue
93	Pseudogranulosa unknown	#	brown	orange	orange

Tab. 3. The secondary substances of the species. A. The numbers of the substances are referred to in the text and in Tab. 3B. B. Substances recorded in each species.

No.	Secondary substance	No.	Secondary substance
46	Alectorialic acid	112	Gracilenta unknown 1
34	Alectoronic acid	113	Gracilenta unknown 2
1	Allopertusaric acid	114	Gracilenta unknown 3
95	Allophana unknown 1	79	Granulosin
96	Allophana unknown 2	115	Griseovirens unknowns
2	Androgyna B unknown 1	19	Gyrophoric acid
3	Androgyna B unknown 2	90	Herbidella unknown 1
108	Androgyna B unknown 3	91	Herbidella unknown 2
73	Aotearone	20	Hyperlatolic acid
48	Argopsin	21	Imbricaric/stenosporic acid
74	Arthothelin	98	Impudens unknowns
40	Atranorin	80	Isoarthothelin
41	Barbatic acid	22	Isohyperlatolic acid
47	Barbatolic acid	23	Isosphaeric acid
100	Calycin	67	Isousnic acid
4	Caperatic acid	71	Latebrarum unknown
32	Chloroatranorin	24	Lecanoric acid
109	Chrysophthalma unknown	72	Lepraric acid
5	Colobina unknowns	7	Lichesterinic acid
15	Confluentic acid	81	Lichexanthone
49	Connorstictic acid	36	Lobaric acid
50	Constictic acid	55	Menegazziaic acid
75	Coronaton	106	Methoxymicareic acid
51	Cph-1	25	5-O-Methylhiascic acid
52	Cph-2	126	2'-O-Methylmicrophyllinic acid
53	Cryptostictic acid	82	O-Methylmonochlornorlichexanthone
17	4-O-Demethylsphaerophorin	27	2'–O–Methylperlatolic acid
16	4-O-Demethylisosphaeric acid	107	Micareic acid
76	Dichloronorlichexanthone	8	Murolic acid complex
77	4,5-Dichloronorlichexanthone	56	Norargopsin
6	Dihydropertusaric acid	28	Nordivaricatic acid
18	Divaricatic acid	9	Norrangiformic acid
110	Efflorescens unknown	57	Norstictic acid
43	Elatinic acid	29	Obtusatic acid
111	Expallens unknown	62	Pannaric acid
78	Flavoleprosa unknown	63	Pannaric acid-6–methylester
97	Flavopunctata unknown	58	Pannarin
54	Fumarprotocetraric acid	92	Parietin
35	Gangaleoidin	30	Perlatolic acid

Tab 3A (continued).

No.	Secondary substance	No.	Secondary substance
38	Picrolichenic acid	117	Subaurifera unknown 1
101	Pinastric acid	118	Subaurifera unknown 2
68	Placodiolic acid	119	Subaurifera unknown 3
31	Planaic acid	120	Subaurifera unknown 4
64	Porphyrilic acid	14	Subcinnabarina unknowns
59	Protocetraric acid	61	Succinprotocetraric acid
10	Protolichesterinic acid	33	Superlatolic acid
93	Pseudogranulosa unknown	84	2,4,5,7-tetrachloro-3-O-methylnorlichexanthone
69	Pseudoplacodiolic acid	45	Thamnolic acid
102	Pulvinic acid	85	Thiophanic acid
103	Pulvinic acid dilactone	86	Thiophaninic acid
11	Rangiformic acid	87	Thuringione
104	Rhizocarpic acid	88	2,5,7-trichloro-3-O-methylnorlichexanthone
94	Rhodocladonic acid	89	4,5,7-trichloro-3-O-methylnorlichexanthone
12	Rigidula unknown	39	Unknown with picrolichenic acid
83	Rinodina sp. A unknown	70	Usnic acid
13	Roccellic acid	37	Variolaric acid
116	Scalaris unknown	121	Vouauxii unknown 1
65	Schizopeltic acid	66	Vouauxii unknown 2
32	Sphaerophorin	105	Vulpinic acid
44	Squamatic acid	99	Zeorin
60	Stictic acid		

Tab. 3B.

Species	Substances present
Bacidia epixanthoides	none
Baeomyces rufus	50, 53, 57, 60
Buellia arborea	40, 68
- griseovirens	40, 49, 57, 115
Caloplaca chlorina	none
- citrina	92
- herbidella	90, 91
- obscurella	none

Tab. 3B (continued).

Species	Substances present
Caloplaca sorocarpa	13
Candelariella reflexa	100, 102, 103
- xanthostigma	100, 102, 103
Catillaria pulverea	40, 51, 52, 54, 59, 99
Chaenotheca furfuracea	102, 103, 105
- gracilenta	112, 113, 114
Chrysothrix candelaris	100, 101, 105
- chlorina	99, 100, 102, 105
- chrysophthalma	104, 109
Cliostomum leprosum	4, 40
Enterographa zonata	15, 26
Fuscidea arboricola	52, 54, 59
- praeruptorum	46, 47
- pusilla	18, 21, 28
- recensa	18, 21, 28
Gyalideopsis anastomosans	none
Haematomma ochroleucum	40, 64, 70, 99
Halecania viridescens	48, 56, 112
Hypocenomyce leucococca	46
- scalaris	24, 40, 116
- sorophora	46
Japewia subaurifera	36, 117, 118, 119, 120
Lecanactis latebrarum	13, 71, 72
Lecania baeomma	35, 40, 42
Lecanora allophana "f. sorediata"	40, 95, 96
- conizaeoides	52, 54, 59, 70
- expallens	70, 85, 99, 111
- farinaria	13, 40, 42
- flavoleprosa	70, 78, 99
- flavopunctata	40, 53, 60, 67, 70, 97
- impudens	40, 42, 98
- norvegica	40, 59
Lecidea cinnabarina	40, 42, 52, 54, 59
- efflorescens	48, 56
- gyrophorica	19, 24
- leprarioides	69
- nylanderi	18
- porphyrospoda	36
- praetermissa	52, 54, 59
- pullata	16, 17, 20, 22, 23, 32, 33

Tab. 3B (continued).

Species	Substances present
Lecidea subcinnabarina	14
- vacciniicola	19, 24
Lecidella elaeochroma "f. soralifera"	73, 74, 77, 79, 80, 81, 88
- flavosorediata	74, 79
- scabra	40, 74, 77, 87
- subviridis	40, 74, 85, 111
- sp. A	40, 73, 84, 87, 88, 89
Lepraria caerulescens	13, 40, 64
- caesioalba	13, 40, 51, 52, 54, 59
- eburnea	46, 47, 59
- elobata	40, 50, 53, 57, 60, 99
- incana	18, 28, 99
- jackii	9, 11, 13, 40
- lobificans	40, 49, 53, 57, 60, 99
- neglecta	13, 46
- obtusatica	29, 41
- rigidula	12, 40
- umbricola	45
- sp. A	9, 11, 40
Leproloma membranaceum	13, 40, 62
- vouauxii	62, 63, 66, 121
Loxospora elatina	43, 44, 45
Megalospora tuberculosa	70, 99
Micarea coppinsii	19, 24, 25
- leprosula	19, 24, 48
- prasina	106, 107
Mycoblastus alpinus	31, 40, 42, 67, 70
- caesius	30
- fucatus	40, 42, 52, 54, 59
- sanguinarius "f. leprosus"	4, 9, 11, 40, 42, 94
Ochrolechia alboflavescens	7, 10, 37, 40
- androgyna A	19, 24
- androgyna B	2, 3, 19, 24, 108
- androgyna C	8, 19, 24
- androgyna D	19, 24, 37
- arborea	19, 24, 81
- frigida "f. lapuensis"	19, 24
- microstictoides	7, 37
- subviridis	19, 24
- turneri	34, 37

Tab. 3B (continued).

Species	Substances present
Opegrapha gyrocarpa	19, 24, 65
- multipuncta	none
- sorediifera	19
Pertusaria albescens	1, 6
- amara	38, 39, 59
- borealis	52, 54, 59, 61
- coccodes	49, 57
- corallina	45
- coronata	50, 53, 57, 60, 75
- dactylina	54, 72
- flavida	15, 27, 50, 53, 55, 57, 60, 82, 86
- geminipara	46
- hemisphaerica	24, 37
- oculata	19, 52, 54, 59
- pupillaris	19, 52, 54, 59
Phlyctis argena	49, 57
Placynthiella dasaea	19, 24
- icmalea	19, 24, 25
Porpidia tuberculosa	15
- sp. A	50, 53, 60
Psilolechia lucida	104
Pyrrhospora quernea	76, 80, 85
Rimularia fuscosora	57
Rinodina colobina	5
- degeliana	40, 42, 99
- disjuncta	23, 32
- efflorescens	58, 99, 110
- flavosoralifera	74, 85
- griseosoralifera	40, 99
- sp. A	83, 99
Ropalospora viridis	20, 22, 30, 33
Schaereria corticola	19, 24, 25
Schismatomma umbrinum	65
Scoliciosporum gallurae	19
- sarothamni	19
Trapelia corticola	19, 24, 25
Trapeliopsis flexuosa	19, 24
- granulosa	19, 24
- pseudogranulosa	19, 24, 93
Varicellaria rhodocarpa	24, 81

Substances recorded

Higher aliphatic acids

(1) *Allopertusaric acid.* Literature: Huneck et al. (1986), see also Hanko (1983: Abb. 1-3) and Kümmerling (1991). In *Pertusaria albescens.*

(2) *Androgyna B unknown 1* (Fig. 18). Not evident by one-dimensional TLC in solvent B. Common accessory in *Ochrolechia androgyna* B. Sometimes with an accompanying fatty acid.

(3) *Androgyna B unknown 2* (Fig. 18). Diagnostic compound in *Ochrolechia androgyna* B.

(4) *Caperatic acid.* In *Cliostomum leprosum* as a constant and diagnostic compound and in *Mycoblastus sanguinarius* "f. *leprosus*" (chemotype I).

(5) *Colobina unknowns.* R_F-classes: A 4-5, B 5, C 6. Unidentified accessory fatty acids in *Rinodina colobina* (tentatively).

(6) *Dihydropertusaric acid.* Literature: Huneck et al. (1986), see also Hanko (1983: Abb. 1-3) and Kümmerling (1991). Spot visible in UV-light on untreated plates. In *Pertusaria albescens.*

(7) *Lichesterinic acid.* Spot visible in UV-light on untreated plates. In *Ochrolechia alboflavescens* and *O. microstictoides.*

(8) *Murolic acid complex* (Fig. 19). Three substances were observed: Large amounts of 2 fatty acids in R_F-classes A 3-4, B 3-5, C 3-5; trace amounts of one fatty acid in R_F-classes A2-3, C2-3. These compounds appeared to be similar to fatty acids found in all specimens studied of *Usnea hirta* from Norway, Sweden and Finland. According to Clerc (1987), *Usnea hirta* contains fatty acids of the murolic acid complex, see also White & James (1985), who recorded murolic and muronic acids from that species. The murolic acid complex was diagnostic in *Ochrolechia androgyna* C.

(9) *Norrangiformic acid.* In *Lepraria* sp. A and *Mycoblastus sanguinarius* "f. *leprosus*" (chemotype II) as a minor constituent with rangiformic acid. Although its presence was not always proved, it might prove to be a constant satellite compound with rangiformic acid.

(10) *Protolichesterinic acid.* Spot not visible in UV-light on untreated plates. In *Ochrolechia alboflavescens* as a constant compound.

(11) *Rangiformic acid.* In *Lepraria* sp. A and *Mycoblastus sanguinarius* (chemotype II). Usually with norrangiformic acid in moderate to trace amounts.

(12) *Rigidula unknown* (Fig. 18). Possibly two fatty acids with nearly identical R_F-values. Diagnostic substance in *Lepraria rigidula.*

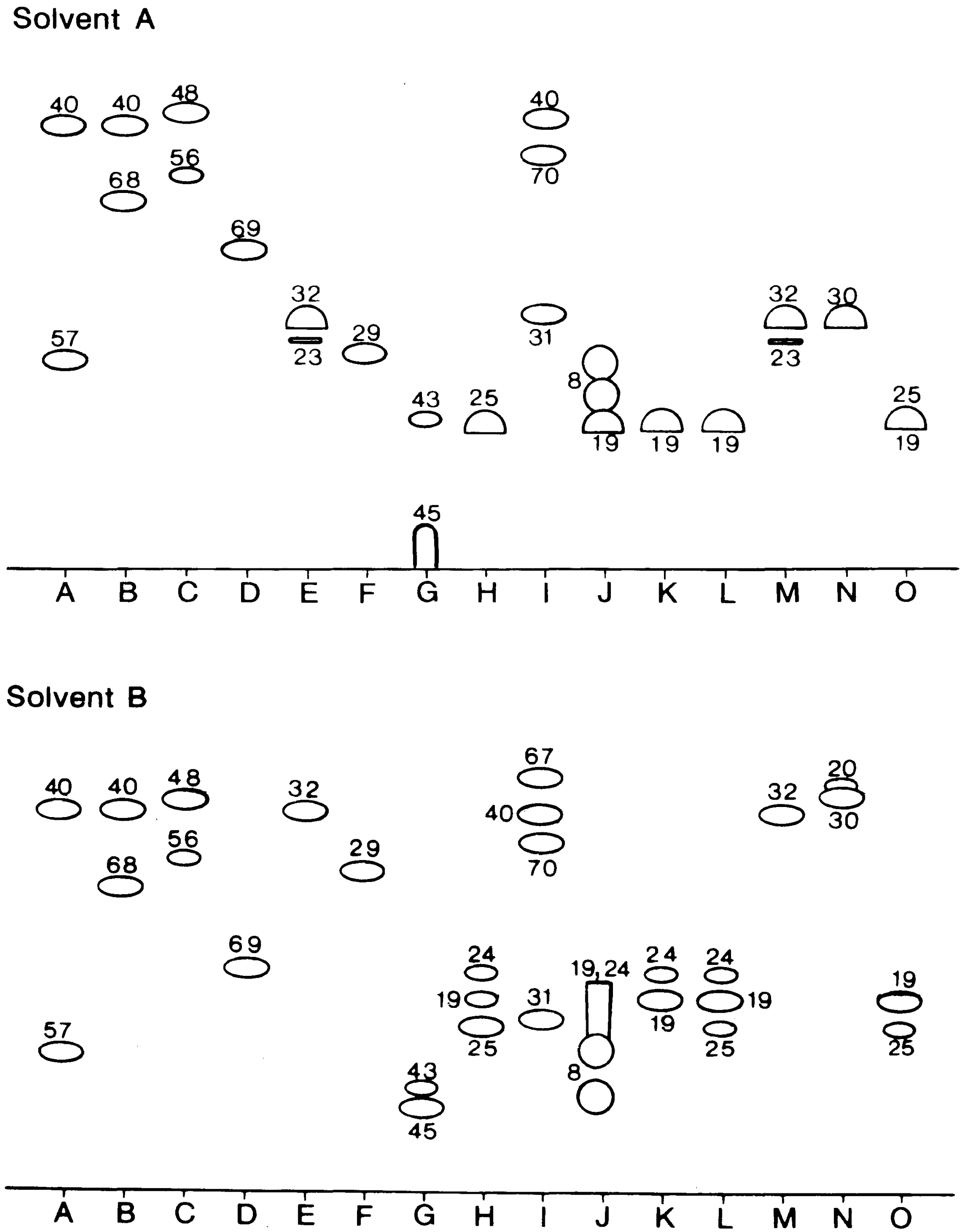
(13) *Roccellic acid* (Fig. 18). Observed in *Caloplaca sorocarpa, Lecanactis latebrarum, Lecanora farinaria, Leproloma membranaceum, Lepraria caerulescens, L. caesioalba, L. neglecta,* and *L. jackii.*

(14) *Subcinnabarina unknowns* (Fig. 18). Observed in *Lecidea subcinnabarina,* usually in moderate to trace amounts.

Orcinol depsides and tridepsides

(15) *Confluentic acid.* In *Porpidia tuberculosa* (as a constant constituent according to Gowan 1989a), *Enterographa zonata* (accessory) and *Pertusaria flavida* (accessory)).

(16) *4-O-Demethylisosphaeric acid.* Probably present in *Lecidea pullata* (see Culberson


Solvent A
40
40
48
40
56
68
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A B C D E F G H I J K L M N O
Solvent B
67
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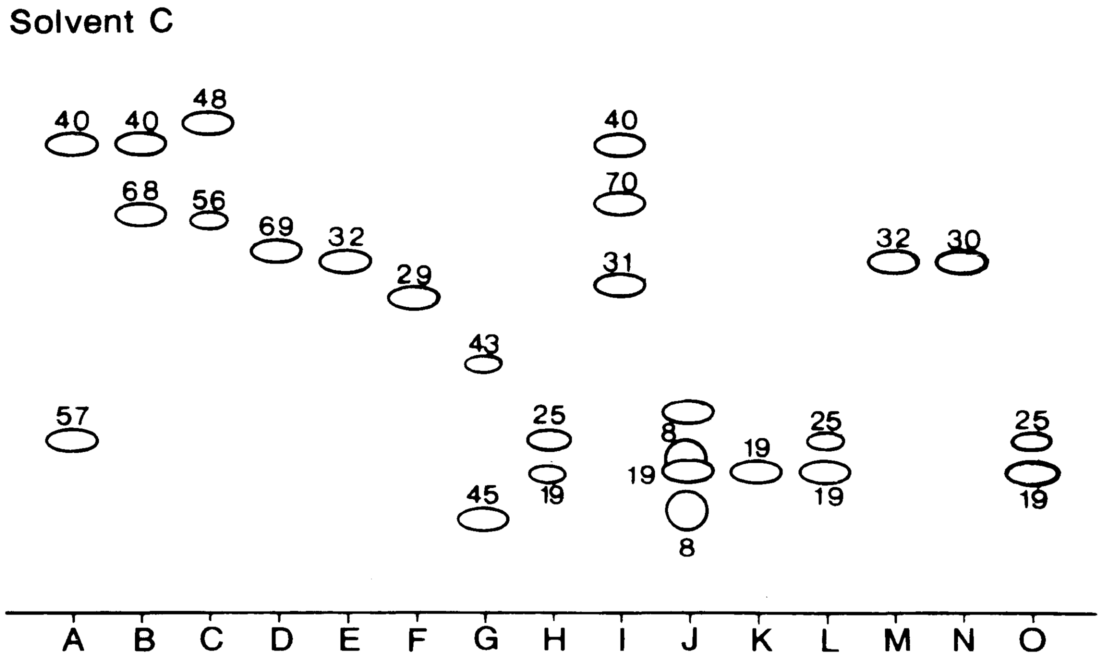


Fig. 19. Chromatogram in solvent systems A, B and C of some rarely occurring or interesting substances. The numbers refer to those in the text. A - References. B - *Buellia arborea*. C - *Lecidea efflorescens*. D - *Lecidea leprarioides*. E - *Lecidea pullata*. F - *Lepraria obtusatica*. G - *Loxospora elatina*. H - *Micarea coppinsii*. I - *Mycoblastus alpinus*. J - *Ochrolechia androgyna* C. K - *Placynthiella dasaea*. L - *Placynthiella icmalea*. M - *Rinodina disjuncta*. N - *Ropalospora viridis*. O - *Schaereria corticola*.

et al. 1984). Identified by two-dimensional TLC (C × B) of one specimen (Tønsberg 6436a).

(17) *4-O-Demethylsphaerophorin*. Probably present in *Lecidea pullata* (see Culberson et al. 1984). Identified by two-dimensional TLC (C × B) of one specimen (leg. Tønsberg 6436a).

(18) *Divaricatic acid*. A major substance in *Fuscidea pusilla*, *F. recensa*, *Lecidea nylanderi*, and *Lepraria incana*.

(19) *Gyrophoric acid* (Fig. 18-19). A major substance in a number of species Separates from lecanoric acid in solvent B and from 5-O-methylhiascic acid in solvents B and C. Gyrophoric acid was usually accompanied by several satellite substances, including lecanoric acid. According to Yoshimura & Kurokawa (1991) species with gyrophoric acid also contain lecanoric acid and orsellinic acid. In *Ochrolechia alboflavescens*, *O. microstictoides* and *O. turneri* gyrophoric acid occurred in the apothecia only.

(20) *Hyperlatolic acid* (Fig. 19). Identified by HPLC as a substance in moderate amounts in *Ropalospora viridis* (Culberson et al. 1984). The TLC spot representing hyperlatolic acid/isohyperlatolic acid/superlatolic acid separated slightly from the spot for perlatolic acid in solvents B. According to Culberson et al. (1984) no method is known to separate hyperlatolic and isohyperlatolic acid.

(21) *Imbricaric/stenosporic acid.* In *Fuscidea pusilla* and *F. recensa* in trace amounts (by HPLC of one specimen of each species).

(22) *Isohyperlatolic acid.* Identified by TLC/HPLC as a minor constituent of *Ropalospora viridis* and *Lecidea pullata* (Culberson et al. 1984; the specimen mentioned on page 158 as Tønsberg 6436a has later been identified as *Lecidea pullata*). See also under hyperlatolic acid, above.

(23) *Isosphaeric acid* (Fig. 19). With sphaerophorin in *Lecidea pullata* and *Rinodina disjuncta.* In the latter it occurred only in trace amounts; in the former it usually also occurred in trace amounts, but rarely it occurred in concentrations higher than (leg. Tønsberg 6436a, analyzed by TLC/HPLC; see Culberson et al. 1984: 158) or ± equal to that of sphaerophorin.

(24) *Lecanoric acid.* In *Hypocenomyce scalaris, Pertusaria hemisphaerica* and *Varicellaria rhodocarpa* as a major substance. In all species with gyrophoric acid as a major substance, lecanoric acid occurred as a constant satellite substance in trace amounts or in a concentration ± equal to that of gyrophoric acid. Lecanoric acid was sometimes accompanied by unidentified substances in trace to moderate amounts. According to Yoshimura & Kurokawa (1991), species containing lecanoric acid always contain orsellinic acid, but gyrophoric acid is absent (Leuckert 1985).

(25) *5-O-Methylhiascic acid* (Fig. 19). Literature: Elix & Jayanthi (1977). R_F-classes: A 3, B 5, C 4. Separated well from gyrophoric acid in solvent C. Observed in *Micarea coppinsii, Placynthiella icmalea, Trapelia corticola* and *Schaereria corticola.* It always occurred with gyrophoric acid, either in a concentration higher than (*Micarea coppinsii*), more or less equal to (*Schaereria corticola*) or, lower than (*Trapelia corticola, Placynthiella icmalea*) that substance (see Tab. 4).

(26) *2'-O-Methylmicrophyllinic acid.* R_F-classes: A 3-4, B 3, C 5. Spot ice-blue in long-wave UV-light after charring. A constant substance in *Enterographa zonata.* Probably present also in *Porpidia tuberculosa* as a minor substance in addition to confluentic acid (see Gowan 1989a,b); the present specimen was too meagre to allow for detection of minor substances. Listed as "unknown" by White & James (1985: Tab. 4, sheet 3).

(27) *2'-O-Methylperlatolic acid.* In *Pertusaria flavida* (chemotype II).

(28) *Nordivaricatic acid.* In *Fuscidea pusilla, F. recensa,* and *Lepraria incana* (as an accessory in trace amounts).

(29) *Obtusatic acid* (Fig. 19). In *Lepraria obtusatica* as the major constituent.

(30) *Perlatolic acid* (Fig. 19). In *Mycoblastus caesius* and *Ropalospora viridis* as the major compound.

(31) *Planaic acid* (Fig. 19). A major substance in *Mycoblastus alpinus* (and in *M. affinis*, its primary counterpart).

Tab. 4. Relative occurrence of gyrophoric and 5-0-methylhiascic acid in *Micarea coppinsii, Placynthiella dasaea, P. icmalea, Schaereria corticola* and *Trapelia corticola.*

Secondary substance	*M. coppinsii*	*P. dasaea*	*P. icmalea*	*S. corticola*	*T. corticola*
Gyrophoric acid	minor	major	major	major	major
5-O-methylhiascic acid	major	absent	minor	major	minor

(32) *Sphaerophorin* (Fig. 19). The major substance of *Rinodina disjuncta* and most specimens of *Lecidea pullata*; in the latter species its concentration was rarely equal to or lower than that of isosphaeric acid.

(33) *Superlatolic acid.* Identified by HPLC (Culberson et al. 1984). Did not separate from hyperlatolic/isohyperlatolic acid by TLC. Occurred in trace amounts in *Ropalospora viridis*.

Orcinol depsidones

(34) *Alectoronic acid.* A rare, accessory substance in trace amounts in *Ochrolechia turneri*.

(35) *Gangaleoidin.* In *Lecania baeomma* as a diagnostic substance.

(36) *Lobaric acid.* In *Lecidea porphyrospoda* (constant) and in *Japewia subaurifera* (as a rare accessory).

(37) *Variolaric acid.* A constant substance in *Ochrolechia alboflavescens*, *O. androgyna* D, *O. microstictoides*, and *O. turneri* and, accessorily, in *Pertusaria hemisphaerica*. (Usually with a satellite substance in trace amounts (R_F-classes A 2, B (4-) 5, C 2.)

Orcinol depsones

(38) *Picrolichenic acid.* KC+ violet. Major substance in *Pertusaria amara*.

(39) *Unknown with picrolichenic acid.* Literature: Holien et al. (1980) and Hanko (1983, as "Rh"). R_F-classes: A 3, B 5, C 3. The spots have the same pale green-grey colour after charring as the spot for picrolichenic acid. A minor substance in 8 % of the specimens of *Pertusaria amara*.

β-orcinol depsides

(40) *Atranorin.* A common substance in a number of genera and species.

(41) *Barbatic acid.* Substance in trace amounts in *Lepraria obtusatica* (HPLC of one specimen (leg. Tønsberg 8832).

(42) *Chloroatranorin.* Separated from atranorin in solvent H. These two substances are indistinguishable in the standard solvents B and C. In solvent A chloroatranorin had a slightly lower R_F-value than atranorin and was more distinctly UV+ in long-wave UV-light before charring. In solvent H spots usually trail, and the R_F-values were greatly concentration dependent. The more concentrated the substance, the higher it migrated. Chloroatranorin accompanied atranorin in *Lecania baeomma* (trace), *Lecanora farinaria*, *Lecanora impudens* (accessory), *Lecidea cinnabarina*, *Mycoblastus alpinus*, *M. fucatus*, *M. sanguinarius*, and *Rinodina degeliana*. Specimens with chloroatranorin always proved to contain atranorin in addition, in more or less equal or higher concentration. Chloroatranorin was not observed in any of the atranorin-containing species of *Lepraria* and *Leproloma*.

(43) *Elatinic acid* (Fig. 19). Literature: Culberson et al. (1986). R_F-classes: A 3, B 3, C 5, G 3(-4); before treatment: bright blue in shortwave UV light; after charring: pale grey-green in long-wave UV light, pale orange in daylight. A minor, but probably constant constituent of *Loxospora elatina*.

(44) *Squamatic acid.* A minor, accessory substance in *Loxospora elatina*.

(45) *Thamnolic acid* (Fig. 19). A major substance in *Lepraria umbricola*, *Loxospora elatina*, and *Pertusaria corallina*.

Benzyl esters

(46) *Alectorialic acid*. A major substance in *Fuscidea praeruptorum*, *Hypocenomyce leucococca*, *H. sorophora*, *Lepraria eburnea*, *L. neglecta* and *Pertusaria geminipara*. Herbarium specimens with alectorialic acid were pinkish. Alectorialic acid was always accompanied by several (usually four) unidentified substances in trace to moderate amounts.

(47) *Barbatolic acid*. R_F-classes A2, B5, C3. Barbatolic acid was observed in moderate amounts with alectorialic acid in *Lepraria eburnea*; it was also observed (by 2-dimensional chromatography (A × B) of one specimen) in *Fuscidea praeruptorum*. A specimen of *Bryoria capillaris* which was used as a control for barbatolic acid (see, e.g., Holien 1989) contained barbatolic acid as a major substance, and alectorialic acid in moderate amounts.

β-orcinol depsidones

Chromatographic treatment of the stictic acid complex has been carried out by Culberson et al.) (1981).

(48) *Argopsin* (Fig. 19). A major compound in *Halecania viridescens*, *Lecidea efflorescens*, and *Micarea leprosula*. Argopsin corresponds to albicans unknown 2 of Swinscow & Krog (1981).

(49) *Connorstictic acid* (Fig. 18). A satellite in trace to moderate amounts or, rarely, high concentration in species with large amounts of norstictic acid.

(50) *Constictic acid*. A satellite substance in moderate to trace amounts in all species with stictic acid except *Lecanora flavopunctata*.

(51) *Cph-1*. Literature: Culberson et al. (1981), Huovinen & Ahti (1986a, 1986b). R_F-classes D 2, G 2. Cph-1 was a common satellite in all species containing fumarprotocetraric acid.

(52) *Cph-2*. Literature: Culberson et al. (1981), Huovinen & Ahti (1986a, 1986b). R_F-classes D 2, G 3. A common accessory in trace amounts in species containing fumarprotocetraric acid. A common accessory in moderate amounts in *Catillaria pulverea*.

(53) *Cryptostictic acid*. A satellite substance in moderate to trace amounts in all species with stictic acid.

(54) *Fumarprotocetraric acid*. Separated well in solvents G and D2 from both protocetraric acid, a common satellite substance, and from succinprotocetraric acid. A major substance in a number of species.

(55) *Menegazziaic acid*. In *Pertusaria flavida* in moderate amounts.

(56) *Norargopsin* (Fig. 19). R_F-classes: A 6, B 6, C 6. A minor substance occurring with argopsin in *Halecania viridescens* and *Lecidea efflorescens*. Norargopsin corresponds to albicans unknown 1 of Swinscow & Krog (1981). Norargopsin, is the immediate precursor of argopsin (P. M. Jørgensen, pers. comm.).

(57) *Norstictic acid*. A major substance in *Buellia griseovirens*, *Pertusaria coccodes*, *Phlyctis argena*, and *Rimularia fuscosora*, and in trace amounts in species with the stictic acid complex.

(58) *Pannarin* (Fig. 18). In *Rinodina efflorescens* as a major substance.

(59) *Protocetraric acid*. R_F-classes: D 3, G 2-3. Separated well from both

fumarprotocetraric and succinprotocetraric acids in Solvents G and D. In *Lecanora norvegica* and *Lepraria eburnea* (as a major substance), *Pertusaria amara* (as an accessory in large to trace amounts), and a satellite in trace amounts in all species containing fumarprotocetraric acid.

(60) *Stictic acid.* A major constituent of *Baeomyces rufus, Lepraria lobificans, L. elobata, Pertusaria coronata* and *Porpidia* sp. A, and in moderate to trace amounts in most specimens of *Lecanora flavopunctata.*

(61) *Succinprotocetraric acid.* R_F-classes: D 3, G 3. Did not separate from fumarprotocetraric and protocetraric acids in Solvents A, B and C; separated well from these substances in Solvents G and D. Observed in *Pertusaria borealis* where it usually occurred in moderate to trace amounts, occasionally in amounts more or less equal to or higher than that of fumarprotocetraric acid.

Dibenzofurans

(62) *Pannaric acid* (Fig. 18). In *Leproloma membranaceum* (major) and *L. vouauxii* (trace).

(63) *Pannaric acid-6-methylester* (Fig. 18). Literature: Laundon (1989; as methyl-pannaric acid), Leuckert & Kümmerling (1989), Kümmerling (1991). R_F-classes: A 2-3, B 5, C 2-3. Observed in *Lepraria vouauxii* as a major diagnostic substance.

(64) *Porphyrilic acid.* A major substance in *Haematomma ochroleucum* and *Lepraria caerulescens.*

(65) *Schizopeltic acid.* A constant major substance in *Schismatomma umbrinum* (see also James & Coppins 1979, Jørgensen & Tønsberg 1988) and an accessory in *Opegrapha gyrocarpa.* Always with a range of unidentified minor constituents.

(66) *Vouauxii unknown 2* (Fig. 18). Apparently a dibenzofuran. Possibly identical to oxypannaric acid-6-methylester (see Kümmerling 1991). However, its R_F-values in solvent systems A and C were lower than those obtained from oxypannaric acid-6-methylester on chromatograms of an isotype (BG) of *Leproloma diffusum* v. *chrysodetoides* Laundon known to contain that substance (see Laundon 1989, Kümmerling 1991)), but was similar in all other TLC-characteristics such as behavior in day-light and UV-light on untreated as well as on treated plates. In *Lepraria vouauxii* as a diagnostic substance in moderate amounts.

Usnic acids

(67) *Isousnic acid* (Fig. 19). A constant substance in *Lecanora flavopunctata* and an accessory in *Mycoblastus alpinus.* Isousnic acid separated from usnic acid in solvents B (runs above atranorin) and in C and H (ran between atranorin and usnic acid). In solvent H the spots representing usnic and isousnic acids were dark in long-wave UV-light on untreated plates, whereas those of atranorin and chloroatranorin were luminous. The R_F-values varied strongly with the concentration. Isousnic acid usually occurred with usnic acid. However, a few specimens of *Lecanora flavopunctata* contained isousnic acid without detectable amounts of usnic acid.

(68) *Placodiolic acid* (Fig. 19). In *Buellia arborea* (major). (Placodiolic acid occurred in all specimens from Norway and Sweden analysed of *Lecidea turgidula*, the primary counterpart of *L. leprarioides.*)

(69) *Pseudoplacodiolic acid* (Fig. 19). In *Lecidea leprarioides* (major).

(70) *Usnic acid* (Fig. 18-19). Separated well from isousnic acid in solvent B and H, see

also under isousnic acid above. In *Haematomma ochroleucum* v. *ochroleucum*, *Lecanora expallens*, *L. flavopunctata*, *Lecanora conizaeoides* (accessory), *Lecanora* sp. A, *Megalospora tuberculosa*, and *Mycoblastus alpinus*. Usnic acid and atranorin rarely occur together in the same lichen thallus (Huovinen & Ahti 1982). Joint occurrences of these substances were observed in *Haematomma ochroleucum* v. *ochroleucum*, *Lecanora flavopunctata* and *Mycoblastus alpinus*. In the latter species, usnic acid, with the accessory isousnic acid, occurred in the soralia only; *M. affinis*, its primary counterpart, was devoid of these pigments. In *Cliostomum leprosum*, usnic acid occurred in the apothecia only.

Chromones

(71) *Latebrarum unknown* (Fig. 18). The similarities of this substance with lepraric acid, in daylight and UV-light on untreated as well as of treated plates indicate that it is a chromone. Observed as a substance in moderate amounts in *Lecanactis latebrarum*.

(72) *Lepraric acid* (Fig. 18). R_F-classes A 3, B 2, C 3, D 3, G 2. In *Lecanactis latebrarum* as a major constant compound, and in *Pertusaria dactylina* as an accessory. Dibben (1980) mentioned lepraric acid as a possible accessory in very low concentrations in North American and exotic collections of *P. dactylina*. In the Norwegian material of that species, this accessory occurred in easily detectable amounts and its TLC characteristics (R_F-values and UV properties on treated as well as untreated plates in 5 solvent systems) were identical to those of lepraric acid found in *Lecanactis latebrarum*.

Xanthones

Literature: Leuckert & Knoph (in press) and Hanko (1983).

(73) *Aotearone*. In *Lecidella* (major) and *L. elaeochroma* (chemotype II)(trace).

(74) *Arthothelin*. A major substance in *Lecidella elaeochroma* (chemotype I), *L. flavosorediata*, *L. scabra*, and *Rinodina flavosoralifera*, and in *Lecanora expallens* and *Lecidella subviridis* in moderate amounts.

(75) *Coronaton*. In *Pertusaria coronata* as a major substance.

(76) *Dichloronorlichexanthone*. In *Pyrrhospora quernea* (trace).

(77) *4,5-Dichloronorlichexanthone*. In *Lecidella elaeochroma* (chemotype I, trace). Possible trace in *Lecidella scabra*.

(78) *Flavoleprosa unknown* (Fig. 18). Unidentified diagnostic substance in *Lecanora flavoleprosa*.

(79) *Granulosin*. In *Lecidella elaeochroma* (chemotype I) and in *L. flavosorediata*.

(80) *Isoarthothelin*. In *Lecidella elaeochroma* (chemotype II) and *Pyrrhospora quernea*.

(81) *Lichexanthone*. In *Lecidella elaeochroma* "f. *soralifera*" (chemotype I and II) where it was restricted to the soralia, and in *Ochrolechia arborea* and *Varicellaria rhodocarpa*.

(82) *O-Methylmonochloronorlichexanthone*. A minor constituent with thiophaninic acid in *Pertusaria flavida*. Literature: Hanko (1983).

(83) *Rinodina sp.* A unknown (Fig. 18). In *Rinodina* sp. A.

(84) *2,4,5,7-tetrachloro-3-O-methylnorlichexanthone*. In *Lecidella* sp. A as a minor compound.

(85) *Thiophanic acid* (Fig. 18). In *Lecanora expallens*, *Lecidella elaeochroma* (chemotype II), *L. subviridis*, *Pyrrhospora quernea*, and *Rinodina flavosoralifera*.

(86) *Thiophaninic acid.* In *Pertusaria flavida* (major).

(87) *Thuringione.* In *Lecidella scabra* as an accessory, and in *Lecidella* sp. A (possible trace).

(88) *2,5,7-trichloro-3-O-methylnorlichexanthone.* A major substance in *Lecidella elaeochroma* (chemotype II) and *Lecidella* sp. A.

(89) *4,5,7-trichloro-3-O-methylnorlichexanthone.* A minor substance in *Lecidella* sp. A.

Anthraquinones

(90) *Herbidella unknown 1* (Fig. 18). Separated from herbidella unknown 2 in solvent C. In *Caloplaca herbidella* as the major pigment.

(91) *Herbidella unknown 2* (Fig. 18). In *Caloplaca herbidella* as a minor pigment.

(92) *Parietin.* In *Caloplaca citrina* as the major pigment.

(93) *Pseudogranulosa unknown* (Fig. 18). K+ purplish. In *Trapeliopsis pseudogranulosa*, usually in large amounts; occasionally lacking. In some specimens there were faint traces of 1-2 additional pigments, probably anthraquinones; these were not further studied.

Naphthoquinones

(94) *Rhodocladonic acid.* In *Mycoblastus sanguinarius* "f. *leprosus*".

Terpenoids

Terpenoids. Zeorin and/or several unidentified terpenoids were observed in *Catillaria pulverea, Chaenotheca gracilenta, Chrysothrix chlorina, Haematomma ochroleucum, Lecanora allophana* "f. *sorediata*" (Fig. 20), *L. expallens, L. flavoleprosa, L. flavopunctata, L. impudens* (Fig. 20), *Lepraria elobata, L. incana, L. lobificans, Megalospora tuberculosa, Rinodina degeliana, Rinodina griseosoralifera* and *Rinodina* sp. A. Most terpenoids occurred in low amounts. Allophana unknown 1 and 2, and zeorin occurred in high concentration. In *Rinodina efflorescens* zeorin seems to be a rare accessory. Zeorin was apparently always accompanied by other terpenoids (e.g., in *Catillaria pulverea*, and *Megalospora tuberculosa* with up to 10 or more additional terpenoids). Chemical analysis of several Norwegian specimens of a number of zeorin-producing foliose and fruticose lichens, e.g. *Cladonia coccifera, C. deformis, C. pleurota, Heterodermia speciosa, Leprocaulon microscopicum, Physcia aipolia, Pilophorus cereolus* and *P. robustus* always revealed a range of other terpenoids in trace amounts, and this appears to be a common feature among lichens (Tønsberg unpubl.). In herbarium material older than 5-10 (occasionally 2-3) years of terpenoid- containing specimens, crystal needles were observed projecting from the surface. Needles were especially abundant on *Megalospora tuberculosa* (collected 1979) giving the thallus surface a woolly appearance, but occurred also on *Haematomma ochroleucum, Lecanora expallens* (very abundant on a specimen from 1823 (leg. Sommerfelt (O)), *L. flavoleprosa*, and *L. flavopunctata*. However, crystals were not observed in *Catillaria pulverea* (absent also on a saxicolous specimens collected 1904 (Sogn og Fjordane: Selje, Havås (UPS)), *Chrysothrix chlorina, Lepraria* spp. and *Rinodina* spp. The reason for this may be that the crystals are formed by terpenoids other than zeorin and that species such as, *Catillaria pulverea* either do not contain terpenoids that develop needles, or produce them in too low concentrations. The presence of needles on zeorin-deficient species, e.g., on *Lecanora flavopunctata* (and *Cladonia zopfii*), support this hypothesis.

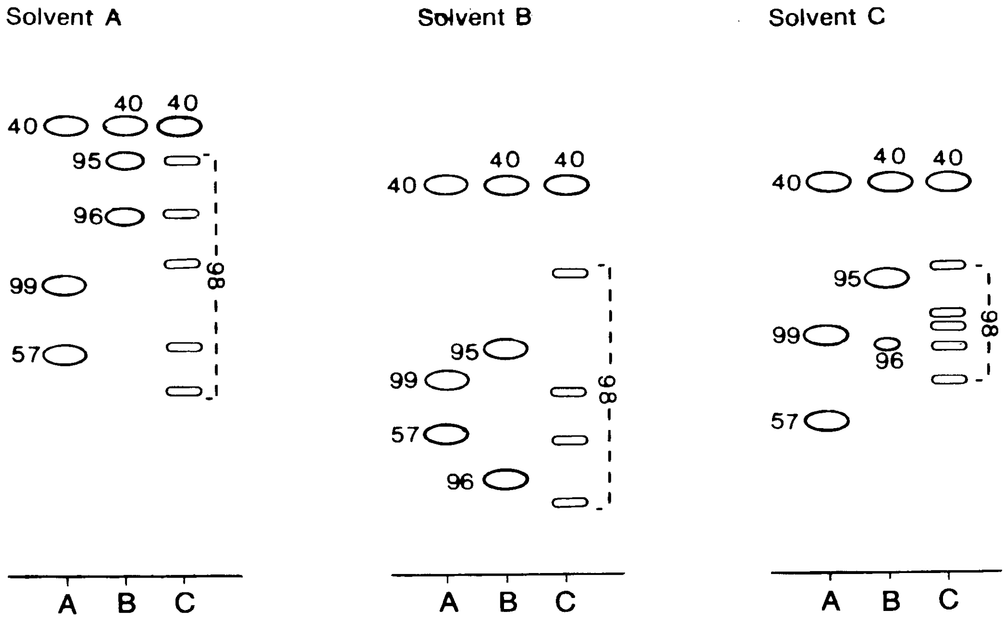


Fig. 20. Chromatogram in solvent systems A, B and C. A - References. B - *Lecanora allophana* "f. *sorediata*". C - *Lecanora impudens*.

(95) *Allophana unknown 1* (Fig. 20). In *Lecanora allophana* "f. *sorediata*" as a diagnostic substance.

(96) *Allophana unknown 2* (Fig. 20). In *Lecanora allophana* "f. *sorediata*" as a diagnostic substance.

(97) *Flavopunctata unknown*. R_F-classes: A 5-6, B 6, C 5-6. In *Lecanora flavopunctata* (easily obscured by terpenoids from the substratum).

(98) *Impudens unknowns* (Fig. 20). In *Lecanora impudens* as diagnostic substances.

(99) *Zeorin*. See under "Terpenoids".

Pulvinic acid derivatives

(100) *Calycin*. In *Candelariella reflexa* (accessory), *C. xanthostigma*, *Chrysothrix candelaris* (chemotype II) and *C. chlorina*. Acetone extracts with calycin as major pigment were orange.

(101) *Pinastric acid*. In *Chrysothrix candelaris* (chemotype I). Acetone extracts with pinastric acid as major pigment were yellow without an orange tinge.

(102) *Pulvinic acid*. In *Candelariella reflexa*, *C. xanthostigma*, and *Chaenotheca furfuracea*.

(103) *Pulvinic acid dilactone*. An accessory in *Candelariella reflexa*, *C. xanthostigma*, and *Chaenotheca furfuracea*. Possibly a constant substance occurring in too low concentration to be positively detected in all specimens.

(104) *Rhizocarpic acid* (Fig. 18). Observed in *Chrysothrix chrysophthalma* and *Psilolechia lucida*.

(105) *Vulpinic acid*. In *Chaenotheca furfuracea* and *Chrysothrix candelaris* (chemotype I, possible trace) and *C. chlorina*.

Diphenyl ethers

(106) *Methoxymicareic acid.* Literature: Elix & Jones et al. (1984), Coppins (1983a). In *Micarea prasina*, chemotype I.

(107) *Micareic acid.* Literature: Elix & Jones et al. (1984), Coppins (1983a). In *Micarea prasina*, chemotype II.

Unidentified diagnostic substances of uncertain position

(108) *Androgyna B unknown 3* (Fig. 18). Diagnostic substance in *Ochrolechia androgyna* B.

(109) *Chrysophthalma unknown* (Fig. 18). Corresponds to the unidentified substance characterized by Laundon (1981). In *Chrysothrix chrysophthalma.*

(110) *Efflorescens unknown* (Fig. 18). Diagnostic pigment in *Rinodina efflorescens.*

(111) *Expallens unknown* (Fig. 18). Often with an accompanying pigment in trace amounts. In *Lecanora expallens* and *Lecidella subviridis* in moderate to trace amounts.

(112) *Gracilenta unknown 1* (Fig. 18). Observed in *Chaenotheca gracilenta* and *Halecania viridescens.* On chromatograms of the latter species, gracilenta unknown 1 runs to a position between argopsin and norargopsin in solvent A and C, overlaps with argopsin in solvent B. Corresponds to inquinans unknown 3 of Middelborg & Mattsson (1987) who reported it from *Calicium parvum*, *Chaenotheca gracilenta*, and *Cyphelium inquinans.* Gracilenta unknown 1 also occurs in *Sphaerophorus fragilis* (as an accessory).

(113) *Gracilenta unknown 2* (Fig. 18). In *Chaenotheca gracilenta* as a major substance.

(114) *Gracilenta unknown 3* (Fig. 18). In *Chaenotheca gracilenta.*

(115) *Griseovirens unknowns* (Fig. 18). A range of unidentified pigments in *Buellia griseovirens.*

(116) *Scalaris unknown.* R_F-classes A 5-6, B 6, C 5-6. In *Hypocenomyce scalaris.* Corresponds to scalaris unknown 3 characterized by Timdal (1984).

(117-119) *Subaurifera unknowns 1-3* (Fig. 18). By one-dimensional chromatography a complex of pigments (trailing) was observed with uppermost spot in R_F-classes A (5-)6, B 2-3, C (5-)6. By comparing one-dimensional and two-dimensional (AxB, AxC) chromatograms, three main pigments were separated: (117) *Subaurifera unkown 1:* R_F-classes: A 5-6 (trailing), B 2-3, C 6; (118) *Subaurifera unknown 2*: R_F-classes A 2(-3), B 2, C 2(-3), and (119) *Subaurifera unknown 3*: R_F-classes: A 1(-2), B 2-3 (trailing), C 6 (trailing). Diagnostic pigments in *Japewia subaurifera.*

(120) *Subaurifera unknown 4* (Fig. 18). Unidentified substance in *Japewia subaurifera.*

(121) *Vouauxii unknown 1* (Fig. 18). Ran to a position between that of pannaric acid-6-methyl-ester and oxypannaric acid-6-methyl-ester in all standard solvents. In *Leproloma vouauxii* as a diagnostic substance.

Localization of substances

The chemical constituents of a lichen are usually not uniformly distributed throughout the thallus. In species with a well-developed stratified thallus, substances such as atranorin, usnic acid and xanthones have been found to be restricted to or having the highest concentrations in the cortical layer, whereas most colourless substances are assumed to be medullary in location (see e.g. Dibben 1980, Egan 1986, Lawrey 1986). The restricted occurrence of many

Tab. 5. Examples of species with a ± restricted occurrence of substances within the thallus.

Thallus parts	Species	Substance
Soralia or mainly soralia	Loxospora elatina	elatinic acid
	Japewia subaurifera	subaurifera unknowns 1-3
	Lecanora flavopunctata	usnic acid
	Lecidella elaeochroma "f. soralifera"	lichexanthone
	Mycoblastus alpinus	usnic acid, ± isousnic acid
	Ochrolechia arborea	lichexanthone
	Pertusaria amara	protocetraric acid
Soralia and cortex	Ochrolechia alboflavescens	variolaric acid
	Ochrolechia androgyna A-C	gyrophoric acid
	Ochrolechia frigida "f. lapuensis"	gyrophoric acid
	Ochrolechia microstictoides	variolaric acid
	Ochrolechia turneri	variolaric acid
	Pertusaria flavida	thiophaninic acid
Soralia and medulla	Pertusaria hemisphaerica	lecanoric acid

substances to apothecial tissues are well documented (see, e.g., W.L. Culberson 1969, Imshaug & Brodo 1966, Botnen & Tønsberg 1988, Brodo 1984a, Tønsberg 1980).

No thorough study of localization was carried out in the present study, but some analyses (using TLC, UV-light, spot tests on specimens with substances giving positive reactions of species with a well-developed thallus) and morphological observations suggest that, in some species, chemical constituents are restricted to or have their main occurrences in the soralia, in the cortical layer and the soralia, or in the medulla and the soralia (see Tab. 5). In *Pertusaria amara* protocetraric acid was a constant substance in fertile tuberculae and an accessory in the interior of sorediate tuberculae in completely sterile specimens.

Sets of biogenetically related compounds

Biogenetically related substances often occur together in sets in which the substances occur in more or less constant relative amounts or in chemosyndroms in which a series of substances occur in variable relative concentration (see e.g. Culberson & Culberson 1976, Culberson et al. 1987; Elix, Whitton & Sargent 1984).

In the present study a number of compounds were found to occur in chemosyndroms or in sets comprising one major compound and one or several biogenetically related compounds in moderate to trace amounts. Occasionally the relative amounts of the substances were changed. Additional sets apparently occur among the xanthones.

(1) Alectorialic acid (major compound), several unidentified compounds in moderate to trace amounts.

(2) Argopsin (major) and norargopsin (minor). Norargopsin was not observed with argopsin in *Micarea leprosula*. Whether norargopsin in that species is completely absent or occurs in a concentration too low to allow for detection was not settled.

(3) Fumarprotocetraric acid (major compound), protocetraric acid (minor). No fumarprotocetraric acid was observed in species with protocetraric acid as a major substance.

(4) Gyrophoric acid (major), lecanoric acid (minor). In some specimens of gyrophoric acid-containing *Ochrolechia* species, lecanoric acid sometimes occurred in amounts more or less equal to that of gyrophoric acid. In *Ochrolechia androgyna* s. lat. a number of compounds in moderate to trace amounts occurred. Some of these compounds probably belong to the gyrophoric acid chemosyndrom.

(5) Norstictic acid (major) and connorstictic acid (minor). No stictic acid was observed in species with norstictic acid as a major substance (see also Leuckert 1985).

(6) Rangiformic acid (major), norrangiformic acid (minor).

(7) Sphaerophorin (major), isosphaeric acid (minor).

(8) Stictic acid (major), constictic acid (moderate amounts), cryptostictic acid (moderate amounts), norstictic acid (trace).

(9) Variolaric acid (major) and unknown with variolaric acid (minor).

Types of intraspecific chemical variation

Three types of intraspecific chemical variation were recognized:

(1) *Replacement pattern* (simple replacement of one or a few substances; Elix, Whitton & Sargent 1984).

An example is *Pertusaria flavida*, which contained the cortical xanthone thiophaninic acid as a constant constituent and the medullary substances 2'-O- methylperlatolic acid, confluentic acid and stictic acid with satellites. 2'-O-methylperlatolic occurred with or without confluentic acid but never with stictic acid (see also Hanko 1983). Based on the medullary substances, this species is considered to constitute three chemotypes: (I) a 2'-O-methylperlatolic acid chemotype with accessory confluentic acid (clearly exceeded the other chemotypes in frequency), (II) a stictic acid chemotype, and (III) an acid deficient chemotype. 2'-O-methylperlatolic acid and stictic acid are biogenetically distinct, the former being a para-depside of the orcinol-type, the latter a β-orcinol depsidone.

A chemical replacement pattern was also observed among the cortical compounds, e.g., in the xanthone-containing *Lecidella elaeochroma* "f. *soralifera*". In this lichen, two chemotypes occurred. Lichexanthone, the only xanthone common to both chemotypes, occurred in the soralia only.

In corticolous material of *Opegrapha gyrocarpa*, schizopeltic acid occurred as an accessory substance; gyrophoric acid was constant. However, in saxicolous material examined, three chemotypes were found, one with gyrophoric acid, one with schizopeltic acid and one with both substances. In this case it seems best to distinguish between three different chemotypes, the two first representing a replacement pattern of chemical variation, the latter being a chemical intermediate or chemical combinant.

(2) *Accessory substances*. These are substances occurring sporadically in species containing one or several constant (diagnostic) substances; their presences are apparently not correlated with any other character such as morphology and distribution (Elix 1982; Elix, Whitton & Sargent 1984). However, the frequency of a particular accessory may vary between populations.

Accessory substances in high concentrations occurred, e.g., in the following species (accessories in brackets): *Enterographa zonata* (confluentic acid), *Pertusaria flavida* chemotype II (confluentic acid), and *P. hemisphaerica* (variolaric acid). For further examples, see under chemosyndromic variation below.

Many species contained traces of unidentified substances. Some of these were apparently accessories, others may prove to be constant satellites, which, due to a low concentration, were not consistently detected by routine TLC-analyses.

(3) *Chemosyndroms.* The set of biogenetically related compounds listed above comprises substances which usually occur in constant relative concentrations within each set. Some exceptions were discovered, however. A few specimens of *Pertusaria coccodes* contained connorstictic acid in a concentration more or less equal to that of norstictic acid. Constictic acid, which usually accompanies stictic acid, was not found with stictic acid in *Lecanora flavopunctata.* In a few specimens of *Lecidea pullata* there was a reverse relative concentration of the compounds: Isosphaeric acid occurred as the major substance (see also Culberson et al. 1984) whereas sphaerophorin was a minor substance. A few specimens of *Pertusaria borealis* contained succinprotocetraric acid in concentrations equal to or higher than that of fumarprotocetraric acid.

CHEMISTRY: ACETONE INSOLUBLE PIGMENTS

The chemical nature of the acetone insoluble pigments is unknown, but they can be characterized by their colour in water (LM) and subsequent reactions to alkali (K) and acid (N) solutions. It is important to note that the colour observed on dry material (DM) is not always identical to that observed with LM in aqueous preparations. In the delimitation of species, great taxonomic value is currently assigned to these pigments and their location, especially those occurring in apothecia. Several acetone insoluble pigments, mostly greenish, bluish or brown, also occurred in the vegetative thallus, mainly in the prothallus, cortex, and external soredia where they were located to the cell-wall of the mycobiont. The colour referred to below was observed in LM in preparations mounted in water.

Pigment A. Dark green, aeruginose or bluish. K-, N+ red. Observed in the soredia of *Micarea coppinsii, M. leprosula,* and *Mycoblastus fucatus* and in the prothallus of *Lecidea pullata* and *Mycoblastus fucatus.* Corresponds to pigment A of Coppins (1983a).

Pigment B. Aeruginose or bluish. K-, N+ violet. Observed in the soredia of *Caloplaca obscurella, Mycoblastus caesius, Lecania baeomma,* and in the cortex and/or prothallus of *Mycoblastus caesius* and *Lecidea nylanderi.* Pigment B may be related to, if not identical with, pigment A.

Pigment C. Green or bluish. K+ violet, N+ violet, C+ violet. Observed in the soredia of *Caloplaca chlorina, Micarea prasina,* and *Rinodina colobina* and in a single specimen of *Caloplaca obscurella.*

Pigment D. Aeruginose. K+ brown, N-. Observed in the soredia of *Trapeliopsis aeruginosa.*

Pigment E. Green to aeruginose. K- (or fading), N+ brownish. Observed in the soredia of *Hypocenomyce leucococca* and *H. sorophora.*

Pigment F. Greyish black. K+ violet, N+ violet. Observed on the tips of the isidia of *Pertusaria oculata.*

Pigment G. Dark green or bluish. K+ fuscous brown, N-. Observed in the external soredia of *Buellia griseovirens*.

Pigment H. Greyish black, K-, N+ red-brown. Observed occasionally in prothallus of *Lecanora conizaeoides*.

Pigment I. Brown, K+ fuscous brown and N+ fuscous brown. Common in prothallus, cortex and/or external soredia of *Fuscidea* spp.

SUBSTRATUM ECOLOGY

Survey of habitats

Three main habitats can roughly be distinguished (Tab. 6: 1-3): (1) More or less vertical trunks of mature trees exposed to direct rain, (2) shrubs or poorly developed trees, and (3) shaded, dry bark under overhanging rock, in concave parts of tree bases, in bark recesses, on the under side of leaning trunks etc.

Most of the species, altogether 103 species (80%), occurred on vertical trunks of trees subjected to more or less direct rain. This was the main habitat for most of the species. In this habitat lichens apparently occur along gradients defined by, e.g., the degree of humidity, the degree of shade (or insolation), and features of the bark surface (such as the degree of roughness (or smoothness) and the degree of decay. Examples of species found in extremes of these gradients are listed in Tabs 7 and 8. Most species occurred on faintly to moderately shaded, more or less smooth bark. Species typical for rotten bark often also occurred on rough bark (Tab. 8).

Lichens do not have any special structures or morphological adaptions by which they can control or retard water loss (Hale 1983), and are therefore often abundant in sites not subjected to too rapid desiccation. The flora of sorediate lichens is therefore often more luxuriously developed and abundant on the shaded side of a sun-exposed trunk than on the sun-exposed side. Even warmth-demanding species such as, *Lecanora impudens* and *L. allophana* "f. *sorediata*", may avoid bark with too much direct sun. It is important to note that trunks of deciduous trees which are sun-exposed during winter may be shaded in summer due to the presence of leaves; this effect is most pronounced for broad-leaved trees such as *Acer platanoides*, *A. pseudoplatanus*, *Aesculus hippocastanum*, *Ulmus glabra* etc.

Forty-three (34 %) of the species were found on shrubs or poorly developed trees (Tab. 6: 2). For 6 (5 %) of the species shrubs were the main habitat, i.e. the species were absent or less frequent on mature trees: *Caloplaca sorocarpa*, *Gyalideopsis anastomosans*, *Lecanora flavopunctata*, *Lecidea porphyrospoda*, *L. vacciniicola*, and *Micarea coppinsii*.

Twenty-seven (21 %) of the species occurred on dry, sheltered bark (Tab. 6: 3). A small number of species were found almost exclusively in this habitat. Species typical of this habitat often have a ± leprose thallus or thallus surface (*Chaenotheca furfuracea*, *Chrysothrix candelaris*, *C. chlorina*, *Haematomma ochroleucum*, *Lecanactis latebrarum*, *Lepraria* spp., *Leproloma* spp., *Opegrapha gyrocarpa*, and *O. multipuncta*) and *Trentepohlia* as photobiont (*Enterographa zonata*, *Lecanactis latebrarum*, *Opegrapha gyrocarpa*, *O. multipuncta*, and *Schismatomma umbrinum*). No isidiate taxon was found in this habitat and most species were completely sterile. These shade tolerant lichens have a well-developed ability to utilize atmospheric humidity (James 1970). This agrees with the fact that the most luxurious and

Tab. 6. The habitats and substrates for the species. Columns 1-3: Survey of the main habitats in which the species were found. Columns 4-10: Substratum preferences. Columns 11-14: General substratum preferences. Columns 15-40: Specific substrates.

Explanations for individual columns: (1) tree trunks exposed to ± direct rain; (2) shrubs (incl. poorly developed trees); (3) sheltered, dry bark under rock overhangs, on the underside of leaning trunks, in concave parts of tree bases, in bark recesses etc., ± protected from direct rain. (4) Species on non-coniferous phorophytes; (5) species on conifers; (6) poor-bark species; (7) intermediate-bark species; (8) rich-bark species; (9) often on (but not completely overgrowing) corticolous mosses; (10) often on (but not completely overgrowing) other corticolous lichen species. (11) Mainly corticolous (or on corticolous mosses and lichens); (12) mainly lignicolous; (13) mainly saxicolous (or on saxicolous mosses) (s - in sheltered overhangs); (14) mainly terricolous (on soil or plant remnants or over bryophytes); (15) *Acer platanoides*; (16) *Acer pseudoplatanus*; (17) *Aesculus hippocastanum*; (18) *Alnus glutinosa*; (19) *Alnus incana*; (20) *Betula nana*; (21) *Betula pubescens+pendula*; (22) *Calluna vulgaris*; (23) *Corylus avellana*; (24) *Fagus sylvatica*; (25) *Fraxinus excelsior*; (26) *Ilex aquifolium*; (27) *Juniperus communis*; (28) *Malus domestica*; (29) *Picea abies*; (30) *Pinus sylvestris*; (31) *Populus tremula*; (32) *Prunus padus*; (33) *Quercus* spp.; (34) *Salix aurita*; (35) *Salix caprea*; (36) subalpine/low-alpine *Salix* spp. (shrubs); (37) *Sorbus aucuparia*; (38) *Tilia cordata*; (39) *Ulmus glabra*; (40) *Vaccinium myrtillus*.

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Bacidia epixanthoides	*	.	.	*	.	.	?	.	*	.	*	.	.	.	.	.	.	.	.	.	.	.	.	*	*	.	.	.	.	.	*	.	.	.	.	.	.	.	*	.
Baeomyces rufus	*	.	.	*	.	*	.	.	.	.	.	.	*	*	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.
Buellia arborea	*	.	.	.	*	*	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.
- griseovirens	*	.	.	*	*	*	*	*	.	.	*	.	.	.	*	.	.	*	*	.	*	.	*	*	*	.	*	.	*	.	*	*	*	*	*	.	*	.	*	.
Caloplaca chlorina	*	.	.	*	.	.	.	*	.	.	*	.	?	.	*	*	*	.	.	.	.	.	.	.	*	.	.	*	.	.	.	.	.	.	.	.	.	*	*	.
- citrina	*	.	.	*	.	.	.	*	.	.	.	.	*	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.
- herbidella	*	*	.	*	*	?	?	.	.	.	*	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.
- obscurella	*	.	.	*	.	.	.	*	.	.	*	.	.	.	*	*	*	.	.	.	.	.	.	.	*	.	.	*	.	.	*	.	.	.	*	.	.	*	*	.
- sorocarpa	(*)	*	.	*	*	*	.	.	.	.	*	.	.	.	.	.	.	.	*	*	*	.	.	.	.	.	*	.	.	.	*	.	.	.	.	*	*	.	.	.
Candelariella reflexa	*	.	.	*	.	.	.	*	.	.	*	.	.	.	.	*	*	*	*	.	.	.	.	.	*	.	.	*	.	.	*	.	*	.	.	.	*	*	*	.
- xanthostigma	*	.	.	*	.	.	.	*	.	.	*	.	.	.	*	.	.	.	*	.	*	.	.	.	*	.	.	*	.	.	*	*	*	.	*	.	*	*	*	.
Catillaria pulverea	*	.	.	*	(*)	*	*	.	*	.	*	.	.	.	.	.	.	*	*	.	*	.	.	.	*	*	.	.	*	.	*	.	*	*	*	.	*	.	.	.
Chaenotheca furfuracea	.	.	*	*	*	*	.	.	.	.	*	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	*	*	*	.	.	.	.	.	.	.	.	.
- gracilenta	.	.	*	*	.	*	.	.	.	.	?	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Chrysothrix candelaris	*	.	*	*	*	*	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	*	.	.	.	.	.	.	.
- chlorina	.	.	*	.	*	*	.	.	.	.	.	.	s	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.
- chrysophthalma	*	.	.	.	*	*	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	*	.	.	.	.	.	.	.	.	.	.
Cliostomum leprosum	*	.	.	.	*	*	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.
Enterographa zonata	.	.	*	*	.	*	.	.	.	.	.	.	s	.	.	.	.	.	.	.	.	.	.	.	*	*	.	.	.	.	*	.	.	.	.	.	*	.	.	.
Fuscidea arboricola	*	.	.	*	*	*	*	?	.	.	*	.	.	.	*	.	.	*	*	.	*	*	.	*	*	.	*	.	*	*	*	.	*	.	*	.	*	*	.	.

Tab. 6 (continued).

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Fuscidea praeruptorum	*	.	*	*	*	*	.	.	.	.	.	.	s	.	.	.	.	.	*	.	*	*	.	.	.	.	.	.	*	*	*	.	.	.	*	.	*	.	.	.
- pusilla	*	.	.	*	*	*	*	.	.	.	*	.	.	.	.	.	.	*	*	.	*	.	.	*	.	.	*	*	*	*	*	.	.	.	*	.	*	.	.	.
- recensa	*	.	.	*	.	*	.	.	.	.	.	.	*	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.
Gyalideopsis anastomosans	.	*	.	*	*	*	.	.	.	.	*	.	.	.	.	.	.	*	.	.	.	*	.	.	.	.	*	.	.	.	.	.	.	*	.	.	.	.	.	.
Haematomma ochroleucum	.	.	*	*	.	*	*	?	.	.	.	.	s	.	.	.	.	.	.	.	.	.	.	*	*	.	.	.	.	.	*	.	*	.	.	.	*	.	.	.
Halecania viridescens	*	*	.	*	.	.	*	*	.	.	*	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.
Hypocenomyce leucococca	*	.	.	*	*	*	.	.	.	.	*	.	.	.	.	.	.	*	*	.	*	.	.	*	.	.	.	.	*	*	.	*	.	.	*	.	*	.	.	.
- scalaris	*	.	.	*	*	*	.	.	.	.	*	*	.	.	*	.	*	.	.	.	*	.	.	.	.	.	.	.	*	*	.	.	.	.	.	.	.	*	.	.
- sorophora	*	.	.	*	*	*	.	.	.	.	.	*	.	.	.	.	.	.	*	.	*	.	.	.	.	.	.	.	*	*	.	.	.	.	.	.	.	.	.	.
Japewia subaurifera	*	.	.	*	*	*	.	.	.	.	*	.	.	.	.	.	.	*	*	.	*	.	.	.	.	.	*	.	*	*	.	*	.	.	*	.	*	.	.	.
Lecanactis latebrarum	.	.	*	*	.	*	.	.	.	.	.	.	s	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.
Lecania baeomma	.	.	*	*	.	*	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.
Lecanora allophana "f. sor."	*	.	.	*	.	.	.	*	.	.	*	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
- conizaeoides	*	.	.	*	*	*	.	.	.	.	*	.	.	.	.	*	*	*	.	.	*	.	*	*	.	.	.	*	*	*	*	*	*	.	*	.	.	*	.	.
- expallens	*	.	*	*	*	*	*	.	.	.	*	*	.	.	*	*	*	.	*	.	*	.	*	.	*	.	*	.	*	*	*	.	*	.	*	.	*	*	*	.
- farinaria	*	*	.	*	(*)	*	.	.	.	.	*	.	.	.	.	.	.	.	*	.	*	*	*	.	.	.	*	.	*	.	*	.	*	*	*	.	*	*	*	.
- flavoleprosa	*	.	.	*	.	*	.	.	.	.	*	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
- flavopunctata	(*)	*	.	*	.	*	.	.	.	.	*	.	.	.	.	.	.	.	*	*	*	.	.	.	.	.	.	.	*	.	*	.	.	.	*	*	.	.	.	.
- impudens	*	.	.	*	.	.	.	*	.	.	*	.	.	.	*	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	*	.	.	.	.	.	.	.	*	.
- norvegica	*	.	.	.	*	*	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.
Lecidea cinnabarina	*	*	.	*	*	*	.	.	.	.	*	.	.	.	.	.	.	.	*	*	*	.	.	.	.	.	*	.	*	*	.	.	.	.	.	*	*	.	.	.
- efflorescens	*	.	.	*	*	*	?	.	.	.	*	.	.	.	*	.	.	*	*	.	*	.	*	*	.	.	*	.	*	.	*	*	*	*	*	.	*	.	*	.
- gyrophorica	*	*	.	*	*	*	.	.	*	.	*	.	.	.	.	.	.	.	*	.	*	.	.	.	.	.	*	.	*	.	*	.	*	.	*	.	*	.	*	.
- leprarioides	*	.	.	.	*	*	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.
- nylanderi	*	*	.	*	*	*	.	.	.	.	*	.	.	.	.	.	.	*	*	.	*	.	.	.	.	.	*	.	*	*	*	*	*	.	.	.	*	.	.	.
- porphyrospoda	*	*	.	*	*	*	.	.	.	.	*	.	.	.	.	.	.	.	.	*	*	.	.	.	.	.	*	.	*	.	.	.	.	.	.	*	.	.	.	.
- praetermissa	*	.	.	*	*	*	.	.	.	.	*	.	.	.	.	.	.	.	*	.	*	.	.	.	.	.	.	.	*	.	.	.	.	.	*	.	*	.	.	.
- pullata	*	*	.	*	*	*	.	.	.	.	*	.	.	.	.	.	.	*	*	*	*	*	.	.	.	.	*	.	*	*	*	*	.	.	*	*	*	.	.	*
- subcinnabarina	*	.	.	*	.	*	.	.	.	.	*	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	*	.	.	.
- vacciniicola	(*)	*	.	*	*	*	.	.	.	.	*	.	.	.	.	.	.	.	.	*	*	*	.	.	.	.	*	.	*	.	.	.	.	.	*	*	*	.	.	*
Lecidella elaeochr. "f. sor."	*	.	.	*	.	.	.	*	.	.	*	.	.	.	.	*	*	.	*	.	.	.	.	.	*	.	.	.	.	.	*	.	.	.	.	.	*	.	.	.
- flavosorediata	*	.	.	*	*	.	.	*	.	.	*	.	.	.	*	*	*	.	*	.	*	.	*	*	*	.	*	*	.	*	*	.	*	.	*	.	*	*	*	.
- scabra	*	.	.	*	.	.	.	*	.	.	*	.	*	.	*	*	.	.	*	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	*	.	.	*	*	.
- subviridis	*	*	.	*	*	*	?	.	.	.	*	.	.	.	.	.	.	*	*	.	*	*	*	*	.	*	*	.	.	*	.	*	.	*	*	.	*	.	.	*
- sp. A	*	*	.	*	.	.	.	*	.	.	*	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	*	.	.	.
Lepraria caerulescens	.	*	.	*	*	*	.	.	.	*	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	*	.	.	.	.
- caesioalba	*	.	.	*	.	*	.	.	*	.	?	.	.	.	.	.	.	*	*	.	*	.	.	*	.	.	.	.	.	.	.	.	*	.	*	.	*	.	.	.
- eburnea	*	.	*	*	*	*	.	.	*	.	?	.	.	.	.	.	.	.	*	.	.	.	*	.	.	.	.	.	*	.	*	.	*	.	.	.	*	.	.	.

Tab. 6 (continued).

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Lepraria elobata	*	.	*	*	*	*	.	.	.	.	?	.	.	.	.	.	.	.	*	.	*	.	.	*	.	.	*	*	*	*	*	.	*	.	*	.	*	.	.	.
- incana	*	.	*	*	*	*	.	.	.	.	?	.	.	.	.	.	.	*	.	.	*	.	.	.	.	.	*	.	*	*	.	.	.	.	.	.	*	.	.	.
- jackii	*	.	*	*	*	*	.	.	.	.	?	.	.	.	.	.	.	*	*	.	*	.	.	.	.	.	.	*	*	*	.	.	*	.	.	.	*	.	.	.
- lobificans	*	.	*	*	.	*	?	.	*	.	?	.	.	.	*	.	.	.	*	.	*	.	.	.	*	.	.	.	.	.	*	.	*	.	*	.	*	*	*	.
- neglecta	.	*	.	*	.	*	.	.	.	.	.	.	*	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.
- obtusatica	.	.	*	*	*	*	.	.	.	.	?	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	*	.	.	.	.	.	.	.	*	.	.	.
- rigidula	*	.	*	*	*	*	.	.	.	.	?	.	.	.	*	*	.	*	*	.	*	.	*	*	*	.	.	*	*	*	.	.	*	.	*	.	*	*	*	.
- umbricola	.	.	*	*	*	*	.	.	.	.	?	.	.	.	.	.	.	.	.	.	*	*	.	.	.	.	.	.	.	*	.	.	.	.	.	.	*	.	.	.
- sp. A	.	.	*	*	*	*	.	.	.	.	?	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	*	.	*	.	.	.	.	.	*	.	.	.
Leproloma membranaceum	.	.	*	*	*	*	.	.	.	.	.	.	s	.	.	.	.	*	.	.	*	.	.	*	.	.	*	.	*	.	*	.	*	.	.	.	.	.	.	.
- vouauxii	.	.	*	*	*	*	.	.	.	.	.	.	*	.	.	.	.	.	*	.	.	.	.	.	*	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.
Loxospora elatina	*	(*)	.	*	*	*	.	.	.	.	*	.	.	.	.	.	.	*	*	.	*	*	*	*	.	*	*	.	*	*	*	*	*	*	*	.	*	*	*	.
Megalospora tuberculosa	*	.	.	*	.	.	?	.	*	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.
Micarea coppinsii	.	*	.	*	*	*	.	.	.	.	*	.	.	.	.	.	.	*	.	.	.	*	.	.	.	.	*	.	.	.	*	.	.	*	.	.	*	.	.	.
- leprosula	*	.	.	*	*	*	.	.	.	.	.	.	*	?	.	.	.	.	*	.	*	*	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.
- prasina	*	*	.	*	*	*	.	.	.	.	*	*	.	.	.	.	.	*	*	.	*	*	.	.	*	.	*	.	*	*	.	*	*	*	*	.	*	.	.	*
Mycoblastus alpinus	*	(*)	.	*	*	*	.	.	.	.	.	*	.	*	.	.	.	*	.	.	*	.	.	.	.	.	*	.	*	*	.	.	.	.	.	.	.	.	.	.
- caesius	*	.	.	*	*	*	.	.	.	.	*	.	.	.	.	.	.	.	*	.	*	*	.	.	*	*	*	.	*	*	.	.	.	.	.	.	*	.	.	.
- fucatus	*	*	.	*	*	*	.	.	.	.	*	.	.	.	.	.	.	*	*	.	*	*	.	*	*	*	*	.	*	*	*	*	*	*	.	.	*	.	.	.
- sanguinarius "f. leprosus"	*	.	.	*	*	*	.	.	.	.	*	.	.	.	.	.	.	*	.	.	*	.	.	.	.	.	*	.	*	.	*	.	.	.	.	.	*	.	.	.
Ochrolechia alboflavescens	*	.	.	*	*	*	.	.	.	.	*	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	*	.	*	*	.	.	.	.	.	.	.	.	.	.
- androgyna A	*	(*)	.	*	*	*	.	.	.	.	?	.	.	.	.	.	.	*	*	*	*	.	*	*	.	.	*	.	*	*	*	*	*	.	*	.	*	.	.	*
- androgyna B	*	(*)	.	*	*	*	*	.	*	.	?	.	.	.	.	.	.	*	*	.	*	.	.	*	.	.	*	*	*	*	.	.	*	.	*	.	*	.	*	.
- androgyna C	*	.	.	*	*	*	*	.	.	.	?	.	.	.	*	.	.	*	*	.	*	.	.	*	*	.	.	.	*	*	*	*	*	.	*	.	*	*	.	.
- androgyna D	*	.	.	*	.	*	.	.	.	.	?	.	.	.	.	.	.	.	*	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.
- arborea	*	*	.	*	*	*	*	.	.	.	*	.	.	.	.	.	.	*	*	.	.	*	.	.	.	.	*	.	.	*	*	.	*	.	*	.	*	.	.	.
- frigida "f. lapuensis"	*	*	.	*	*	*	.	.	.	.	.	.	.	*	.	.	.	.	*	*	*	.	.	.	.	.	*	.	*	*	.	.	.	.	.	.	.	.	.	.
- microstictoides	*	(*)	.	*	*	*	.	.	.	.	*	.	.	.	*	.	.	*	*	.	*	.	.	.	*	*	*	.	*	*	*	*	*	.	*	.	*	.	.	.
- subviridis	*	.	.	*	.	.	*	*	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	*	*	.	.	.	.	.	*	.	*	.	.	.	.	.	.	.
- turneri	*	.	.	*	.	.	.	*	.	.	*	.	.	.	*	*	*	.	.	.	.	.	.	*	*	.	.	.	.	.	*	.	*	.	*	.	*	*	*	.
Opegrapha gyrocarpa	.	.	*	*	.	*	.	.	.	.	.	.	s	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.
- multipuncta	.	*	*	*	*	*	?	.	.	.	*	.	.	.	.	*	.	.	.	.	.	*	.	.	.	.	*	*	*	*	.	.	.	.	.	.	.	.	.	.
- sorediifera	*	.	.	*	.	*	?	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.
Pertusaria albescens	*	.	.	*	*	(*)	*	*	*	.	*	.	.	.	.	*	.	.	*	.	*	.	.	*	*	.	.	.	*	.	*	.	*	.	.	.	*	*	.	.
- amara	*	.	.	*	*	*	*	*	*	.	*	.	.	.	*	.	.	*	*	.	*	.	.	*	*	.	*	.	*	*	*	*	*	.	*	.	*	*	*	.
- borealis	*	.	.	*	*	*	.	.	.	.	*	.	.	.	.	.	.	*	*	.	*	.	*	*	.	.	*	.	*	*	*	*	.	*	*	.	*	.	*	.
- coccodes	*	.	.	*	*	(*)	*	*	.	.	*	.	.	.	*	.	.	.	*	.	*	.	.	*	*	.	*	.	*	.	*	.	*	.	*	.	*	.	*	.
- corallina	*	.	.	*	*	*	.	.	.	.	.	.	*	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	*	.	.	.
- coronata	*	.	.	*	*	(*)	*	*	.	.	*	.	.	.	*	.	.	*	.	.	*	.	.	*	*	.	.	.	*	.	*	*	*	.	*	.	*	*	*	.

Tab. 6 (continued).

Species	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Pertusaria dactylina	*	*	.	*	*	*	.	.	.	.	.	.	.	*	.	.	.	.	.	*	*	.	.	.	.	.	*	.	*	.	.	.	.	.	.	.	.	.	.	.
- flavida	*	.	.	*	(*)	(*)	*	*	.	.	*	.	.	.	.	.	.	.	.	.	*	.	.	*	*	.	.	.	.	.	.	.	*	.	.	.	*	*	*	.
- geminipara	*	*	.	*	*	*	.	.	.	.	.	.	.	*	.	.	.	.	.	*	.	.	.	.	.	.	*	.	*	.	.	.	.	.	.	.	.	.	.	.
- hemisphaerica	*	.	.	*	*	(*)	*	*	.	.	*	.	.	.	*	.	.	*	*	.	*	.	.	*	*	.	*	.	*	.	*	*	*	.	.	.	*	*	.	.
- oculata	*	*	.	*	*	*	.	.	.	.	.	.	.	*	.	.	.	.	.	*	*	.	.	.	.	.	*	.	*	.	.	.	.	.	.	.	.	.	.	.
- pupillaris	*	.	.	*	*	*	.	.	.	.	*	.	.	.	*	.	.	*	*	.	*	.	*	*	.	.	*	.	*	*	*	*	*	.	*	.	*	*	.	.
Phlyctis argena	*	(*)	.	*	*	*	*	*	.	.	*	.	.	.	*	*	*	*	*	.	*	.	*	*	*	*	*	.	*	.	*	*	*	.	*	.	*	*	*	.
Placynthiella dasaea	*	*	.	*	*	*	.	.	.	.	*	.	.	.	*	.	.	*	*	.	*	.	.	.	.	.	*	.	*	.	.	.	.	.	*	.	*	.	.	.
- icmalea	*	*	.	*	*	*	.	.	.	.	*	.	.	.	.	.	.	*	*	.	*	.	.	.	.	.	*	.	*	*	.	*	*	.	.	.	*	*	.	.
Porpidia tuberculosa	.	.	*	*	.	*	.	.	.	.	.	.	*	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
- sp. A	.	.	*	*	.	*	.	.	.	.	?	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
Psilolechia lucida	.	.	*	*	*	*	.	.	.	.	.	.	s	.	.	.	.	.	.	.	*	*	.	.	.	.	.	.	*	*	*	.	.	.	.	.	.	.	.	.
Pyrrhospora quernea	*	.	.	*	*	*	*	.	.	.	*	.	.	.	.	.	*	*	.	.	*	.	.	.	.	.	.	.	*	.	.	.	*	.	.	.	*	.	.	.
Rimularia fuscosora	*	.	.	*	.	*	.	.	.	.	*	.	.	.	.	.	.	.	*	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.
Rinodina colobina	*	.	.	*	.	.	.	*	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	*	.	.	.	.	.	.	.	*	.
- degeliana	*	(*)	.	*	*	*	*	?	.	.	*	.	.	.	*	.	.	*	*	.	*	.	.	.	.	.	*	.	.	.	.	.	*	.	*	.	*	*	.	.
- disjuncta	*	(*)	.	*	.	*	.	.	.	.	*	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	*	.	*	.	.	.
- efflorescens	*	.	.	*	.	*	*	?	.	*	*	.	.	.	.	*	.	*	*	.	*	.	*	*	*	.	.	.	.	.	*	*	*	.	*	.	*	*	.	.
- flavosoralifera	*	.	.	*	.	*	*	.	*	.	*	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	*	.	.	.	.	*	.	.
- griseosoralifera	*	.	.	*	.	.	*	*	.	.	*	.	.	.	*	*	*	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	*	*	.
- sp. A	*	.	.	*	.	?	.	.	*	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.
Ropalospora viridis	*	.	.	*	*	*	*	.	.	.	*	.	.	.	.	*	.	*	*	.	*	.	.	*	*	*	*	.	*	*	*	*	*	*	*	.	*	.	.	.
Schaereria corticola	*	(*)	.	*	*	*	.	.	.	.	*	.	.	.	.	.	.	.	*	.	*	.	.	.	.	.	*	.	*	.	.	.	.	.	*	.	*	.	.	.
Schismatomma umbrinum	.	.	*	*	.	*	.	.	.	.	.	.	s	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	*	.	.	.
Scoliciosporum gallurae	*	*	.	*	.	*	.	.	.	.	*	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.
- sarothamni	*	*	.	*	.	*	.	.	.	.	*	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	*	.	.	.	.	.	.	.	.	.
Trapelia corticola	*	(*)	.	*	*	*	.	.	*	.	*	.	.	.	.	.	.	*	.	.	*	*	.	.	.	.	*	.	*	*	.	.	*	.	*	.	.	.	.	.
Trapeliopsis flexuosa	*	*	.	*	*	*	.	.	.	.	*	*	.	.	.	.	.	*	*	.	*	.	.	.	.	.	*	*	*	*	*	*	.	.	.	.	.	*	.	.
- granulosa	*	*	.	*	*	*	.	.	.	.	.	*	.	*	.	.	.	.	.	.	*	.	.	.	.	.	*	.	.	*	.	.	.	.	.	.	.	.	.	.
- pseudogranulosa	*	*	.	*	*	*	.	.	.	.	*	.	.	?	.	.	.	*	.	.	*	*	.	.	.	.	*	.	*	*	.	.	*	.	.	.	*	.	.	.
Varicellaria rhodocarpa	*	*	.	*	*	*	.	.	.	.	*	.	.	.	.	.	.	.	.	*	*	.	.	.	.	.	*	.	*	*	.	*	.	.	.	*	*	.	.	.
Nos of species	103	43	27	122	85	108	24	24	13	2	84	9	20	7	27	16	14	44	64	13	82	19	16	32	36	9	56	16	70	49	54	26	49	13	50	9	74	30	27	4

Tab. 7. Species typical for well-lit and for shaded bark of trunks exposed to direct rain.

Well-lit bark	Shaded bark
Caloplaca chlorina	Chaenotheca furfuracea
Candelariella xanthostigma	Chaenotheca gracilenta
Lecidella flavosorediata	Enterographa zonata
Rinodina colobina	Lepraria umbricola
Rinodina flavosoralifera	Micarea prasina
Ochrolechia subviridis	Opegrapha gyrocarpa
Ochrolechia turneri	Psilolechia lucida
Pertusaria coccodes	
Pertusaria coronata	
Pertusaria flavida	

species-rich facies of this habitat were found in coastal sites. The communities of shade tolerant lichens occurring on rock are much more species rich than those on bark (James 1970, James et al. 1977). In this habitat the substratum was often dead and more or less decayed. However, *Enterographa zonata, Haematomma ochroleucum, Opegrapha gyrocarpa*, and *Schismatomma umbrinum* occurred on fresh and more or less smooth bark, whereas *Chaenotheca gracilenta* occurred on dead bark, the most common substratum, as well as on

Tab. 8. Examples of species occurring on smooth -, rough -, and decayed bark of trunks subjected to direct rain.

Smooth bark	Rough bark	Decayed bark
Buellia griseovirens	Hypocenomyce scalaris	Micarea prasina
Fuscidea arboricola	Lecidea leprarioides	Placynthiella dasaea
F. pusilla	Lepraria spp.	Placynthiella icmalea
Lecanora farinaria	Micarea prasina	Trapelia corticola
Lecidea subcinnabarina	Ochrolechia spp.	Trapeliopsis granulosa
Lecidella elaeochroma "f. soralifera"	Pertusaria spp.	Trapeliopsis pseudogranulosa
Lecidella flavosorediata	Placynthiella icmalea	
Mycoblastus caesius	Trapelia corticola	
Phlyctis argena	Trapeliopsis granulosa	
Rimularia fuscosora	Trapeliopsis pseudogranulosa	
Rinodina disjuncta		
Ropalospora viridis		
Schaereria corticola		

fresh bark.

About 40 % of the species was found in more than one of the main habitats.

Substratum preferences

The factors determining the occurrence of corticolous lichens are discussed in detail by Barkman (1958); see also Almborn (1948), James et al. (1977), Jeremy et al. (1978), and Gauslaa (1985). The corticolous lichen flora is dependent on a wide range of complex, probably interrelated factors. In his study of the ecology of *Lobarion pulmonariae* in *Quercus*-dominated forests in southern Norway, Gauslaa (1985) found that bark Ph, which was strongly correlated with Ca-content in the bark, differed between individual conspecific trees in a wood and that *Lobarion* communities were restricted to bark with Ph>5.0. Apparently lichens respond to bark characters, not to tree species.

Many species were mainly confined to non-coniferous (mainly deciduous) phorophytes (Tab. 6: 4). The most common species included, e.g., *Buellia griseovirens, Fuscidea arboricola, F. pusilla, L. flavopunctata, Lecidella flavosorediata, Mycoblastus fucatus, Ochrolechia turneri, Pertusaria albescens, Rinodina efflorescens*, and *Ropalospora viridis*.

Species which occurred on conifers are set out in Tab. 6: 5. Restricted to conifers were, e.g., *Chrysothrix chrysophthalma, Cliostomum leprosum, Lecanora norvegica* and *Lecidea leprarioides*, whereas *L. nylanderi*, and *Ochrolechia alboflavescens* also occurred on deciduous phorophytes.

The species can roughly be grouped according to their occurrence on poor versus rich bark (Tab. 6: 6-8).

Among the species on poor bark (see Tab. 6: 6) were, e.g., the species restricted to or mainly occurring on coniferous bark, as well as, e.g., *Hypocenomyce scalaris, Japewia subaurifera, Lecanora conizaeoides, Schaereria corticola*, and *Varicellaria rhodocarpa* which mainly occur on deciduous phorophytes. *Lecanora conizaeoides* occurred in heavily polluted sites in or near larger towns, close to large factories.

Species restricted to rich bark included, e.g., *Caloplaca chlorina, C. citrina, C. obscurella, Lecanora impudens, L. allophana* "f. *sorediata*", *Lecidella flavosorediata, Lecidella scabra, Lecidella* sp. A, *Ochrolechia turneri*, and *Pertusaria albescens*. The rich-bark species were largely found in man made habitats such as church-yards, parks, old gardens, avenues etc. Rich-bark species were frequently found on well-lit parts of the trunks and were not very phorophyte specific. They usually occurred on most, if not all, of the phorophytes with an eutrophic bark. Some rich-bark species were occasionally found on eutrophicated bark of conifers or deciduous trees which normally have an acidic bark. A few species typical of eutrophic bark were in markedly humid sites found on the acidic bark of conifers (see under substratum switches below).

Intermediate with respect to the occurrence on rich or poor bark (Tab. 6: 7) was, e.g., *Pertusaria flavida*. That species is a common inhabiter of rich-bark trees. However, it was most often found on *Quercus* indicating that it is less dependant on rich bark than species typical of that group. Indifferent with respect to the occurrence on poor versus rich bark were, e.g., *Loxospora elatina, Pertusaria amara*, and *Phlyctis argena*. These species usually also displayed a low phorophyte specificity, i.e., they occurred commonly on most of the phorophytes, deciduous as well as coniferous. The most common substratum-indifferent species seemed to be *Loxospora elatina*. This species was found on 19 phorophytes, deciduous as well as coniferous. Other lichen species with a low phorophyte specificity (found on 15 - 17 phorophyte species) included *Lecanora conizaeoides, L. expallens, Lecidea efflorescens, Micarea prasina, Ochrolechia androgyna* A, and *O. microstictoides*.

Species often found on corticolous mosses or on corticolous lichens are set out in Tab. 6: 9-10. Muscicolous lichens probably have a marked preference for humid situations, as moss cushions have a high capacity for water retention. *Bacidia epixanthoides* is primarily a muscicolous species, initiating and maintaining its growth on bryophytes, mostly *Hypnum cupressiforme*; only occasionally it spreads to naked bark. *Lecidea gyrophorica, Lepraria* spp., *Rinodina flavosoralifera, Rinodina* sp. A, and *Trapelia corticola* may also initiate growth on mosses, but occur on naked bark as well. *Ochrolechia* spp., *Pertusaria* spp. and *Phlyctis argena* are naked bark species which by their vigorous growth are capable of overgrowing mosses. Mosses overgrown by crustose lichen species with a strongly adhering, continuous thallus will soon die. Mosses acting as substratum for more delicate, areolate species, such as, e.g., *Trapelia corticola,* will suffer, and the attacked stems and leaves may ultimately wither and die.

Rinodina efflorescens commonly grows on other lichens, especially *Parmelia sulcata.* Often it spreads on to them from bark, but the species may also initiate and maintain growth on this substratum. Attacked thalli of *Parmelia sulcata* may suffer and ultimately die and eventually subsequently be inhabited by *Micarea prasina.* Species of the *Lepraria neglecta* complex and other *Lepraria* species may occur on corticolous lichens. *Ochrolechia* spp., *Pertusaria* spp., *Phlyctis argena* and *Varicellaria rhodocarpa* have a vigorous growth being able to overgrow, incorporate and thereby kill other lichens, even foliose and fruticose ones (see also Høeg 1923).

General substratum preferences

Most of the lichen species considered here have bark as their main substratum (Tab. 6: 11). Some of the species, however, occur mainly on other substrates, their occurrences on bark being more or less occasional. In Tab. 6: 11-14 the species are divided into ecological groups according to their general substratum preferences. However, there are gradual transitions between some of these groups in nature, especially between those comprising terricolous lichens on plant remnants and lignicolous or corticolous lichens on decayed wood or bark.

Lignicolous species which can also be corticolous are set out in Tab. 6: 12). Some of these species, e.g., *Hypocenomyce sorophora* and *Trapeliopsis flexuosa,* are also common on bark, but corticolous populations are usually less well-developed than those on wood. Predominately corticolous species, e.g., *Pertusaria coronata,* may occasionally occur also on wood. *Placynthiella dasaea* is here tentatively regarded as predominately corticolous. However, if a study was made of sorediate lichens growing on wood, it may become apparent that *P. dasaea* is common on wood as well as on bark.

Saxicolous species on naked and/or mossy rock, occasionally occurring on bark are set out in Tab. 6: 13. These species may be further grouped according to their habitat preferences. Species of sheltered, dry rock under overhangs include: *Chrysothrix chlorina, Enterographa zonata, Fuscidea praeruptorum, Haematomma ochroleucum, Lecanactis latebrarum, Lecania baeomma, Lecidella scabra, Leproloma vouauxii, L. membranaceum, Opegrapha gyrocarpa, Porpidia tuberculosa, Psilolechia lucida,* and *Schismatomma umbrinum.*
These species usually inhabit shaded dry bark when corticolous (see Tab. 6: 3). However,

Fuscidea praeruptorum and *Haematomma ochroleucum* sometimes occur on sun-exposed trunks in open situations. In southernmost Scandinavia and further south in Europe, *Haematomma ochroleucum* is a common corticolous lichen on broad-leaved trees in open situations. Species often occurring on rock wetted by rain include *Caloplaca chlorina, C. citrina, Baeomyces rufus, Fuscidea resenca, Lecidella scabra, Lepraria neglecta group, Ochrolechia androgyna* B, and *Pertusaria corallina. Lecidella scabra* often grows on somewhat friable rock (Knoph 1990). A switch from friable (and apparently soft and porous) rock to bark is less dramatic than a switch to bark from a smooth and hard rock surface. The most common corticolous habitat for predominately saxicolous lichens is shaded, dry bark under overhanging rock. This probably reflects the fact that shaded, dry rock has a much richer flora of sorediate taxa than exposed, well-illuminated rock. Predominately corticolous species occasionally occurring on rock include, e.g., *Pertusaria albescens, P. amara*, and *P. coronata*. These species usually occur on well-lit rocks.

Terricolous species on plant debris or mosses, occasionally occurring on bark are set out in Tab. 6: 14. It seems to be a general feature that terricolous lichens, when occasionally growing on bark, prefer the bases of the phorophytes, roots, and more or less horizontal facies of branches low down on the trunk.

Corticolous species which can be terricolous include, e.g., *Pertusaria albescens* and *Trapelia corticola.*

Specific substrates

Papers dealing with the lichen flora on particular phorophytes in north-west Europe include, e.g., Almborn (1955): a number of phorophytes; Dickinson & Thorp (1968): *Corylus avellana*; Rose (1974): *Quercus*; Jermy et al. (1978): a number of phorophytes; Bates & Brown (1981): *Quercus petraea* and *Fraxinus*; Coppins (1984a): *Betula*; McCarthy & Mitchell (1985): *Calluna*, and Watson et al. (1988): *Ulmus*. In Norway, local investigations of lichen communities on *Alnus incana* and *Quercus* have been carried out by Øvstedal (1980) and Gauslaa (1985), respectively.

A survey of the lichen species and the phorophytes on which they were found are set out in Tab. 6: 15-41. Many taxa inhabit a wide range of phorophytes in different habitats and may occur on many, if not all, phorophytes available at a particular site. On the other hand there are taxa which are largely restricted to one particular phorophyte or a particular group of phorophytes throughout their range, i.e. they occur only on one or a few of the phorophytes available. Most taxa are intermediate between these extremes. Species occurring on a high number of phorophytes do not necessarily occur on all phorophytes available. The common species *Pertusaria amara* (found on 17 phorophyte species) was common on *Picea abies*, but was only once collected on *Pinus sylvestris*, in spite of the fact that it occurred commonly on deciduous trees in *Pinus* forests. *Phlyctis argena* (found on 19 phorophyte species) was sparse or absent on conifers and no specimen came from *Pinus sylvestris*.

Some species displayed a high phorophyte specificity being found on only one or a few phorophytes (Tab. 9). Some of these are rare species which may prove to be less specific when new material comes available. However, *Buellia arborea* and *Cliostomum leprosum* are not known to occur on other phorophytes than *Pinus sylvestris* and *Picea abies* throughout their total European range which, in addition to Norway, includes Scotland (*Pinus*), and Sweden and Finland (*Picea*). Outside Europe, *Cliostomum leprosum*, has been reported from

Tab. 9. Species with a high phorophyte specificity (omitting species found only once). No - Number of specimens.

Species	Phorophyte	No
Buellia arborea	Pinus (also wood)	8
Cliostomum leprosum	Picea	8
Lecanora norvegica	Pinus	6
Lecidea leprarioides	Picea	15
Chrysothrix chrysophthalma	Picea, Pinus	19

North America where it is also a species of *Picea* (*P. rubens*) according to Gowan (1990). The species with the highest phorophyte specificity all grew on conifers. This indicates that the differences in bark characteristics between species of conifers are more important than those between species of deciduous trees. Halonen et al. (1991) observed a marked difference between the crustose lichen floras of *Pinus sylvestris* and *Picea abies* in central Finland.

One species, *Fuscidea pusilla*, was found on needles of *Picea abies*. *Fuscidea pusilla* is mainly a species of deciduous phorophytes. However, when inhabiting *Picea abies*, it usually occurred on twigs or, in the southernmost part of its range, on the green needles. No species were found on the green leaves of deciduous trees, on the evergreen *Ilex aquifolium* or on the green needles of *Pinus sylvestris* or *Juniperus communis*.

The number of sorediate and isidiate, crustose species found on the main phorophytes are summarized in Tab. 6: 15-40. The phorophytes with the highest number of species were: *Betula pubescens/pendula* (82 species), *Sorbus aucuparia* (74), *Picea abies* (70), *Alnus incana* (64), *Juniperus communis* (56), and *Populus tremula* (54). *Betula nana* proved to be slightly more species rich than subalpine/low-alpine shrubs of *Salix*. Although these numbers to certain extent probably reflect the frequency and distribution of the different phorophytes in Norway, and the intensity of collecting on these phorophytes, they may also be indicative of the abundance of sorediate and isidiate lichens on the phorophytes, especially with respect to the most common phorophytes.

Phorophyte switches

Many lichens which are specific to particular phorophytes in one area, may occur on quite different ones in other areas. The ability of a lichen to change substratum at the edge of its normal host range will increase its potential area (Brodo 1974). This ability is not only important from an ecological and phytogeographical point of view, but should also be noted by taxonomists (see Jørgensen & Tønsberg 1988). According to Poelt (1987a) habitat switches among corticolous lichens are apparently common.

The main habitat for *Micarea coppinsii* is *Calluna* in maritime heath. However, in areas where it apparently has its optimal conditions (being most luxurious and abundant), it is also able to grow - although usually more sparingly - on a range of other phorophytes: *Alnus* *glutinosa*, *Erica cinerea*, *Juniperus communis*, *Pinus mugo*, *Populus tremula*, *Salix aurita*, and *Sorbus aucuparia*. At an eastern outpost (Rogaland: Sauda) it was found on a trunk of *Alnus incana* on the bank of a brook in a ravine. It is not known to occur on *Calluna vulgaris* so far inland.

Ochrolechia androgyna B, *Pertusaria coccodes*, *P. coronata*, and *P. hemisphaerica* are, in southernmost Norway, chiefly restricted to open forests or free-standing trees of *Quercus* and other broad-leaved trees. However, in the humid, coastal *Picea abies* forests in Nord-Trøndelag and adjacent parts of Nordland these lichens have been found on deeply shaded trunks or branches of *Picea abies* and/or *Sorbus aucuparia*. North of the coastal spruce forests of central Norway, these species occur in open, sunny sites (e.g. S-facing slopes), but here they usually occur on trunks of *Betula*.

The main habitat for *Pertusaria albescens* is bark of broad-leaved trees in the coastal lowlands. However, in microclimatically humid sites in the inland, e.g., in the spray zone of a water-fall in a river gorge, the species may form extensive covers on twigs of *Picea abies*.

Literature provides further examples displaying similar switches in phorophyte and habitat selection. *Bactrospora corticola*, in Scandinavia largely a species restricted to sun-exposed trunks of, e.g., *Quercus* in the southernmost parts (Sweden: Skåne; Denmark), is in Norway known only from Trøndelag where it occurs on shaded bark of trunks and branches of *Picea abies* (Botnen & Tønsberg 1988). *Pannaria ignobilis*, a markedly western species in northern Europe occurs in westernmost Norway mainly on *Fraxinus excelsior*. In central Norway, where *Fraxinus* is rare, there is a change in phorophyte to *Populus tremula* and *Sorbus aucuparia* (Jørgensen 1978). Jørgensen could not give any ecological explanation to this switch in behaviour, but he reported notable morphological differences between the two populations. In the material of *Micarea coppinsii*, *Ochrolechia androgyna* B, *Pertusaria coronata*, and *P. hemisphaerica* discussed above, no such differences were apparent. However, specimens of *Pertusaria coccodes* from the coastal spruce forests of central Norway had smaller or thinner isidia than specimens from sun-exposed rich-bark trees in southernmost Norway. Whether this morphological change was habitat induced or genetically controlled is an open question. It is a general feature that plants which grow under particularly favourable conditions seem to be less substratum specific (see Jørgensen & Tønsberg 1988). High humidity is favourable for many lichens. It is probably correct to assume that the constant high humidity in these coastal spruce forests is in part responsible for the remarkable switch in phorophyte selection. Jørgensen (1978) suggested that humidity may be more important than the properties of the phorophyte. It seems likely that lichen species may occur as different physiological races adapted to different climatic conditions, see also Coppins (1976: 252) and Hawksworth (1973).

DISTRIBUTION

Introduction

Factors governing the distribution of lichens have been discussed by, e.g., Coppins (1976). Of particular importance for corticolous lichens are the range of suitable phorophytes. As pointed out and exemplified by, e.g., Botnen & Tønsberg (1988) and Jørgensen (1978), lichen species often have out-posts far from their main distribution regions, indicating that they are able to establish and maintain growth in microclimatically favourable habitats. Some coastal lichen species occur in river gorges in continental areas, e.g., in the valley Gudbrandsdalen. These gorges are out-posts with a very humid climate. Inhabitants of bark in such inland sites should be regarded as frost-tolerant if they occur on trunks above the snow level. Similarly, southern species may occur on south-facing warm slopes in northerly out-post sites and northern or alpine species may occur in north-facing outpost sites in southernmost Norway.

Ahlner (1948), Almborn (1948), and Degelius (1935) are major contributions to the knowledge of the distribution of epiphytic lichens in Norway, as is the thorough discussion of the distribution of epiphytic Pannariaceae by Jørgensen (1978). However, only Almborn (1948) deals with species included in the present paper. Santesson (1984) gives an account of the distribution for most of the species considered here. Information on the distribution on various species have been published by Degelius (1982), Alstrup & Søchting (1986), Øvstedal (1986), Middelborg & Mattsson (1987), Botnen & Tønsberg (1988), Coppins (1989a), and Muhr & Tønsberg (1989).

The activity of man has destroyed large areas of lichen habitats in Norway. Some lichens, e.g., *Erioderma pedicellatum* and *Pannaria ahlneri*, are now regarded as extinct or highly vulnerable due to forestry in central Norway. Air pollution has led to depletion of lichens, especially in towns, but also in surrounding rural areas. Southernmost and southeasternmost parts of Norway are generally affected by atmospheric air pollution.

On the other hand lichens have been introduced through the activity of man. The range of *Lecanora conizaeoides*, which is restricted to polluted sites, appears to be expanding (for details, see under "The species").

Western element

Markedly western species

Halecania viridescens
Lepraria umbricola
Megalospora tuberculosa
Micarea coppinsii
Opegrapha multipuncta

Micarea coppinsii and *Opegrapha multipuncta* were almost confined to the outer treeless *Calluna* heath. The main distributional area of these species is characterized by high winter temperatures and frequent precipitation (in the form of both fog and rain) rather than maximum precipitation (precipitation maxima occur further east). Their eastern limit is apparently determined by decreasing winter temperature and decreasing precipitation frequency; their northern limit by temperature. Other plants with much the same distribution are *Erica cinerea* on which *Micarea coppinsii* has once been found, the hepatic *Calypogeia* arguta (see E. Jørgensen 1934, Lye 1967) and the moss *Campylopus brevipilus* (see Størmer 1969). Growing close to the sea-shore, *Micarea coppinsii* and *Opegrapha multipuncta* are often strongly influenced by salt spray. However, the occurrences of some populations hardly subjected to significant amounts of spray, indicate that these species should be regarded as salt-tolerant rather than obligate maritime.

Outside Norway *Lepraria umbricola* has its only known occurrences in western Britain. In northern Europe this pattern is shared by *Megalospora tuberculosa* (see James 1978, Coppins 1984b) which is a widespread, mainly tropical species (Sipman 1983). The single known Norwegian collection of *Megalospora tuberculosa* was from a free-standing trunk of *Quercus* on the southwestern coast. Apparently, *Megalospora tuberculosa* has a certain demand for warmth. Species with a western Britain - western Norway disjunct distribution may also be termed hyperoceanic. Other lichens known to have this distribution pattern in northern Europe comprise are *Gomphillus calycioides*, *Bactrospora homalotropa*, *Degelia atlantica*, *Leptogium burgessii*, *L. hibernicum*, *Parmelia* (*Parmotrema*) *arnoldii*, *P.* (*Parmotrema*) *crinita*, *P.* (*Hypotrachyna*) *laevigata*, *Pseudocyphellaria intricata*, *P. norvegica* and *Sticta canariensis* (see Jørgensen 1973, 1978, Coppins 1976, Coppins & James 1979b, Tønsberg & Øvstedal 1982, Tønsberg 1988a, 1990a). These are all rare species in Norway.

Species restricted to central Norway

Lecidea subcinnabarina
Rinodina disjuncta

These species belong to a small group of lichens which have their main or only European occurrences in the humid spruce forests of central Norway. *Rinodina disjuncta* seems to be restricted to the westernmost spruce forests of that area. It is a typical lowland species, being known at altitudes up to 150 m. Apparently it requires constant high humidity and is frost sensitive. *Lecidea subcinnabarina* appears to be somewhat less moisture demanding as it occasionally occurred in more open spruce forests and had a slightly wider distribution extending further to the east and towards higher altitudes, that is, into areas with considerable frost during the winter.

Other lichen species belonging to this group are *Arthothelium norvegicum* (mapped by Botnen & Tønsberg 1988), *Cavernularia hultenii* (mapped by Ahlner 1948), *Gyalideopsis alnicola* Noble & Vězda (mapped by Tønsberg 1988b), *Lichinodium ahlneri* (see Henssen 1963), and *Pannaria ahlneri* (mapped by Jørgensen 1978). *Erioderma pedicellatum*, probably extinct in Europe, also belonged to this subordinate element (see Jørgensen 1990).

Outside Norway *Rinodina disjuncta* is known from western North America - a pattern it shares with, e.g., *Gyalideopsis alnicola* (see Tønsberg 1988b).

Western species

Catillaria pulverea
Chrysothrix chrysophthalma
Fuscidea recensa
Gyalideopsis anastomosans
Lecanactis latebrarum
Lecania baeomma
Lecidella elaeochroma "f. *soralifera*"
Lepraria obtusatica
Mycoblastus caesius
Psilolechia lucida
Rinodina flavosoralifera

Rinodina griseosoralifera
Schismatomma umbrinum
Trapelia corticola
Trapeliopsis pseudogranulosa

These are moisture-demanding species. Some of the species, e.g., *Fuscidea recensa* (see Muhr 1987, as *F. curvula*), *Lecanactis latebrarum*, and *Lepraria obtusatica*, have outposts in eastern Norway and/or in Sweden. *Lecidella elaeochroma* "f. *soralifera*" is apparently maritime as it always occurred close to the sea.

Rinodina flavosoralifera and *R. griseosoralifera* have been found from Kristiansand on the southernmost coast as far north as Sogn og Fjordane. They often occurred in open, well-illuminated sites and were frequently dried by direct insolation. Although their centres of distribution are clearly western, *Rinodina flavosoralifera* and *R. griseosoralifera* are apparently warmth-demanding as well as moisture-demanding species and therefore transitional to the southern element. In the British Isles *R. griseosoralifera* occurs most frequently in eastern Scotland and Mid-Wales (Coppins 1989a), whereas *R. flavosoralifera* is so far only known from Norway.

Slightly western species

Chrysothrix candelaris
Fuscidea arboricola
F. praeruptorum
Lecanora farinaria
Lepraria caesioalba
Lepraria eburnea
Lepraria incana
Lepraria lobificans
Lepraria rigidula
Leproloma vouauxii
Micarea leprosula
Micarea prasina
Ochrolechia androgyna B
Ochrolechia androgyna C
Opegrapha sorediifera
Pertusaria pupillaris
Rinodina efflorescens
Ropalospora viridis
Schaereria corticola

Several of these species may also occur sparingly - as outposts - in Hedmark and Oppland in sites with microclimatically high humidity, e.g. river gorges and on river banks in deeply shaded spruce forests. Some grow high up on tree trunks unprotected by snow during the winter; these are able to withstand considerable frost. These species, including, e.g., *Chrysothrix candelaris*, *Lecanora farinaria*, and *Ropalospora viridis*, are moisture-demanding and seem to be less dependent on an oceanic temperature climate.

Widespread species with a western tendency

Bacidia epixanthoides
Buellia griseovirens
Enterographa zonata
Haematomma ochroleucum
Mycoblastus fucatus
Opegrapha gyrocarpa
Pertusaria amara
Pertusaria coronata
Phlyctis argena
Placynthiella icmalea

Southern element

Almborn (1948) gave a detailed treatment of lichens belonging to the southern element in Scandinavia. Several of the species included in the present work have been thoroughly treated by him. The species referred to this element not only have a southern range, but also occupy climatically favourable sites such as south-facing slopes. Many warmth-demanding species grow on the sun-exposed parts of the trunks; others prefer the shaded moist parts.

Markedly southern species

No species was conclusively assigned to this element. *Rinodina* sp. A, known from one site at the southernmost coast (Vest-Agder: Kristiansand) may belong here.

Southern species

Pyrrhospora quernea
Rinodina colobina

Pyrrhospora quernea has a climatically and topographically favourable outpost in central Norway.

Slightly southern species

Caloplaca chlorina
Caloplaca obscurella
Candelariella reflexa
Lecanora conizaeoides
Lecidella flavosorediata
Lecidella scabra
Loxospora elatina
Ochrolechia arborea
Ochrolechia subviridis

Ochrolechia turneri
Pertusaria albescens
Pertusaria flavida
Pertusaria hemisphaerica

Caloplaca chlorina is transitional to the southeastern element.

Ochrolechia subviridis and *Pertusaria flavida*, although rather abundant west of the Oslofjord, are not known to occur E of this fjord. In Sweden both occur as far north as Bohuslän on the western coast (Almborn 1948, Hanko 1983: map 5). Several vascular plants, e.g. *Allium ursinum, Brachypodium sylvaticum, Bromus benekenii* and *Carex sylvatica*, show similar distributional patterns in the Oslofjord area (see Fægri 1960, Lid 1985). These species have a certain demand for rich soil and avoid the more acidic soil prevailing east of the Oslofjord. A similar explanation cannot be used for corticolous lichens as their phorophytes, e.g. *Quercus* and other broad-leaved trees, are not absent east of the Oslofjord. Although further investigations in coastal Østfold may reveal finds of these species, they are certainly not common there.

Owing to their westerly distribution in south-eastern Norway, these two species do not fit well into any of the subordinate elements of the southern main element. It is interesting to note that, unlike all other predominately corticolous species assigned to the southern element, these two species mainly reproduce by isidia. *Pertusaria albescens* displays a similar distribution pattern in the Oslofjord area to *Ochrolechia subviridis* and *Pertusaria flavida*, being known only from one site in Østfold. That species had outposts in Hedmark and Oppland.

Widespread species with southern tendency

Candelariella xanthostigma
Chrysothrix chlorina
Fuscidea pusilla
Lecanora expallens
Leproloma membranaceum
Ochrolechia microstictoides
Pertusaria corallina
Placynthiella dasaea

This element is transitional to the ubiquitous element.

South-eastern element

Species restricted to central parts of southern Norway

Buellia arborea
Lecanora norvegica

Lecanora norvegica has been found in upper parts of Gudbrandsdalen (Oppland) and in Hallingdalen (Buskerud) where it occurred on moderately shaded to sun-exposed trunks of

Pinus in open *Pinus* forests. *Buellia arborea*, which may occur closely associated with *Lecanora norvegica*, has a similar, but broader range comprising eastern Sogn og Fjordane. From the presently available collections, *Buellia arborea* and *Lecanora norvegica* appear to have a distribution pattern typical of continental species. Several terrestric and saxicolous lichens have their only or main Norwegian occurrences in the upper parts of Gudbrandsdalen (Kleiven 1959, Poelt & Buschardt 1978). However, these species belong to a xerophilous element of species confined to dry south-facing slopes and with occurrences also on the calcareous islands Öland and Gotland. *Buellia arborea* and *Lecanora norvegica* are ecogeographically distinct from these species.

Buellia arborea is also known from eastern Scotland. *Lecanora norvegica* is only known from Norway.

Markedly south-eastern species

Species listed here are mainly confined to broad-leaved trees.

Lecanora allophana "f. *sorediata*"
Lecanora impudens

South-eastern species

None of the treated species belong here.

Slightly southeastern species

Pertusaria coccodes

Pertusaria coccodes exhibits a rather unusual disjunctive distribution pattern for a lichen: the Oslofjord-area and Nord-Trøndelag, with an isolated outpost in Sogn og Fjordane. In the southern sub-area it occurs on sun-exposed broad-leaved trees, whereas in the northern sub-area it occurs on shaded trunks of *Sorbus* in *Picea*-forests. It might be that the taxonomy of the species is ill-defined or that each of the disjunct populations represents different physiological races. The moss *Eurhynchium angustirete* (Broth.) Kop. (see Størmer 1984), displays a disjunctive distribution pattern reminiscent of that of *Pertusaria coccodes*.

Widespread species with a southeastern tendency

Lecidea nylanderi

Eastern element

Eastern species

Cliostomum leprosum
Hypocenomyce sorophora

Lecidea praetermissa
Mycoblastus alpinus
Ochrolechia alboflavescens
Rimularia fuscosora

Mycoblastus alpinus and *Ochrolechia alboflavescens* have a few localities in eastern Hordaland and Sogn og Fjordane, respectively, and are thereby transitional to the distributional group of slightly eastern species.

Slightly eastern species

Hypocenomyce leucococca
Hypocenomyce scalaris
Japewia subaurifera
Lecidea efflorescens
Lecidea gyrophorica
Lecidea leprarioides
Lecidea pullata
Lepraria elobata
Lepraria jackii
Rinodina degeliana

Hypocenomyce leucococca, Japewia subaurifera, Lecidea efflorescens, and *L. pullata* belong to a northern type of the eastern element.

Northern element

Caloplaca sorocarpa
Lecanora flavopunctata
Lecidea cinnabarina
L. porphyrospoda
L. vacciniicola
Ochrolechia androgyna D
Ochrolechia frigida "f. *lapuensis*"
Pertusaria dactylina
P. geminipara
P. oculata
Varicellaria rhodocarpa

According to Gjærevoll (1990) an alpine species is "one that has its main distribution above the birch forest limit and north of the polar birch forest limit". The predominately terricolous *Ochrolechia frigida* "f. *lapuensis*", *Pertusaria dactylina*, *P. geminipara*, and *P. oculata* would be classified as alpine species following this definition. No predominantly corticolous species are strictly alpine *sensu* Gjærevoll as they are also frequent below the limit of the birch forest and south of the polar birch forest limit. This is accordance with the fact that none of the phorophytes for the presently treated species are alpine *sensu* Gjærevoll

(1990). *Caloplaca sorocarpa, Lecanora flavopunctata* and *Lecidea vacciniicola*, have their main occurrences in low-alpine and subalpine areas.

Ubiquitous species

Baeomyces rufus
Chaenotheca furfuracea
C. gracilenta
Mycoblastus sanguinarius "f. *leprosus*"
Ochrolechia androgyna A
Pertusaria borealis
Trapeliopsis flexuosa
T. granulosa

Included here are species which occur throughout the part of the country where a phorophyte occurs. Phorophytes are lacking in the northernmost parts of the country and in the proper alpine zones. No true corticolous species is therefore ubiquitous in the strict sense.

Species insufficiently known with respect to distribution

Caloplaca herbidella
Lecanora flavoleprosa
Lecidella sp. A
Lecidella subviridis
Rinodina sp. A
Scoliciosporum gallurae
Scoliciosporum sarothamni.

In Norway *Caloplaca herbidella* appears to be an alpine, southern unicentric species. However, in Sweden it has been recorded also from the lowlands, e.g., from Skåne (Santesson 1984). The species is probably not well-defined (see also under *Caloplaca herbidella* in the taxonomic section).

REPRODUCTIVE STRATEGY

Introduction

Lichen species are usually adapted only to one mode of dispersal, either with ascospores (or basidiospores) or with one type of vegetative diaspores. Apparently it is energetically too expensive consistently to produce both vegetative propagules and apothecia or several types of vegetative diaspores. This behaviour is well illustrated by *Peltigera didactyla* which occurs in two forms, one richly fertile and esorediate, and one richly sorediate and sterile; forms with both soredia and apothecia are rare. However, some species combine the two strategies by having consistently fertile thalli which also have vegetative diaspores, and a few species have the potential of producing more than one type of vegetative diaspore.

Fertility

The frequency of fertile specimens (i.e., with at least one apothecium in the herbarium packet) of each species is given in Fig. 21 and Tab. 10. Of the 128 species considered, eleven species

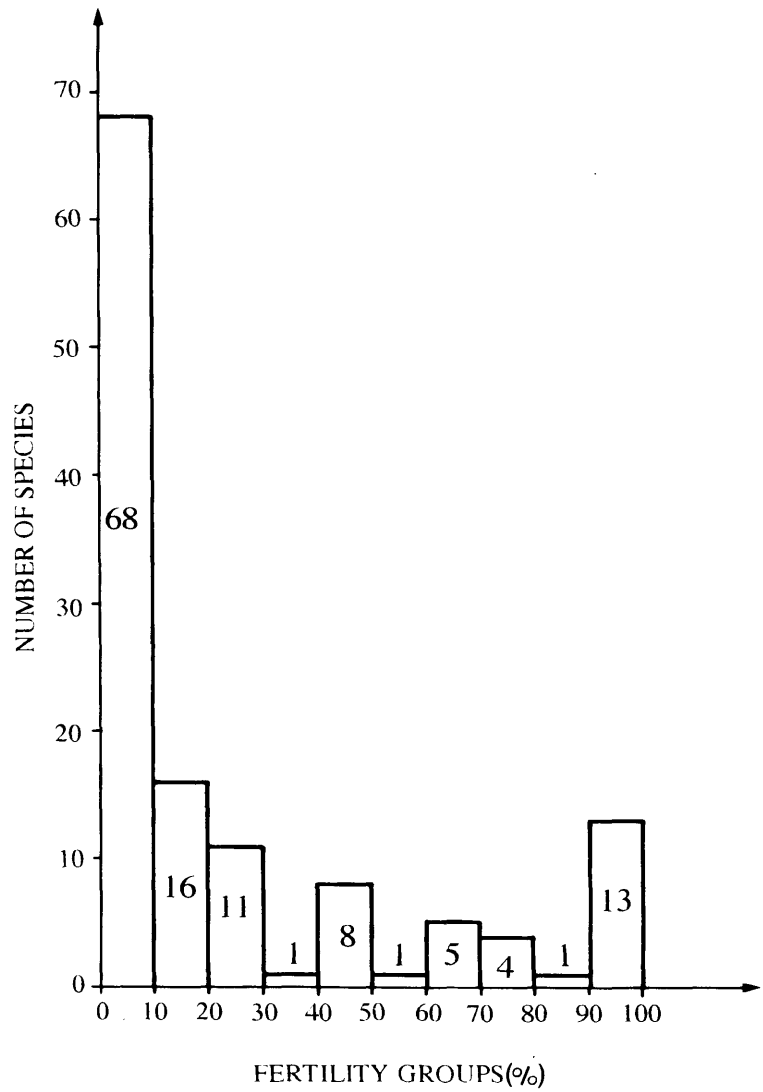


Fig. 21. Number of species in 10 fertility groups.

Tab. 10. Mode of vegetative reproduction and fertility (ap: fertility (in %), fr: poorly specialized thalline fragments, is: isidia, no: number of collections, ot: other specialized structures, sc: schizidia, so: soredia/consoredia, th: thlasidia).

	ap	no	so	is	th	sc	fr	ot
Bacidia epixanthoides	62	13	+					
Baeomyces rufus	67	3	+			+		
B. arborea	0	4	+					
B. griseovirens	25	178	+					
Caloplaca chlorina	71	56	+					
C. citrina	0	2	+					
C. herbidella	100	8		+				
C. obscurella	41	58	+					
C. sorocarpa	7	46	+					
Candelariella reflexa	10	48	+					
C. xanthostigma	22	58	+					
Catillaria pulverea	21	93	+					
Chaenotheca furfuracea	100	61	(+)					
C. gracilenta	100	7	+					
Chrysothrix candelaris	0	8	+					
C. chlorina	0	3	+					
C. chrysophthalma	21	19	+					
Cliostomum leprosum	70	10	+					
Enterographa zonata	20	10	+					
Fuscidea arboricola	12	142	+					
F. praeruptorum	5	19	+					
F. pusilla	0	143	+					
F. recensa	0	8	+					
Gyalideopsis anastomosans	0	10			+			
Haematomma ochroleucum	13	15	+					
Halecania viridescens	25	4	+					
Hypocenomyce leucococca	0	176	+					
H. scalaris	9	102	+					
H. sorophora	13	23	+					
Japewia subaurifera	7	147	+					
Lecanactis latebrarum	0	4	+					
Lecania baeomma	0	1	+					
Lecanora allophana "f. sorediata"	0	2	+					
L. conizaeoides	60	75	+					
L. expallens	14	98	+					
L. farinaria	15	131	+					
L. flavoleprosa	100	1	+					
L. flavopunctata	47	64	+					
L. impudens	0	19	+					
L. norvegica	0	6	+					
Lecidea cinnabarina	94	195	+					

Tab. 10 (continued).

	ap	no	so	is	th	sc	fr	ot
Lecidea efflorescens	31	203	+					
L. gyrophorica	14	43	+					
L. leprarioides	100	15	+					
L. nylanderi	9	82	+					
L. porphyrospoda	76	29	+					
L. praetermissa	46	28	+					
L. pullata	41	232	+					
L. subcinnabarina	86	14	+					
L. vacciniicola	26	82	+					
Lecidella elaeochroma "f. soralifera"	100	28	+					
L. flavosorediata	13	61	+					
L. scabra	46	28	+					
L. subviridis	3	36	+					
L. sp. A	0	3	+					
Lepraria caerulescens	0	4	+					
L. caesioalba	0	15	+					
L. eburnea	0	17	+					
L. elobata	0	43	+					
L. incana	0	8	+					
L. jackii	0	34	+					
L. lobificans	0	17	+					
L. neglecta	0	2	+					
L. obtusatica	0	6	+					
L. rigidula	0	66	+					
L. umbricola	0	12	+					
L. sp. A	0	4	+					
Leproloma membranaceum	0	21	+					
L. vouauxii	0	6	+					
Loxospora elatina	20	155	+				+	
Megalospora tuberculosa	0	1	+					
Micarea coppinsii	21	47	+					
M. leprosula	0	5	+					
M. prasina	72	72	+					
Mycoblastus alpinus	6	16	+					
M. caesius	0	35	+					
M. fucatus	3	103	+					
M. sanguinarius "f. leprosus"	100	21	+					
Ochrolechia alboflavescens	42	31	+					
O. androgyna A	21	198	+					
O. androgyna B	21	110	+				+	
O. androgyna C	6	96	+					
O. androgyna D	14	7	+					
O. arborea	0	22	+					

Tab. 10 (continued).

	ap	no	so	is	th	sc	fr	ot
Ochrolechia frigida "f. lapuensis"	0	7	+					+
O. microstictoides	1	153	+				+	
O. subviridis	0	35	+	+				
O. turneri	3	33	+					
Opegrapha gyrocarpa	0	5	+					
O. multipuncta	0	12	+					
O. sorediifera	0	1	+					
Pertusaria albescens	0	133	+				+	
P. amara	2	359	+				+	
P. borealis	2	159	+					
P. coccodes	0	86	+	+				
P. corallina	0	4		+				
P. coronata	1	78		+				
P. dactylina	100	20		+				
P. flavida	1	80		+				
P. geminipara	13	8	+					
P. hemisphaerica	0	109	+					
P. oculata	63	19		+				
P. pupillaris	18	96	+					
Phlyctis argena	7	271	+				+	
Placynthiella dasaea	3	62	+					
P. icmalea	43	28		+				+
Porpidia tuberculosa	0	1	+					
P. sp. A	0	1	+					
Psilolechia lucida	17	6	(+)					
Pyrrhospora quernea	0	11	+					
Rimularia fuscosora	13	8	+					
Rinodina colobina	100	25	+					
R. degeliana	0	31	+					
R. disjuncta	44	41	+					
R. efflorescens	4	81	+					
R. flavosoralifera	11	19	+					
R. griseosoralifera	11	18	+					
R. sp. A	0	2	+					
Ropalospora viridis	3	123	+					
Schaereria corticola	66	56	+					
Schismatomma umbrinum	0	3	+					
Scoliciosporum gallurae	100	4	+					
S. sarothamni	100	3	+					
Trapelia corticola	4	23	+					
Trapeliopsis flexuosa	13	45	+					
T. granulosa	50	8	+					
T. pseudogranulosa	0	31	+					
Varicellaria rhodocarpa	99	166	+					

(9%) were always fertile, whereas for 48 (38%) of the species, apothecia were never observed. (It should be noted that among these were three species, *Rinodina colobina*, *Scoliciosporum gallurae*, and *S. sarothamni*, which could not be conclusively determined on thalline characters alone. These species probably also form completely sterile populations.) Many of the species found to be sterile in the present study, are known to occur with apothecia in other parts of their range and/or when growing on other substrata. Fig. 21 shows that most species are sterile or infrequently fertile.

The apothecia of many species often contained immature asci, i.e., without spores or with few and/or aborted spores. Immature asci appear to be common among lichens adapted to vegetative dispersal (see also, e.g., Coppins 1989a, Oberhollenzer & Wirth 1990). Spores of few-spored asci of species which typically are 8-spored were often larger than those of 8-spored asci.

Richly sorediate forms are usually less fertile (have fewer apothecia) or are more often completely sterile (without apothecia) than forms where the soredia are more sparingly produced. Each of the colony-forming species *Lecanora allophana* and *L. conizaeoides* often forms mosaic populations of sorediate and esorediate thalli. Whereas the former thalli were sterile or infrequently fertile, the latter thalli were often abundantly fertile. Such species apparently have a great potential for survival and dispersal. *Lecanora allophana* f. *allophana* was always richly fertile, whereas "f. *sorediata*" was consistently sterile in the present Norwegian material. In material of *Lecanora conizaeoides*, there was a slight tendency for esorediate thalli to be more richly fertile than the associated sorediate thalli.

The production of ascocarps was often related to luxuriance of the specimens, but this did not always seem to be the case. A decline in fruiting ability has occurred in many lichens over the recent centuries (see e.g. Hawksworth et al. 1973, Laundon 1989). Sulphur dioxide in the air has been shown to have a deleterious effect on lichen vegetation, and air pollution is known to inhibit production of apothecia (see, e.g., Hawksworth et al. 1973). Most of the fertile specimens of *Loxospora elatina* were collected in Oslo in the 19th century (for details, see that species). The decline in fertility displayed by that species is probably due to increase in pollution. Haugsjå (1930), in his study of the urban effect on the corticolous lichen vegetation in and around Oslo, observed that many normally fertile lichen species showed a decline in fertility with decreasing distance from the city. He also noted abnormally large spores in unhealthy apothecia of *Physcia stellaris*.

Vegetative strategy

A few species have several modes of vegetative dispersal (Tab. 10): *Baeomyces rufus* develops both schizidia and soredia (and is often fertile as well). In that species the vegetative diaspores follow a sequential pattern in the life cycle of the thallus (Jahns 1982): Schizidia are produced by the young thallus while soredia are produced by the old thallus. *Ochrolechia subviridis* is usually isidiate, but occasionally the isidia break down to a mass of soredia and consoredia.

Pertusaria albescens and *P. amara* produce soredia and/or cortical fragments which apparently act as diaspores, but individual thalli do not usually produce both types of propagules. In *Placynthiella icmalea*, the cylindrical, branched and knobby isidia were very fragile being composed of globose, soredia-like segments. *Pertusaria coccodes* may rarely produce both isidia and soredia.

The possible role of conidia as asexual propagules was discussed by Coppins (1983a), see also Culberson et al. (1988). Coppins referred to a number of species which produce pycnidia regularly, but where apothecia were unknown or normally absent. He stated that many crustose lichens have two conidium types. In the genus *Micarea* Coppins suspected that meso- and macroconidia function as asexual diaspores. In the present study pycnidia occurred in various species, but only in *Cliostomum leprosum*, a commonly fertile species, were they regularly observed. Pycnidia were seen in sterile populations of predominantly sterile species (e.g., *Haematomma ochroleucum*, *Phlyctis argena*) and in species in which apothecia are not uncommon (e.g. *Ochrolechia androgyna* s. lat.). Micro-pycnidiate specimens of commonly sterile sorediate species might be regarded as representing neotenic forms, as their conidia probably no longer have any function. Micro- and mesoconidia were observed in *Micarea prasina*. In a pycnidiate specimen of *Schismatomma umbrinum* (leg. Tønsberg 8835a), the only pycnidiate specimen known so far of this species (see Jørgensen & Tønsberg 1988), soredia were lacking. It is uncertain if the filiform conidia of this species act as asexual diaspores and/or as spermatia (see, however, the discussion of this species in the taxonomic section). It might be noteworthy that although no corticolous material of this species was fertile, saxicolous specimens with apothecia occurred in the vicinity of the pycnidiate, corticolous specimens.

Pertusaria oculata has pycnidia in the apices of the isidia. The isidia in this species are slender and fragile. They probably act both as true isidia and as stalks for the pycnidia (and thereby facilitate the dispersal of the conidia). In *Pertusaria dactylina* the isidia always seem to have an apothecium immersed in the apices. These isidia are thick and probably not easily detached. They probably are more important as apothecial stalks and as a framework for the photosynthetic active algal component, than as vegetative propagules.

Vegetative propagules such as isidia, thlasidia, schizidia, and soredia can probably germinate in a broader range of habitats than ascospores or meso- and macroconidia, since they do not require a re-synthesis of the symbiosis (see also Bowler & Rundel 1975, Ott 1987a, 1987b).

According to Poelt (1974), the leprarioid structures of lichens growing in habitats that receive no precipitation have nothing to do with vegetative dispersal. I agree with Poelt in that a leprose thallus is an adaptation to shaded habitats, but I believe that the soredia-like elements of the leprose thallus act as diaspores and consequently should be denoted soredia. The hyphal projections occurring on the soredia, e.g., in *Lepraria rigidula*, probably facilitate the anchoring of the detached soredia to a new substratum.

Thlasidia occur in *Gyalideopsis anastomosans*. These are easily detached and probably function as isidia. Vĕzda (1979) reported that the mature thlasidia probably also are able to pour out a gelatinous mass containing algal cells and hyphae. This mass possibly also acts as a diaspore.

Crustose lichens are usually not regarded as being well adapted to dispersal by unspecialized thallus fragments. However, birds, snails, insects, mites and mammals, e.g. the Norwegian squirrel, exhibit a lot of activity on tree trunks and branches and thereby probably act as detaching agents for soredia and isidia as well as other projecting particles, such as areolae and tuberculae.

TAXONOMIC CONSIDERATIONS

Introduction

The taxonomic ranking of taxa adapted to dispersal by vegetative diaspores is currently much discussed (see e.g. Poelt 1970, 1972, Tehler 1982, W.L. Culberson 1986, Mattsson & Lumbsch 1989).

Poelt (1970) postulated that every sorediate species has been derived from a corresponding extinct or extant non-sorediate, fertile counterpart and that they could never be ancestral to such forms. Poelt (1972) termed the counterparts primary and secondary species, and the set was denoted a species pair. According to Poelt (1972), the counterparts of a species pair are identical in apothecial characters and thallus chemistry and morphology except for the presence of soredia or isidia. The secondary species, which is often destitute of apothecia, normally occupies a broader geographical region than its fertile counterpart due to its more efficient mode of reproduction and dispersal (Bowler & Rundel 1975).

Tehler (1982) rejected Poelt's species pair concept. He claimed that most asexual morphotypes arise sporadically from individuals of the corresponding sexual taxon, rather than through evolution, and that the species of a species pair are genetically almost identical. Different distributional patterns of the members of a species pair are not considered as sufficient to treat them as distinct species (Tehler 1982). Tehler regarded asexual forms as clones of the sexual primary species and combined them taxonomically in the rank of forma with the corresponding fertile species. Only when the sexual species is unknown or extinct, Tehler advocated the use of specific rank. This principle is followed in his monographic treatment of *Dirina* and *Roccellina* (Tehler 1983).

W.L. Culberson (1986) refuted Tehler's arguments for a sporadic and repeated origin of asexual morphotypes from their sexual counterparts. As asexual reproduction must be considered as favourable, Culberson claimed that most successful primary species would have such mechanisms if they were easy to develop. Bowler & Rundel (1975) showed that crustose lichens generally have few sorediate or isidiate representatives. Although the larger foliose and fruticose families in general have a relatively high percentage of species with vegetative reproduction, many genera are destitute of vegetative dispersal mechanisms (Bowler & Rundel 1975, W.L. Culberson 1986). Furthermore, W.L. Culberson (1986) pointed to the fact that the secondary species have a uniform morphology with respect to type and position of the reproductive structures such as soralia and isidia. He concluded 'of course, it is always possible that some asexual morphs are indeed polyphyletic, but we must insist upon evidence. For the present, claims without evidence for a polyphyletic origin of the asexual state must be rejected as unparsimonious'.

Recently, Mattsson & Lumbsch (1989) referred to preliminary studies which indicate that 'the genetic variation between individuals in a sterile taxon may be greater than in a fertile one' and that 'speciation among sterile lichens is possible'. Contrary to Poelt (1972) and Tehler (1982), they argued that sterile lichens do not represent dead ends of evolution but may have the ability to generate new ones. Mattsson & Lumbsch (1989) concluded that it is of primary importance for the ranking of a sorediate taxon to connect it with its primary counterpart.

Apart from systems based on sexual reproduction, some fungi may have an alternative genetic system termed parasexuality (see, e.g., Deacon 1988). Fungi having the potential for parasexuality do not need apothecia for genetic recombination. If this also applies to lichen fungi, apothecia may not be necessary for genetic recombination. However, the parasexual cycle has not been demonstrated in lichen fungi.

Most sorediate and isidiate lichens now and then produce ascocarps. In the present study, it was found that relatively few species produce them regularly (Fig. 21, Tab. 10). When apothecia are present, they may be destitute of asci or contain asci without spores, with fewer (and often larger) spores than typical for the genus and/or with spores that are immature or abortive. Occasional fertile specimens of secondary counterparts for which the primary part is extinct may be regarded as representing neotenic forms indicating the course of evolution, i.e. that sorediate or isidiate forms have evolved from fertile non-sorediate or non-isidiate progenitors. Species of *Lepraria* and *Leproloma* seem to have lost their ability to develop apothecia completely; apothecia in these genera are known only from a single specimen of *Leproloma membranaceum* collected in Scotland in 1790 (Laundon 1989). The restricted occurrence of protocetraric acid to the interior of sterile, sorediate tuberculae of *Pertusaria amara*, indicates that these soralia are rudimentary fertile tuberculae (for details, see that species).

Among the species treated in this work, the primary taxon is known for only a few of the taxa, and taxa for which the primary counterpart is not known are given the rank of species. The term taxon pair is used to denote any pair of a primary and a secondary taxon at species level or below.

Consistently sorediate populations are treated at species level if they do not seem to arise sporadically from individuals of a fertile counterpart, but seem to represent self-perpetuating populations reproducing themselves through regular production and dispersal of soredia or isidia. These populations therefore become widely distributed - wider than the corresponding fertile counterpart - by having less restricted germination requirements (Bowler & Rundel 1975). In order to rank the sorediate counterparts, it is therefore necessary to know the distribution of each of the counterparts. If the asexual counterpart occurs sporadically within the geographical range of the sexual counterpart it should be treated at an intraspecific level, even if apothecia are completely lacking. A sorediate or isidiate taxon at species level should not be connected with the fertile counterpart through intermediates (e.g. varying along a gradient from numerous apothecia without or with few soralia to numerous soralia with no or few apothecia). However, the possibility that a secondary counterpart becomes widely distributed through regular dispersal of soredia and at the same time still arises from individuals of the primary counterpart in areas where the two counterparts are sympatric, cannot be ruled out.

The mixed stand method should be applied with great caution when dealing with counterparts of a species (or taxon) pair. A strict application of this method to mixed populations of, e.g., *Lecanora allophana* f. *allophana*/"f. *sorediata*" and esorediate/sorediate forms of *Lecanora conizaeoides* will lead to a rigid taxonomy where the counterparts have to be accepted at specific level if no intermediates were observed in the mixed stands studied.

The occurrence of mosaic populations of the primary and the secondary counterparts of a taxon pair probably indicate a polyphyletic origin of the latter, i.e. that one or more of the thalli of the vegetative form are offspring of individuals of the fertile form or are descendants from such offspring. The common occurrence of such mosaics in some taxon pairs is therefore believed to indicate a conspecific relationship between the mosaic-forming counterparts. Apparently, in these cases two different reproductive strategies are employed simultaneously.

According to the species pair hypothesis of Poelt (1970, 1972), members of such a pair

have (1) identical thallus and apothecial morphology and anatomy except for the presence of soredia or isidia on the secondary counterpart, and (2) identical chemistries. I amend his latter criterion to refer to non-sorediate thallus parts, and allow the soralia of the secondary counterpart to contain substances that are absent in the primary counterpart. Likewise, substances present in esorediate parts of the primary counterpart, for example in the cortex, may be absent in the secondary counterpart if the surface of the latter is entirely sorediate. As asci of sorediate taxa are often immature, great care should be taken when ascribing spore characters to these taxa. The primary and the secondary taxon in a taxon pair may differ in their spore characteristics (see discussions under the treatments of, e.g., *Mycoblastus alpinus* and *Scoliciosporum gallurae*).
Having linked a secondary counterpart with its primary counterpart, the following characters should be considered concerning the taxonomic ranking of the counterparts: (1) Geographical range/ecological demands of each of the counterparts, (2) degree of regularity of the production of soralia on the secondary counterpart, (3) presence or absence of intermediates, and (4) occurrence of mosaic populations with both counterparts.

Species pairs

Six species pairs are discussed below (see also Tab. 11); the possible occurrence of some other species pairs is mentioned under the treatment of the species.

(1) *Japewia subaurifera* is distinct from *J. tornoënsis* (Nyl.) Tønsb. morphologically in being sorediate, and chemically by the presence of several pigments restricted to the soralia (Tønsberg 1990b). The apothecia of *J. subaurifera* are rare, usually flattened and have yellowish hymenial oil drops. In *J. tornoënsis* hemiglobose apothecia are abundantly present and oil drops are rare or absent. The difference in the occurrence of hymenial oil drops makes it unlikely that these two species form a species pair. The presence of the accessory lobaric acid in *J. subaurifera,* a substance not known to occur in *J. tornoënsis* (see Middelborg 1988), supports this view. Some esorediate and sparingly fertile, but richly pycnidiate specimens (leg. Tønsberg 12479, 12755) of a probably undescribed *Japewia* from British Columbia, an area where *J. subaurifera* also occurs, contained thalline pigments corresponding to those of *J. subaurifera* and numerous yellow hymenial oil drops. These specimens may prove to represent

Tab. 11. Species pairs.

Primary species	Secondary species
?Japewia sp. ined.	J. subaurifera
Lecanora confusa	L. expallens
Lecidea turgidula	L. leprarioides
Mycoblastus affinis	M. alpinus
Ochrolechia tartarea	O. androgyna B
Porpidia grisea	P. tuberculosa

the primary counterpart of *J. subaurifera*.

(2) *Lecanora confusa* Almb. differs from *L. expallens* in being destitute of soredia (Almborn 1955). These species have identical chemistries. *Lecanora confusa* has a more restricted distribution than *L. expallens* (Almborn 1955, also see Santesson 1984).

(3) *Lecidea turgidula* Fr. and *L. leprarioides* contain placodiolic acid and pseudoplacodiolic acid, respectively. In *L. leprarioides*, the occurrence of pseudoplacodiolic acid is apparently restricted to the soredia as the species is leprose. In the esorediate *L. turgidula*, the placodiolic acid is located in the areolae. As these two species do not have any specific thalline tissues in common, they might well be chemically different and still form a species pair. *Lecidea turgidula* seems to occupy a broader geographical range than *L. leprarioides*, since the latter in Europe is apparently restricted to the northern part of the range of the former (see Fries 1874, Wirth 1980, Clauzade & Roux 1985). An intraspecific rank might then be most appropriate. However, the range of *L. leprarioides* is not well-known and might be broader than presently known. Intermediates between *L. turgidula* and *L. leprarioides* do not seem to occur; specimens belonging to this species pair are either esorediate or completely sorediate. *Lecidea leprarioides* has not been observed growing intermixed with *L. turgidula*; this indicates that the former taxon does not represent local offspring of the latter.

(4) Omitting the soralia of *Mycoblastus alpinus*, *M. affinis* and *M. alpinus* are similar in apothecial and thalline characters (for details, see the treatment of *M. alpinus*). *Mycoblastus alpinus* appears to occupy a broader geographical range than *M. affinis*, at least in Europe.

(5) According to Gowan (1989a), *Porpidia grisea* Gowan matches *P. tuberculosa* in apothecial characters and all non-sorediate structures of the thallus. *Porpidia grisea* and *P. tuberculosa* are ecologically similar (Gowan 1989a), but geographically allopatric, and occur in North America and in North America and Europe, respectively (Gowan 1989a, Clauzade & Roux 1985).

(6) *Ochrolechia tartarea* (L.) Massal. and *O. androgyna* B appear to be chemically and morphologically similar disregarding the soralia of the latter species. Both species have large apothecia with esorediate margins. *Ochrolechia tartarea* is a saxicolous species which in Norway is restricted to coastal sites, especially coastal mountains. *Ochrolechia androgyna* B is much more widespread and common and is saxicolous as well as corticolous. Intermediates and mosaic populations have not been observed.

Intraspecific variation

Guidelines for the taxonomic ranking of intraspecific taxa have been proposed by, e.g., Hawksworth (1976), Egan (1986), and Mattsson & Lumbsch (1989). With respect to the infraspecific ranking of counterparts, I find it premature to use or propose any discriminating ranking system. Our present knowledge of the biological, genetical and ecological mechanisms governing the behaviour of these lichens is presently too fragmentary. It is evident from the examples discussed below that the characteristics of such pairs vary considerably and that different pairs probably represent different modes of biological strategy and behavior. Taxon pairs should be studied as integral parts of monographic treatments of whole genera. Detailed field studies of both counterparts are necessary.

For the purpose of the present paper, I admit to being somewhat arbitrary. I have found it convenient to refer by name to those counterparts for which names exist, but I have deliberately avoided introducing new epithets and making new combinations. As a provisional measure, I refer to intraspecific taxa of such pairs at form level and in quotation marks. Pairs of taxa or populations believed to involve a primary counterpart and its conspecific secondary counterpart, are summarized in Tab. 12.

Three main types of intraspecific variation based on the occurrence of soralia can roughly be distinguished:

(1) *Typically esorediate, but occasionally sorediate.* Soralia often irregularly distributed and concentrated in a local and often minor part of the thallus. Apothecia often abundantly present.

A joint occurrence of these features is seen in species where the production of soredia seems to be of limited taxonomic value, e.g., in *Fuscidea cyathoides* (not with soredia on bark in Norway), *Lecidella elaeochroma*, and *Mycoblastus sanguinarius*. *Lecidella elaeochroma* "f. *soralifera*" is of particular interest, and merits further comment.

Lecidella elaeochroma "f. *soralifera*" occurs associated with f. *elaeochroma* in well-developed mosaic populations in maritime situations. It is distinct from f. *elaeochroma* in morphological, chemical and distributional characters (for details, see the treatment of the species). Following the guidelines for taxonomic ranking proposed by, e.g., Hawksworth (1976) and Egan (1986), "f. *soralifera*" would clearly deserve specific rank. However, as the presence of lichexanthone is restricted to the soralia, the differences in morphology and chemistry should not be regarded as representing unrelated characters. There is ample intergradation of form between the two types and sorediate specimens are commonly richly fertile. "F. *soralifera*" appears to rise sporadically from maritime individuals of f. *elaeochroma*, rather than through evolution of populations. An intraspecific rank for "f. *soralifera*" seems most appropriate.

The taxonomic implications of the restriction of "f. *soralifera*" to a maritime habitat is not clear. A possible explanation would be that the development of the soralia is triggered by one or more ecological factors related to a maritime environment. An ecologically triggered pigment (rhodocladonic acid) was recently reported from *Cladonia norvegica* Tønsb. & Holien by Timdal (1989). In that lichen the presence of rhodocladonic acid is correlated with the presence of a lichenicolous mite. Specimens containing rhodocladonic acid appear to have a slightly restricted distribution within the range of *C. norvegica*, being sparse or absent at least in central and northern Norway. Apparently, the range to the north of *C. norvegica* is slightly wider than that of the mite.

(2) *Typically esorediate, but occasionally sorediate.* Soralia often regularly distributed

Tab. 12. Intraspecific taxon pairs.

Species	Primary counterpart	Secondary counterpart
Lecanora allophana	f. allophana	"f. sorediata"
Lecidella elaeochroma	f. elaeochroma	"f. soralifera"
Mycoblastus sanguinarius	f. sanguinarius	"f. leprosus"
Ochrolechia frigida	f. frigida	"f. lapuensis"

throughout the entire thallus surface. Apothecia sparse or absent.

The material of *Lecanora allophana* "f. *sorediata*" comprises only two specimens which were found associated with *L. allophana* f. *allophana* in mosaic populations. The specimens were abundantly sorediate and destitute of apothecia. "*F. sorediata*" seems in Scandinavia and in North America (see Brodo 1984) to have a restricted distribution within the range of the primary counterpart and probably represents offspring from local populations of f. *allophana*. Furthermore, "f. *sorediata*" is linked with f. *allophana* by intermediates. A Swedish specimen examined (Uppland, R. Santesson 12179 (UPS)) was richly fertile and less abundantly sorediate than the Norwegian specimens.

Ochrolechia frigida comprises several morphotypes characterized mainly by the shape of thalline projections (see Lynge 1928, Verseghy 1962, Howard 1970, Thomson 1979, Hanko et al. 1985). The extremes of these types are very characteristic, but as they seem to be linked with each other through intermediates, they are currently regarded as representing intraspecific variation (see Santesson 1984, Hanko et al. 1985, Egan 1987). Occasional sorediate individuals occur in the present corticolous material belonging to different morphotypes. According to Hanko et al. (1985), sorediate individuals of *O. frigida*, "f. *lapuensis*", have a restricted distribution within the total range of the species. Apparently the specimens of "f. *lapuensis*" represent occasional offspring from individuals of different morphotypes of f. *frigida*. In "f. *lapuensis*" the occurrence of soralia showed ample variation from few and with a restricted distribution on the thallus, to many and regularly distributed. However, apothecia are often sparse or absent.

(3) *Typically sorediate, but occasionally esorediate*. Apothecia usually absent.

In many typically sorediate species, esorediate forms occasionally occur, e.g, in *Chrysothrix chrysophthalma*, *Fuscidea pusilla*, *Lecanora conizaeoides*, *Loxospora elatina*, *Ochrolechia microstictoides*, *Pertusaria albescens*, *P. amara*, *Phlyctis argena*, *Psilolechia lucida*, *Schismatomma umbrinum*, and *Varicellaria rhodocarpa*. These species are briefly discussed below.

The present Norwegian specimens of *Chrysothrix chrysophthalma* were either leprose sorediate throughout, or esorediate. However, although the type specimen of *Chrysothrix chrysophthalma* is devoid of soredia, Laundon (1981) gave no formal taxonomic status to the sorediate form since there seemed to exist a continuum between the sorediate and esorediate extremes.

Fuscidea pusilla is not known with apothecia, and the occasional esorediate specimens are believed to fall within the variation range of the species.

In some populations of *Lecanora conizaeoides* well-developed esorediate thalli occurred intermixed with sorediate ones (see also, e.g., Degelius 1986). Apothecia seem to be more frequent in the esorediate thalli, but completely sterile esorediate thalli also occur. The esorediate thalli are regarded as representing an extreme form within the variation range of *Lecanora conizaeoides* since they were linked with abundantly sorediate forms through intermediates.

The lack of soredia in some specimens of *Ochrolechia microstictoides* is probably due to pollution as such specimens only occurred in the centres of larger towns. Other examples of occurrences of esorediate specimens of normally sorediate species in polluted areas include several macrolichens (see Haugsjå 1930, Hawksworth et al. 1973). In contrast, in polluted areas some species display an unusually abundant production of soredia (see e.g. Haugsjå 1930, Skye 1968). Hawksworth et al. (1973) found that the decrease in ascocarp production in some instances is related to an increased tendency to produce soredia. These environmentally induced morphological differences do not merit taxonomic recognition.

In *Pertusaria albescens* and *P. amara*, and more rarely, in *Loxospora elatina*, and *Phlyctis argena* a tuberculate (quasi-isidiate), usually esorediate form occurs. It appears that the production of these esorediate tuberculae and the subsequent suppression of the production of soredia are restricted to markedly eutrophicated habitats such as trees subjected to road-side dust or nutrients from agriculture. The sorediate, typical forms and the tuberculate extremes of these species are connected with intermediates; it is not possible to refer every specimen to one form or the other. As these extreme forms in these species appear to be environmentally controlled, they should not be treated as taxonomic entities, not even at form level.

In *Psilolechia lucida* specimens with *Stichococcus* as photobiont are esorediate, whereas those with a coccoid (trebouxoid) photobiont are sorediate (Coppins & Purvis 1987). The latter photobiont was absent in the present corticolous material. According to Art. 13.1(d) of the International Code of Botanical Nomenclature, the names given to lichens are treated as referring to the mycobiont. As the phototypes of *Psilolechia lucida* seem to have identical mycobionts (Coppins & Purvis 1987), they do not merit formal nomenclatural recognition.

In *Schismatomma umbrinum*, specimens with pycnidia were esorediate. The pycnidiate thalli were small (to about 0,5 cm diam.), perhaps too small for production of soredia. The possibility that the production of pycnidia in this case had delayed or suppressed the production of soredia was not ruled out. Another possibility is that *Schismatomma umbrinum* is dioecious and that the pycnidiate thalli represent "male" specimens (see also under the treatment of the species).

Varicellaria rhodocarpa is nearly always richly fertile, and there appears to be a continuous variation of form from esorediate to richly sorediate specimens.

TAXONOMY

KEY TO THE TAXA

Note: Apothecial characters have been included only for species which are not conclusively determinable based on thalline characters only. Rare morphotypes are not consistently included. The key requires chemical characters as obtained by TLC.

Synopsis

1 Thallus with isidia, thlasidia or schizidia 2
1 Thallus sorediate; isidia, thlasidia and schizidia absent 14

14 Photobiont green, but not *Trentepohlia* or *Stichococcus* 15
14 Photobiont *Trentepohlia* or *Stichococcus* 133

15 Thallus squamulate . . . . *Hypocenomyce scalaris*
15 Thallus crustose to subsquamulate 16

16 Thallus with patches of orange or red pigments 17
16 Thallus not orange or red pigmented 19

19 Pycnidia present, black, up to 0.4 mm in diameter . . . . *Cliostomum leprosum*
19 Pycnidia present or absent, variously coloured, up to 0.2 mm in diameter 20

20 Usnic acid present 21
20 Usnic acid absent 26

26 Acetone-soluble pigments present 27
26 Acetone-soluble pigments absent 45

45 Thallus with a leprose surface. Soredia not originating from endosubstratal thallus parts 39
45 Thallus with a surface not completely dissolved into soredia or with soralia originating from endosubstratal thallus parts 68

68 Picrolichenic acid present . . . . *Pertusaria amara*
68 Picrolichenic acid absent 69

69 Soralia PD+ 70
69 Soralia PD- 91

91 Gyrophoric acid, lecanoric acid and/or 5-O-methylhiascic acid present 92
91 Gyrophoric acid, lecanoric acid and/or 5-O-methylhiascic acid absent 107

107	Thallus UV+	108
107	Thallus UV-	119
119	Atranorin present	120
119	Atranorin absent	127
127	Lichen substances present	128
127	Lichen substances absent	131

1	Isidia, thlasidia or schizidia present; soredia present or absent	2
1	Isidia, thlasidia and schizidia absent; soredia present	14
2 (1)	Schizidia present	*Baeomyces rufus*
2	Thlasidia or isidia present	3
3 (2)	Thlasidia present. Lichen substances absent	*Gyalideopsis anastomosans*
3	Isidia present. Lichen substances present	4
4 (3)	Thallus areolate	5
4	Thallus continuous	6
5 (4)	Isidia orange. Herbidella 1 & 2 (anthraquinones) present	*Caloplaca herbidella*
5	Isidia dark green to brown. Gyrophoric acid (major constituent) and 5-O-methylhiascic acid present	*Placynthiella icmalea*
6 (4)	Tuberculae resembling coarse, irregular isidia. Picrolichenic acid or fatty acids diagnostic substances	7
6	Tuberculae, if present, not resembling isidia. Picrolichenic acid and fatty acids absent	8
7 (6)	Picrolichenic acid (KC+ violet) present	*Pertusaria amara*
7	Allopertusaric and dihydropertusaric acids (KC-) present .	*Pertusaria albescens*
8 (6)	Isidia with a distinct medulla	9
8	Isidia without a medulla	11
9 (8)	Isidia whitish, up to 1 mm wide, always with apothecia immersed in the apices	*Pertusaria dactylina*
9	Isidia greyish, up to 0.5 mm wide, sterile	10
10 (9)	Isidia apically darkened, pigment K+ violet. Fumarprotocetraric acid present	*Pertusaria oculata*
10	Isidia not apically pigmented. Thamnolic acid present . . .	*Pertusaria corallina*
11 (8)	Xanthones (C+ orange or C-) present. Thallus mostly yellowish, rarely greyish; UV+ orange	12

11 Gyrophoric acid (C+ red) or norstictic acid (K+ red) present. Thallus mostly greyish, greenish or brownish, rarely yellowish; UV+ whitish blue or UV- . 13

12 (11) Thallus more or less sulphur-yellow, thiophaninic acid present; cortex C+ orange . . . . *Pertusaria flavida*

12 Thallus pale yellow or grey, coronaton present; cortex C- . *Pertusaria coronata*

13 (11) Gyrophoric acid (C+ red; UV+ bluish white) present. Isidia not darkened towards the apices . . . . *Ochrolechia subviridis*

13 Norstictic acid (K+ red; UV-) present. Isidia often distinctly darkened towards the apices . . . . *Pertusaria coccodes*

14 (1) Photobiont *Trentepohlia* or *Stichococcus*. In shaded habitats, mostly on bark under overhanging rock 134

14 Photobiont green, mostly coccoid, not *Trentepohlia* or *Stichococcus*. In various habitats, sun-exposed to shaded 15

15 (14) Thallus of uniformly squamiform, imbricate areolae . . *Hypocenomyce scalaris*

15 Thallus continuous, or areolate with crustose, subsquamiform, or rarely squamiform, but never imbricate 16

16 (15) Thallus with an orange-red or red pigment (K+ purplish) 17

16 Thallus not orange to red pigmented. K- reaction variable, but never purple 19

17 (16) Thallus continuous. Rhodocladonic acid present, scattered in the medulla. Atranorin, chloroatranorin and caperatic acid or rangiformic acid present . . . . *Mycoblastus sanguinarius* "f. *leprosus*"

17 Thallus areolate. Anthraquinones present, apparent on the surface or in the soredia. Atranorin, chloroatranorin and fatty acids absent 18

18 (17) Areolae crustose, soralia bursting from the apices of the areolae. Gyrophoric acid present . . . . *Trapeliopsis pseudogranulosa*

18 Areolae subsquamiform, soralia marginal/labriform. Gyrophoric acid absent . . . . *Caloplaca citrina*

19 (16) Pycnidia black, always present, up to 0.4(-0.6) mm, with a violet, K+ aeruginous, N+ reddish pigment and droplet-shaped conidia. Caperatic acid present . . . . *Cliostomum leprosum*

19 Pycnidia present or absent, black pycnidia < 0.2 mm, never with a violet K+ aeruginous, N+ reddish pigment. Caperatic acid absent 20

20 (19) Usnic acid present 21

20 Usnic acid absent 26

21 (20) Thallus with discrete soralia surrounded by esorediate thallus parts 22

21 Thallus with a more or less leprose surface 23

22 (21) Planaic acid and chloroatranorin present. Soralia up to 2.5 mm in diameter . . . . *Mycoblastus alpinus*
22 Planaic acid and chloroatranorin absent, often with stictic acid. Soralia up to 0.3 mm in diameter . . . . *Lecanora flavopunctata*

23 (21) Porphyrilic acid and atranorin present. Prothallus distinct, white . . . . *Haematomma ochroleucum*
23 Porphyrilic acid and atranorin absent. Prothallus indistinct 24

24 (23) Xanthones absent . . . . *Megalospora tuberculosa*
24 Xanthones present 25

25 (24) Thiophanic acid present. (Common) . . . . *Lecanora expallens*
25 Flavoleprosa unknown present. (Rare) . . . . *Lecanora flavoleprosa*

26 (20) Acetone-soluble pigments (xanthones, pulvinic acid derivatives and unidentified substances) present as major constituents; spots yellowish, more or less orange, red or brown in long-wave UV-light on untreated plates. Thallus UV+ yellow, orange or rust-red 27
26 Acetone-soluble pigments absent (or present in trace amounts). Thallus UV- or UV+ bluish white 45

27 (26) Griseovirens unknowns and norstictic acid present . . . . . . *Buellia griseovirens*
27 Griseovirens unknowns and norstictic acid absent 28

28 (27) Subaurifera unknowns 1-3 (pigments) present. Soralia of brown external soredia and distinctly yellow internal soredia . . . . *Japewia subaurifera*
28 Subaurifera unknowns absent. Soralia variously coloured, but never partly brown, partly yellow 29

29 (28) Efflorescens unknown and pannarin present, soralia PD+ immediately rust-red . . . . *Rinodina efflorescens*
29 Efflorescens unknown and pannarin absent, soralia PD- 30

30 (29) Pulvinic acid or pulvinic acid derivatives present. Soredia usually bright yellow or vivid yellowish green, C- 31
30 Xanthones present. Soredia variably coloured, but not bright yellow or vivid yellowish green, C- or C+ orange to red 36

31 (30) Thallus areolate with marginal soralia, or thallus entirely composed of soredia-like corticate granules. Pulvinic acid a major substance 32
31 Thallus more or less continuously sorediate throughout, soredia ecorticate. Pulvinic acid, if present, in trace amounts 33

32 (31) Thallus entirely composed of soredia. Discrete soralia absent . . . . *Candelariella xanthostigma*
32 Thallus areolate with marginal to sublabriform soralia . . *Candelariella reflexa*

33 (31) Rhizocarpic acid present 34
33 Pinastric or vulpinic acid present 35

34 (33) Chrysophthalma unknown present. On moderately shaded bark more or less exposed to rain . . . . . . *Chrysothrix chrysophthalma*
34 Chrysophthalma unknown absent. On deeply shaded, dry bark under overhangs . . . . . . *Psilolechia lucida*

35 (33) Pinastric acid or calycin present as major pigments. Zeorin absent . . . . . . *Chrysothrix candelaris*
35 Vulpinic acid and zeorin present . . . . . . *Chrysothrix chlorina*

36 (30) Lichexanthone present. Soralia UV+ yellow 37
36 Lichexanthone absent. Thallus UV+ orange to reddish brown 39

37 (36) Soralia yellow. Arthothelin and granulosin or 2,5,7-trichloro-3-methylnorlichexanthone, isoarthothelin and thiophanic acid present. Soralia C- or C+ orange . . . . . . *Lecidella elaeochroma* "f. *soralifera*"
37 Soralia grey. Gyrophoric or lecanoric acids present. Soralia C+ red 38

38 (37) Lecanoric acid (C+ blood-red) present. Northern . . . . *Varicellaria rhodocarpa*
38 Gyrophoric acid (C+ red) major depside present. In the lowlands; southern . . . . . . *Ochrolechia arborea*

39 (36) Atranorin present 40
39 Atranorin absent 42

40 (39) Thiophanic acid major xanthone. Thallus areolate . . . . . . *Lecidella subviridis*
40 Thiophanic acid absent. Thallus continuous (sometimes secondarily cracked) 41

41 (40) Arthothelin, +/- thuringione present . . . . . . *Lecidella scabra*
41 Aotearone and 2,5,7-trichloro-3-O-methylnorlichexanthone present . . . . . . *Lecidella* sp. A

42 (39) Thallus of scattered areolae and/or soralia. On naked bark, corticolous mosses and other lichens 43
42 Thallus continuous, or areolate, but then soon forming a more or less continuous sorediate crust. On naked bark 44

43 (42) Soralia yellow, arthothelin and thiophanic acid present. Zeorin absent . . . . . . *Rinodina flavosoralifera*
43 Soralia grey, rinodina sp. A unknown and zeorin present . . . . . *Rinodina* sp. A

44 (42) Arthothelin and granulosin major xanthones . . . . *Lecidella flavosorediata*
44 Thiophanic acid and isoarthothelin major xanthones . . . . *Pyrrhospora quernea*

45 (26) Thallus with a leprose surface. Soredia usually superficial from the beginning .

. . . . 46

45 Thallus with a surface which is not completely dissolved in soredia or consoredia, or with soralia originating from endosubstratal thallus parts (bursting through the uppermost cell-layers of the substratum) 68

46 (45) Photobiont micareoid 47
46 Photobiont of various types, but not micareoid 48

47 (46) Argopsin and gyrophoric acid present . . . . *Micarea leprosula*
47 Micareic- or methoxymicareic acids present . . . . *Micarea prasina*

48 (46) Gyrophoric acid present (trace amounts only!) 49
48 Gyrophoric acid absent 50

49 (48) Thallus composed of discrete soralia. Spores often distinctly curved, 20-30 x 2(-2.5) µm . . . . *Scoliciosporum sarothamni*
49 Thallus composed of a more or less continuous mass of soredia and hyphae, discrete soralia sparse or absent. Spores straight to slightly curved, 15-22 x 2.5-3.5 µm . . . . *Scoliciosporum gallurae*

50 (48) Thallus minute, <1 cm in diameter, greyish to blue-grey, usually forming delimited rosettes which may be minutely lobed marginally. In slightly shaded to sun-exposed habitats exposed to rain 51
50 Thallus up to several cm or dm in diameter, variously coloured, delimited to diffuse. Often in dry, deeply to semi-shaded habitats 54

51 (50) Alectorialic acid present . . . . *Lepraria neglecta*
51 Alectorialic acid absent 52

52 (51) Fumarprotocetraric acid present . . . . *Lepraria caesioalba*
52 Fumarprotocetraric acid absent 53

53 (52) Porphyrilic acid and roccellic acid present . . . . *Lepraria caerulescens*
53 Rangiformic acid present . . . . *Lepraria* sp. A

54 (50) Pannaric acid, or pannaric acid-6-methylester present 55
54 Dibenzofurans absent 56

55 (54) Lobes distinct. Hypothallus distinct, brown. Pannaric acid, roccellic acid and atranorin present . . . . *Leproloma membranaceum*
55 Lobes absent. Hypothallus indistinct to distinct. Pannaric acid-6-methylester major substance present; pannaric acid, if present, only in trace amounts . . . . *Leproloma vouauxii*

56 (54) Alectorialic acid and protocetraric acid present. Thallus C+ red . . . . *Lepraria eburnea*
56 Alectorialic acid and protocetraric acid absent. Thallus C- 57

57 (56) Stictic acid present 58
57 Stictic acid absent 59

58 (57) Thallus with a distinct medulla, lobed, on eutrophic bark, in coastal habitats . . . . *Lepraria lobificans*
58 Thallus unstratified, unlobed, on acidic bark, widespread . . . *Lepraria elobata*

59 (57) Thamnolic acid present . . . . *Lepraria umbricola*
59 Thamnolic acid absent 60

60 (59) Fumarprotocetraric acid present . . . . *Lepraria caesioalba*
60 Fumarprotocetraric acid absent 61

61 (60) Divaricatic acid present 62
61 Divaricatic acid absent 63

62 (61) Zeorin present. Prothallus not evident . . . . *Lepraria incana*
62 Zeorin absent. Prothallus usually distinct, blue; pigment N+ violet . . . . *Lecidea nylanderi*

63 (61) Pseudoplacodiolic acid present. On conifers only . . . . *Lecidea leprarioides*
63 Pseudoplacodiolic acid absent. On various phorophytes 64

64 (63) Obtusatic acid present . . . . *Lepraria obtusatica*
64 Obtusatic acid absent 65

65 (64) Lichen substances absent . . . . *Caloplaca chlorina*
65 Fatty acids and atranorin present 66

66 (65) Soredia with distinct, projecting hyphae up to 120 µm long, rigidula unknown present . . . . *Lepraria rigidula*
66 Soredia without or with shortly projecting hyphae; rangiformic acid present 67

67 (66) Roccellic acid present . . . . *Lepraria jackii*
67 Roccellic acid absent . . . . *Lepraria* sp. A

68 (45) Picrolichenic acid present . . . . *Pertusaria amara*
68 Picrolichenic acid absent. Reaction with KC various, but not violet 69

69 (68) Medulla and/or soralia PD+ yellow, orange or red 70
69 Medulla and soralia PD- (rarely brownish) 91

70 (69) Alectorialic acid present 71
70 Alectorialic acid absent 74

71 (70) Prothallus brown. Soralia bursting from the apices of the areolae, concave. Medulla indistinct . . . . *Fuscidea praeruptorum*

71 Prothallus usually indistinct. Soralia marginal or laminal, flat to strongly convex. Medulla distinct 72

72 (71) Soralia capitate. Thallus continuous or composed of distinctly convex, often papilliform areolae . . . . *Pertusaria geminipara*

72 Soralia labriform to laminal and orbicular, rarely more or less capitate. Thallus areolate, never continuous 73

73 (72) Areolae mostly distinctly crustose, yellowish green, up to 0.6 mm in diameter, often becoming completely dissolved into soredia. Soralia usually not labriform. On *Betula pubescens/pendula, Picea abies*, and *Pinus sylvestris* . . . . *Hypocenomyce sorophora*

73 Areolae often subsquamiform, greyish white to yellowish brown, rarely with a green tinge, up to 1 mm in diameter, usually not becoming completely dissolved into soredia. Soralia often more or less labriform. On various phorophytes, but mostly *Alnus incana, Betula pubescens/pendula*, and *Sorbus aucuparia* . . . . *Hypocenomyce leucococca*

74 (70) Norstictic acid present 75

74 Norstictic acid absent 77

75 (74) Soralia dark brown. Eastern . . . . *Rimularia fuscosora*

75 Soralia variously coloured, but not brown. Common and widespread in the lowlands 76

76 (75) Soralia irregular, spreading, > 1 mm in diameter. Soredia coarse, non-pigmented. Atranorin absent . . . . *Phlyctis argena*

76 Soralia orbicular, < 1 mm in diameter. Soredia fine; external soredia often with a blue pigment. Atranorin present . . . . *Buellia griseovirens*

77 (74) Thamnolic acid present. Prothallus distinct, white . . . . *Loxospora elatina*

77 Thamnolic acid absent. Prothallus indistinct 78

78 (77) Stictic acid present . . . . *Porpidia* sp. A

78 Stictic acid absent 79

79 (78) Argopsin or pannarin present 80

79 Fumarprotocetraric acid and/or protocetraric acid present 83

80 (79) Areola-like aggregations of consoredia blue-grey, with minute, white flecks; contiguous. Photobiont micareoid. Gyrophoric acid present . *Micarea leprosula*

80 Areolae greyish, greenish or brownish, scattered. Photobiont not micareoid. Gyrophoric acid absent 81

81 (80) Pannarin present. Soralia often brown-pigmented . . . . . . *Rinodina efflorescens*

81 Argopsin present. Soralia green to yellow, never brown 82

82 (81) Gracilenta unknown 1 present. Soralia green, up to 0.2 mm in diameter .... *Halecania viridescens*
82 Gracilenta unknown 1 absent. Soralia yellow to green, up to 0.5 mm in diameter .... *Lecidea efflorescens*

83 (79) Protocetraric acid major β-orcinol depsidone present .... *Lecanora norvegica*
83 Fumarprotocetraric acid major β-orcinol depsidone present 84

84 (83) Atranorin present 85
84 Atranorin absent 87

85 (84) Soralia greenish, irregular, often becoming confluent. Zeorin present. Chloroatranorin absent .... *Catillaria pulverea*
85 Soralia variously coloured, mostly regularly rounded and discrete. Zeorin absent. Chloroatranorin present 86

86 (85) Cortex and/or prothallus often with a bluish tinge, external soredia tinged bluish or brownish. Thallus often infested with the black basidiocarps of *Tremella lichenicola*. In the lowlands .... *Mycoblastus fucatus*
86 Thallus without a bluish or brownish tinge, not host to lichenicolous fungi. Northern. .... *Lecidea cinnabarina*

87 (84) Thallus continuous, greyish. Soralia more or less whitish grey to pale yellow-grey 88
87 Thallus areolate, usually greenish. Soralia greenish or yellowish brown ... 89

88 (87) Thallus mostly endosubstratal in non-sorediate parts. Soralia usually concave to flat; succinprotocetraric acid absent .... *Pertusaria pupillaris*
88 Thallus episubstratal or occasionally endosubstratal in non-sorediate parts. Soralia more or less convex. Succinprotocetraric acid present .... *Pertusaria borealis*

89 (87) Esorediate areolae indistinct or absent. Soralia up to 0.2 mm in diameter, discrete .... *Lecidea praetermissa*
89 Esorediate areolae distinct, numerous, at least at the edge of the thallus. Soralia up to 0.5 mm in diameter, irregular, diffuse, persistently discrete or becoming confluent 90

90 (89) Prothallus conspicuous, brown, N-. Soralia discrete. In non-polluted areas ... . *Fuscidea arboricola*
90 Prothallus usually indistinct, greyish white to greyish black, greyish black pigment N+ red-brown. Soralia becoming confluent. In heavily polluted areas .... *Lecanora conizaeoides*

91 (69) Gyrophoric acid, lecanoric acid or 5-O-methylhiascic acid present. Medulla and soralia (C+ red) 92
91 Gyrophoric acid and related substances absent. Medulla and soralia C- or C+ orange (variolaric acid) 107

92 (91) Lecanoric acid major substance. Gyrophoric acid absent . . . . *Pertusaria hemisphaerica*

92 Gyrophoric acid present. Lecanoric acid present in trace to moderate amounts only 93

93 (92) External soredia distinctly brown 94

93 External soredia greyish, greenish or yellowish 95

94 (93) Soralia delimited, persistently discrete, punctiform. 5-O-methylhiascic acid present. Coastal . . . . *Schaereria corticola*

94 Soralia diffuse, often soon becoming confluent. 5-O-methylhiascic acid absent. Widespread . . . . *Placynthiella dasaea*

95 (93) Thallus continuous (at least towards the centre), usually delimited 96

95 Thallus areolate throughout, diffuse 100

96 (95) With thin, pointed spinules projecting from the tuberculae . . . . *Ochrolechia frigida* "f. *lapuensis*"

96 Spinules absent 97

97 (96) Variolaric acid present, northern . . . . *Ochrolechia androgyna* D

97 Variolaric acid absent, widespread or southern 98

98 (97) Soralia soon becoming confluent. Thallus surface more or less leprose 99

98 Soralia more or less discrete. Corticate parts of surface distinct 102

99 (98) Soredia green grey. On eutrophic bark, southern . . . . . *Ochrolechia subviridis*

99 Soredia with a brownish or brownish yellow tinge. On acidic bark, in northern Norway . . . . form of *Ochrolechia androgyna* A

100 (95) Soralia often forming a shallow, green layer on subglobular tuberculae filled with oxalate. The murolic acid complex present . . . . *Ochrolechia androgyna* C

100 Soralia yellowish or greyish, tuberculae more or less irregular or indistinct. Murolic acids absent 101

101 (100) Thallus usually pale to medium grey, thin, not wrinkled or folded; soredia often yellowish. Without androgyna B unknowns . . . . *Ochrolechia androgyna* A

101 Thallus medium to dark grey, thick, often wrinkled and folded. Soredia more or less concolorous with the cortex. With androgyna B unknowns . . . . *Ochrolechia androgyna* B

102 (98) Areolae usually distinct, markedly convex throughout, or when scattered or at the edge of thallus sometimes incised, usually >0.1 mm in diameter 103

102 Areolae usually indistinct, minute, <0.1 mm in diameter, never incised . . . 105

103 (102) 5-O-methylhiascic acid major substance. Areolae convex, not incised. Mostly on *Calluna vulgaris*, in maritime situations . . . . *Micarea coppinsii*

103 Gyrophoric acid major substance, 5-O-methylhiascic acid absent. Marginal or scattered areolae often flattened and more or less incised. On various phorophytes; widespread 104

104 (103) Areolae usually green to grey-green, marginal areolae more or less flattened and incised. Soralia grey-green to dark green (more or less aeruginous). Common . . . . *Trapeliopsis flexuosa*

104 Areolae usually whitish to pale grey, marginal areolae sometimes more or less flattened and incised. Soralia whitish to cream-yellow. A terricolous lichen rarely spreading to more or less decaying bark on bases of usually coniferous trees . . . . *Trapeliopsis granulosa*

105 (102) Soralia usually dull greyish white, more rarely green, punctiform, markedly convex, not becoming confluent. 5-O-methylhiascic acid present. In the lowlands along the western coast . . . . *Trapelia corticola*

105 Soralia green or yellowish green, irregular, flat to slightly convex, becoming confluent. 5-O-methylhiascic acid absent. Widespread, or montane and northern 106

106 (105) Photobiont 2-4-celled, with a common external gelatinous cap, globose to more or less cubic. On smooth, naked bark of shrubs (especially *Salix*) and on dwarf shrubs. Northern . . . . *Lecidea vacciniicola*

106 Photobiont coccoid. Usually on corticolous mosses on mature trunks of deciduous trees in the lowlands and on subalpine *Betula pubescens* and *Juniperus communis* . . . . *Lecidea gyrophorica*

107 (91) Thallus UV+ brightly bluish white. Divaricatic acid, lobaric acid, perlatolic acid, sphaerophorin or variolaric acid present 108

107 Thallus UV-. Various substances present, but not divaricatic acid, lobaric acid, perlatolic acid, sphaerophorin or variolaric acid 119

108 (107) Perlatolic acid present 109

108 Perlatolic acid absent 110

109 (108) Thallus with a green to yellowish green over-all colour. Hyperlatolic acid present . . . . *Ropalospora viridis*

109 Thallus grey with a distinct blue tinge. Blue pigment N+ violet. Hyperlatolic acid absent . . . . *Mycoblastus caesius*

110 (108) Sphaerophorin present 111

110 Sphaerophorin absent 112

111 (110) Soralia punctiform, discrete. Soredia not in firm aggregations. Prothallus usually distinct, often blue and N+ red. Widespread and common, but mostly subalpine and northern . . . . *Lecidea pullata*

111 Soralia irregular in form and size, often becoming contiguous. Soredia in isidia-like aggregations. Prothallus indistinct to distinct, brown. Usually in moist *Picea*-forest.

In the coastal lowlands of central Norway, rare . . . . *Rinodina disjuncta*

112 (110) Lobaric acid present 113
112 Divaricatic acid or variolaric acid present 114

113 (112) Internal soredia distinctly yellow . . . . *Japewia subaurifera*
113 Internal soredia greenish . . . . *Lecidea porphyrospoda*

114 (112) Divaricatic acid present. Thallus C- 115
114 Variolaric acid present Thallus C+ 117

115 (114) Thallus grey with a bluish over-all tinge. Esorediate areolae few and indistinct. Usually on conifers . . . . *Lecidea nylanderi*
115 Thallus green, yellowish green or brownish. Usually on deciduous trees . . 116

116 (115) Thallus with a green-brown to dark brown over-all colour. Soralia discrete, often brown due to a pigment in the external soredia. Rarely corticolous . . . . *Fuscidea resenca*
116 Thallus with a greenish to yellowish green over-all colour. Soralia often becoming confluent. External soredia without a brown pigment . . . . . . *Fuscidea pusilla*

117 (114) Cortex usually straw-coloured. Soralia distinctly delimited, orbicular, persistently discrete. Lichesterinic and protolichesterinic acids present . . . . *Ochrolechia alboflavescens*
117 Cortex grey. Soralia more or less delimited to diffuse, irregular, discrete or becoming confluent. Lichesterinic acid present or fatty acids absent 118

118 (117) Soralia mostly discrete. Fatty acids absent. In the coastal lowlands; southern . . . . *Ochrolechia turneri*
118 Soralia mostly soon becoming confluent. Lichesterinic acid present. Widespread . . . . *Ochrolechia microstictoides*

119 (107) Atranorin present. Cortex K+ yellow 120
119 Atranorin absent. Cortex K- 127

120 (119) External soredia dark green, N+ violet. Gangaleoidin present. On bark under overhanging rock. Very rarely corticolous . . . . *Lecania baeomma*
120 External soredia variously coloured, but not dark green, N-. Gangaleoidin absent. On bark under overhanging rock or in open situations 121

121 (120) Placodiolic acid present . . . . *Buellia arborea*
121 Placodiolic acid absent 122

122 (121) Porphyrilic acid present. Soredia coarse. Prothallus distinct, felty . . . . *Haematomma ochroleucum* v. *porphyrium*
122 Porphyrilic acid absent. Soredia farinose. Prothallus indistinct 123

123 (122) Thallus continuous 124
123 Thallus areolate 125

124 (123) Allophana unknowns present . . . . *Lecanora allophana* "f. *sorediata*"
124 Impudens unknowns present . . . . *Lecanora impudens*

125 (123) Areolae distinct. Soralia whitish, marginal, linear to more or less labriform . . . . *Rinodina degeliana*
125 Areolae usually indistinct. Soralia blue-grey or pale yellow, punctiform, bursting from the apices of the areolae 126

126 (125) Zeorin present. Soralia blue-grey. On eutrophic bark *Rinodina griseosoralifera*
126 Roccellic acid present. Soralia often pale yellowish. On acidic bark . . . . *Lecanora farinaria*

127 (119) Lichen substances present (soredia shining in polarized light) 128
127 Lichen substances absent 131

128 (127) Confluentic acid present. Medulla K/I+ blue . . . . *Porpidia tuberculosa*
128 Confluentic acid absent. Medulla K/I- 129

129 (128) Soralia doliiform, persistently discrete. Roccellic acid present. Mostly on *Salix*-shrubs; northern . . . . *Caloplaca sorocarpa*
129 Soralia discrete and punctiform or maculiform, or more or less confluent. Roccellic acid absent. On various phorophytes, but not on *Salix*-shrubs; in the lowlands 130

130 (129) Pseudoplacodiolic acid present. Widespread. . . . . *Lecidea leprarioides*
130 Subcinnabarina unknowns present. In central Norway *Lecidea subcinnabarina*

131 (127) Thallus with a bluish over-all colour, pigment K+ violet 132
131 Thallus green to yellowish or greyish. K+ violet pigment absent 133

132 (131) Areolae indistinct, not incised, up to 0.2 mm in diameter. Soredia often indistinct, but evident under the microscope. Apothecia with black disc; spores brown . . . . *Rinodina colobina*
132 Areolae and/or soredia distinct. Areolae up to 0.3 mm in diameter, often incised. Apothecia with orange disc; spores colourless . . . . *Caloplaca chlorina*

133 (131) Thallus more or less leprose throughout; esorediate parts indistinct or absent; soredia green to yellowish. Usually muscicolous . . . . . . *Bacidia epixanthoides*
133 Thallus with distinct greyish areolae and crateriform soralia. Soredia grey to green. On naked bark . . . . *Caloplaca obscurella*

134 (14) Photobiont *Trentepohlia* 135
134 Photobiont *Stichococcus* 140

135 (134) Thallus of rounded, convex subfruticose cushions. Lepraric acid present . . . . *Lecanactis latebrarum*
135 Thallus crustose. Lepraric acid absent 136

136 (135) Lichen substances absent. Esorediate parts indistinct or absent. . . . . *Opegrapha multipuncta*
136 Lichen substances present. Esorediate parts usually distinct 137

137 (136) Gyrophoric acid present. Soralia orange in fresh material 138
137 Gyrophoric acid absent. Soralia variously coloured, but not orange 139

138 (137) Thallus areolate to continuous; surface of continuous parts smooth to weakly tuberculate. Medulla indistinct to distinct. Prothallus distinct, brown. Schizopeltic acid an accessory. On shaded bark at the base of trees growing adjacent to rock under overhangs . . . . *Opegrapha gyrocarpa*
138 Thallus continuous; surface uneven, following the contours of the substrate. Medulla absent. Prothallus not apparent. Schizopeltic acid absent. On mature boles of broad-leaved trees; usually not associated with rock walls . . . . *Opegrapha sorediifera*

139 (137) Schizopeltic acid present. Thallus UV+. Soralia green, yellowish or brownish, irregular in form and size, becoming more or less confluent . . . . *Schismatomma umbrinum*
139 2'-O-methylmicrophyllinic, ± confluentic acid present. Thallus UV-. Soralia grey, brown or lilac-coloured, punctiform and discrete . . . . . . *Enterographa zonata*

140 (134) Thallus grey. Pulvinic acid derivatives absent . . . . . . *Chaenotheca gracilenta*
140 Thallus bright green to yellow. Vulpinic acid or rhizocarpic acid present . . 141

141 (140) Vulpinic acid present . . . . *Chaenotheca furfuracea*
141 Rhizocarpic acid present . . . . *Psilolechia lucida*

DESCRIPTIONS OF THE SPECIES IN ALPHABETICAL ORDER

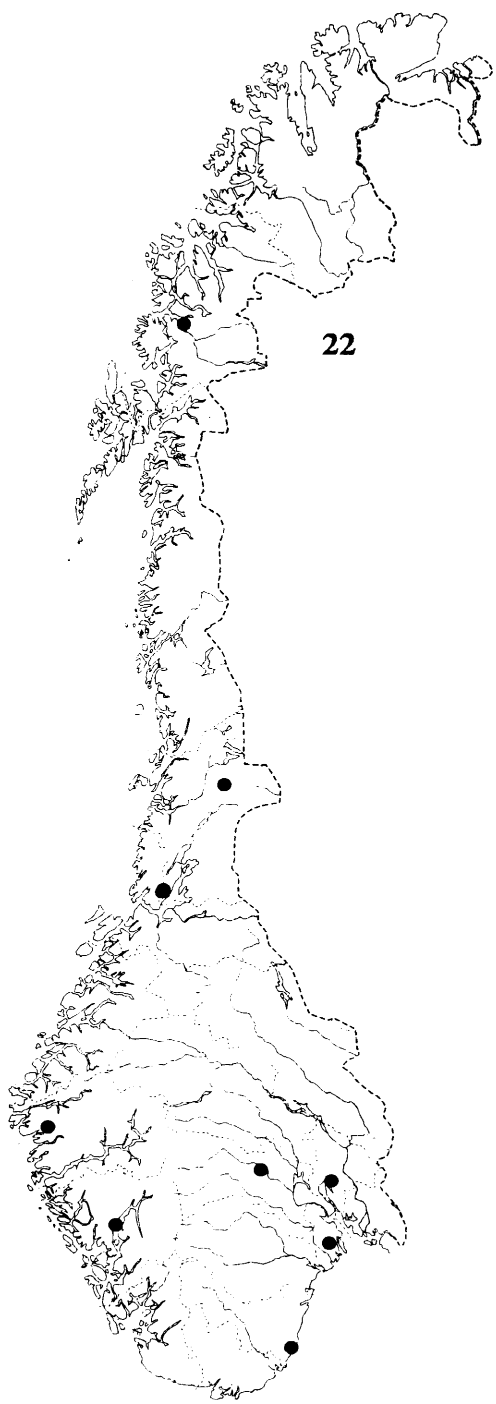
Bacidia de Not.

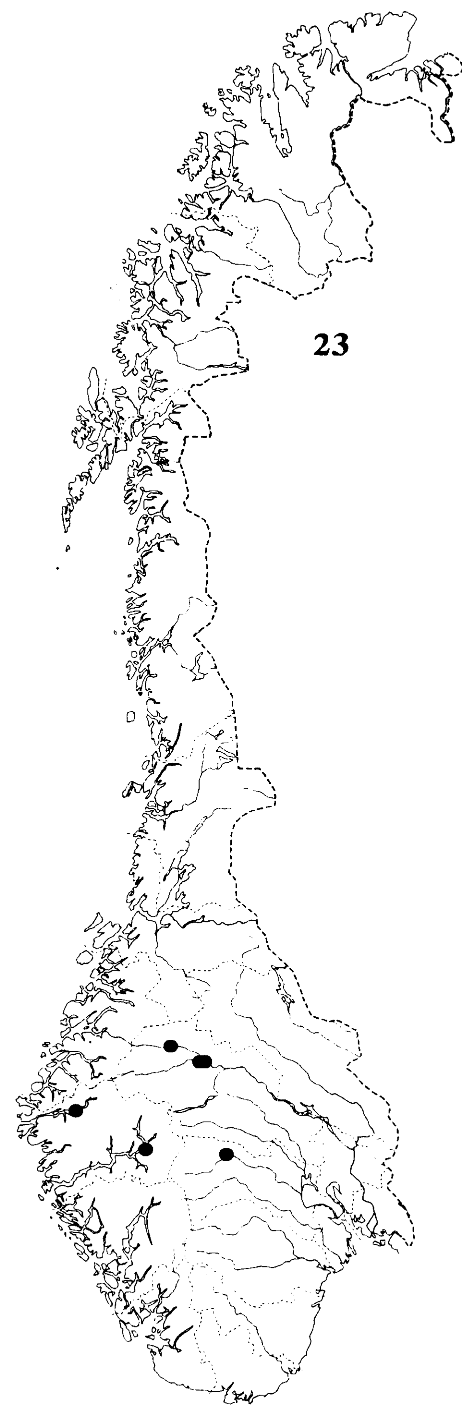
The genus *Bacidia* is in urgent need of monographic treatment. The genus is here treated in a broad, classical sense. *Bacidia epixanthoides* was transferred to *Biatora* Fr. by Diederich (1989).

Bacidia epixanthoides (Nyl.) Lettau

Fig. 22.

Thallus crustose, endo- to episubstratal in non-sorediate parts, indeterminate, forming





Figs 22-23. Distribution maps. Fig. 22. *Bacidia epixanthoides*. Fig. 23. *Buellia arborea*.

rosettes or irregular patches, up to one dm across, areolate, especially towards the margin, or more or less continuous, sorediate. Prothallus indistinct or absent. Areolae greyish green, discrete to contiguous, irregular, convex, 0.1-0.2 mm in diameter. Continuous parts concolorous with the areolae, tuberculate. **Soralia** green- yellow to pale yellow, bursting from the areolae and tuberculae, or through the uppermost cell layer(s) of the substratum, diffuse, irregular, to 0.1 - 0.2 mm in diameter, soon becoming confluent forming a more or less continuous leprose crust. Soredia fine, 15-20(-30) µm in diameter, often in irregular consoredia; wall distinct. Medulla absent. Photobiont green, coccoid, 6-10 µm in diameter.

Apothecia observed in 8 (62%) of the collections, biatorine, pale flesh-coloured to blackish brown, up to 0.7 mm in diameter, becoming immarginate and distinctly convex, often tuberculate. Pycnidia not seen.

Chemistry: No lichen substances.

Substratum. *Bacidia epixanthoides* has been collected on trunks of *Ulmus glabra* and, more rarely, *Fagus sylvatica*, *Fraxinus excelsior*, and *Populus tremula*. It occurred on corticolous mosses or, rarely, naked bark. Noteworthy associated lichens included *Acrocordia gemmata*, *Gyalecta ulmi*, *Leptogium lichenoides*, *L. saturninum*, and *Parmeliella triptophylla*.

Distribution. *Bacidia epixanthoides* has been found in a broad belt along the coast (Fig. 22). Its vertical distribution ranged from about sea-level to 610 m (Buskerud: Krødsherad). **Counties:** Akershus, Buskerud, Vestfold, Aust-Agder, Hordaland, Sogn og Fjordane, Nord-Trøndelag, Troms.

Discussion. With its greenish yellow, largely sorediate, mostly muscicolous thallus, *Bacidia epixanthoides* is similar to *Lecidea gyrophorica*. However, it is distinct from that species in being devoid of lichen substances.

Bacidia epixanthoides is a species of eutrophic bark in coastal habitats.

Specimens seen (selected): Oslo 1865, Moe (UPS). - Bu: Krødsherad 1982, Tønsberg 6957. - Vf: Andebu 1922, Høeg (TRH). - AA: Grimstad 1990, Tønsberg 13536. - Ho: Kvam 1990, Tønsberg 13380. - SF: Gloppen 1991, Gaarder 280. - NT: Grong 1981, Tønsberg 6110b. Leksvik 1980-1981, Tønsberg 4860a, 5876b. - Tr: Målselv 1866, Norman (TRH). A total of 13 specimens seen.

Baeomyces Pers.

Baeomyces rufus (Huds.) Rebent.

Thallus crustose to subsquamulose, episubstratal, indeterminate forming more or less irregular patches up to 6 cm in diameter, areolate, with schizidia, with or without soredia. Prothallus indistinct to distinct, white, felty. Areolae greyish green to brown, at first adnate, crustose, rounded and convex, later, often tending to become flattened, subsquamiform, and/or somewhat incised to deeply divided, up to 1.5 mm across, persistently discrete or becoming contiguous or fused. Schizidia concolorous with the areolae, flat to semiglobular, rounded, often more or less peltate, to 0.1(-0.4) mm, causing rounded, ecorticate, concave scars upon detachment. **Soralia** present in one collection, on large areolae, light greyish green, diffuse, marginal at first, later expanded to cover most of the surface. Soredia fine to coarse, 20-50 µm in diameter; wall distinct. Medulla distinct in well-developed areolae. Photobiont green, coccoid, up to 12 µm in diameter.

Apothecia sparingly present in two (67%) of the specimens, stipitate, biatorine, immarginate; disc brown, convex, up to 0.6 mm in diameter. Pycnidia not observed.

Chemistry: Stictic acid (major substance), constictic acid, cryptostictic acid, norstictic acid (trace) and several unidentified substances in moderate to trace amounts.

Substratum. *Baeomyces rufus* was found on trunks of *Alnus incana* and *Sorbus aucuparia* in moderately shaded sites. The specimens occurred from the base of the trunk up to about 2 m above the ground.

Distribution. Corticolous specimens were found in a few sites in western and northern Norway at altitudes below 100 m. **Counties:** Hordaland, Sogn og Fjordane, Nordland.

Discussion. *Baeomyces rufus* is easily recognized by the presence of the schizidiate, more or less squamiform areolae containing stictic acid and related substances. Christensen & Alstrup (1990) found usnic acid, atranorin, barbatic acid, and squamatic acid as accessories in addition to the diagnostic stictic acid complex. According to Kümmerling (1991), *Baeomyces rufus* may contain gyrophoric acid in the epihymenium.

Baeomyces rufus is a common and widespread terricolous and saxicolous species. Only occasionally is it corticolous.

Specimens seen. Ho: Bergen 1991, Tønsberg 17460. - SF: Førde 1985, Tønsberg 9358. - No: Bindal 1982, Tønsberg 6781.

Buellia de Not.

Buellia arborea Coppins & Tønsb. sp. nov.

Thallus lignicola vel corticola, areolatus, sorediatus, soraliis plerumque caesiis, acidum atranoricum et placodialicum continens. Apothecia infrequentia, illis Buelliae disciforme simila.

Type: U.K.: Scotland, Inverness-shire, Easterness, VC 96, Abernethy Forest, ENE of Forest Lodge, grid: 38/01.16, alt. 275-300m, on decorticate trunk of *Pinus sylvestris*, 30 April 1980, B.J. Coppins 4788 & M.A. Sherwood (E - holotype!). TLC: atranorin, placodiolic acid.

Figs 14, 19, 23-24.

(Description based on Norwegian and Scottish, corticolous as well as lignicolous material.)

Thallus (Fig. 24) crustose, mostly endosubstratal in non-sorediate parts, indeterminate, forming roundish patches up to 4 cm in diameter, areolate, sorediate. Prothallus whitish, mostly not evident. Areolae sparse, whitish, discrete or more or less contiguous, slightly convex, up to 0.5 mm in diameter. **Soralia** bursting through the uppermost cell layer(s) of the substratum, which often forms a whitish, more or less lacerate ring around each soralium, bluish, greenish, sometimes brownish or dark green, more or less rounded or, in lignicolous material ellipsoid to linear due to the presence of parallel wood fibres in the substratum, flat to crateriform, up to 0.4 mm in diameter. Soredia fine, up to 30 µm in diameter, simple or loosely aggregated, heavily incrusted with crystals dissolving in K, revealing an olivaceous, N- pigment in the external hyphae of exposed soredia; wall distinct. Medulla absent. Squash of thallus K/I-. Photobiont green, coccoid, up to 15 µm.

Apothecia not observed in Norwegian corticolous material (but present in one Norwegian lignicolous specimen and in the Scottish type specimen), bursting through the uppermost layers of the substratum, more or less immersed to sessile, black, circular to broadly ellipsoid, up to 0.5 mm in diameter; margin distinct, persistent, up to 0.05 mm wide; disc mostly concave, more rarely more or less plane. In section: Excipulum brown along the outermost edge and below the subhymenium, otherwise olivaceous, of outwardly radiating

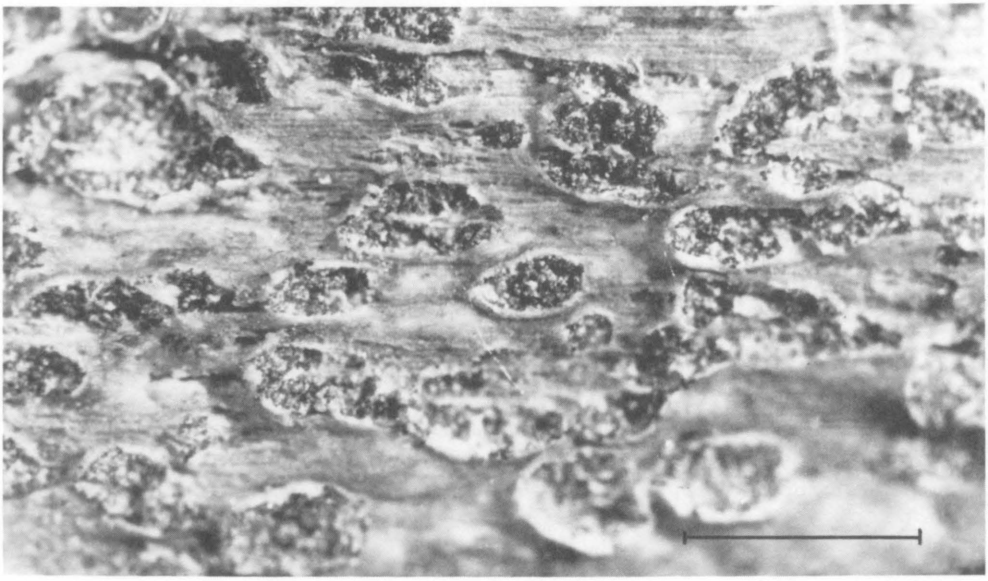


Fig. 24. *Buellia arborea*. Holotype. Scale 1 mm.

hyphae, 30-60 µm wide at the midpoint; cells cylindrical, up to 4.5 µm wide; outermost cell swollen, with a sharply delimited brown pigment in the cell wall. Epihymenial gelatine olivaceous. Hymenium colourless to dilute olivaceous, with oily droplets, up to 120 µm deep in apothecia with more or less plane discs; hymenial gelatine K/I+ blue. Paraphyses branched in upper part, 1.5-2 µm wide; apical cell up to 4 µm wide, with a sharply delimited brown pigment in the wall of the upper half of the cell. Asci clavate, with up to 8 spores; tholus distinct, K/I+ blue with a K/I+ deeply blue tube. **Spores** brown, often with pale apices, smooth, mostly pointedly ellipsoid (see Sheard 1964) with thin-walled apices, sometimes bluntly ellipsoid (see Sheard 1964), 1-septate (rarely tending to become 3 septate), (17.5-)19-25(-28) x (7.5-)8.5-10(-12.5) µm, sometimes sprouting through the often disintegrated apices. Subhymenium not sharply delimited from the hymenium, more or less olivaceous, K/I + blue. No crystals present in the apothecium. Apothecial pigments K- or K+ fuscous brown, N-. Pycnidia not observed.

Chemistry: Atranorin, placodiolic acid. TLC: Fig. 19.

Substratum. In Norway *Buellia arborea* has been found on *Pinus sylvestris* in open *Pinus* forests. One collection was from a river gorge. The species occurred on wood (5 specimens) and on bark (4 specimens). The most well-developed specimens were from wood; those from bark usually formed small patches between other lichen species. Associated species included *Calicium* sp., *Hypocenomyce scalaris*, *Hypogymnia physodes*, *Parmeliopsis aleurites*, *P. ambigua*, *Parmelia sulcata*, and *Usnea hirta*. The Scottish specimens were from wood and bark of *Pinus sylvestris*.

Distribution. *Buellia arborea* has been found in Gudbrandsdalen, Hallingdalen and in easternmost parts of Sogn og Fjordane (Fig. 23). The vertical distribution ranged from 70 m (Sogn og Fjordane: Lærdal) - 600 m (Oppland: Lesja). In Scotland it has been collected in Inverness-shire and West Ross at altitudes between 15-155 and 380 m. **Counties:** Oppland, Buskerud, Sogn og Fjordane.

Discussion. With its often pointedly ellipsoid, 1-septate spores with pale, thin-walled apices, hymenium with oil droplets, a brownish (N-) excipulum and epihymenium and its corticolous or lignicolous habit, *Buellia arborea* is apparently most closely related to *B. disciformis*. It is distinct from that species in having an areolate, regularly sorediate thallus containing placodiolic acid. *Buellia disciformis* is continuous, esorediate (see however Sheard 1964) and contains atranorin and an unidentified substance in trace amounts (R_F-classes: A 6, B 6, C 6). When sterile, *B. arborea* is likely to be confused with *B. griseovirens* which may have similarly pigmented soredia. Sterile specimens of these species can always be separated by chemistry: placodiolic acid in *B. arborea*, norstictic acid and a range of pigments in *B. griseovirens*. A frequent form of *B. griseovirens* is yellowish sorediate; a corresponding form has not been seen in *B. arborea*. When fertile *B. arborea* is distinct from *B. griseovirens*, e.g., in having 1-septate rather than more or less muriform spores. The thallus of the lignicolous *Xylographa vitilago* may sometimes be very similar to that of *Buellia arborea*. Both species have elongate to rounded, pigmented soralia following the grain of the wood. However, *Xylographa vitilago* contains stictic acid. *Mycoblastus fucatus* is lignicolous and corticolous and has pigmented soredia. That species produces fumarprotocetraric acid, as well as atranorin and chloroatranorin.

Buellia arborea appears to be a continental species on acidic bark and wood.

Specimens seen: Norway: Op: Lesja 1991, Tønsberg 17356 (wood), 17357 (bark). Sel 1990, Tønsberg 13141 (bark). Vågå 1990, Tønsberg 13130 (bark). - Bu: Ål 1991, Tønsberg 17227 (bark). - SF: Gloppen 1991, Anonby 615 (wood). Lærdal 1991, Anonby 506 & Gaarder (wood); Anonby 512 & Gaarder (wood), Anonby s.n. (wood). **U.K.:** Scotland (additional specimens): Inverness-shire, Easterness, Abernethy Forest, alt. 1250 ft, 1976, Coppins 3159 & Tibell (E (not seen), BG dupl.); Easterness, VC 96, Allt Fhearnagan, Nr. Achlean, Glen Feshie, on dead pine trunk, Aug. 1968, U. Duncan (E). West Ross, VC 105, Beinn Eighe NNR, Coille na Glas-leitire, Allt na h-Arighe, 28/00.64, on old pine near road, 17 May 1984, Coppins 10837 et al. (E).

Buellia griseovirens (Turner & Borrer ex Sm.) Almb.

Fig. 18.

Thallus crustose, endosubstratal, or more commonly, episubstratal in non-sorediate parts, indeterminate to delimited, forming rosettes or irregular patches, typically areolate, sometimes more or less continuous, sorediate. Prothallus indistinct or distinct, brownish, more rarely bluish. Areolae mostly distinct, whitish grey, sometimes greenish grey or grey tinged with brown, discrete at first, later often becoming contiguous or confluent, rounded in outline, slightly convex, up to 0.4 mm in diameter. Continuous parts concolorous with the areolae, sometimes maculated, smooth or slightly tuberculate, more or less rimose-cracked. **Soralia** greyish white to pale yellow or dark grey with a bluish tinge, bursting from the apices of the areolae and tuberculae, usually discrete, mostly circular in outline, rarely fissure-shaped, usually convex with the upper surface more or less plane or crateriform, more rarely hemispherical, often surrounded laterally by a lacerate, cortical sheet, up to 0.3(-0.8) mm in diameter. Soredia fine, 20-40 µm in diameter; wall distinct; pigmentation of the external soredia brown, sometimes with a possible green tinge; pigment K+ fuscous brown, N-. Medulla indistinct to distinct. Photobiont green, coccoid, 8-12 µm in diameter.

Apothecia present in 45 (25%) of the specimens, sparse to abundant, lecideine, black, up to 2 mm in diameter; proper margin thick; disc plane.

Chemistry: Atranorin, norstictic acid with connorstictic acid (trace), ± griseovirens unknowns. A few specimens contained only atranorin or only norstictic acid with connorstictic acid. Specimens with large amounts of pigments: Soralia C+ orange; UV+ orange; TLC: Fig.

18.

Substratum. *Buellia griseovirens* has been found on a wide range of phorophytes including *Alnus incana* (68), *Sorbus aucuparia* (35), *Betula pubescens/pendula* (17), and *Acer platanoides, Alnus glutinosa, Corylus avellana, Fagus sylvatica, Fraxinus excelsior, Juniperus communis, Picea abies, Populus tremula, Prunus padus, Quercus, Salix aurita, S. caprea,* and *Ulmus glabra*. *Buellia griseovirens* was usually found on smooth bark surfaces.

Distribution. *Buellia griseovirens* occurred commonly in a broad belt along the coast. Inland, in Hedmark and Oppland, it was mainly found in microclimatically moist sites, e.g., in shaded *Picea abies* forests and on river banks. Its vertical distribution ranged from about sea-level to 700 m (Oppland: Vang). **Counties:** Østfold - Troms.

Discussion. *Buellia griseovirens* is morphologically very variable. The thallus is typically areolate, but may rarely be continuous. The soralia and prothallus vary greatly in colour. Specimens growing on the whitish bark of *Betula* always have a distinct brown or blue prothallus, in specimens growing on trees with a dark bark the prothallus is usually not evident. In endosubstratal specimens the soralia may be initiated below the uppermost cell layer(s) of the substratum.

Specimens of *Buellia griseovirens* with a distinct bluish prothallus may resemble *Mycoblastus caesius* and forms of *M. fucatus*. However, in these species the pigment reacts N+ red and the major secondary substances are perlatolic acid and fumarprotocetraric acid, respectively. Specimens of *Buellia griseovirens* with a distinct brown prothallus may resemble species of *Fuscidea*, but the presence of, e.g., atranorin and norstictic acid makes *Buellia griseovirens* chemically distinct from species of that genus.

Buellia griseovirens appears to be uncommon on coniferous trees, and is not yet known from *Pinus sylvestris*. It is a widespread species on acidic bark. It has also been collected on wood (*Juniperus communis*).

Specimens seen (selected): Øf: Trøgstad 1978, Tønsberg 3379. - Ak: Bærum 1981, Tønsberg 6426b. - He: Kongsvinger 1985, Tønsberg 9421. - Op: Lunner 1982, Tønsberg 7553. - Bu: Hole 1981, Tønsberg 6449. - Vf: Hedrum 1922, Høeg (TRH). - Te: Nissedal 1987, Tønsberg 10237. - AA: Birkenes 1978, Tønsberg 3282. - VA: Mandal 1983, Øvstedal. - Ro: Sauda 1986, Botnen 86/12a. - Ho: Stord 1980, Tønsberg 5031. - SF: Førde 1983, Tønsberg 7818. - MR: Smøla 1983, Tønsberg 8281. - ST: Melhus 1982, Tønsberg 6643. - NT: Frosta 1983, Tønsberg 8431. - No: Nesna 1986, Tønsberg 9686. - Tr: Storfjord 1982, Tønsberg 7306. Exsiccata examined: Havaas, Lich. Norv. 116 (BG, O, UPS). A total of 178 specimens seen.

Caloplaca Th. Fr.

The *Caloplaca* species of northwest Europe are not well-known and the genus is in need of a thorough revision. Sect. *Gasparrinia* has been revised for northern Europe by Nordin (1972), and a revision of the lignicolous species on Svalbard has been published by Søchting (1989).

Caloplaca chlorina (Flotow) Sandst.

Fig. 25.

Thallus crustose, episubstratal, with a distinct bluish grey over-all colour, indeterminate, forming irregular patches up to one dm or more in diameter, areolate, sorediate, sometimes leprose throughout; bluish pigmentation K+ violet, N+ violet or ± brown with a violet tinge. Prothallus sometimes distinct, brownish to brownish violet. Areolae usually present, indistinct to distinct, bluish grey, sometimes greyish or greenish grey, discrete to contiguous, sometimes confluent, convex and rounded at first, later usually becoming flattened, more or less irregular in outline, more or less incised, sometimes with marginal tuberculae, up to 0.2(-1) mm in diameter. **Soralia** concolorous with the areolae or darker, often marginal on the areolae, sometimes more or less punctiform where the areolae have been completely dissolved into soredia, usually more or less discrete and up to 0.2 mm in diameter, sometimes becoming confluent forming a leprose sorediate crust. Soredia fine; (15-)20-30(-40) µm in diameter, sometimes forming subcylindrical (up to 90 µm long), globose to irregular consoredia, with a distinct, continuous cortex (wall) of globular cells. Medulla indistinct or absent. Photobiont green, coccoid, up to 20 µm in diameter.

Apothecia present in 40 (71%) of the specimens, lecanorine, up to 0.6(-0.8) mm in diameter; margin greyish blue, prominent at first, later often becoming eroded and flush with the level of the disc; disc orange, K+ purple, rarely brownish and K-, sometimes faintly white pruinose. Pycnidia not seen.

Chemistry: Thallus: No substances. Apothecia: Parietin.

Substratum. *Caloplaca chlorina* has been found on *Acer platanoides, A. pseudoplatanus, Aesculus hippocastanum, Fraxinus excelsior, Malus domestica, Tilia,* and *Ulmus glabra.* It was sometimes restricted to the base of the phorophytes, but occurred also high up on the trunks. Noteworthy associates included *Caloplaca obscurella, Lecanora impudens, L. sambuci, Parmelia (Melanelia) subargentifera, Rinodina colobina,* and species of *Candelariella, Phaeophyscia, Physcia, Physconia* and *Xanthoria.*

Distribution. *Caloplaca chlorina* was found in the lowlands of southern Norway as far north as Nord-Trøndelag (Fig. 25). In the southeast (Østlandet) it occurred as far north as southernmost parts of Hedmark, Oppland and Buskerud. Its vertical distribution ranged from about sea-level to 230 m (Hedmark: Ringsaker). **Counties:** Østfold - Sogn og Fjordane, Sør-Trøndelag, Nord-Trøndelag.

Discussion. *Caloplaca chlorina* is a variable species. One form has well-developed, flat areolae with marginal soredia and consoredia; these diaspores sometimes aggregate to form coarse marginal, isidia-like projections. Another form is leprose throughout. Most specimens were intermediate between these extremes having small areolae up to about 0.2 mm in diameter.

Omitting the form with well-developed, distinctly incised areolae, *Caloplaca chlorina* has very similar thalline characters to *Rinodina colobina* which occurs in the same habitats. The identity of some sterile specimens belonging to either *Caloplaca chlorina* or the apparently rare *Rinodina colobina* could not be conclusively settled. Some completely leprose sterile specimens from Oslo (Tønsberg 9926, 11422) composed entirely of masses of simple soredia, were tentatively assigned to *Caloplaca chlorina* as they were similar to some fertile specimens of that species in thalline characters. However, the possibility that a corresponding form also occurs in *Rinodina colobina*, could not be ruled out.

Caloplaca chlorina may also occur on rock (Santesson 1984). When corticolous, *Caloplaca chlorina* is a species of eutrophic bark in southern areas.

Specimens seen (selected). Øf: Råde 1989, Tønsberg 11689. - Ak: Asker 1989, Tønsberg 11425, 11427. Vestby 1989, Tønsberg 11682a. - Oslo 1986-1989, Tønsberg 9926, 11422. - He: Ringsaker 1990, Tønsberg 13152. - Op: Gjøvik 1989, Tønsberg 11661. - Bu: Sigdal 1990, Tønsberg 13317. - Vf: Våle 1990, Tønsberg 13688. - Te: Bø 1990, Tønsberg 13038. - AA: Arendal (Moland) 1987, Tønsberg 10222. - VA: Kristiansand 1988, Tønsberg 10639. - Ro: Haugesund 1990, Tønsberg 13457. - Ho: Granvin 1990, Tønsberg 13329. - SF: Vik 1990, Tønsberg 13351. - ST: Trondheim 1990, Tønsberg 13723. - NT: Steinkjer 1981, Tønsberg 6252. A total of 56 specimens seen.

Caloplaca citrina (Hoffm.) Th. Fr.

Thallus crustose to subsquamulose, episubstratal, indeterminate, forming irregularly spreading patches up to a few cm in diameter, areolate, sorediate. Prothallus not evident. Areolae greyish green, green with an orange tinge or yellowish orange, more or less subsquamulose and incised, rounded, flat to slightly convex, scattered to contiguous, occasionally becoming fused, up to 0.8 mm in diameter. **Soralia** yellowish to yellowish orange, marginal, punctiform at first, later linear to sublabriform, up to 0.3 mm long. Soredia fine, 20 - 30 µm in diameter, often in consoredia up to 40 µm in diameter; wall distinct. Medulla indistinct or absent. Photobiont green, coccoid, up to 16 µm in diameter.

Apothecia not observed, lecanorine; margin sorediate; disc often pruinose, brown-yellow. Pycnidia sparse, more or less immersed in convex areolae, orange and contrasting the greenish orange surrounding thallus surface, 0.05 mm in diameter. Conidia ellipsoid to droplet-shaped, 3 x 1.5-2 µm.

Chemistry: Parietin. Orange parts K+ purplish.

Substratum. *Caloplaca citrina* has been collected on the base of trunks of *Acer platanoides* and *Ulmus glabra* in a churchyard. Associated lichens included *Caloplaca chlorina.*

Distribution. *Caloplaca citrina* was found in the coastal lowlands of Telemark, at an altitude of 0-20 m. **County:** Telemark. All substrates (see Nordin (1972): Østfold, Akershus, Oppland - Telemark, Rogaland - Sogn og Fjordane, Sør-Trøndelag - Finnmark.

Discussion. *Caloplaca citrina* is a polymorphic species (Nordin 1972). One form, to which the present material belonged, has well-developed, subsquamiform areolae. Another extreme, the commonest form, is leprose. According to J. Santesson (1970), *C. citrina* contains parietin as the major substance, and several other anthraquinones.

Caloplaca citrina is mainly a species of mortar, calciferous or siliceous rocks. It occurs more rarely on dust-impregnated bark and on wood, mosses or soil (Santesson 1984).

Specimens seen: Te: Porsgrunn 1990, Tønsberg 13701, 13703.

Caloplaca herbidella (Hue) Magnusson

Fig. 18, 26.

Thallus crustose, episubstratal, forming irregular patches up to several cm in diameter, indeterminate, areolate. Prothallus usually not evident, sometimes visible as a blackish, endosubstratal stain. Areolae yellow to orange, grey on shaded niches, more or less isidioid, 0.2 (-0.4) mm in diameter, loosely attached, mostly subglobose to globose or more or less club-shaped, sometimes flattened, discrete or forming a thickish crust of contiguous to fused, more or less coralloid areolae. Medulla indistinct or absent. Photobiont green, coccoid, up to 17 µm in diameter.

Apothecia present in all specimens, but sparse in specimens with well-developed coralloid areolae, bright orange-red, up to 0.5(-1) mm in diameter; margin persistent, more or less flexuose; disc more or less plane. Pycnidia concolorous with the apothecia, sessile, 0.1 mm in diameter; conidia rod-shaped, 3.5-4 x 1 µm.

Chemistry: Unidentified anthraquinones herbidella unknown 1 (major constituent) and herbidella unknown 2 (minor constituent); ± traces of other unidentified pigments. Pigmented parts K+ purplish. TLC: Fig. 18.

Substratum. *Caloplaca herbidella* has been found on *Betula pubescens* and *Juniperus*

Figs 25-26. Distribution maps. Fig. 25. *Caloplaca chlorina*. Fig. 26. *Caloplaca herbidella*.

communis in species-rich lichen communities including, e.g., *Candelariella xanthostigma*.

Distribution. *Caloplaca herbidella* occurred on the Dovre plateau, southern Norway (Fig. 26), in subalpine birch forests at altitudes of 900 - 1050 m. **Counties:** Oppland, Sør-Trøndelag.

Discussion. With its anthraquinone-containing, isidioid areolae *Caloplaca herbidella* should not be confused with any of the other species considered here.

In southern Sweden and Britain, the species has been reported to occur on *Quercus* and *Ulmus glabra* in the lowlands (Magnusson 1932, James 1971). It is thus remarkable that the species appears to be subalpine in Norway. The species is apparently in need of a thorough investigation. In southern Europe the species has been recorded from an altitude of 1700-2100 m by Magnusson (1932) and at altitudes between 600 and 1550 m by Schauer (1965).

In the lowlands of southeast Norway another *Caloplaca* with loosely attached, more or less isidioid areolae has occasionally been collected in churchyards on *Acer platanoides* and *Fraxinus excelsior*. Such specimens (e.g., Buskerud: Ringerike 1990, Tønsberg 13311; Vestfold: Ramnes 1990, Tønsberg 13694) have affinities to *Caloplaca cerina* having an anthraquinone-deficient thallus and apothecia with a thalline margin.

Parietin, reported by J. Santesson (1970) to be the main anthraquinone of *Caloplaca herbidella*, was not found.

Caloplaca herbidella is a species of bark and wood in subalpine sites, which have probably been enriched by bird excrement.

Specimens seen. Op: Dovre 1982, Tønsberg 7496, 7503, 7506. - ST: Oppdal 1926, Degelius (LD); 1928, Fægri (BG); 1863, Th. M. Fries (UPS - 2 collections); 1868, Zetterstedt (UPS).

Caloplaca obscurella (Lahm) Th. Fr.

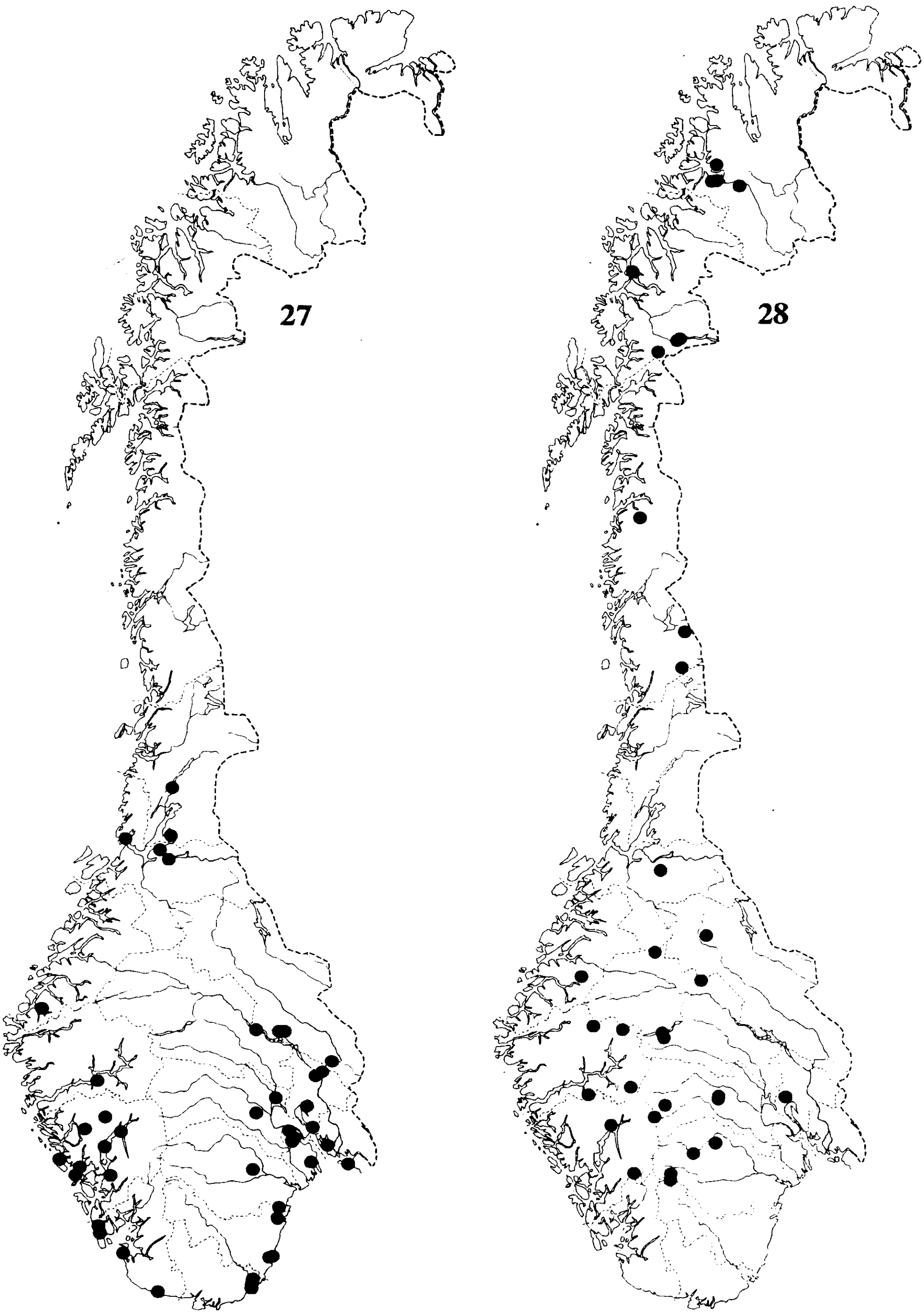
Fig. 27.

Thallus crustose, episubstratal, indeterminate, forming extensive patches up to one dm or more in diameter, areolate, sorediate. Prothallus usually not evident, but sometimes forming a conspicuous bluish stain on smooth bark. Areolae greyish white to pale greyish green, adnate, scattered to contiguous, sometimes a few becoming confluent, flat to convex, irregular in outline, more or less placodioid in well-developed specimens, up to 0.3(-1.0) mm in diameter. **Soralia** mostly green or grey-green, rarely bluish black, discrete, sometimes a few becoming confluent, laminal, usually distinctly crateriform, delimited by a reflexed, lacerate ring-shaped sheet formed by the thallus, or rarely, the uppermost cell-layers of the substratum, 0.08 - 0.3 mm in diameter. Soredia greyish green to green, or rarely blue, fine, (12-)20-25(-30) µm in diameter, with a well-developed cortex (wall) of more or less globose cells; cortex colourless or, in exposed parts of the external soredia, rarely with a brownish to grey-black or black, K- or rarely K+ violet, N+ violet pigment. Medulla absent. Photobiont green, coccoid, up to 20 µm in diameter. Pycnidia not seen.

Apothecia observed in 24 (41%) of the specimens, reddish brown to blackish brown, up to 0.5 mm in diameter; proper margin indistinct to distinct, 0.04 mm wide; thalline margin usually indistinct or absent, but sometimes distinct, rarely sorediate.

Chemistry: No substances.

Substratum. *Caloplaca obscurella* has been found on *Acer platanoides*, *A. pseudoplatanus*, *Aesculus hippocastanum*, *Fraxinus excelsior*, *Malus domestica*, *Populus simonii*, *P. tremula*, *Salix caprea*, *Salix nigricans*, *Tilia* and *Ulmus glabra*. Close associates included *Caloplaca chlorina*, *Candelariella* spp., *Lecanora impudens*, *Parmelia* (*Melanelia*)



Figs 27-28. Distribution maps. Fig. 27. *Caloplaca obscurella*. Fig. 28. *Caloplaca sorocarpa*.

subargentifera, *P.* (*Parmelina*) *tiliacea*, *Rinodina colobina*, *R. griseosoralifera* and species of *Phaeophyscia*, *Physcia* and *Xanthoria*. *Caloplaca obscurella* was most commonly found at the base of the phorophytes, where it occurred more or less hidden by grass and other herbs. However, it sometimes formed extensive patches high up on the trunks, especially on more or less spongy bark on the upper side of slightly sloping trunks.

Distribution. *Caloplaca obscurella* has been found in the lowlands of southern Norway as far north as Nord-Trøndelag (Fig. 27). Its vertical distribution ranged from about sea-level to 420 m (Hordaland: Vaksdal). **Counties:** Østfold - Nord-Trøndelag.

Discussion. *Caloplaca obscurella* is morphologically characteristic on account of the crateriform soralia which are delimited by the reflexed, lacerate thallus ring. However, as it often occurs as inconspicuous patches (often comprising only a few areolae) mixed in populations of other species, e.g., *Caloplaca chlorina*, *Rinodina colobina* and *R. griseosoralifera*, it may easily be overlooked. Soredia with a blue, K+ violet pigment were observed only in a single collection (leg. Tønsberg & P.W. James 1979); in all other specimens with pigmented soredia, the pigment was K-. *Caloplaca ulcerosa* Coppins & P. James, recently reported from southernmost Sweden (Arup & Ekman 1991b), has not been found in Norway.

Caloplaca obscurella is a species of eutrophic bark in southern parts of Norway. It has also been found on wood (*Tilia*).

Specimens seen (selected). Øf: Råde 1989, Tønsberg 11693. - Ak: Vestby 1989, Tønsberg 11686 (fertile). - Oslo: Østensjø, 1871, Moe (mixed in a collection of *Rinodina colobina* (UPS)). - He: Hamar (Vang) 1990, Tønsberg 13171. - Op: Gjøvik 1989, Tønsberg 11662b. - Bu: Sigdal 1990, Tønsberg 13316. - Vf: Sande 1990, Tønsberg 13671, 13674. - Te: Bø 1990, 13039. - AA: Grimstad 1990, Tønsberg 13545. - VA: Kristiansand 1988, Tønsberg, 10633. - Ro: Randaberg 1990, Tønsberg 13484. - Ho: Voss 1990, Tønsberg 13341. - SF: Vik 1990, Tønsberg 13342. - MR: Volda 1990, Øvstedal. - ST: Klæbu 1979, Tønsberg & P. W. James; Trondheim 1990, Tønsberg 13724. - NT: Inderøy 1981, Tønsberg 6242b. A total of 58 specimens seen.

Caloplaca sorocarpa (Vainio) Zahlbr.

Figs 28-29.

Thallus (Fig. 29) crustose, endo- to episubstratal in non-sorediate parts, indeterminate, often forming small, inconspicuous patches between other lichens, sometimes spreading irregularly and discontinuously up to a dm or more across, areolate, sorediate. Prothallus indistinct or visible as a dark stain on light-coloured bark. Areolae greyish brown to brown or whitish green, discrete or becoming more or less contiguous, flattened to weakly convex, irregularly rounded to somewhat elongate, up to 0.2 mm in diameter. **Soralia** brownish due to pigmentation of the external soredia, greenish or, where the soredia have been shed, whitish, usually discrete, sometimes becoming contiguous but never confluent, mostly one, occasionally 2-3 per areola, distinctly delimited, circular in outline, either flush with the level of the thallus or, more usually, raised, sometimes doliiform, surrounded laterally by a corticate sheet which in the upper part forms a white circular rim bordering the soralia, up to 0.3(-0.5) mm in diameter. Soredia fine; external soredia brown, up to 20(-30) µm in diameter, surrounded by a continuous wall of more or less isodiametric (up to 7 µm diameter) to somewhat elongate cortical cells; brown pigment K+ fuscous brown, N+ reddish brown. Medulla absent. Photobiont green, globose to broadly ellipsoid, up to 12(-15) µm in diameter.

Apothecia rare, sparingly present in 3 (7%) of the specimens, up to 0.3(- 0.5) mm in diameter, rust red; margin indistinct; disc plane, rough, densely beset with K+ purple crystals.

Chemistry: Roccellic acid.

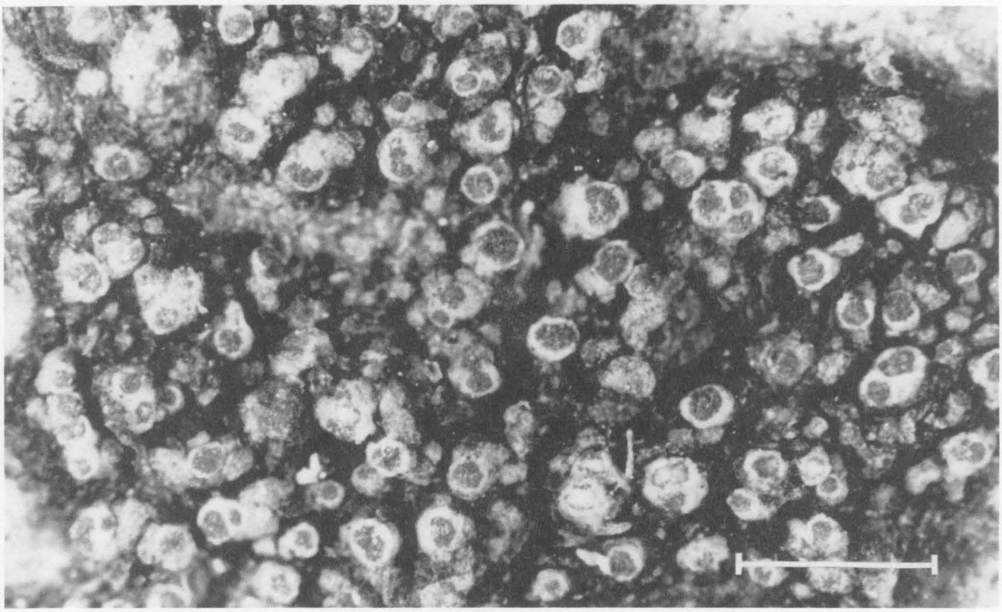


Fig. 29. *Caloplaca sorocarpa*. Tønsberg 7528. Scale 1 mm.

Substratum. *Caloplaca sorocarpa* has mainly been collected on shrubs of *Salix* spp. (25 specimens). Other phorophytes included *Alnus incana, Betula nana, B. pubescens, Juniperus communis, Populus tremula,* and *Sorbus aucuparia*. It often occurred associated with *Anzina carneonivea, Lecanora flavopunctata, Lecidea porphyrospoda,* and *L. pullata*.

Distribution. *Caloplaca sorocarpa* occurred in subalpine/low-alpine and northern sites (Fig. 28). In southern Norway its vertical distribution ranged from 320 m (Hordaland: Granvin) to 1400 m (Sogn og Fjordane: Luster). In northern Norway it descended to sea-level. **Counties:** Akershus - Buskerud, Telemark, Aust-Agder, Hordaland - Sør-Trøndelag, Nordland - Finnmark.

Discussion. *Caloplaca sorocarpa* is not a very variable species and is usually easily recognized, even in the field, by the morphology of the soralia. However, Magnusson 20443a, cited by Magnusson (1948) as *Lecidea pullata* v. *impullata* Vain., is an extreme with a very well-developed thallus with more or less contiguous soralia 0.3-0.5 mm wide.

Although *Caloplaca sorocarpa* has not been very often collected, it appears to be one of the characteristic inhabitants of *Salix* shrubs in subalpine/low-alpine sites.

Specimens seen (selected): Oslo 1870, Moe (UPS). - He: Tynset 1983, Tønsberg 8190a. - Op: Vang 1985, Tønsberg 9312. - Bu: Hol 1984, Tønsberg 9037. - Te: Vinje 1984, Tønsberg 8905b. - AA: Bykle, 1984 Tønsberg 8907a. - Ho: Eidfjord 1984, Tønsberg 9051. - SF: Aurland 1988, Tønsberg 10922 (fertile). - MR: Norddal 1947, Magnusson 20443a (UPS). - ST: Melhus 1982, Tønsberg s. n. - No: Hattfjelldal 1980, Tønsberg 5143a. - Tr: Bardu 1988, Tønsberg 11090. - Fi: Alta 1982, Tønsberg 7258. Exsiccata examined: Havaas, Lich. Norv. 24 (BG, UPS). A total of 46 specimens seen.

Candelariella Müll. Arg.

Candelariella is in urgent need of a monographic treatment. The Fennoscandian species were treated by Hakulinen (1954). The concept of the species recognized here follows James (1971).

Candelariella reflexa (Nyl.) Lettau

Thallus crustose to subsquamulose, episubstratal, indeterminate, forming irregular patches a few mm to a dm or more across, areolate, sorediate. Prothallus not evident. Areolae greenish yellow to citrine yellow, more rarely dull orange yellow, scattered to contiguous, adnate, subsquamiform to squamiform and more or less edge on to the substratum, crenulate, rounded to elongate, more or less flattened, up to 0.5(-1) mm wide, often becoming completely dissolved into soredia. **Soralia** concolorous with esorediate parts or more bright yellow or citrine, 1-4 per areola, at first marginal to sublabriform, rarely laminal; later the areolae become dissolved into soredia forming scattered, punctiform, diffuse and more or less convex soralia which may fuse forming a more or less leprose crust. Soredia fine to coarse, 20 - 40(-50) µm in diameter; wall distinct. Photobiont green, coccoid, up to 15(-20) µm in diameter.

Apothecia sparsely present in 5 (10%) of the specimens, lecanorine, up to 0.4 mm in diameter; thalline margin bright yellow, occasionally sorediate; disc bright yellow to yellowish orange, plane to slightly convex. Asci 8-spored, mostly immature. Spores 12-15 x 5-6 µm. Pycnidia not seen.

Chemistry: Pulvinic acid, ± calycin, ± pulvinic acid dilactone (trace), unidentified pigment (trace).
Note: Re-analysis of a number of specimens in which no calycin and pulvinic acid dilactone were originally found, by over- loading the base-line spot, showed the presence of these substances in every specimen, indicating that these substances were constant constituents.

Substratum. *Candelariella reflexa* was found on *Fraxinus excelsior* (10 specimens), *Alnus incana* (eutrophicated trunk, 5), *Malus domestica* (5), *Sorbus aucuparia* (5), and, more rarely, on *Acer pseudoplatanus*, *Acer* sp., *Aesculus hippocastanum*, *Alnus glutinosa*, *Crataegus*, *Populus tremula*, *Pyrus*, *Quercus*, *Tilia*, and *Ulmus glabra*. It occurred on naked bark as well as on corticolous mosses and other lichens, in lightly shaded to open and sun-exposed habitats. Associated lichens included *Caloplaca obscurella*, *C. chlorina*, *Candelariella vitellina*, *C. xanthostigma*, *Lecanora carpinea*, *Lecidella elaeochroma*, *Pachyphiale fagicola*, *Parmelia* (*Melanelia*) *exasperatula*, *Phaeophyscia orbicularis*, *Physcia aipolia*, *P. tenella*, *Physconia enteroxantha*, and *Scoliciosporum chlorococcum*.

Distribution. *Candelariella reflexa* has been found in a broad belt along the coast from Akershus to Sogn og Fjordane. Its vertical distribution ranged from about sea-level to 230 m (Oppland, Øyer). **Counties:** Akershus, Oppland - Telemark, Vest-Agder - Sogn og Fjordane

Discussion. *Candelariella reflexa* is morphologically similar to *C. efflorescens*. In both species the areolae break down forming soralia. According to Harris & Buck (1978), they differ only in their spore number which is eight in *C. reflexa*, up to 32 in *C. efflorescens*. In the fertile specimens examined by me most asci were immature, but all apparently mature asci were octosporous (see also Wirth 1987: 512). *Candelariella reflexa* may occur closely associated/intermixed with *C. vitellina*, a species with polysporous asci; collections of such mixed specimens may easily erroneously be identified as *C. efflorescens*. *Candelariella reflexa* may be superficially similar to *C. xanthostigma*, but can usually be distinguished by the presence of at least some distinct, usually subsquamiform areolae which have not been completely dissolved into soredia. Several specimens of *Candelariella reflexa* were erroneously cited as *Candelaria concolor* by Haugsjå (1930).

Candelariella reflexa is a species of eutrophic bark in southernmost Norway.

Specimens seen (selected): Oslo: 1984, Tønsberg 8915. - Op: Øyer 1984, Tønsberg 9001. - Bu: Drammen 1990, Tønsberg 13667. - Vf: Hof 1990, Tønsberg 13077. - Te: Bø 1990, Tønsberg 13043. - VA: Farsund 1977, Tønsberg 1887b. - Ro: Sola 1990, Tønsberg 13488. - Ho: Odda 1984, Tønsberg 8890. - SF: Eid 1989, Tønsberg 11934. A total of 48 specimens seen.

Candelariella xanthostigma (Ach.) Lettau

Thallus crustose, episubstratal, citrine yellow to dull orange yellow, indeterminate, widely spreading, forming irregular patches up to a dm or more in diameter, usually sorediate throughout, rarely with discrete soralia, occasionally with a few areolae. Prothallus not evident. Areolae rare and sparse, more or less loosely attached, minute, indistinct and more or less fragile, tending to become dissolved into soredia. Discrete, irregularly-sized, punctiform, diffuse soralia occasionally present. **Soredia** usually spreading over the surface of the substratum, scattered to clustered, loosely attached, globular, fine to coarse, 20 - 60 µm, often in consoredia up to 110 µm in diameter; surface of individual soredia somewhat roughened; wall distinct. Medulla absent. Photobiont green, coccoid, up to 18 µm in diameter.

Apothecia observed in 13 (22%) of the collections, up to 0.4 mm in diameter, lecanorine; margin concolorous with the soredia, discontinuous; disc dull orange-yellow. Pycnidia rare, orange yellow, sessile, surrounded laterally by soredia, 0.08 - 0.12 mm in diameter; ostiolum punctiform to widely gaping; conidia cylindrical, ellipsoid to drop-shaped, 2.5-3 x 1.5 µm.

Chemistry: Calycin, pulvinic acid, ± pulvinic acid dilactone, unidentified pigments (traces).

Substratum. *Candelariella xanthostigma* has been collected on *Acer platanoides* and *Acer* sp. (8 specimens), *Populus tremula* (4), *Sorbus aucuparia* (3), *Ulmus glabra* (4), and, more rarely, on *Alnus incana, Betula pubescens/pendula* (eutrophicated trunk), *Fraxinus excelsior, Malus domestica, Prunus cerasus, P. padus, Quercus, Salix caprea*, and *Tilia*. Noteworthy associates included *Buellia punctata, Caloplaca herbidella, C. ulcerosa, Candelariella reflexa, C. vitellina, Parmelia (Melanelia) exasperatula, Physcia adscendens, P. dubia, P. tenella*, and *Rinodina degeliana*.

Distribution. *Candelariella xanthostigma* has been found throughout most of the country, but was sparse on the westernmost coast. The vertical distribution ranged from about sea-level to 1050 m (Oppland: Dovre), but only few collections were from altitudes above 500 m. Lignicolous specimens have been collected up to 850 m altitude. **Counties**: Corticolous specimens: Østfold - Vest-Agder, Hordaland - Nord-Trøndelag, Troms, Finnmark. All specimens: Østfold - Vest-Agder, Hordaland - Nord-Trøndelag, Troms, Finnmark.

Discussion. As circumscribed here, *Candelariella xanthostigma* corresponds largely to Räsänen, Lich. Fenn. Exs. 58. The thallus is usually composed entirely of spherical soredia and is not variable. This circumscription of *C. xanthostigma* is in agreement with the concept of the species given by James (1971) and Hakulinen (1954). Some often richly fertile specimens of *Candelariella* superficially resembled *C. xanthostigma* as circumscribed above, but proved on closer examination to be minutely areolate and esorediate. The areolae of these specimens were scattered to contiguous, usually adnate, and varied in form and size from rounded and often convex and up to 0.1 mm in diameter to irregularly elongate, more or less flattened and more or less crenulate, and up to 0.2-0.3 mm across; the surface was more or less smooth. Several of these specimens were collected in subalpine/low-alpine sites at altitudes up to 1000 m or higher. As it was uncertain whether such specimens should be treated as being within the variation range of *C. xanthostigma*, they were left out of *C. xanthostigma* in the present account. As circumscribed here, *C. xanthostigma* turns out to be largely a lowland species. Several specimens were erroneously cited as *Candelaria concolor* by Haugsjå (1930). For comparison with *Candelariella reflexa*, see under that species.

Candelariella xanthostigma is a widespread and common species of eutrophic bark. It has also been found on wood.

Specimens seen (selected): Øf: Halden 1981, Tønsberg s.n. - Oslo: Skøien, Moe (BG). - He: Sør-Odal 1990, Tønsberg 13280. - Op: Lillehammer 1938, Ahlner (S). - Bu: Sigdal 1981, Tønsberg 6321b. Vf: Tønsberg 1930, Haugsjå (O). - Te: Bø 1990, Tønsberg 13030. - AA: Grimstad 1990, Tønsberg 13552. - VA: Kristiansand 1986, Tønsberg (mixed in and filed under *Caloplaca obscurella*, Tønsberg 9557). - Ho: Voss 1989, Øvstedal. - SF: Gloppen 1980, Anonby 167. - MR: Hareid 1964, Rui (O). - ST: Trondheim 1981, Tønsberg 5410. - NT: Røyrvik 1974, Tønsberg 400. - Tr: Målselv 1983, Øvstedal. - Fi: Porsanger, Norman (O). A total of 58 specimens seen.

Catillaria Massal.

The genus *Catillaria* was defined by Kilias (1981) and Hafellner (1984). *Catillaria pulverea* is not congeneric with *Catillaria chalybeia* (Borrer) Massal., the type species of *Catillaria* s. str. (Coppins 1989a).

Catillaria pulverea (Borrer) Lettau

Pertusaria miniescens Erichsen; Rev. Mycol. 3: 111 (1938). Type: Sweden: Västergötland, Råda, Mölnlycke, 8 Mars 1927, A. H. Magnusson 10365 (UPS! - isotype).

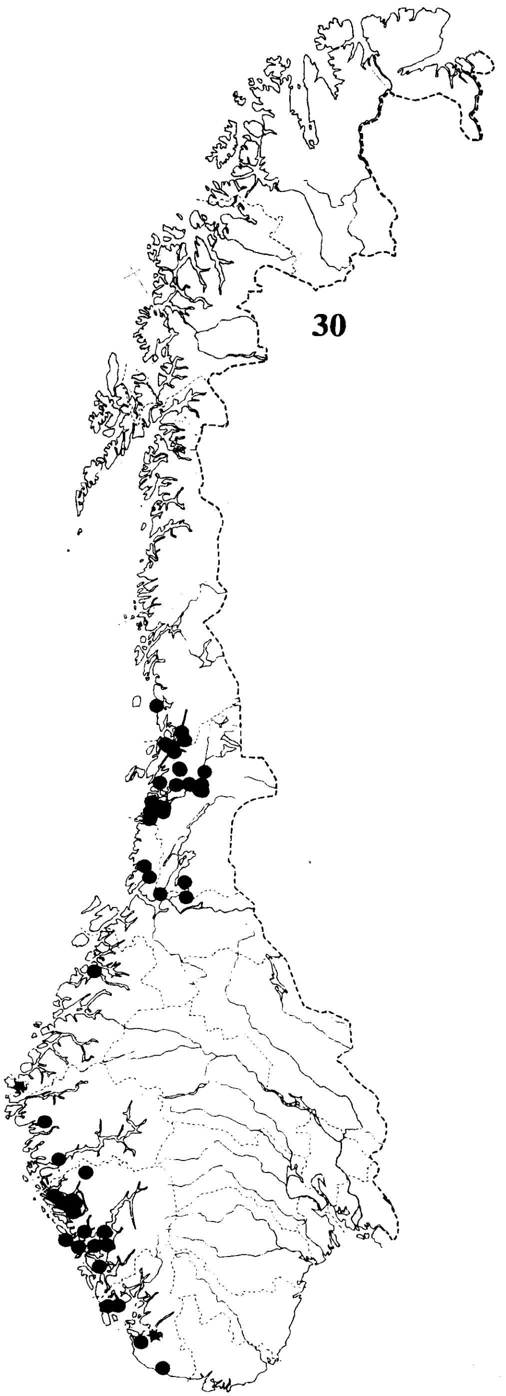
Figs 15-16, 30.

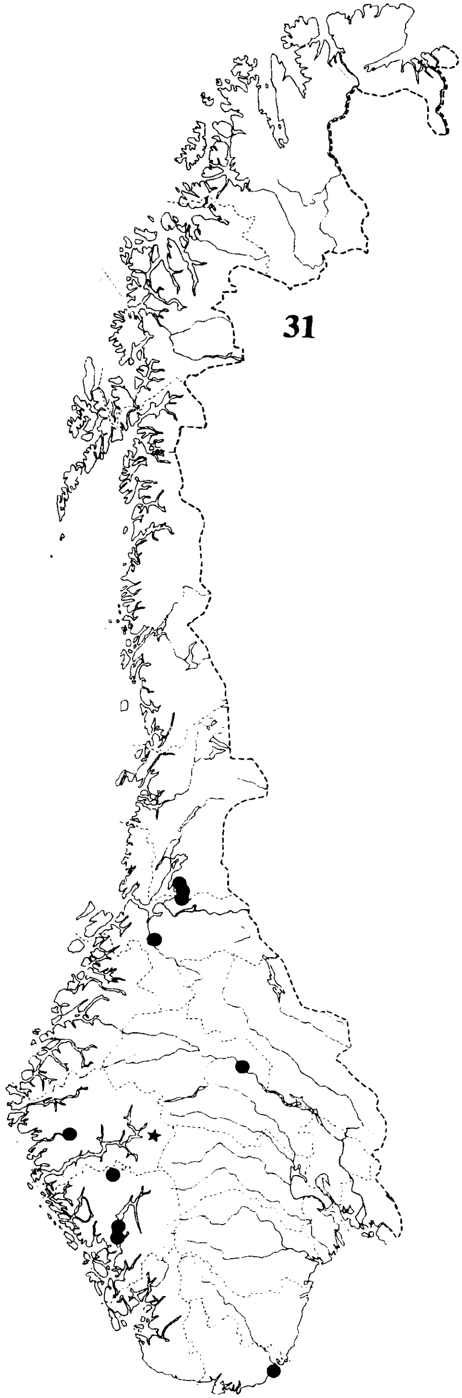
Thallus crustose, episubstratal, indeterminate or delimited, irregularly spreading, up to several dm in diameter, areolate, sorediate. Prothallus indistinct or rarely, distinct, white. Areolae mostly absent or indistinct, scattered or more or less contiguous, whitish, irregularly rounded, convex, up to 0.3 mm in diameter. **Soralia** greyish green, bluish green or yellowish green, mostly diffuse, irregular, at first often scattered on an often more or less endosubstratal thallus, later tending to fuse and form a more or less thick leprose crust. Large soralia and sorediate parts often crack into smaller more or less angular portions. Soredia mostly coarse, (20-)30-50 µm, often in globose, sub-cylindrical to sub-coralloid consoredia (Figs 15-16) up to 125 µm in diameter; wall distinct. Medulla distinct in well-developed specimens, white. Photobiont green, coccoid, up to 20 µm in diameter.

Apothecia present in 19 (20%) of the specimens, lecideine, bluish black, up to 2 mm in diameter, marginate; disc plane to slightly convex.

Chemistry: Atranorin, fumarprotocetraric acid (absent in 2 collections), ± cph-1, ± cph-2 (trace), protocetraric acid, zeorin, a range (thirteen or more) of additional terpenoids in trace amounts, ± unidentified fatty acids in R_F-classes A 3, B 3, C 3 (a few specimens only).

Substratum. *Catillaria pulverea* was most commonly collected on *Sorbus aucuparia*





Figs 30-31. Distribution maps. Fig. 30. *Catillaria pulverea*. Fig. 31. *Chrysothrix candelaris*.

(33), but was frequent also on *Alnus incana* (16), and *Quercus* (15); other phorophytes included *Alnus glutinosa, Fraxinus excelsior, Populus tremula,* and rarely *Betula pubescens/pendula, Ilex aquifolium, Picea abies, Salix aurita* and *S. caprea. Catillaria pulverea* occurred on naked bark as well as on corticolous mosses. On some trunks it was evident that mosses were preferred rather than naked bark.

Distribution. *Catillaria pulverea* has been collected in the coastal lowlands of western Norway (Fig. 30). Its vertical distribution ranged from about sea-level to 170 m (Hordaland: Kvam). **Counties**: Rogaland - Nordland (Sømna).

Discussion. *Catillaria pulverea* is not a very variable species. The variation in colour from greyish or bluish green to yellowish green probably reflects the illumination at the sites. *Catillaria pulverea* is easily recognized on account of its irregular, diffuse soralia, its coarse soredia and its chemistry. Morphologically it may resemble *Lecanora farinaria,* but that species has fine soredia and contains atranorin and roccellic acid. The generic affinity of *Catillaria pulverea* is uncertain.

Catillaria pulverea occurred rarely (2 specimens) growing over mosses and other lichens on rock (Havås 1936, Jørgensen & Øvstedal 1975). *Catillaria pulverea* is a coastal species, mainly of acidic bark.

Specimens seen (selected). Ro: Sandnes 1923, Høeg (TRH). - Ho: Austevoll 1985, Tønsberg 9403. - SF: Høyanger 1984, Tønsberg 8639. - MR: Tingvoll 1979, James & Tønsberg. - ST: Malvik 1987, Tønsberg 9989. - NT: Flatanger 1981, Tønsberg 5531. - No: Bindal 1982, Tønsberg 6823. A total of 93 specimens seen.

Chaenotheca (Th. Fr.) Th. Fr.

The genus *Chaenotheca* has been monographed for the northern hemisphere by Tibell (1980). Treatments of the genus in Norway and in Sweden have been published by Middelborg & Mattsson (1987) and Tibell (1978), respectively. *Cybebe gracilenta* (Ach.) Tibell is included in *Chaenotheca,* following Middelborg & Mattsson (1987).

Chaenotheca furfuracea (L.) Tibell

Thallus crustose, episubstratal, indeterminate, bright green-yellow to yellow, soft and ecorticate, in young parts composed of more or less discrete areolae of loosely arranged photobiont chains and fungal hyphae; these areolae usually were fused and formed a thick, more or less continuous cover, and from this basal crust fungal hyphae densely beset with crystals were projecting, giving the thallus surface a soft texture; soredia sometimes present; wall absent. Prothallus sometimes evident, of loosely organized, white hyphae. **Soredia** scattered or in groups, rounded, soft, mostly coarse, 30-50 µm in diameter, with projecting hyphae densely beset with crystals, sometimes in aggregations up to 0.2 - 0.3 mm in diameter. Photobiont *Stichococcus*, cells more or less rectangular, forming chains.

Apothecia usually richly present, stalked, densely covered in a bright yellow to green-yellow pruina, up to 3.5 mm long; stalk black where the pruina has been shed.

Chemistry: Vulpinic acid, pulvinic acid, ± pulvinic acid dilactone.

Substratum. *Chaenotheca furfuracea* has been found on *Picea abies* (the most common phorophyte), *Betula pubescens/pendula, Pinus sylvestris,* and *Populus tremula.* It often occurred on more or less decayed bark. *Chaenotheca furfuracea* was found exclusively in shaded niches, mostly under overhanging rock and in dry, concave parts of the base of the phorophytes.

Distribution. *Chaenotheca furfuracea* has been found throughout most of the country. The vertical distribution of corticolous specimens ranged from sea level to 890 m (Oppland: V. Gausdal). **Counties:** Østfold - Finnmark.

Discussion. *Chaenotheca furfuracea* may resemble *Chrysothrix chlorina* which also contains vulpinic acid. However, that species has a coccoid photobiont. It is also reminiscent of *Psilolechia lucida* from which it can be distinguished by the chemistry, as the latter contains rhizocarpic acid as the only major substance.

Chaenotheca furfuracea is a species of shaded sites.
It is a commonly-distributed species occurring on a wide range of substrates including bark, plant remnants, bryophytes, wood, soil and rock.

Specimens seen (selected): Øf: Fredrikstad 1928, Lunde (O). - Ak: Frogn 1948, Dahl (O). - He: Engerdal 1973, Tibell (UPS). - Op: Ringebu 1952, Lindahl (UPS). V. Gausdal 1958, Ahlner (S). - Bu: Sigdal 1989, Tønsberg 11739. - Vf: Larvik, Norman. - Te: Seljord 1987, Tønsberg 10325. - AA: Bykle 1987, Tønsberg 10209. - VA: Vennesla 1990, Tønsberg 13576. - Ro: Sauda 1989, Botnen 1867. - Ho: Odda 1984, Tønsberg 8748. - SF: Høyanger 1984, Tønsberg 8643 (BG, O). - MR: Smøla 1983, Tønsberg 8308 (O). - ST: Trondheim 1981, Holien 17/81 (TRH). - NT: Namdalseid 1981, Holien 482/81. - No: Rødøy 1986, Tønsberg 9674. - Tr: Målselv, Norman (BG). - Fi: Alta, Norman (BG). Exsiccata seen: Havaas, Lich. Exs. Norv. 344 (BG, O). A total of 61 corticolous specimens seen.

Chaenotheca gracilenta (Ach.) Mattsson & Middelb.

Sommerfeltia 5: 45 (1987).

Fig. 18.

Thallus crustose, episubstratal, indeterminate, forming patches up to a dm or more in diameter, greyish green, ecorticate, mostly composed of soredia. Prothallus not evident. **Soredia** irregular in size and form, mostly more or less rounded, fine, 10-20 µm in diameter, composed of a thin cover 1.5-2.5 µm wide surrounding the algal cells, often aggregated forming subcylindrical consoredia up to 40 x 15 µm; wall indistinct, forming a thin cover (up to 2.5µm wide); individual cells indistinct, cylindrical. Photobiont mostly globose and with 1-3 cells; stichococcoid chains absent or poorly developed.

Apothecia present in all specimens, sparse to abundant, stalked, up to 3.5 mm long; stalk black, but sometimes covered in soredia from the thallus; excipulum with a greyish pruina.

Chemistry: Gracilenta unknowns 1 - 3, in addition to a range of other unidentified substances (mostly in trace amounts), including several UV+ deeply blue spots on the chromatographic plates. TLC: Fig. 18.

Substratum. *Chaenotheca gracilenta* was found on decaying bark lying on the ground and on the bark of living trees. Identified phorophytes included *Fraxinus excelsior*. The collections were from dry bark under overhanging rock.

Distribution. Corticolous specimens have been found in scattered localities at altitudes from about sea level to 550 m (Oppland: Dovre), whereas non-corticolous material has been collected up to 620 m altitude (Oppland: Dovre, Ahlner (S)). **Counties**: Oppland, Hordaland, Nord-Trøndelag, Troms. All specimens: Oppland, Hordaland, Nord-Trøndelag, Troms, Finnmark.

Discussion. *Chaenotheca gracilenta* resembles *C. stemonea* which according to Middelborg & Mattsson (1987) has a farinaceous, green thallus. However, that species seems to lack soredia and is further distinguished by the presence of two unidentified substances (in R_F-classes A 4 & (4-)5, B 6, C 6) not occurring in *C. gracilenta* (see also Tibell 1980). According to Middelborg & Mattsson (1987), *C. gracilenta* has *Stichococcus* as its photobiont.

Chaenotheca gracilenta is a species of deeply shaded habitats. It occurs on bark as well as over bryophytes and on silicious rock and is ubiquitous in Fennoscandia (Middelborg & Mattsson 1987).

Specimens seen (selected): Op: Dovre 1948, Ahlner (S). - Ho: Odda 1984, Tønsberg 8747. - NT: Leksvik 1983, Tønsberg 8354. - Tr: Målselv, Middelborg 370 (O). A total of 7 specimens seen.

Chrysothrix Mont.

The genus *Chrysothrix* has been monographed by Laundon (1981).

Chrysothrix candelaris (L.) Laundon

Fig. 31.

Thallus episubstratal, indeterminate, leprose, unstratified, unlobed, bright yellow. Prothallus not apparent. **Soredia** more or less spherical, (6-) 12-25 (-30) µm in diameter, easily becoming disintegrated; wall distinct. Photobiont coccoid, up to 15 µm.

Apothecia not observed in Norwegian material; according to Laundon (1981) they are rare, minute, up to 0.5 mm in diameter, soft, light orange (see Laundon 1981). Pycnidia not observed.

Chemistry: I. Pinastric acid major substance, possible trace of vulpinic acid, unidentified terpenoids (traces); 7 specimens. II. Calycin, possible traces of unidentified terpenoids; 1 specimen. (III. Calycin, pinastric acid, unidentified substance in R_F-classes A 1-2, B 3, C 1-2; 1 specimen; lignicolous material only).

Substratum. *Chrysothrix candelaris* has been found on *Picea abies* (6 specimens) and *Quercus* (2). A specimen from *Quercus* grew in shaded bark-crevices adjacent to an overhanging rock wall. On *Picea* it sometimes covered substantial areas on trunks and/or branches in shaded habitats, e.g., under an overhang, in a river gorge, and in a north-facing slope. Closely associated species on *Picea* included *Bactrospora corticola* and *Lecanactis abietina*.

Distribution. *Chrysothrix candelaris* has been found in the coastal lowlands of southern Norway and in a humid river gorge in Gudbrandsdalen (see Fig. 31). Its vertical distribution ranged from about sea-level to 450 m (Oppland: Ringebu). **Counties**: Corticolous specimens: Oppland, Vest-Agder, Hordaland, Sør-Trøndelag, Nord-Trøndelag. All specimens: Oppland, Vest-Agder, Hordaland, Sogn og Fjordane, Sør-Trøndelag, Nord-Trøndelag.

Discussion. *Chrysothrix candelaris* is easily distinguished chemically from *C. chlorina* and *C. chrysophthalma* in lacking vulpinic acid (pigments in trace amounts disregarded) and rhizocarpic acid, respectively. With respect to the major substances, the three chemotypes listed above confirm the findings of Laundon (1981), who examined material from various parts of the world.

Chrysothrix candelaris is corticolous and lignicolous on old barns (always the shaded side) and, rarely, saxicolous on silicious rock.

Specimens seen (chemotype I if not otherwise stated): Op: Ringebu 1984, Tønsberg 9014. - VA: Søgne

1978, Tønsberg 3198. - Ho: Kvam 1914, Lillefosse (O; chemotype II). - ST: Malvik 1987, Tønsberg 9978, 9981. Meldal 1991, Holien 4217 (TRH). - NT: Levanger 1988, Holien 3137 (TRH). Stjørdal 1991, Holien 4190 (TRH).

Chrysothrix chlorina (Ach.) Laundon

Thallus episubstratal, indeterminate, leprose, unstratified, unlobed, vivid yellow-green. Prothallus not apparent. Soredia 20-35(-70) µm in diameter, loosely constructed and easily disintegrated in squash preparations; wall usually poorly developed, sometimes not evident. Photobiont coccoid, up to 15 µm in diameter.

Apothecia and pycnidia not observed.

Chemistry: Vulpinic acid, calycin, pulvinic acid (trace), zeorin, a range of unidentified terpenoids (in trace amounts); ± unidentified fatty acid (trace) in R_F-classes A 5, B 5, C 5 (also found in saxicolous specimens).

Substratum. *Chrysothrix chlorina* was collected on trunks of *Pinus sylvestris* adjacent to saxicolous populations.

Distribution. Corticolous specimens of *Chrysothrix chlorina* were found in scattered localities in southern Norway at altitudes between 250 and 360-380 m. Saxicolous specimens have been found in the lowlands throughout most of the country at altitudes up to 525-540 m. **Counties:** Oppland, Sogn og Fjordane, Sør-Trøndelag. All specimens: Akershus - Buskerud, Telemark - Sør-Trøndelag, Troms, Finnmark.

Discussion. The coarse soredia and the content of vulpinic acid in high concentration in addition to the occurrence of zeorin, readily separate *C. chlorina* from *C. candelaris* and *C. chrysophthalma*. According to Laundon (1981), *C. chlorina* comprises a single chemotype containing calycin and vulpinic acid. However, pulvinic acid, zeorin (in easily detectable amounts), and other terpenoids proved to be constant substances in the corticolous material as well as in all saxicolous specimens examined.

Chrysothrix chlorina is a widespread, saxicolous species under overhanging rock; it only rarely occurs on bark.

Specimens seen: Op: Øyer 1984, Tønsberg 9008. - SF: Lærdal 1991, Anonby 529 & Gaarder. - ST: Rennebu 1982, Tønsberg 7483.

Chrysothrix chrysophthalma (P. James) P. James & Laundon

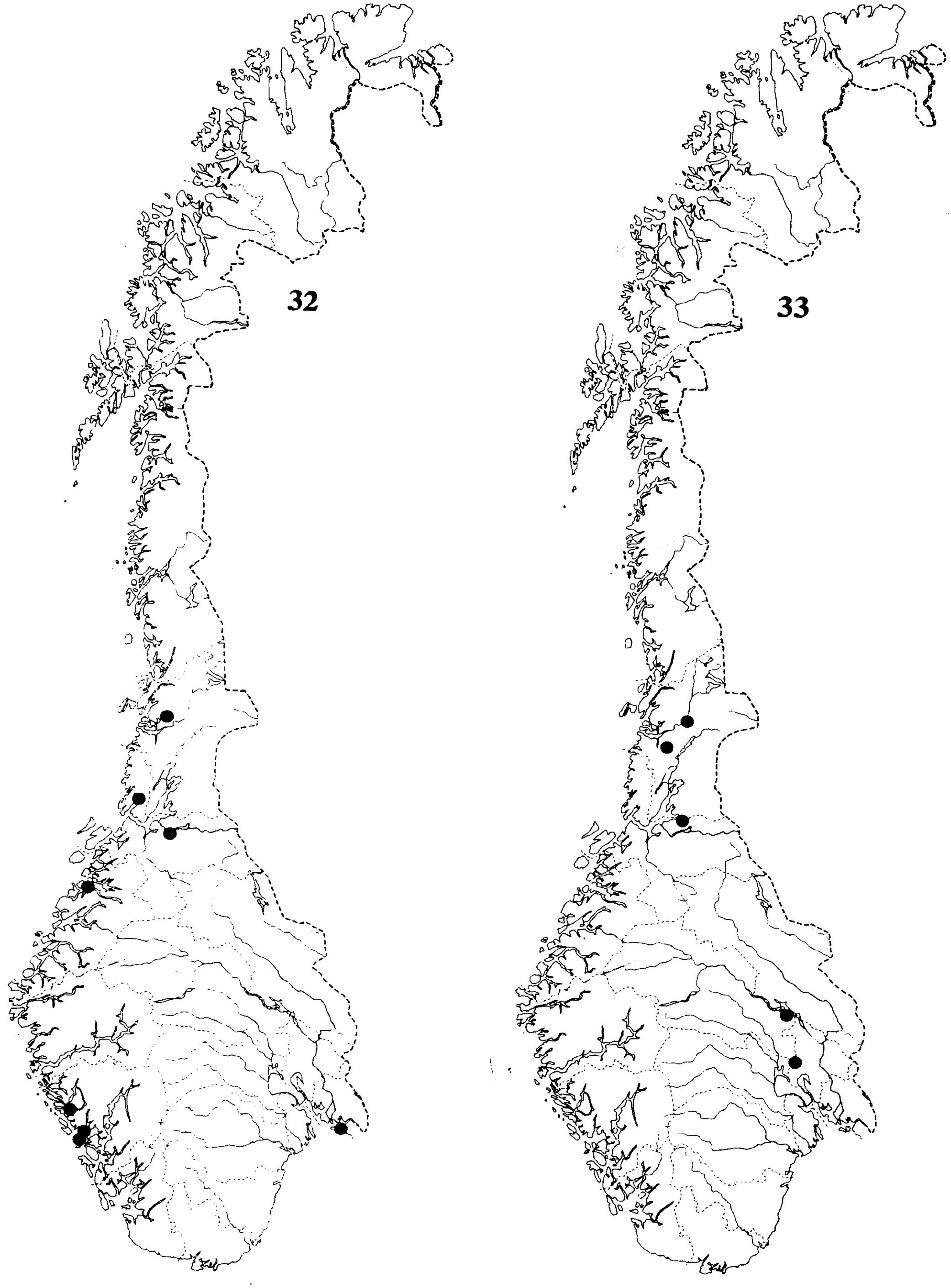
Fig. 18, 32.

Thallus episubstratal, indeterminate, from a few mm up to one m or more in diameter, leprose, unstratified, unlobed, bright green to bright yellow. Prothallus not apparent. **Soredia** fine, 15 - 25 µm in diameter, sometimes completely lacking in fertile specimens; wall distinct, incomplete. Photobiont coccoid, to 18 µm in diameter.

Apothecia sparse, present in one sorediate specimen and in 3 esorediate specimens with a endosubstratal thallus (altogether 21% of the specimens), scattered, pale yellowish brown to greenish yellow, more or less plane to subspherical, emarginate, up to 0.4 mm in diameter. Pycnidia not observed.

Chemistry: Sorediate thalli: Rhizocarpic acid, chrysophthalma unknown. (Esorediate thalli were too scanty for TLC (no thallus evident).) TLC: Fig. 18.

Substratum. *Chrysothrix chrysophthalma* has been found on *Pinus sylvestris* (12 specimens) and *Picea abies* (7). Associated species included *Arthonia leucopellaea*,



Figs 32-33. Distribution maps. Fig. 32. *Chrysothrix chrysophthalma*. Fig. 33. *Cliostomum leprosum*.

Bactrospora corticola, Chaenotheca chrysocephala, C. brunneola, Lecanactis abietina, Lecidea hypopta, Lepraria spp., and *Protoparmelia ochrococca.*

Distribution. *Chrysothrix chrysophthalma* was found in the lowlands along the coast of southern Norway (Fig. 32). Its vertical distribution ranged from about sea-level to 200-240 m (Sør-Trøndelag: Klæbu). **Counties**: Corticolous specimens: Østfold, Hordaland, Sør-Trøndelag, Nord- Trøndelag. All specimens: Østfold, Hordaland, Møre og Romsdal, Sør-Trøndelag, Nord-Trøndelag.

Discussion. *Chrysothrix chrysophthalma* is a variable species. In the esorediate form no thallus or thalline pigments were detectable. The presence of rhizocarpic acid is apparently correlated with the presence of soredia. In Norway, sorediate material with apothecia is known only from Hordaland: Os (leg. Skjolddal). All specimens from central Norway were fertile and esorediate. Chrysophthalma unknown apparently corresponds to the unidentified substance reported from *C. chrysophthalma* by Laundon (1981). The fine soredia and the content of rhizocarpic acid distinguish *Chrysothrix chrysophthalma* morphologically and chemically from *C. candelaris* and *C. chlorina.* In the field, *C. chrysophthalma*, may more readily be mistaken for the much more common *Lecanora expallens* from which it is easily distinguished by its chemistry. *Psilolechia lucida*, mainly a species growing on rock under overhangs, may resemble *C. chrysophthalma.* However, chrysophthalma unknown is absent in *Psilolechia lucida.*

In Østfold (Hvaler), *Chrysothrix chrysophthalma* sometimes made conspicuous patches up to a meter or more in diameter. In the other parts of its range it was more poorly developed; the specimens from Trøndelag comprised only minute, esorediate patches up to a few mm in diameter.

Chrysothrix chrysophthalma is a southern, coastal lowland species. It appears to be mainly corticolous; other substrates include wood of *Pinus sylvestris* and *Quercus* (see also Laundon 1981). From outside Norway it is recorded from the British Isles (Laundon 1981) and Sweden (Moberg 1989).

Specimens seen (selected): Øf: Hvaler 1983-1990, Tønsberg 7851, 7861, 9097, 9098, 13195. - Ho: Austevoll 1990, Tønsberg 13617. Bergen 1984, Tønsberg 8788. Os 1980, Skjolddal. - (MR: Tingvoll 1980, James (on wood (BM).) - ST: Klæbu 1989, Holien 3478b (TRH). Rissa 1990, Holien 3970 (BG). - NT: Namsos 1987, Holien 3079b (TRH; det. B. Coppins 1990). A total of 19 collections seen.

Cliostomum Fr.

The genus *Cliostomum* has been treated for North America and Europe by Gowan (1990).

Cliostomum leprosum (Räsänen) Holien & Tønsb. comb. nov.

Catillaria leprosa Räsänen, in Lich. Fenn. Exs. 492 (1939). Type: Finland, Tavasti borealis, Saarijärvi, Pyhäjärvi. Ad caudicem basalem *Picea excelsae* in piceeto juxta viam publicam. 11 August 1937, A. Koskinen (O! - isotype). TLC: atranorin, caperatic acid, unidentified fatty acid in R_F-classes: A 5, B 5, C 5-6.

Cliostomum luteolum Gowan, in Mycologia 82: 769 (1990). Type: Canada, New Brunswick, Albert Co., Fundy National Park, Point Wolfe, on *Picea rubens*, Gowan 3836 (CANL! - holotype). TLC: Atranorin, caperatic acid, usnic acid (the latter substance in apothecia only).

Lecanora varia f. *ceracella* Th. Fr., in Lich. Scand. I: 262 (1871). Type: Sweden, Hälsingland, Bjuråker, no 16, J. A. Hartman (UPS! - lectotype); TLC: atranorin, caperatic acid, usnic acid (the latter substance in apothecia only).

Fig. 33.

Thallus crustose, whitish to pale green or pale green-yellow, mostly endosubstratal in esorediate parts, forming extensive patches up to a dm or more in diameter, indeterminate, sorediate. Prothallus not evident, endosubstratal. Areolae hardly evident. **Soralia** irregular in size and form, bursting here and there through the uppermost cell layers of the substratum (sometimes leaving visible scars where the soredia have been shed), discrete and minute at first, later becoming more or less confluent forming diffuse, more or less continuously sorediate patches up to several cm in diameter. Soredia not well-developed, variable in form and size, fragile (becoming easily disintegrated when mounted under a coverslip), 20 - 100 µm in diameter; wall not evident. Medulla not observed. Photobiont green, coccoid, up to 15(-19) µm in diameter.

Apothecia sparsely present in 7 (70%) of the collections, up to 0.6 mm in diameter; disc pale yellow turning pale orange or brownish in the herbarium, flat to convex; proper margin paler than the disc, more or less prominent, thin, up to 0.08 mm. Pycnidia present in all collections, black, up to 0.4(-0.6) mm in diameter, irregularly rounded, in squash preparations with a brown, K-, N+ reddish and a violet, K+ aeruginose, N+ reddish pigment. Conidia subglobose to droplet-shaped, (2-)2.5-3 x 1.5-2 µm (measurement based on Norwegian and Swedish material).

Chemistry: Atranorin, caperatic acid. Apothecia: usnic acid.

Substratum. *Cliostomum leprosum* has been collected on *Picea abies* in old *Picea* forests. Associated species included *Lecanactis abietina.*

Distribution. *Cliostomum leprosum* was found in eastern parts of southern Norway (Fig. 33) at altitudes between 100-120 and 760 m. **Counties**: Akershus, Oppland, Nord-Trøndelag.

Discussion. *Cliostomum leprosum* is apparently closely related to *C. corrugatum* (Ach.) Fr. (syn. *C. graniforme* (Hagen) Coppins), with which it has been regarded as conspecific (see Santesson 1984). Both species have yellow apothecia containing usnic acid. Whether *Cliostomum corrugatum* is the primary species of *C. leprosum*, is an open question. The two species differ markedly in thalline characters apart from the soredia of the latter, as the former has distinct, convex areolae; in apothecial characters they seem to be similar (see Gowan 1990). *Cliostomum corrugatum* is not known in Norway; in Sweden, however, it is not rare. *Cliostomum griffithii* is distinct from both *C. leprosum* and *C. corrugatum*, e.g., in having brown (usnic acid deficient) apothecia and in producing roccellic acid in the thallus.

Cliostomum leprosum is a rare lichen. The specimens were found on mature trunks in forest reserves. Apparently, *C. leprosum* is an indicator of old coniferous forests. The joint occurrence of *C. leprosum* with *Lecanactis abietina* indicates a preference for dry, sheltered and shaded bark in humid situations. In North America *Cliostomum leprosum* has been found on the Atlantic coast where it is corticolous on *Picea rubens*. The species has so far only been found on *Picea*.

Specimens seen: Norway: Oslo 1868, N.G. Moe (UPS - 2 collections). - Op: Østre Toten 1990-1991, Gaarder 210, 266b, 271. - NT: Grong 1991, Holien 4438 (TRH). Namdalseid 1990-1991, Holien 3744a, 4462 (TRH). Stjørdal 1990, Holien 3961 (BG-dupl.); Tønsberg 13716. **Sweden**: Åsele 1990, Tibell 18679 (UPS)). **Finland**: Tavastia borealis 1946, A. Koskinen (Lichenotheca Fenn. 136; O, TROM).

Enterographa Fée

The genus *Enterographa* has been monographed for parts of the Mediterranean area by Torrente & Egea (1989). A key to the British species has been published by Coppins & James (1979a).

Enterographa zonata (Körber) Källsten

in Torrente & Egea (1989): 154 & 198.

Thallus crustose, endo- to episubstratal in non-sorediate parts, indeterminate to delimited, forming rosettes up to 2 cm in diameter, or irregular patches in often extensive, mosaic-like colonies, continuous or, more rarely, indistinctly areolate, sorediate. Prothallus indistinct, but a brown-black border was usually evident between individual thalli in colonies. Esorediate parts greyish brown, chocolate brown or more rarely indistinctly greenish brown, not tuberculate, sometimes faintly cracked. **Soralia** whitish grey to pale lilac-coloured, often with a brown tinge due to pigmentation of the external soredia, usually discrete, punctiform, plane, about 0,2 mm in diameter. Soredia fine, often with only one photobiont cell, brown pigment K-, N- or fuscous brown; wall usually distinct. Medulla absent. Photobiont *Trentepohlia*.

Apothecia present in 2 (20%) of the specimens, black, conical and 0.2 x 0.3 mm or lirelliform and 0.4 x 0.2 mm; disc epruinose.

Chemistry: (I) Confluentic acid, 2'-O-methylmicrophyllinic acid (4 specimens). (II) 2'-O-methylmicrophyllinic acid (5 specimens).

Substratum. *Enterographa zonata* was collected on trunks/roots of *Fraxinus excelsior, Ilex aquifolium, Populus tremula* and *Sorbus aucuparia.* Associated species included *Arthopyrenia ranunculospora, Schismatomma umbrinum, Lecanora expallens, Opegrapha gyrocarpa, O. rufescens, O. vulgata, O. vermicellifera,* and *Thelotrema lepadinum.*

Distribution. *Enterographa zonata* was found in the coastal lowlands. The known vertical distribution of corticolous specimens ranged from about sea-level to 100 m. **Counties:** Vest-Agder - Sogn og Fjordane, Nordland. All specimens: Akershus, Oppland - Finnmark.

Discussion. *Enterographa zonata* resembles *Opegrapha gyrocarpa.* That species usually has larger soralia which often become confluent, and a different chemistry including schizopeltic acid and/or gyrophoric acid.

Enterographa zonata was referred to the saxicolous community *Opegrapha horistico-gyrocarpae* Wirth, an association of shaded rock overhangs (see, e.g., James et al. 1977). Occasionally it is corticolous on trees growing adjacent to such overhangs. When saxicolous, *Enterographa zonata* is a common coastal lowland species in Norway (Botnen & Tønsberg 1988), known as far north as Finnmark (Alta) and at altitudes up to 600 m (Oppland: Lom).

Specimens seen: VA: Kristiansand 1988, Tønsberg 10085. - Ro: Suldal 1988, Tønsberg 10848. Tysvær 1981, Skjolddal 582. - Ho: Bergen 1984, Tønsberg 8548a. Lindås 1984, Tønsberg 8607, 8608. Os 1984, Tønsberg 8717. Tysnes 1978, Øvstedal. - SF: Stryn 1983, Tønsberg 7880. - No: Sørfold 1986, Tønsberg 9730. A total of 10 corticolous specimens seen.

Fuscidea V. Wirth & Vězda

Monographic treatments of many species of the genus *Fuscidea* have been carried out by Oberhollenzer & Wirth (1984, 1985, 1990).

Fuscidea arboricola Coppins & Tønsb. sp. nov.

[*Fuscidea arboricola* Coppins (ined.), in Degelius, Acta Regiae Scient. Lit. Gothoburgensis. Botanicae 2: 68 (1982).]

Thallus areolatus, sorediatus. Areolae viridulae ad brunneolae, prothallo circumcinctae. Soralia flavido-viridia ad subviridia, interdum brunnea suffusa, punctiformia. Apothecia *F. cyathoideae* similis. Sporae hyalinae vel brunneolae, simplices vel uniseptatae, medianae constrictae, 7-9 x 4-5 µm. Pycnidia fusco-nigra, sessilia; conidia 3-3.5 x 1-1.5 µm. Thallus acidum fumarprotocetraricum continens.

Type: Norway, Nordland, Bindal, Skjelsvik, alt. 0-10 m, UTM grid ref.: 33W UN 7131 (1825 III), 1 June 1982, on trunk of *Betula pubescens*, Tønsberg 6865 (BG - holotype; UPS, E - isotypes).

Figs 34-35.

Thallus (Fig. 34) crustose, often in colonies, episubstratal, delimited, forming rosettes up to 3 (-5) cm in diameter, or becoming irregularly spreading and/or confluent with adjacent thalli and then up to one dm or more in diameter, usually areolate but sometimes more or less continuous and tuberculate, sorediate, occasionally zoned with alternating bands consisting of areolae surrounded by prothalline hyphae and prothallus without areolae. Prothallus usually distinct, brown, of radiating, partly ramifying hyphae forming a border around the thallus and individual areolae, often giving the thallus a more or less brown over-all appearance. Areolae

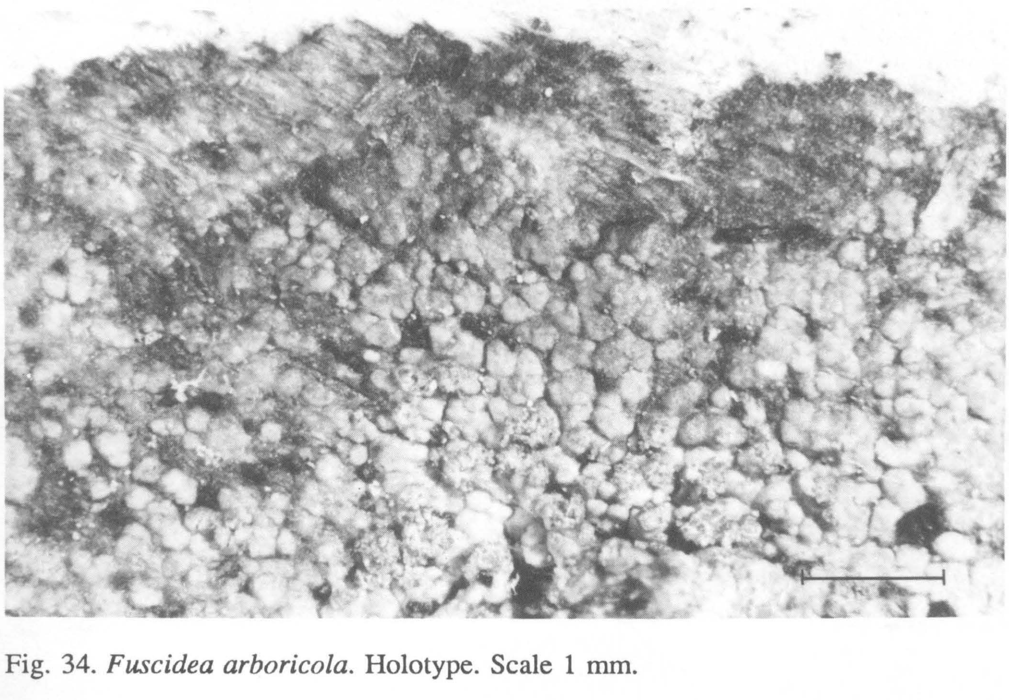
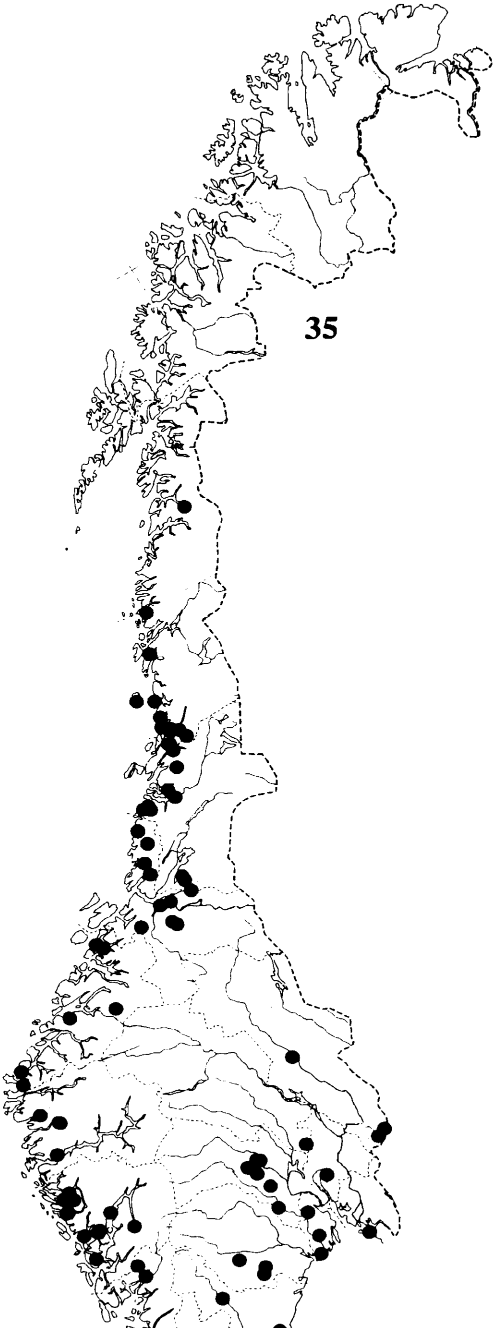
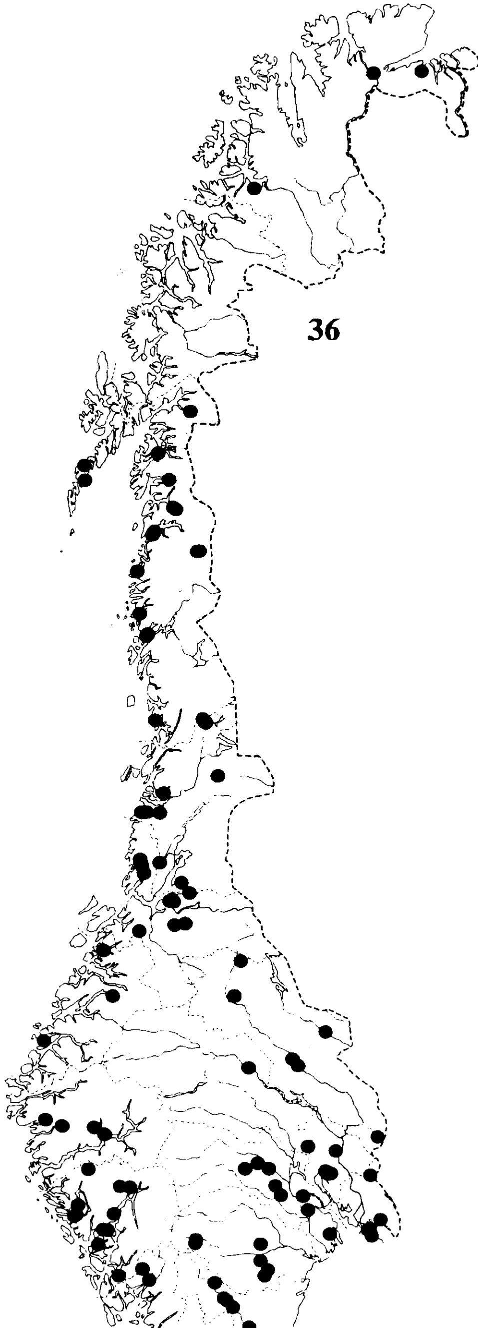


Fig. 34. *Fuscidea arboricola*. Holotype. Scale 1 mm.





Figs 35-36. Distribution maps. Fig. 35. *Fuscidea arboricola.* Fig. 36. *Fuscidea pusilla.*

greyish, greenish or brownish, rarely greyish white, discrete or locally fused; convex, sometimes bullate, circular to irregularly rounded, mostly 0.2-0.3 mm in diameter, often esorediate at the edge of the thallus, but in the thallus centre soon bursting apically to form soralia. **Soralia** pale yellowish green to pale green, sometimes tinged brown due to pigmentation of the external soredia; usually delimited, punctiform or, more rarely, orbicular, or more or less irregular, mostly 0.2-0.5 mm in diameter, usually discrete, occasionally locally fused, but never forming a continuous leprose crust throughout. Soredia fine, (15-)20-30 µm in diameter; wall distinct. Medulla indistinct. Photobiont green, coccoid, up to 10(-15) µm in diameter.

Apothecia sparsely present in 17 (12%) of the specimens, lecideine, (of *Fuscidea cyathoides*-type (see Oberhollenzer & Wirth 1984: 545)), up to 0.8 mm in diameter, proper margin distinct, dark brown to brownish black, often becoming flexuose; disc more or less plane, concolorous with the margin or darker. In sections: Proper exciple brown in outer parts, dilute brown to colourless in inner part, consisting of radiating hyphae which are firmly conglutinated, especially in the rim, with colourless crystals PD+ orange (fumarprotocetraric acid), dissolving in K; pigment K & N- or fading. Epihymenium brown; pigment amorphous, present as a cap surrounding the 1-2 uppermost cells of the paraphyses, K & N- or fading. Hymenium colourless, 45-75 µm deep, I+ faintly violet. Paraphyses simple or sparingly branched, conglutinated, but becoming free in K, 1.5-2.0 µm wide (K), upper cell more or less swollen, sometimes globose, up to 3.5(-4.0) µm wide (K). Asci mostly immature, of *Fuscidea*-type (see Hafellner 1984: 279), up to 40 x 15 µm, 8-spored. Spores colourless, or becoming brown-walled, simple, or 1-septate with a distinct median constrictor, more or less oblong, 7-9 x 4-5 µm (K). Subhymenium 40-60 µm deep, I+ faintly violet. Pycnidia not common, mostly along the edge of the thallus, blackish brown, sessile, rounded and convex, up to 0.3(0.5) mm in diameter; ostiolum widely gaping. Conidia narrowly obovoid to more or less bacilliform, 3-3.5 x 1-1.5 µm.

Chemistry: Fumarprotocetraric acid, ± protocetraric acid (trace), ± cph-2 (trace).

Substratum. *Fuscidea arboricola* has most commonly been collected on *Alnus incana* (44 specimens), *Betula pubescens/pendula* (33), and *Sorbus aucuparia* (14); other phorophytes included *Acer platanoides, Alnus glutinosa, Juniperus communis, Pinus sylvestris, Salix caprea* and, more rarely, *Calluna vulgaris, Fagus sylvatica, Fraxinus excelsior, Picea abies, Populus tremula, Quercus, Salix* sp., and *Tilia*.

Distribution. *Fuscidea arboricola* occurred in the lowlands along the coast from Østfold and southernmost Hedmark as far north as Nordland (Fig. 35). Its vertical distribution ranged from about sea-level to 600 m (Buskerud: Krødsherad). Inland it has been found in microclimatically moist sites, e.g., in shaded *Picea*-forests. It occurred often in shaded sites, but was also found in rather open situations, e.g., in maritime *Calluna vulgaris* heath. **Counties:** Østfold - Nordland.

Discussion. With its medially constricted spores and well developed proper exciple *Fuscidea arboricola* belongs in the *F. cyathoides* group (see Oberhollenzer & Wirth 1984, Magnusson 1925). *Fuscidea arboricola* is chemically concordant with *F. cyathoides*. However, that species has distinctly bean-shaped spores and usually an esorediate thallus. *Fuscidea cyathoides* var. *sorediata* (Magnusson) Poelt is apparently only a rare, sporadically occurring, sorediate form of little or no taxonomic importance. Its soralia, which are often few in number, are initiated marginally on the areolae and are very irregularly distributed on the thallus surface (Poelt & Buschardt 1978, James et al. 1981). The corticolous form of *F. cyathoides* (var. *corticola* (Fr.) Kalb) is not known with soredia in Norway.

Fuscidea arboricola resembles *F. lightfootii* (Sm). Coppins & P. James in having a sorediate thallus and spores which may be medially constricted. However, the latter contains divaricatic acid and the spores are mostly simple and often curved (James et al. 1981, Oberhollenzer & Wirth 1984). *Fuscidea lightfootii* is not known to occur in Scandinavia. *Fuscidea praeruptorum* (Du Rietz & Magnusson) strongly resembles *F. arboricola* in the morphology of the thallus, but it is readily distinguished by the presence of alectorialic acid. Its spores, which are simple or, occasionally, 1-septate and slightly longer (up to 12 µm in Norwegian material; see also Magnusson 1925) vary considerably in form, even within a single apothecium, being bean-shaped, more or less oblong with obtuse apices or clavate; 1-septate spores are often medially constricted. *Fuscidea praeruptorum* may be corticolous, but it is primarily a saxicolous species on shaded overhangs. When sterile *F. arboricola* may resemble sterile forms of the chemically concordant *Lecanora conizaeoides*. The presence of a distinct brown prothallus in *Fuscidea arboricola* usually makes it distinct. However, forms with an intermediate thallus morphology may rarely occur.

The first known collection of *Fuscidea arboricola* was made by O.A. Høeg in 1921 in Vestfold (Andebu (TRH)). *Fuscidea arboricola* is a species mainly of acidic bark in the coastal, lowlands. Outside Norway it is known from Sweden and U.K.: Scotland.

Specimens seen (selected): **Norway.** Øf: Hvaler 1983, Tønsberg 8154. - Oslo 1984, Tønsberg 8847. - He: Kongsvinger 1985, Tønsberg 9428b. - Op: Lunner 1982, Tønsberg 7548a. - Bu: Flesberg 1987, Tønsberg 10367. Krødsherad 1982, Tønsberg 6965a. - Vf: Andebu 1921, Høeg (TRH). - Te: Drangedal 1987, Tønsberg 10257. Kviteseid 1987, Tønsberg 10296. - AA: Bygland 1987, Tønsberg 10190. - VA: Lindesnes 1977, Tønsberg 1746. - Ro: Sauda 1988, Tønsberg 10815. - Ho: Bergen 1984, Tønsberg 8534b, 9064; 1986, 9492. Fusa 1987, Tønsberg 10033. Lindås 1984, Tønsberg 8600. Odda 1986, Tønsberg 9495. Osterøy 1983, Tønsberg 7766a. - SF: Flora 1983, Tønsberg 7915, 7918. Førde 1983, Tønsberg 7822; 1984, 8659a, 8676, 8688. Høyanger 1984, Tønsberg 8640. - MR: Aure 1983, Tønsberg 8277a. Vestnes 1979, Tønsberg 3866a. - ST: Åfjord 1983, Tønsberg 8212, 8225. Malvik 1987, Tønsberg 9971. Melhus 1982, Tønsberg 6608, 6646, 7025. Rissa 1983, Tønsberg 8364. Trondheim 1987, Tønsberg 9999. - NT: Flatanger 1983, Tønsberg 8479a, 8484, 8489, 8493. Fosnes 1984, Tønsberg 8945. Nærøy 1982, Tønsberg 6690. - No: Bindal 1982, Tønsberg 6828, 6847, 6865 (type collection). Brønnøy 1985, Tønsberg 9227. Leirfjord 1985, Tønsberg 9239. Rødøy 1986, Tønsberg 9661. Sømna 1985, Tønsberg 9215. Sørfold 1986, Tønsberg 9736, 9741. Vega 1979, Degelius V-2358 (herb. Degelius). A total of 142 Norwegian specimens seen. **Sweden:** Uppland: Fiby par. Coppins 6090 & Tibell (E). Värmland: Dalby par., Muhr 3153, 4197, 4199A, 4199b (UPS). Karlskoga par., Muhr 6234 (UPS). Norra Finnskoga par., Muhr 7138 (UPS). Västerbotten: Skellefteå par. 1984, Muhr 7539 (UPS). **U.K.:** Scotland, West Ross 1984, Coppins 10575 et al. (E); Loch Marec 1984, Coppins 10741 et al. (BG dupl.); - Beinn Eighe, Coppins 10840 et al. (E).

Fuscidea praeruptorum (Du Rietz & Magnusson) V. Wirth & Vězda

Fig. 7.

Thallus (Fig. 7) crustose, episubstratal, distinctly delimited, areolate, rosette-forming, to 4 cm in diameter, unzoned or, sometimes, more or less zoned with alternating bands of areolae and prothallus. Prothallus usually distinctly brown, visible between the areolae and along margin of the thallus, giving the thallus a more or less brown appearance. Areolae grey or green, or green-brown, usually discrete, but sometimes locally fused, rarely predominantly contiguous, matt, convex, 0.2-0.3 mm in diameter, usually without a distinct medulla, esorediate at first, later bursting apically to form soralia. **Soralia** greyish green, pale yellowish or brownish grey, minute, up to 0.3 mm, concave, mostly discrete. Soredia fine, 30-40 µm; wall distinct; hyphae forming a network; external soredia occasionally tinged with brown. Medulla indistinct. Photobiont green, coccoid, up to 12 µm in diameter.

Apothecia sparse in 1 (5%) of the corticolous collections, lecideine, dark brownish black, up to 1 mm in diameter; proper margin 0.04-0.08 mm wide; disc plane to slightly convex.

Chemistry: Alectorialic acid with satellites. Two-dimensional chromatography (AxC) of one specimen (Tønsberg 10264) yielded a possible trace of barbatolic acid.

Substratum. *Fuscidea praeruptorum* has been found on *Betula pubescens/pendula* (8 specimens), and on *Alnus incana, Calluna vulgaris, Picea abies, Pinus sylvestris, Populus tremula, Salix caprea, and Sorbus aucuparia.* Common associates were *F. arboricola* and *Ropalospora viridis.*

Distribution. *Fuscidea praeruptorum* was found in coastal sites at altitudes between sea-level and 260 m (Aust-Agder: Bygland) and as far north as Nordland: Rana. It mostly occurred in shaded sites but was also found in open and sun-exposed situations. **Counties:** Corticolous specimens: Telemark - Sogn og Fjordane, Sør-Trøndelag, Nordland. All substrates: Østfold, Akershus, Buskerud, Telemark - Sogn og Fjordane, Sør-Trøndelag, Nordland.

Discussion. Sterile specimens of *Fuscidea praeruptorum* and *F. arboricola* are not easily distinguishable on morphology alone. However, the two species are easily separated by their chemistry, containing alectorialic acid and fumarprotocetraric acid, respectively. The only fertile specimen (Tønsberg 10205a) was from the trunk of a *Picea abies* subjected to spray from a waterfall.

Fuscidea praeruptorum is usually a saxicolous species growing on shaded to lightly shaded rock, mostly under overhangs; it may be subjected to rain or not. It has also been found on wood (*Juniperus communis*). The corticolous form seems to be less dependant on shade, often being found on trees away from cliffs and even sometimes on well-illuminated trunks. From outside Norway I have seen a corticolous specimen from Sweden: Halland (UPS). *Fuscidea praeruptorum* appears to be a coastal species. However, its range in Norway is not well known.

Specimens seen (selected): Te: Drangedal 1987, Tønsberg 10264. - AA: Bygland 1987, Tønsberg 10205a. - VA: Songdal 1987, Tønsberg 10083a. - Ro: Sauda 1988, Botnen 1658b. - Ho: Fusa 1987, Tønsberg 10024. - SF: Førde 1984, Tønsberg 8694. - ST: Åfjord 1983, Tønsberg 8227. - No: Rødøy 1986, Tønsberg 9666c. A total of 19 corticolous specimens seen.

Fuscidea pusilla Tønsb. sp. nov.

Thallus corticolosus, plerumque minute rosulans ad 4-10(20) mm in diameter, sorediatus. Areolae griseo-virides vel virides saepe prothallos brunneos circumcinctae. Soralia viridia vel pallide flaveola, discreta vel confluentia. Apothecia et pycnidia incognita. Acidum divaricaticum continens.

Type: Norway, Hedmark, Åmot, Åset-Bechsminne, along state road 3, UTM grid ref.: 32W PN 2674 (1917 II), alt. 240 m, on *Betula pubescens/pendula* (road-side tree), 6 August 1983, Tønsberg 8041 (BG - holotype; E, UPS - isotypes).

Figs 36-37.

Thallus (Fig. 37) crustose, episubstratal, delimited, areolate or rarely continuous and rimose-cracked, sorediate, usually forming minute, inconspicuous rosettes up to 4-10 mm in diameter, rarely reaching 2 cm in diameter or more; when larger the thallus is the result of a fusion of several small ones. Occasionally the thallus was distinctly zoned with bands (up to five) of a dark brown prothallus alternating with bands of green areolae, each of which were surrounded by a pale brown prothallus; individual bands up to 0.5 mm wide. Prothallus distinct, of pale to dark brown ramifying hyphae visible between the areolae and/or as a border surrounding the thallus. Areolae greyish green to green, discrete or more or less

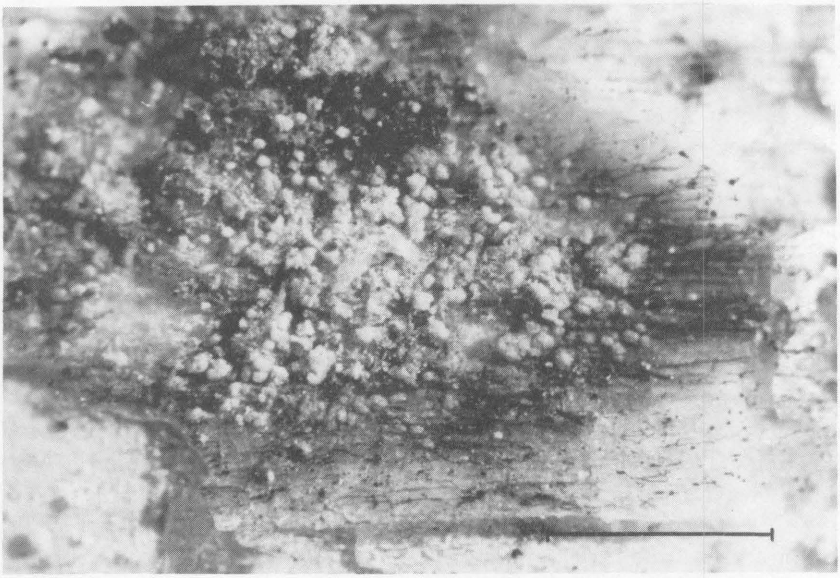


Fig. 37. *Fuscidea pusilla*. Holotype. Scale 1 mm.

contiguous, rather variable, irregularly rounded, convex, sometimes bullate, rarely tending to become edge on to the substratum and then more or less subsquamiform, up to 0.4 mm in diameter. **Soralia** green to pale yellowish, bursting from the apices of the areolae, irregular, in specimens with contiguous areolae usually soon becoming confluent. Soredia loosely packed; fine to coarse, 20-50 µm in diameter; wall distinct, discontinuous. Medulla indistinct or absent. Photobiont green, coccoid or, when in the process of cell division, with a dividing wall, globose to broadly ellipsoid, individual cells up to 10 µm in diameter.

Apothecia and pycnidia unknown.

Chemistry: Divaricatic acid, ± a trace of nordivaricatic acid. Specimens tested with HPLC also contained a trace of imbricaric/stenosporic acid.

Substratum. *Fuscidea pusilla* has most commonly been collected on *Betula pubescens/pendula* (46 specimens) and *Alnus incana* (38); other phorophytes included *Alnus glutinosa*, *Malus domestica* and *Picea abies* (especially twigs and needles), and more rarely, *Acer*, *Fagus sylvatica*, *Juniperus communis*, *Pinus sylvestris*, *Populus tremula*, *Prunus avium*, *P. domestica*, *Pyrus communis*, *Rhododendron catawbiense*, *Salix caprea*, and *Sorbus aucuparia*. On needles of *Picea* it has been found associated with *Lilliputeana curvata* Serusiaux ined. (see Serusiaux 1989).

Distribution. *Fuscidea pusilla* was found throughout most of the country (Fig. 36). Its vertical distribution ranged from about sea-level to 800m (Telemark: Vinje). *Fuscidea pusilla* occurred in shaded as well as in open situations. It was often found in polluted sites in or near the centres of larger towns, e.g., Bergen, Drammen, Grimstad, Kristiansand, Oslo, and Trondheim, and along some busy state roads. In polluted areas it often occurred closely associated with *Scoliciosporum chlorococcum* and, sometimes, with *Lecanora conizaeoides*. Most collections were, however, from non-polluted sites. **Counties**: Østfold - Nordland, Finnmark.

Discussion. Diagnostic characters for *Fuscidea pusilla* are the minute colony-forming thalli, the distinct, brown prothallus and the presence of divaricatic acid. *Fuscidea recensa* is chemically concordant with *F. pusilla*, but has a larger, more or less glossy brown thallus with distinctly delimited soralia and blackened external soredia and should not be confused with *F. pusilla*. *Fuscidea lightfootii*, another divaricatic acid-producing species, is not known to occur in Scandinavia. That species is usually fertile or has pycnidia (see Duncan 1970, Coppins & James 1978) and is further distinct in being usually brownish grey, having soredia which may be black-brown, a black prothallus as well as a larger thallus (up to 5 cm in diameter) according to Oberhollenzer & Wirth (1984).

Fuscidea pusilla may be morphologically similar to *Ropalospora viridis*. However, that species is usually much larger and often more intensely green. Chemically *R. viridis* is distinct from *Fuscidea pusilla* in containing perlatolic acid as its major substance and no divaricatic acid.

Some large specimens, about 1-2 cm in diameter, with very coarse, contiguous, greyish green and frequently esorediate areolae were only tentatively assigned to *Fuscidea pusilla*. Most of these specimens (e.g., Tønsberg 4170, 7805, 7812, 7817, and 7821) were from western parts of southern Norway. The possibility that this material represents a taxon of its own was not ruled out.

Fuscidea pusilla has not been found with apothecia or pycnidia. The assignment of the species to *Fuscidea* should therefore be regarded as conjectural. However, the areolate, rosette-forming thallus, the distinct brown prothallus and the presence of divaricatic acid suggest an affinity with *Fuscidea*.

Fuscidea pusilla seems to be a toxitolerant species. It is the only corticolous species of *Fuscidea* known to occur as far north in Norway as Finnmark. From outside Norway *Fuscidea pusilla* is known from Sweden and U.K.: Scotland.

Specimens seen (selected): **Norway**: Øf: Hvaler 1983-1990, Tønsberg 7831, 8274, 13220. - Oslo 1980, Tønsberg 5346; 1981, Tønsberg 6506; 1983, Tønsberg 7780, 7782, 7785, 7787; 1984, Tønsberg 8850, 8852. - He: Åmot 1983, Tønsberg 8041 (type collection). Eidskog 1985, Tønsberg 9412a. Trysil 1988, Tønsberg 11024. Tynset 1983, Tønsberg 8181. - Op: Lunner 1982, Tønsberg 7556. Øyer 1982, Tønsberg 7523. - Bu: Krødsherad 1982, Tønsberg 6968b. Flesberg 1987, Tønsberg 10354. - Vf: Hof 1990, Tønsberg 13046. Stokke 1922, Høeg (TRH; mixed in a collection of *Phlyctis argena*). - Te: Drangedal 1987, Tønsberg 10255. Nissedal 1987, Tønsberg 10234. Seljord 1987, Tønsberg 10328. Vinje 1987 - 1991, Tønsberg 10133, 17425a. - AA: Birkenes 1986, Tønsberg 9569b. Bygland 1987, Tønsberg 10188; 1988, Tønsberg 10885. Valle 1987, Tønsberg 10165. - VA: Kristiansand 1986, Tønsberg 9545. Mandal 1986, Tønsberg 9566. - Ro: Sauda 1988, Tønsberg 10822. Suldal 1988, Tønsberg 10827, 10829a. - Ho: Bergen 1989, Tønsberg 11406. Fusa 1979, Tønsberg 4170. Osterøy 1983, Tønsberg 7752c. Tysnes 1986, Tønsberg 9503. Voss 1988, Tønsberg 11007, 11008. - SF: Flora 1983, Tønsberg 7919. Førde 1983, Tønsberg 7805, 7812, 7817, 7821, 7813, and 7817. - MR: Nesset 1979, Tønsberg 3783. - ST: Åfjord 1983, Tønsberg 8376. Melhus 1982, Tønsberg 6660, 7068. Trondheim 1981, Tønsberg 6169. - NT: Flatanger 1983, Tønsberg 8481, 8486. Namdalseid 1983, Tønsberg 8433. Namsskogan 1982, Tønsberg 6585. - No: Bodø 1986, Tønsberg 9600, 9607. Gildeskål 1986, Tønsberg 9636. Grane 1983, Tønsberg 8109. Hamarøy 1986, Tønsberg 9755. Sømna 1985, Tønsberg 9216. Sørfold 1986, Tønsberg 9735. Vestvågøy 1987, Tønsberg 10507. - Fi: Alta 1982, Tønsberg 7243b. A total of 143 Norwegian specimens seen. **Sweden**: Bohuslän, Skaftö par. 1981, Muhr 4400 (UPS). - Värmland 1985, Tønsberg 9416. - Öland 1983, Tønsberg 8012. **Denmark**: Bornholm 1987, Muhr 10506. **U.K.**: Scotland, Easterness 1985, Coppins 11145 (E).

Fuscidea recensa (Stirton) Hertel, V. Wirth & Vězda

Beitr. Naturk. Südwest-Deutschl. 31: 92 (1972). *Lecidea recensa* Stirton, in Scot. Nat. 5:1 (1880). Type: U.K.: Scotland, Kinloch Rannoch, September 1879, Stirton (BM!).

Thallus crustose, episubstratal, distinctly delimited, forming rosettes up to 2 cm diameter with a green to dark brown over-all colour, areolate or, rarely, more or less continuous, sorediate.

Prothallus distinct, dark brown, of ramifying hyphae visible between areolae and as a border surrounding the thallus. Areolae greyish brown, greenish brown or greyish green, discrete to more or less contiguous, irregularly rounded, convex, up to 0.4 mm in diameter. Continuous surface parts concolorous with the areolae, tuberculate and irregularly cracked. Soralia greyish white, often more or less brown due to a pigment (K & N+ fuscous brown in the external soredia, rarely pale green, delimited, mostly flat to concave, circular to elliptical in outline, up to 0.5 mm in diameter; in continuous specimens sometimes following thallus cracks and becoming more or less linear and up to 1 mm. Soredia fine, 20-30 µm in diameter; wall distinct, discontinuous. Medulla indistinct. Photobiont green coccoid (but frequently in the process of dividing) globose to ellipsoid, up to 10 µm in diameter.

Apothecia and pycnidia not observed in Norwegian corticolous material.

Chemistry: Divaricatic acid, ± nordivaricatic acid (trace). One specimen analysed by HPLC contained in addition a possible faint trace of imbricaric/stenosporic acid.

Substratum. *Fuscidea recensa* was collected on *Sorbus aucuparia* (6 specimens) and *Betula pubescens/pendula* (2).

Distribution. *Fuscidea recensa* occurred in the lowlands along the coast and in a small river gorge in Oppland. The vertical distribution of corticolous specimens ranged from about sea-level to 680-700 m (Oppland: Vågå). The saxicolous form has been collected up to 750 m altitude. *Fuscidea recensa* occurred in rather open situations. **Counties:** Corticolous specimens: Oppland, Møre og Romsdal - Nordland. All specimens: Oppland, Aust-Agder, Rogaland - Troms.

Discussion. According to James et al. (1981), *Fuscidea recensa* is a fertile species lacking soredia. This agrees with Stirton's description. However, the type specimen is distinctly sorediate and is in accordance with the concept of the species as used here. *Fuscidea recensa* may resemble *F. arboricola* morphologically, but is readily distinguished by the presence of divaricatic acid instead of fumarprotocetraric acid.

Fuscidea recensa is chemically concordant with *F. pusilla*. That species has a smaller thallus and unpigmented soredia. In one collection (leg. Tønsberg 8486b), in which *F. recensa* and *F. pusilla* occurred together on the same small piece of bark (*Betula*), the differences between them were evident. The thalli of *Fuscidea recensa* were up to 2 cm in diameter, the soralia discrete and rounded, and the external soredia greyish with a brown tinge. The thalli of *F. pusilla* were small, up to 3 mm in diameter, and with pale green, irregular, confluent soralia towards the centre.

Fuscidea recensa is mainly a saxicolous species in the coastal lowlands.

Specimens seen: Op: Vågå 1985, Tønsberg 9307. - MR: Smøla 1983, Tønsberg 8329. - ST: Åfjord 1983, Tønsberg 8219. Agdenes 1977, Tønsberg 1810. - NT: Flatanger 1981, Tønsberg 5494; 1983, Tønsberg 8486b. - No: Brønnøy 1985, Tønsberg 9219, 9220. A total of 8 collections seen.

Gyalideopsis Vězda

The genus *Gyalideopsis* has been treated by, e.g., James (1975), Vězda (1979), and Kalb & Vězda (1988).

Gyalideopsis anastomosans P. James & Vězda

Fig. 38.
Thallus crustose, episubstratal, grey to green, more or less indeterminate, very thin (film-like), following the contours of the substratum, smooth, glossy, mostly continuous, but sometimes more or less discontinuous at the edge, up to 3 cm in diameter, with thlasidia. Prothallus not evident. **Thlasidia** numerous, mostly discrete, pale green towards the base due to the presence of photobiont cells, colourless in the upper part, simple or, rarely, bifurcately divided in the upper part, subcylindrical in the lower part, often flattened and widening in the upper colourless part, up to 0.4 mm tall and 0.04-0.08 mm wide; apices acute. Medulla absent. Photobiont green, coccoid, in thallus 5-12 µm, in thlasidia 5-7.5 µm.

Apothecia not seen in Norwegian material, but according to James (1975), based on British material, red to black-brown with an even or irregularly crenulate proper margin, up to 0.4 mm in diameter.

Chemistry: No substances found.

Substratum. *Gyalideopsis anastomosans* has been collected most frequently on *Calluna vulgaris* and more rarely on *Alnus glutinosa*, *Juniperus communis*, and *Salix aurita*. It was usually found on naked bark; in one specimen it had secondarily spread to a bryophyte. Noteworthy associated lichen species included *Micarea coppinsii*, *M. lignaria*, *M. peliocarpa*, *Placynthiella icmalea*, and *Trapeliopsis pseudogranulosa*. Most specimens were from maritime heath.

Distribution. *Gyalideopsis anastomosans* has been found in westernmost Norway (Vestlandet)(Fig. 38) at altitudes between sea-level and 100(-240) m. **Counties**: Rogaland - Sogn og Fjordane.

Discussion. *Gyalideopsis anastomosans* is an easily- recognized species on account of the characteristic thlasidia. However, due to its small size, the species is easily overlooked in the field. In Norway two other corticolous species of *Gyalideopsis* are known, *G. alnicola* Noble & Vězda (Tønsberg 1988b) and *G. muscicola* (Santesson 1984). Those species are distinct from *Gyalideopsis anastomosans* by their hyphophores, which are brown to black, curved towards the thallus surface, and become wider and deeply divided towards the apices.

Gyalideopsis anastomosans is a coastal lowland species in Norway. In Sweden it is known from Värmland and Skåne (Muhr 1987, Arup & Ekman 1991a).

Specimens seen: Ro: Tysvær 1981, Skjolddal. - Ho: Bergen 1984, Tønsberg 9054a. Fjell 1989, Tønsberg 12017. Os 1989, Tønsberg 11523, 11550. - SF: Askvoll 1989, Tønsberg 11780. Bremanger 1989, Tønsberg 11831, 11837, 11847. Gulen 1989, Tønsberg 11746.

Haematomma Massal.

The species of *Haematomma* discussed here has been treated by Laundon (1970, 1978). *Haematomma elatinum* (Ach.) Massal. is placed in *Loxospora*.

Haematomma ochroleucum (Necker) Laundon var. ***ochroleucum*** & var. ***porphyrium*** (Pers.) Laundon

Thallus crustose, yellow-green to yellow, green, greenish grey, bluish grey or, sometimes grey with a faint trace of brown, episubstratal, delimited, forming rosettes or, more rarely, irregular

Figs 38-39. Distribution maps. Fig. 38. *Gyalideopsis anastomosans*. Fig. 39. *Halecania viridescens*. Distribution in Scandinavia.

patches, up to a dm or more in diameter, usually thick, continuous and with a leprose sorediate surface, rarely with distinct esorediate areolae. Prothallus distinct, white. Surface usually entirely sorediate, only young, more or less areolate specimens may have discrete soralia. **Soredia** mostly in coarse, rounded to elongate consoredia, 25-125(- 250) µm in diameter; old herbarium specimens had colourless crystal needles projecting from the surface; wall usually distinct. Medulla distinct in well-developed specimens, white. Photobiont green, coccoid, up to 12 µm in diameter.

Apothecia present in two (13%) of the specimens (var. *porphyrium*), up to 10 mm in diameter; disc crimson (K+ violet), up to 5 mm in diameter. Pycnidia observed in three collections (Tønsberg 8739, 8740, 13414) of var. *porphyrium*, crimson (K+ violet), more or less surrounded by soredia, 0.2 mm in diameter; conidia colourless, simple, curved, 12-15 × 1 µm.

Chemistry: I (= var. *ochroleucum*) Atranorin, usnic acid, porphyrilic acid, zeorin, unidentified terpenoids. (5 specimens). II (= var. *porphyrium*) Atranorin, porphyrilic acid, zeorin, unidentified terpenoids (as in I), ± 1-2 fatty acids in moderate to trace amounts. (10 specimens).

Substratum. *Haematomma ochroleucum* was found on *Fagus sylvatica, Fraxinus excelsior, Quercus, Populus tremula,* and *Sorbus aucuparia* on shaded bark close to rock walls or, more rarely, on trees in open, sunny sites.

Distribution. *Haematomma ochroleucum* occurred in the coastal lowlands from Østfold to Sogn og Fjordane. The vertical distribution ranged from about sea-level to 200 m. **Counties:** - Var. *ochroleucum*: Østfold, Akershus, Vest-Agder. - Var. *porphyrium*: Østfold, Rogaland, Hordaland, Sogn og Fjordane. All substrates: - Var. *ochroleucum*: Østfold, Akershus, Vestfold, Aust-Agder - Sogn og Fjordane, Sør-Trøndelag, Nord-Trøndelag, Nordland. - Var. *porphyrium*: Østfold, Akershus, Oppland - Aust-Agder, Rogaland - Nordland.

Discussion. *Haematomma ochroleucum* comprises two colour variants based on the presence or absence of usnic acid. It is a tradition among lichenologists to assign formal taxonomic status to chemotypes which are immediately recognized by colour due to differences in the content of pigments. The former variant, var. *ochroleucum*, is usually more or less yellowish, the latter, var. *porphyrium*, is usually more or less greyish. However, var. *ochroleucum* varies greatly in colour. Specimens growing in deep shade may be greenish without a yellowish tinge and produce only a trace of usnic acid. Sometimes the varieties are hardly determinable without using chemical methods. Var. *ochroleucum* resembles *Megalospora tuberculosa* which also has yellow, coarse soredia and develops crystal needles on the surface (herbarium specimens). However, that species lacks atranorin and porphyrilic acid. Var. *ochroleucum* may also resemble *Lecanora expallens* but is distinguished from that species by the distinct, white prothallus and the lack of xanthones.

Haematomma ochroleucum is easily recognized by the chemistry. With the exception of *Lepraria caerulescens*, no other species discussed here contains the dibenzofuran porphyrilic acid (see also var. *porphyrium* below).

The presence of terpenoids other than zeorin appears not to have been previously reported from *Haematomma ochroleucum* (see Culberson 1969, 1970; Culberson et al. 1977, Laundon 1978). Terpenoids were also present in all saxicolous specimens examined, and seem to be constant substances; the crystal needles projecting from the surface of the soredia apparently originate from these substances.

Haematomma ochroleucum is a common saxicolous taxon growing on shaded rock walls under overhangs; corticolous specimens are rare. In southernmost Scandinavia (Denmark, Sweden: Skåne) corticolous forms are rather common and in parts of Central Europe most specimens are corticolous (Wirth 1980). In Norway the saxicolous form of var. *ochroleucum* has been found in the lowlands (up to 250 m) along the coast from Østfold to Nordland; from Nord-Trøndelag there is a microclimatically humid inland station at 400-480 m altitude (leg. Holien 3583 (TRH)). The saxicolous form of var. *porphyrium* is known as far N as Nordland and up to an altitude of 990 m (Sør-Trøndelag: Oppdal). In Norway var. *porphyrium* is more common than var. *ochroleucum*, especially in the northern part of the range of the species, and in North America var. *porphyrium* is the only variety present (see Egan 1987, 1989, 1990, 1991).

Specimens seen: - Var. *ochroleucum*. Øf: Hvaler 1983, Tønsberg 7859, 8150, 8151. - Oslo 1984, Tønsberg 8513. - VA: Søgne 1978, Tønsberg 3178. - Var. *porphyrium*. Øf: Hvaler 1983, Tønsberg 7860. - Ro: Rennesøy 1971, Jørgensen 3506; Tysvær 1986, Øvstedal. - Ho: Odda 1984, Tønsberg 8739, 8740. Sund 1990, Tønsberg 13414, 13424. - SF: Naustdal 1983, Tønsberg 7926b. Stryn 1983, Tønsberg 7878, 7881.

Halecania Mayrhofer

The genus *Halecania*, which was introduced by Mayrhofer (1987), is closely related to *Lecania* s. str. and to *Catillaria* s. str. (Mayrhofer 1987, Coppins 1989b).

Halecania viridescens Coppins & P. James

Lichenologist 21: 224 (1989). Type: U.K.: Scotland, Dunbartonshire, Loch Lomond National Nature Reserve, Shore Wood, 26/42.87, on prostrate branch of *Salix* by shore of lake, 5 Sept. 1980, Coppins 8212 (E! -isotype). TLC: argopsin, norargopsin (moderate amounts), gracilenta unknown 1.

Fig. 39.

Thallus crustose, episubstratal, thin, forming irregular patches from a few mm to several cm in diameter, indeterminate, areolate, sorediate. Prothallus not evident. Areolae fragile, green, rounded, convex, more or less discrete, up to 0.2 mm in diameter, usually soon bursting to form soralia. Soralia green, punctiform, more or less discrete, concave to more or less plane, up to 0.2 mm in diameter. **Soredia** fine, 12-20 µm in diameter; wall poorly developed; encapsulating hyphae of external soredia sometimes with a brown, K-, N- pigment. Medulla absent. Photobiont green, coccoid to broadly ellipsoid, up to 6(-12) µm, mostly in clusters.

Apothecia sparingly present in one (25%) of the collections, inconspicuous, up to 0.2 mm in diameter; thalline margin sorediate; disc plane, pale greyish brown. Spores 1-septate, with epispore, 13-15 × 4-5.5 µm.

Chemistry: Argopsin (major substance), norargopsin (trace to moderate amounts), gracilenta unknown 1.

Substratum. *Halecania viridescens* has been found on *Aesculus hippocastanum* and *Malus domestica* in gardens, and on *Salix nigricans* on a river bank. Associated lichens included *Buellia griseovirens*, *Candelariella reflexa*, *Parmelia* (*Melanelia*) *glabratula*, *P. saxatilis*, *P. sulcata*, *Physcia tenella* and *Xanthoria polycarpa*.

Distribution. *Halecania viridescens* has been found in the coastal lowlands of westernmost Norway (Fig. 39) at 40-60 m altitude. **County:** Hordaland.

Discussion. *Halecania viridescens* is an inconspicuous lichen. However, it may be identified, even in the field, by the dark green colour of the minute soralia. Chemically, it is similar to *Lecidea efflorescens* in producing argopsin and norargopsin, but differs by the presence of gracilenta unknown 1. Morphologically it is distinct from that species by the much smaller, green (never yellowish) soralia. *Halecania viridescens* and *Lecidea efflorescens* are largely allopatric. The former appears to be a coastal species, so far known from U.K.: Scotland and westernmost Norway only, whereas the latter is an eastern species in northern Europe being very rare in the British Isles (Coppins, pers. comm. 1990) and with only a few outpost localities in westernmost Norway (see Figs 39 and 51).

Halecania viridescens appears to be a species of eutrophic bark in coastal sites. It is new to Scandinavia.

Specimens seen: Ho: Austevoll 1990, Tønsberg 13584. Bergen 1990, Tønsberg 13441, 13731. Voss 1991, Tønsberg 17368.

Hypocenomyce M. Choisy

The genus *Hypocenomyce* has been monographed for Norway and Sweden by Timdal (1984).

Hypocenomyce leucococca R. Sant.

Thunbergia 2: 3 (1986). [*Ochrolechia dispersa* R. Sant. (ined.), in Degelius, Acta Regiae Scient. Lit. Gothoburgensis. Botanica 2: 89 (1982).]

Figs 40-41.

Thallus (Fig. 40) crustose to subsquamulate, episubstratal, usually indeterminate, thick, forming small patches between other lichens or, more rarely, spreading irregularly up to a dm or more across, areolate, sorediate. Prothallus usually as an indistinct pale greyish brown stain or, more rarely, distinctly brown, blue or blackish (aeruginose in LM; N-). Areolae usually persistently discrete, rarely becoming contiguous or, very rarely, more or less imbricate, varying in outline from almost circular to irregular and elongate, often distinctly incised and constricted at the base (subsquamiform), occasionally tending to become raised at the edge (as a result of development of marginal soralia?), flat to convex, conspicuous, up to 0.4(-1.0) mm across; esorediate surface usually distinct, smooth, dull, greyish white, pale yellowish green, or pale yellowish brown; in the herbarium often becoming more distinctly yellowish brown or pink. **Soralia** pale green to pale yellowish with a brown tinge, (usually becoming distinctly yellowish brown in the herbarium), occasionally distinctly aeruginose due to a pigment (fading in K, N+ brown) in the external soredia, usually marginal and more or less labriform, sometimes laminal and more or less orbicular, or apical and more or less capitate, usually delimited. Soredia mostly fine, 20-45 µm in diameter; wall distinct. Medulla distinct, white. Photobiont green, coccoid, up to 15 µm in diameter.

Apothecia and pycnidia not observed.

Chemistry. Alectorialic acid with satellites in trace amounts.

Substratum. *Hypocenomyce leucococca* has been found on *Betula pubescens/pendula* (79 specimens), *Alnus incana* (45), and *Sorbus aucuparia* (27), and, more rarely, on *Alnus glutinosa, Fagus sylvatica, Picea abies* (mainly twigs), *Pinus sylvestris, Prunus avium, P. padus*, and *Salix caprea.*

Distribution. *Hypocenomyce leucococca* occurred most commonly in north-eastern parts of Norway (Fig. 41). It has been found near the centres of towns, and along busy state roads. In such sites it often occurred associated with, e.g., *Fuscidea pusilla* and *Scoliciosporum*

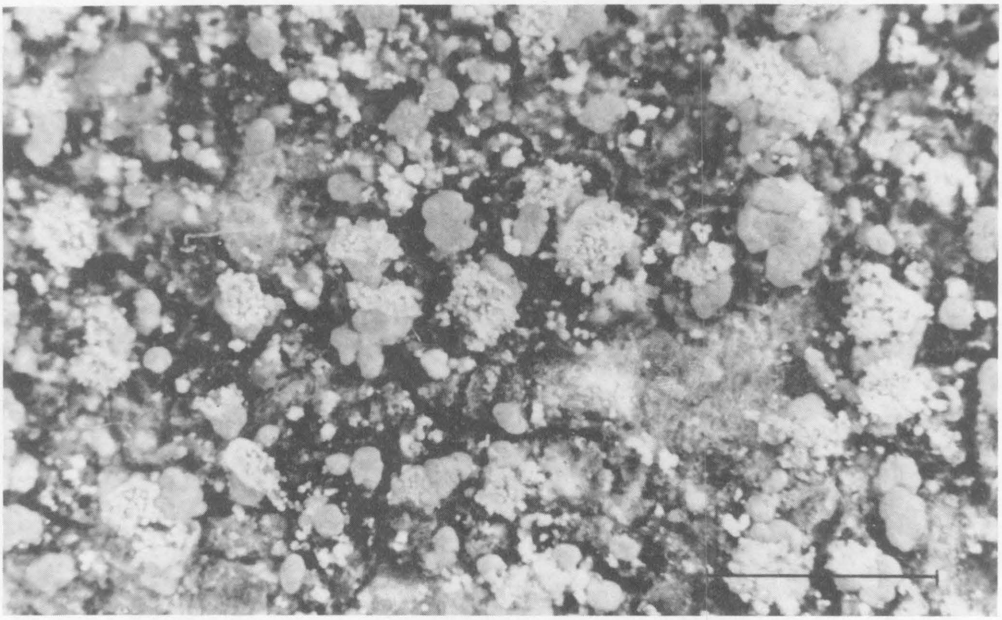
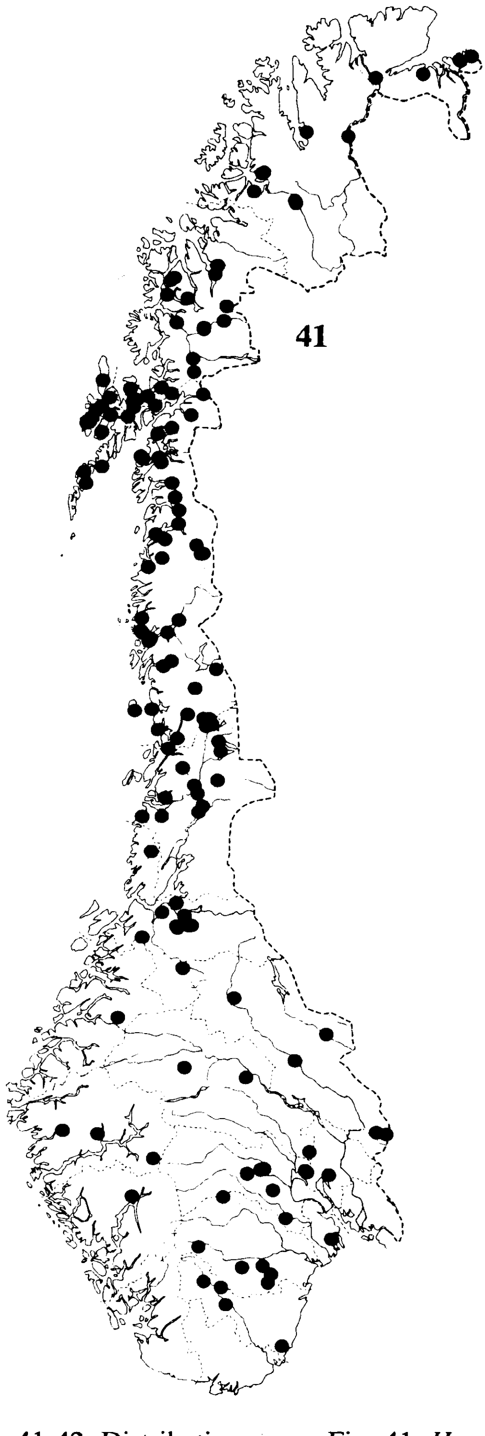
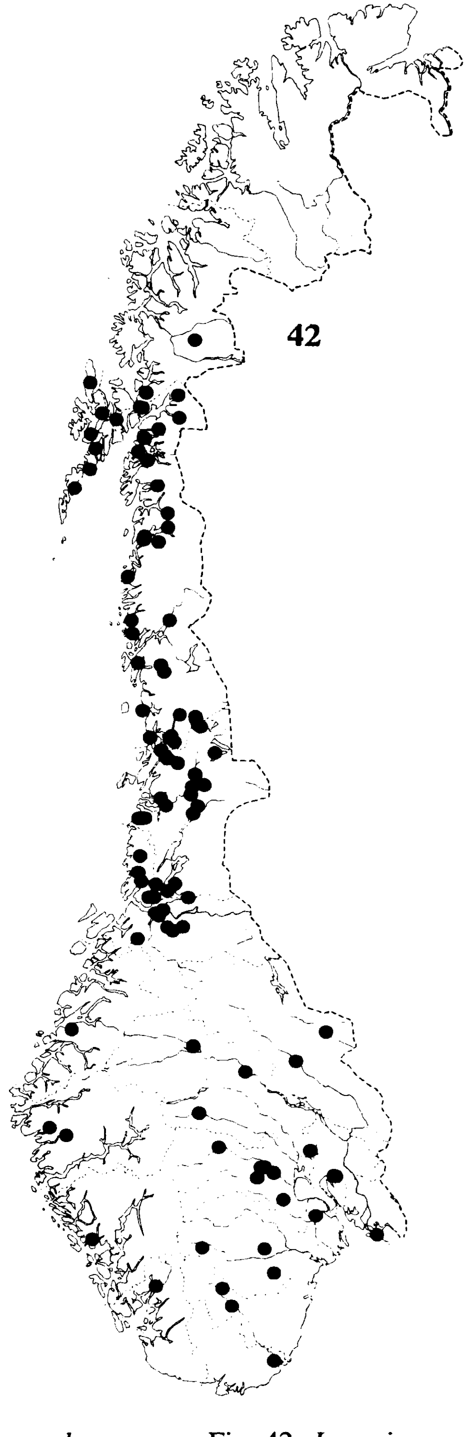


Fig. 40. *Hypocenomyce leucococca*. Tønsberg 6620. Scale 1 mm.

chlorococcum. However, most collections were from non-polluted areas. Its vertical distribution ranged from about sea-level to 900 m (Oppland: Vågå). The first known collection of *Hypocenomyce leucococca* was made in Troms in 1910 (leg. Lynge, mixed in material of *Lecidea cinnabarina* (UPS)), and *Ochrolechia androgyna* A (O)). **Counties:** Akershus - Aust-Agder, Hordaland - Finnmark.

Discussion. *Hypocenomyce leucococca* is usually an easily recognized species on account of its conspicuous, usually more or less incised, often subsquamiform, greyish white to pale yellowish areolae, and its corticolous habit. It is, however, rather similar to *H. sorophora*. That species has smaller areolae which are superficial or immersed in the substratum, and frequently entirely dissolved into soredia. Furthermore, *H. sorophora* favours wood of conifers; only rarely is it corticolous (for details, see that species), while *H. leucococca* is mainly corticolous on deciduous trees. In two collections (Tønsberg 6569 and 7453) in which *H. leucococca* and *H. sorophora* occurred together on the same small pieces of bark (*Pinus sylvestris* and *Picea abies*) the differences between them were obvious. The areolae of *H. sorophora* were mostly yellowish green, crustose, minute, up to 0.2 (-0.4) mm in diameter, superficial and partly corticate in one specimen, immersed and completely dissolved into soredia in the other. Those of *H. leucococca* were yellowish brown without a green tinge, crustose to subsquamiform, larger, up to 0.5(- 0.8) mm in diameter, distinctly superficial and with distinct esorediate areas. A form of *H. leucococca* with more or less capitate soralia may resemble the chemical concordant *Pertusaria geminipara*. However, in the former species there will always be at least some subsquamiform, marginally sorediate areolae. These are absent in the latter. The satellite substances occurring with alectorialic acid appeared to be identical with those occurring with alectorialic acid in *Pertusaria geminipara*. *Hypocenomyce leucococca* is neither known with apothecia, nor with pycnidia. The species





Figs 41-42. Distribution maps. Fig. 41. *Hypocenomyce leucococca*. Fig. 42. *Japewia subaurifera*.

may prove to be a member of the *H. xanthococca* group (see Timdal 1984) as it shows morphological similarities to and is chemically concordant with *H. sorophora*. However, fertile material, or at least material with pycnidia is needed before its affinities can be conclusively settled.

Hypocenomyce leucococca is a species of acidic bark with a preference for northern sites. It may rarely occur on wood (*Picea* and *Pinus*). It seems to be able to withstand moderate amounts of air pollution. In Sweden it occurs commonly from Värmland and northwards. Outside Scandinavia it is known from Finland, Canada (British Columbia) and Austria (Santesson 1986). In Austria it has been collected at 1385 m altitude.

Specimens seen (selected): Ak: Bærum 1981, Tønsberg 6420b. - He: Kongsvinger 1985, Tønsberg 9429. - Op: Lunner 1982, Tønsberg 7555. - Bu: Krødsherad 1982, Tønsberg 6928. - Vf: Stokke 1922, Høeg (TRH; mixed in a collection of *Phlyctis argena*). - Te: Kviteseid 1987, Tønsberg 10297. - AA: Bykle 1987, Tønsberg 10153. - Ho: Voss 1988, Tønsberg 11005. - SF: Førde 1984, Tønsberg 8696. - MR: Nesset 1979, Tønsberg 3901b. - ST: Melhus, 1982, Tønsberg 7083. - NT: Namsskogan 1980, Tønsberg 5101. - No: Grane 1981, Tønsberg 5986. - Tr: Målselv 1982, Tønsberg 7315. - Finnmark: Alta 1982, Tønsberg 7241. A total of 176 specimens seen.

Hypocenomyce scalaris (Ach.) M. Choisy

(Description somewhat modified from Timdal (1984).)

Thallus squamulose, indeterminate. Squamules up to 1.2 (-2.0) mm in diameter, ascending, geotropically oriented, imbricate, remaining discrete or more rarely becoming somewhat contiguous, weakly convex to hemispherical. Margin slightly upturned, entire or crenulate. Upper side greyish green to dark brown, dull; underside white. **Soralia** labriform, occurring along the margin and covering the underside of the squamules. Soredia brown along the margin of the squamules, otherwise green, mostly fine, 20-35 µm in diameter; wall distinct. Photobiont green, coccoid, up to 12(-19) µm in diameter.

Apothecia present in 9 (9%) of the corticolous specimens, up to 1.5 (-2.5) mm in diameter, attached marginally to the base of the squamules, persistently plane and marginate, black, mostly bluish-white pruinose. Pycnidia not common, up to 0.2 mm in diameter, attached marginally or laminally to the upper or lower side of the squamules, or apparently directly to the substratum. Conidia bacilliform, 5-7.5 × 1.0 µm.

Chemistry: Lecanoric acid, ± scalaris unknown (pigment; corresponds to scalaris unknown 3 of Timdal (1984)), ± atranorin (trace), (unidentified substances in moderate to trace amounts, see Timdal 1984). Cortex PD- , K-, C+ red, KC+ red, UV-. Medulla and soralia PD-, K-, C+ red, UV+ faintly white.

Substratum. *Hypocenomyce scalaris* was most commonly collected on *Pinus sylvestris*, both when corticolous (72 specimens) and lignicolous, and on *Betula pubescens/pendula*, and *Picea abies*; other phorophytes included *Acer platanoides, Aesculus hippocastanum, Larix decidua*, and *Tilia*. It usually occurred most abundantly low down on the tree-trunks.

Distribution. *Hypocenomyce scalaris* was found throughout most of the country. The vertical distribution of corticolous specimens ranged from about sea-level to 990 m (Oppland: Vågå). **Counties**: Corticolous specimens: Østfold - Nord-Trøndelag, Troms, Finnmark. All specimens: Østfold - Finnmark.

Discussion. Although variable, *Hypocenomyce scalaris* is a distinctive species on account of its distinctly squamiform areolae. An extreme form most frequent on bark is mostly sterile, and has greyish green, rather small, discrete squamules with an entire, strongly sorediate margin and underside. Another form, most frequent on burnt wood, has dark brown, larger and more proliferating squamules with a crenulate margin. Most specimens were intermediate between these two extremes (Timdal 1984).

Hypocenomyce scalaris is common also on burnt wood, and may rarely occur on rock and on the ground (Timdal 1984). The species is toxitolerant and may cover extensive parts of tree-trunks in semi-urban areas. According to Timdal (1984), *Hypocenomyce scalaris* is widespread and common in Norway except for the westernmost parts. However, several recently collected specimens from Rogaland: Sola (lignicolous) and Hordaland: Bergen (corticolous) extend its area to include the western coast as well.

Corticolous specimens seen (selected): Øf: Moss 1986, Tønsberg 9592. - Oslo 1977, Tønsberg 1803. - He: Grue 1980, Timdal 2203 (O). - Op: Sel 1982, Tønsberg 7513. - Bu: Nedre Eiker 1981, Timdal 3085 (O). - Vf: Larvik 1922, Høeg (TRH). - Te: Notodden 1980, Timdal 1003 (O). - AA: Bygland 1980, Nordnes (O). - VA: Kristiansand 1980, Hansen (O). - Ro: Sokndal 1980, Timdal 1325 (O). - Ho: Bergen 1986, Tønsberg 9502. - SF: Luster 1982, Timdal 3576 (O). - MR: Sunndal 1902, Havaas. - ST: Trondheim 1980, Tønsberg 4529. - NT: Grong 1981, Timdal 2979 (O). - Tr: Tromsø 1914, Lynge (O). - Fi: Sør-Varanger, Norman. A total of 102 specimens seen.

Hypocenomyce sorophora (Vainio) P. James & Poelt

(Description modified from Timdal (1984).)

Thallus crustose, episubstratal, areolate, indeterminate, spreading irregularly to a dm or more in diameter, sorediate, unzoned. Prothallus indistinct. Corticate areolae persistently discrete or becoming contiguous, circular or when well-developed, often somewhat irregular and more or less incised, sometimes slightly constricted at base, up to 0.6 mm in diameter, pale grey to yellowish brown, dull. **Soralia** bursting from the apices or, more rarely, from the margins of the areolae, yellow to yellowish green or yellowish brown or green, occasionally tinged brown to brown-green in the exposed part of the external soredia, discrete or sometimes becoming confluent forming a more or less leprose crust; brown pigment N+ brownish, perhaps with a violet tinge. Soredia mostly fine, simple and 20-30 µm in diameter, sometimes in elongate consoredia up to 50 µm; wall distinct. Medulla indistinct or distinct. Photobiont green, coccoid, up to 12 µm in diameter.

Apothecia present in three (13%) of the specimens, up to 0.6 mm in diameter, attached to the areolae or apparently directly to the substratum, persistently plane and marginate, black, epruinose. Pycnidia (not observed in corticolous material) up to 0.2 mm in diameter, attached to the areolae or apparently directly to the substratum. Conidia ellipsoid to shortly bacilliform, 3.5-5 × 1.5-2.5 µm.

Chemistry: Alectorialic acid with satellites. Cortex, medulla and soralia PD+ yellow. K+ yellow, C+ red, KC+ red; UV-.

Substratum. Corticolous specimens of *Hypocenomyce sorophora* have been collected on *Picea abies* (9 specimens) including one collection from *P. abies* ssp. *obovata* and *Pinus sylvestris* (9), and, more rarely, *Alnus incana* ssp. *kolaënsis* and *Betula pubescens/pendula*.

Distribution. The corticolous specimens of *Hypocenomyce sorophora* were found in eastern parts of the country at altitudes between about sea-level and 970 m. Lignicolous specimens have been collected up to 920 m altitude. **Counties:** Corticolous specimens: Hedmark - Buskerud, Vest-Agder, Telemark, Sør-Trøndelag - Nordland, Finnmark. All specimens: Akershus - Buskerud, Telemark, Vest-Agder, Sør-Trøndelag - Finnmark.

Discussion. The present corticolous material of *Hypocenomyce sorophora* exhibits little variation. When lignicolous, however, *H. sorophora* shows great variation (Timdal 1984). One form has distinct corticate areolae, another is sorediate throughout with no distinct corticate parts. Most specimens are intermediate between these extremes. *Hypocenomyce sorophora* is apparently closely related to *H. leucococca* with which it is most likely to be confused (see that species). Specimens with a brownish, indeterminate, more or less leprose sorediate thallus may resemble *Lecidea porphyrospoda*. However, that species contains lobaric acid (PD-, C-; UV+) and should not be confused with *H. sorophora*.

Hypocenomyce sorophora is usually a lignicolous species on old, erect trunks of *Pinus sylvestris*, and on man-made substrates (fences, buildings). It seems to prefer open situations. In Norway *Hypocenomyce sorophora* appears to be an eastern species (see also Timdal 1984).

Corticolous specimens seen (selected): He: Engerdal 1988, Tønsberg 11038. - Op: Sel 1990, Tønsberg 13146. - Bu: Krødsherad 1982, Tønsberg 6954b. - Te: Nissedal 1987, Tønsberg 10249. - VA: Songdalen 1991, Tønsberg 17407. - ST: Oppdal 1982, Tønsberg 7046. - NT: Namsos 1984, Tønsberg 8926. - No: Grane 1983, Tønsberg 7978. - Fi: Sør-Varanger 1987, Øvstedal. A total of 23 specimens seen.

Japewia Tønsb.

The recently described genus *Japewia* (Tønsberg 1990b) was referred to the Bacidiaceae on the basis of the ascus structure by Eriksson & Hawksworth (1991a).

Japewia subaurifera Muhr & Tønsb.

Lichenologist 22: 206-207 (1990). Type: Norway, Nord-Trøndelag, Namsskogan, along brook Åsbekken S of hill Smalåsen, 290-300 m, UTM grid ref.: 33W, VN 2217 (map 1925 III), 8 April 1982, T. Tønsberg 6590 (BG - holotype; BM, UBC - isotypes).

Fig. 18, 42.

Thallus crustose, endo- to episubstratal in non-sorediate parts, indeterminate, forming more or less irregular patches between other crustose lichens, usually up to 1-2 cm diameter, sometimes becoming confluent with other thalli and then forming larger patches, mostly areolate, but sometimes partly continuous and then often secondarily cracked into angular segments, sorediate. Prothallus usually indistinct, sometimes forming a brownish, weakly developed network of hyphae between the soralia and areolae and an irregular border around the thallus. Areolae indistinct or absent, greenish on shaded parts of thallus, greenish-brown to brown on exposed parts, rounded to irregular in outline, flat to slightly convex, up to 0.15 mm in diameter, mostly discrete, but occasionally tending to fuse forming an irregular, continuous crust. **Soralia** bursting through the uppermost cell layers of the substratum or from episubstratal areolae, medium brown to dark brown externally, yellow to yellowish-green internally or, where the external soredia have been more or less shed, a mixture of brown and yellow, delimited to diffuse, punctiform, rounded, more or less convex and discrete at first, later often becoming confluent forming a more or less thickish, leprose crust. Soredia to 30 µm in diameter, sometimes in more or less rounded aggregations to 75 µm, with yellowish, oily droplets (evident at least in fresh material); external soredia surrounded by a cortex (wall) of brown, globose cells; brown pigment K+ fuscous brown. Photobiont green, coccoid, up to 10(-15) µm in diameter.

Apothecia sparse, in 10 (7%) of the collections, emarginate, biatorine, discrete, irregularly dispersed, chestnut brown, epruinose, matt to glossy, up to 0.4 (-0.6) mm in diameter, more or less circular in outline, more or less plane to slightly or, rarely, markedly convex; surface often somewhat uneven. Pycnidia not seen.

Chemistry: Subaurifera unknowns 1 - 3 (pigments), subaurifera unknown 4 (trace), traces of other unidentified substances (probably pigments), ± lobaric acid. Yellow pigment: PD-, K- or K+ intensifying, C- or C+ intensifying, KC- or KC+ fugitive pale orange. Thallus UV-, or UV+ bluish white in specimens with lobaric acid. Lobaric acid was found, in easily detectable amounts, in 7 specimens. TLC: Fig. 18.

Substratum. *Japewia subaurifera* has mostly been collected on trunks of *Betula pubescens/pendula* (51 specimens), *Alnus incana* (41), *Sorbus aucuparia* (20) and trunks and twigs of *Picea abies* (20); other phorophytes included *Alnus glutinosa*, *Juniperus communis*, *Prunus padus*, *Salix caprea*, and *Pinus sylvestris*.

Distribution. *Japewia subaurifera* has been most commonly collected in Trøndelag and in Nordland; on the southernmost and westernmost coasts and in Troms and Finnmark it was sparse or absent (Fig. 42). Its known vertical distribution ranged from about sea-level to 800 m (Te: Vinje). **Counties**: Østfold - Troms.

Discussion. *Japewia subaurifera* is usually easily recognized on account of its characteristic soralia consisting of brown and yellow soredia. In specimens from shaded habitats the yellow pigment may be less distinct. Such specimens may be confused with *Placynthiella dasaea*. However, these two species differ markedly in chemical constituents.

Japewia subaurifera is a species of acidic bark of deciduous as well as of coniferous trees. It has occasionally been found on wood (*Pinus sylvestris*). It seems to prefer moderately shaded and somewhat humid habitats, e.g., river-banks and north-facing slopes. Outside Norway, *Japewia subaurifera* is known from Sweden, Finland, U.K.: Scotland, Canada (British Columbia), and U.S.A.: Washington (Tønsberg 1990b).

Specimens seen (selected): Øf: Hvaler 1989, Tønsberg 11711. - Oslo 1983, Tønsberg 7842. - He: Åmot 1982, Tønsberg 6895. - Op: Lunner 1982, Tønsberg 7544b. - Bu: Ål 1991, Tønsberg 17228. - Vf: Hof 1990, Tønsberg 13051. - Te: Drangedal 1987, Tønsberg 10253. - AA: Valle 1987, Tønsberg 10180. - VA: Vennesla 1939, Magnusson 16650 (UPS; mixed in a collection of *Pertusaria borealis*). - Ro: Suldal 1988, Botnen 1584. - Ho: Os 1984, Tønsberg 8773. - SF: Førde 1984, Tønsberg 8679. - MR: Vestnes 1979, Tønsberg 3858b. - ST: Åfjord 1983, Tønsberg 8210. - NT: Narvik 1986, Tønsberg 9777. - Troms 1982, Tønsberg 7349. A total of 147 corticolous specimens seen.

Lecanactis Körber

The genus *Lecanactis* is in urgent need of monographic treatment.

Lecanactis latebrarum (Ach.) Arnold

Arnold Lich. Exs. 1125, label 1885. Lichen latebrarum Ach., Lich. Suec. Prodr., 1798: 7. Type: Sweden "in montibus Ostrogothiae silvestris colleginus", E. Fries: Lich. suec. exs. 121 (UPS! - neotype; BG!, O! - isoneotypes).

Synonyms: see Jørgensen & Tønsberg (1988).

Fig. 18.

Thallus crustose to subfruticose, episubstratal, greyish white, sometimes brown-tinged, often with a rose tinge when fresh, with a leprose surface composed of irregular to somewhat flattened aggregations of soredia and hyphae, forming soft, more or less delimited, rounded, convex, often semiglobular cushions up to 0.5 cm wide. Medulla composed of colourless hyphae densely beset with plate-like crystals. Hypothallus indistinct or absent. **Soredia**

sometimes fine, consisting of a single photobiont cell surrounded by hyphae, but usually they were coarse containing numerous photobiont cells, rounded or more or less irregular and up to 200 µm or more in diameter, without a wall. Photobiont *Trentepohlia*; cells coccoid, simple (not forming chains) up to 20 µm.

Apothecia not known.

Chemistry: Lepraric acid, latebrarum unknown, roccellic acid. TLC: Fig. 18.

Substratum. Corticolous specimens of *Lecanactis latebrarum* were found on *Betula pubescens/pendula* and *Sorbus aucuparia* under rock overhangs. Associated lichens included *Chaenotheca stemonea, Enterographa zonata, Haematomma ochroleucum*, and *Lecanora expallens*.

Distribution. Corticolous specimens of *Lecanactis latebrarum* occurred in westernmost and central Norway at altitudes up to 70 m. **Counties**: Corticolous specimens: Sogn og Fjordane, Nord-Trøndelag. All specimens: Oppland, Buskerud, Telemark, Rogaland, Hordaland - Nord-Trøndelag.

Discussion. *Lecanactis latebrarum* may be rather similar morphologically to *Lecanactis abietina* with which it sometimes occurs. That species, which is usually richly pycnidiate and apotheciate, also forms - especially when saxicolous - convex, leprose, subfruticose cushions. However, *L. latebrarum* is distinct from *L. abietina* in the absence of pycnidia and/or apothecia and in its chemical constituents (lecanoric and schizopeltic acids in *L. abietina*).

Lecanactis latebrarum is a saxicolous species of shaded rock under overhangs, often associated with *Chrysothrix chlorina*. It occurs only rarely on bark. The saxicolous form is similar to the corticolous form, but the individual cushions are usually larger, up to 2 cm in diameter. The subfruticose thalli and the semiglobular cushions make *Lecanactis latebrarum* a distinctive species.

According to Jørgensen & Tønsberg (1988), *Lecanactis latebrarum* is mainly a lowland species with clear oceanic affinities. The species has also been found in some microclimatically humid outpost localities inland, e.g., in the continental valley Gudbrandsdalen (see Jørgensen & Tønsberg 1988). Saxicolous specimens have been found up to 450 m altitude.

Specimens seen: SF: Naustdal 1983, Tønsberg 7926c; Stryn 1983, Tønsberg 7882. - NT: Leksvik 1983, Tønsberg 8355, 8357. A total of 4 specimens from 3 sites seen.

Lecania Massal.

The saxicolous species of the genus *Lecania* have been monographed by M. Mayrhofer (1988).

Lecania baeomma (Nyl.) P. James & Laundon

Thallus crustose, episubstratal, indeterminate, forming small, irregular patches up to 0.5 cm in diameter, areolate, sorediate. Prothallus white. Areolae pale yellowish white, more or less contiguous, irregularly rounded, convex, 0.1 mm in diameter. **Soralia** bursting from the areolae which become entirely dissolved, dark green due to a pigment in the external soredia or, where the soredia have been shed, pale yellowish white, soon becoming confluent forming a more or less leprose crust; green pigment K-, N+ violet. Soredia fine, 10-20 µm in diameter, often in loose aggregations; wall distinct. Medulla absent. Photobiont green, unicellular, globose and up to 9 µm in diameter, or 2-4 - celled, more or less ellipsoid, and up to 18 × 12 µm.

Apothecia (unknown in Norwegian corticolous material, but sometimes present in saxicolous material), lecanorine; margin becoming sorediate; disc greenish black. Pycnidia not seen.

Chemistry: Atranorin, chloroatranorin, gangaleoidin.

Substratum. The only corticolous specimen found was collected on the base of a trunk of *Salix caprea* growing adjacent to a shaded rock wall. Associated species included *Cystocoleus ebeneus*, *Schismatomma umbrinum*, and *Lepraria* spp.

Distribution. *Lecania baeomma* was found on the westernmost coast close to sea-level. **Counties**: Corticolous specimens: Hordaland. Saxicolous specimens: Hordaland, Sør-Trøndelag, Nordland.

Discussion. *Lecania baeomma* is usually a species of shaded rock underhangs. The corticolous material available is rather poorly developed. Saxicolous specimens may form patches up to several cm diameter and the external soredia may become more intensely pigmented giving the thallus a dark green to bluish colour. With its often more or less yellowish, sorediate thallus *Lecania baeomma* may resemble *Lecanora expallens* and *Haematomma ochroleucum* var. *ochroleucum* which are both likely to occur in the same corticolous habitat as *Lecania baeomma*. However, *L. baeomma* is chemically distinct in the presence of gangaleoidin.

M. Mayrhofer (1988) considered the blue-green pigment of *Lecania baeomma* to be due to the presence of cyanobacteria on the thallus surface. In the present corticolous specimen and in all additional Norwegian saxicolous specimens examined, the blue-green pigment (N+ violet) was a cell-wall substance of the mycobiont.

In Norway, *Lecania baeomma* is an oceanic lowland species (Botnen & Tønsberg 1988).

Specimen seen: Ho: Askøy 1984, Tønsberg 8835b.

Lecanora Ach.

The genus *Lecanora* s. lat. in Europe is in need of a thorough revision. The North American species of the *Lecanora subfusca* group have been monographed by Brodo (1984a).

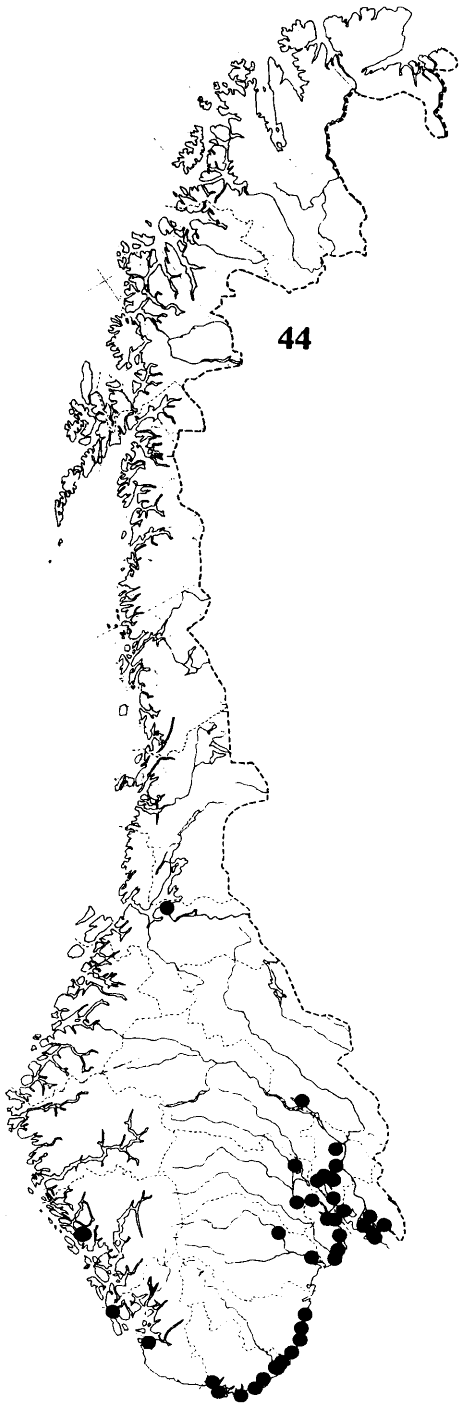
Lecanora allophana (Ach.) Nyl. "f. ***sorediata*** (Schaerer) Vainio"

Fig. 20, 43.

Thallus crustose, episubstratal, forming patches to 4 cm in diameter, continuous but sometimes secondarily cracked, sorediate. Prothallus not evident. Esorediate surface grey to greenish grey or more or less whitish. Tuberculae slightly convex, more or less rounded, up to 0.2 mm. **Soralia** pale greyish green to whitish green, flat to hemiglobose, up to 1 mm in diameter, always some becoming more or less contiguous or fused. Soredia fine, mostly simple or loosely aggregated, occasionally in consoredia to 35 µm; wall distinct. Photobiont green, coccoid, up to 16 µm in diameter.

Apothecia and pycnidia not observed. In f. *allophana* they were constricted at base, up to 2.5 mm in diameter; disc reddish brown; margin white, often flexuose.

Chemistry: Atranorin (major), allophana unknowns 1 and 2 (triterpenes) major substances, additional terpenoids in moderate to trace amounts. TLC: Fig. 20.



Figs 43-44. Distribution maps. Fig. 43. *Lecanora allophana* "f. *sorediata*". Fig. 44. *Lecanora conizaeoides*.

Substratum. *Lecanora allophana* "f. *sorediata*" was found twice on *Acer platanoides*. Associated lichens included, e.g., *Buellia punctata*, *Lecanora allophana* f. *allophana*, *L. impudens*, *Parmelia* (*Melanelia*) *subargentifera*, as well as species of *Phaeophyscia* and *Xanthoria*.

Distribution. *Lecanora allophana* "f. *sorediata*" occurred in southeastern Norway (Fig. 43) at altitudes of 100 and 200 m. **Counties:** Oppland, Buskerud.

Discussion. *Lecanora allophana* "f. *sorediata*" and *L. impudens* seem to be morphologically indistinguishable. However, when applying Poelt's (1972) species-pair hypothesis to the mixed material of these taxa, two chemically distinct secondary taxa are shown to be present: *L. allophana* "f. *sorediata*" with a terpenoid composition concordant with that of *L. allophana* f. *allophana*, its fertile counterpart, and *L. impudens*. The present material of *L. allophana* "f. *sorediata*" is abundantly sorediate. However, a specimen from Sweden, Uppland (Santesson 12179 (UPS!)) had abundant apothecia and was sparingly sorediate compared with the present Norwegian specimens. From North America "f. *sorediata*" has not yet been reported, although f. *allophana* is widely distributed there (Brodo 1984a). In Sweden (see Santesson 1984) and Norway f. *allophana* is much more frequent and more widely distributed than "f. *sorediata*". I therefore regard the specimens of "f. *sorediata*" as occasional local offspring from individuals of the fertile counterpart. An intraspecific rank seems therefore most appropriate.

In *Lecanora allophana* "f. *sorediata*" atranorin is a major substance in the thallus. The apothecia of this form and the thallus and the apothecia of f. *allophana* seem to contain atranorin only in trace to moderate amounts. This indicates that the soredia of *L. allophana* "f. *sorediata*" contain large amounts of atranorin.

Lecanora allophana "f. *sorediata*" is a taxon of eutrophic bark. It has a markedly southeastern distribution.

Specimen seen: Op: Gjøvik 1989, Tønsberg 11667b. - Bu: Ringerike 1990, Tønsberg 13297.

Lecanora conizaeoides Nyl. ex Crombie

Fig. 44.

Thallus crustose, episubstratal, delimited or more or less indeterminate, greyish green to brownish yellow, at first forming discrete rosettes up to a few cm in diameter, later often becoming irregularly spreading and confluent with other thalli covering areas up to a few dm in diameter, areolate, sorediate. Prothallus indistinct to distinct, white, greyish white to greyish black, up to 0.5 mm wide; greyish black pigment K-, N+ red brown. Areolae at the edge of the thallus discrete, up to 0.3 mm in diameter, convex, rounded or often becoming irregular and bullate, towards the thallus centre usually becoming contiguous. **Soralia** concolorous with non-sorediate parts, bursting from the apices of the areolae, diffuse, irregular, often, especially towards the centre, becoming confluent forming a more or less leprose crust which secondarily cracks into angular parts a few mm in diameter. Soredia fine, 20-50 µm in diameter, often in consoredia and then appearing coarse; wall distinct. Photobiont green, coccoid, up to 15(-19) µm in diameter.

Apothecia sparse to abundant, present in 45 (60%) of the specimens, lecanorine, up to 2.5 mm in diameter, margin concolorous with the thallus or more greyish, persistently esorediate or more or less sorediate; disc pale greenish brown to pale brown, flat to convex. Pycnidia observed in a few specimens (e.g., in Tønsberg 9992), more or less immersed; conidia filiform, distinctly curved, of *Eulecanora*-type (see Eigler (1969)), up to 25 µm long.

Chemistry: Fumarprotocetraric acid, protocetraric acid (trace), ± cph-2 (trace), ± trace of unidentified substance. A trace of usnic acid was found in both the thallus and the apothecia (2 specimens) or in the apothecia only (1 specimen).

Substratum. *Lecanora conizaeoides* has been collected on a range of phorophytes including *Betula pubescens/pendula*, the most common one (24 specimens), *Acer pseudoplatanus, Aesculus hippocastanum, Alnus glutinosa, Corylus avellana, Fagus sylvatica, Malus, Mespilus germanicus, Picea abies, Pinus sylvestris, Populus tremula, Prunus cerasus, P. padus, Quercus, Salix caprea, Tilia*, and *Larix*.

Distribution. *Lecanora conizaeoides* occurred in the coastal lowlands from Østfold to Hordaland (Bergen), with an outpost site in Sør-Trøndelag (Trondheim) (Fig. 44). An inland outpost site was Hamar city centre (Hedmark), where it occurred by the shore of lake Mjøsa. Its vertical distribution ranged from about sea-level to 200 m (Oslo). **Counties:** Østfold - Hedmark, Buskerud - Hordaland, Sør-Trøndelag.

Discussion. *Lecanora conizaeoides* is a variable species. Newly collected material varies from greyish green to yellowish brown. Old herbarium specimens are mostly yellowish brown. Esorediate forms occur (see also, e.g., Hawksworth 1973a, Degelius 1986). These are sometimes intermixed with distinctly sorediate forms. Apothecia appear to be most frequent in the former. Sterile specimens of *L. conizaeoides* may be confused with the chemically concordant *Fuscidea arboricola*. A nearly leprose form of *Parmeliopsis hyperopta* occurring in heavily polluted sites can be superficially reminiscent of *Lecanora conizaeoides* morphologically. However, in that species minute lobes are usually found, and the presence of atranorin and divaricatic acid makes it chemically distinct. However, that species has usually a distinct brown prothallus.

Lecanora conizaeoides is pollution-tolerant especially to sulphur dioxide and its derivatives (see, e.g., Hawksworth 1973a, Laundon 1973). It is often found close to or in the centres of towns. In the city centre of Oslo it seemed to be absent; however, the species occurred abundantly just outside the city centre. In other towns (e.g., Bergen, Drøbak, Kristiansand), it occurred in the city centre as well. In some rural areas, e.g., Hvaler (southeast part of Østfold county) and outside Kristiansand (the southernmost parts of Vest-Agder county), *Lecanora conizaeoides* occurred in well-developed populations. Apparently these areas are generally affected by high levels of air-born pollutants. *Lecanora conizaeoides* is frequently associated with other toxitolerant lichens, especially *Hypocenomyce scalaris* and *Scoliciosporum chlorococcum*. Ahti (1965) suggested a suboceanic distribution for *Lecanora conizaeoides* in Europe. However, on the Scandinavian peninsula the species appears to have a southern distribution. The presence of *Lecanora conizaeoides* in inland sites such as Hamar, indicates that the species can withstand considerable frost during the winter.

Lecanora conizaeoides occurs commonly on acidic bark in urban sites along the south coast north to the Bergen-area. I have especially sought for it without success in Hedmark: Brumunddal, Oppland: Lillehammer and Gjøvik, Hordaland: Odda, and Voss, Møre og Romsdal: Ålesund, and Nord-Trøndelag: Levanger and Steinkjer. In Norway the first collections were made in 1947 in Rogaland: Stavanger (leg. Ahlner (S)), whereas in Sweden it was found (near Göteborg) as early as 1915 (Magnusson 1930). The first known collection from Oslo was made in 1973 in Frognerparken (leg. Lye (NLH)). In Trondheim the first collections were made in 1987. In that locality all specimens lacked apothecia and were richly sorediate.

Lecanora conizaeoides has rarely been found on wood (*Juniperus communis*).

Specimens seen (selected): Øf: Hvaler 1983, Tønsberg 7871. - Oslo 1973, Lye (NLH); 1983, Tønsberg

7791. - He: Hamar 1990, Tønsberg 13172. - Bu: Drammen 1986, Tønsberg 9532. - Vf: Larvik 1987, Tønsberg 10071. - Te: Porsgrunn 1987, Tønsberg 10092. - AA: Arendal 1986, Tønsberg 9534. - VA: Kristiansand 1986, Tønsberg 9555. - Ro: Stavanger 1947, Ahlner (S). - Ho: Bergen 1967, Santesson (UPS). - ST: Trondheim 1987, Tønsberg 9992 (with pycnidia), 10009. A total of 75 specimens seen.

Lecanora expallens Ach.

Fig. 18.

Thallus crustose, mostly green or pale yellow, rarely deep yellow or green with a bluish or greyish tinge, usually endosubstratal in non-sorediate parts, usually thin, occasionally thick, weakly delimited or indeterminate, at first forming small rosettes up to a cm or more in diameter, later usually becoming irregular and often confluent with adjacent thalli and then sometimes covering extensive areas up to several dm across; areolate, mostly becoming continuous, sorediate. Prothallus often distinct, whitish or, more rarely, partly tinged blue, very rarely distinctly blue throughout giving the thallus a more or less blue over-all colour. Esorediate areolae often not evident or, in richly fertile specimens, occasionally distinct, more or less contiguous, slightly convex, up to 0.2 mm in diameter. **Soralia** usually protruding through the uppermost cell layer of the substratum or, rarely, bursting from corticate areolae; diffuse; variably formed, but mostly soon becoming confluent forming a leprose crust, more rarely more or less persistently discrete, more or less orbicular, and usually up to 0.5 mm in diameter. Soredia farinose, 20-50 µm in diameter, often in aggregations; wall distinct. Medulla rarely distinct, white. Photobiont green, coccoid, up to 15(-20) µm in diameter.

Apothecia lecanorine, present, usually sparse, in about 14 (14%) specimens, up to 1 mm in diameter; disc dull yellow to flesh coloured, more or less plane, rarely distinctly convex, up to 0.8 mm in diameter; thalline margin becoming sorediate.

Chemistry: Usnic acid, zeorin, thiophanic acid (major constituents), unidentified xanthone with R_F-classes similar to those of arthothelin, expallens unknown (pigment), traces of unidentified terpenoids. TLC: Fig. 18.

Substratum. *Lecanora expallens* has most commonly been collected on *Alnus incana* (18 specimens), *Picea abies* (14), *Quercus* (13), *Sorbus aucuparia* (11) and *Betula pubescens/pendula* (12), but has also been found on *Acer platanoides, A. pseudoplatanus, Aesculus hippocastanum, Corylus avellana, Fraxinus excelsior, Juniperus communis, Pinus sylvestris, Populus tremula, Salix caprea, Tilia,* and *Ulmus glabra.* On *Picea abies* it occurred on trunks and twigs, frequently associated with *Mycoblastus sanguinarius*, *Ochrolechia androgyna* A, *O. turneri* and *Pertusaria amara. Lecanora expallens* was often found on the dry bark of trees growing under overhanging rock, sometimes associated with, i.a., *Haematomma ochroleucum* and *Enterographa zonata*, and on the dry, concave part of trunks, as well as on the under-side of leaning trunks.

Distribution. *Lecanora expallens* occurred in the lowlands throughout most of Norway. Its known vertical distribution ranged from about sea-level to 600 m (Hedmark: Tynset). **Counties:** Østfold - Troms.

Discussion. *Lecanora expallens* varies considerably in the colour of the thallus and in the shape and degree of fusion of the soralia. Even on the same small piece of bark the colour sometimes varied between green without a yellow tinge and pale yellow. Both colour forms were found to contain the same pigments (usnic acid, xanthones). The difference in colour was probably only reflecting differences in the amounts of the pigments.

Morphologically, *Lecanora expallens* may resemble forms of *Haematomma ochroleucum* var. *ochroleucum*, *H. ochroleucum* var. *porphyrium* and *Lecanora farinaria*. However, all these species are easily recognized by their chemical constituents. Some sterile specimens from Nord-Trøndelag (Tønsberg 4904, 4906, 6683a, 6708, and 8411b) differed morphologically from the typical form in having mostly discrete soralia on a conspicuously blue prothallus. Chemically they conform with the typical form. As the colour of the prothallus of a species often varies, these specimens were assigned to *Lecanora expallens*.

Lecanora expallens seems to be toxitolerant and is still to be found close to or in centres of cities (e.g. Oslo and Trondheim). The first Norwegian collection was made in 1821 (Nordland: Saltdalen, leg. Sommerfelt (O)).

Lecanora expallens is a widespread species of wood and of acidic to eutrophic bark.

Specimens seen (selected): Øf: Hvaler 1983, Tønsberg 8153. - Oslo 1981, Tønsberg 6498. - He: Tynset 1983, Tønsberg 8185, Op: Lunner 1982, Tønsberg 7542a. - Bu: Sigdal 1981, Tønsberg 6342. - Vf: Hedrum 1922, Høeg (TRH). - Te: Bamble 1983, Tønsberg 7947. - AA: Arendal (Moland) 1987, Tønsberg 10225. - VA: Farsund 1977, Tønsberg 1884. - Ro: Bokn 1981, Skjolddal 289. - Ho: Bergen 1986, Tønsberg 9476. - SF: Balestrand 1983, Tønsberg 7942. - MR: Smøla 1983, Tønsberg 8284. - ST: Trondheim 1982, Tønsberg 6566. - NT: Leksvik 1983, Tønsberg 8348. - No: Vefsn 1982, Tønsberg 7606. - Tr: Storfjord 1982, Tønsberg 7292a. A total of 98 specimens seen.

Lecanora farinaria Borrer in Hook.

Fig. 45.

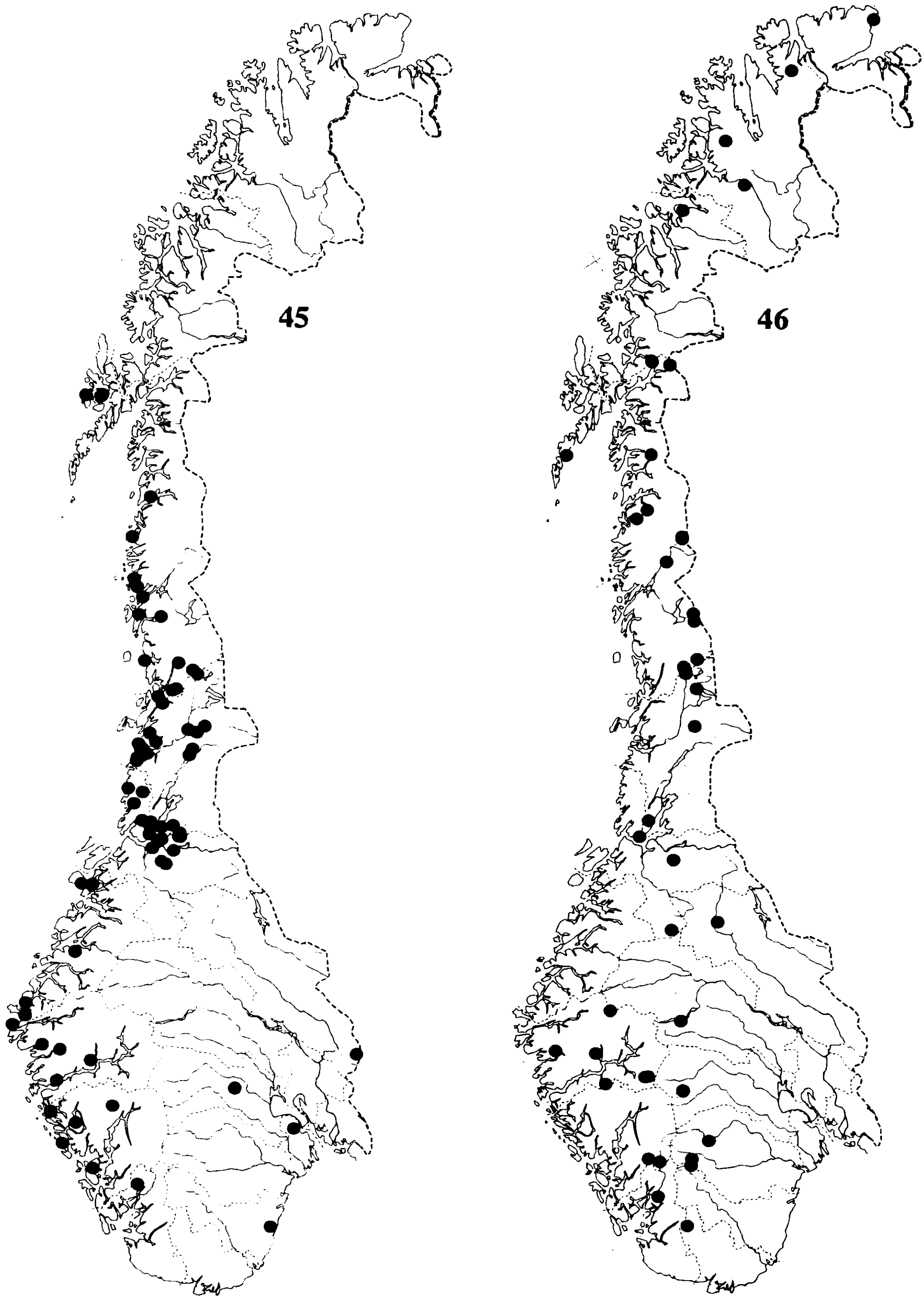
Thallus crustose, mostly endosubstratal in non-sorediate parts, weakly delimited to indeterminate, forming rosettes or, more often, irregular patches, up to about 5 cm across, but usually forming 1-2 cm wide patches between other lichens, areolate, rarely more or less continuous, sorediate. Prothallus indistinct to distinct, white or, sometimes, bluish, mostly endosubstratal. Esorediate parts usually absent or indistinct, grey to greyish-green, rarely with a brownish tinge, discrete to more or less contiguous, often more or less covered in tiny hyaline bark flakes from the substratum; rarely with distinct areolae up to 0.3 mm, purely white within due to the presence of oxalate. Rarely a more or less continuous and tuberculate thallus was formed. **Soralia** protruding through the uppermost cell layers of the substratum or, more rarely, bursting from the apices of the areolae or tuberculae; very variable in colour and form, mostly pale yellow, greyish yellow, pale green, rarely deep yellow or grey without a yellowish tinge, very rarely tinged dark green or greenish blue due to pigmentation of some of the external soredia; diffuse or, more rarely, delimited; mostly rounded, occasionally irregular in outline; flat to convex; when well delimited up to about 1 mm in diameter, discrete and scattered or, occasionally, becoming partly confluent forming a more or less continuous leprose crust. Soredia fine, 25-40 µm in diameter, often in consoredia; wall distinct. Photobiont green, coccoid, up to 16 µm in diameter.

Apothecia mostly sparingly present in 20 (15%) of the specimens, up to 1 mm in diameter; disc pale to dark brown, flat to slightly convex, up to 0.8 mm in diameter; thalline margin usually completely dissolved into soredia concolorous with those of the thalline soralia.

Chemistry: Atranorin, chloroatranorin, roccellic acid, ± unidentified fatty acids (traces).

Substratum. *Lecanora farinaria* was collected on *Alnus incana* (50 specimens) and *Sorbus aucuparia* (35), and, more rarely, *Betula pubescens/pendula*, *Calluna vulgaris*, *Corylus avellana*, *Juniperus communis*, *Picea abies* (twigs), *Populus tremula*, *Quercus*, *Salix aurita*, *S. caprea*, *Tilia*, and *Ulmus glabra*.

Distribution. *Lecanora farinaria* occurred commonly in the lowlands along the western coast, but was most frequent in the humid, coastal *Picea*-forests of central Norway (Fig. 45).



Figs 45-46. Distribution maps. Fig. 45. *Lecanora farinaria*. Fig. 46. *Lecanora flavopunctata*. Distribution in Norway.

In Hedmark: Kongsvinger, its innermost site in southeast Norway, it was found near water in a shaded *Picea abies* forest. *Lecanora farinaria* occurred as far north as Nordland: Sortland. Its vertical distribution ranged from about sea-level to 370 m (Sogn og Fjordane: Førde). **Counties:** Hedmark, Buskerud, Vestfold, Aust-Agder, Rogaland - Nordland.

Discussion. *Lecanora farinaria* is a very variable species with respect to shape and colour of the soralia. When typical, *L. farinaria* is characterized morphologically by the diffuse, pale yellowish soralia on an otherwise endosubstratal thallus. The species is not always recognized on morphology alone, but the chemistry excludes all other species considered here. *Lepraria* spp. may have a joint occurrence of atranorin and roccellic acid, but species of that genus lack chloroatranorin. Morphologically *Lecanora farinaria* is most likely to be confused with *Buellia griseovirens*, with which it often grows. When typical it is distinguished from that species in being endosubstratal in non-sorediate parts and, rarely, in having a greenish blue pigment in the external soredia. It may also resemble *Lecanora expallens* (see that species).

In some specimens the soralia were infested by the lichenicolous fungus *Skyttea gregaria* Sherw., Hawksw. & Coppins.

Lecanora farinaria is a species of acidic bark in the coastal lowlands. In Norway, *Lecanora farinaria*, is so far known only from bark. In U.K.: England and U.S.A.: Massachusetts it is reported as being only lignicolous (Laundon 1963, Brodo 1984a). However, several recently collected specimens (E) from U.K.: England and Scotland were corticolous on deciduous trees. *Lecanora farinaria* is here reported as new to Scandinavia.

Specimens seen (selected): He: Kongsvinger 1985, Tønsberg 9422. - Bu: Krødsherad 1982, Tønsberg 6922. - Vf: Sande 1922, Høeg (TRH). - AA: Froland 1978, Tønsberg 3259. - Ro: Sauda 1988, Tønsberg 10810. - Ho: Voss 1987, Tønsberg 10115. - SF: Balestrand 1979, Tønsberg 4028. - MR: Rauma 1979, Tønsberg 3818. - ST: Roan 1980, Tønsberg 4989. - NT: Flatanger 1983, Tønsberg 8385. - No: Nesna 1986, Tønsberg 9689. A total of 131 specimens seen.

Lecanora flavoleprosa Tønsb. sp. nov.

Thallus flavidus vel flavoviridis, plerumque sorediatus dissolutus. Apothecia sordide aeruginosa, margine disco complano. Excipulum proprium superne sordide olivaceum, crystallis brunneis. Hymenium superne dilute aeruginosum. Sporae simplices, vulgo ellipsoideae, 10-15 × 4-5 µm. Thallus acidum usnicum, zeoricum et flavoleprosum ignotens continens.

Type: Norway, Sogn og Fjordane, Gloppen, Våtedalen, alt. 160 m, UTM grid ref.: 32V LP 68,40-41 (map 1318 III), 19 July 1979, Tønsberg 3987 (BG - holotype; UPS - isotype).

Fig. 18.
(Description based on material from Norway and Austria.)

Thallus episubstratal, indeterminate, extensive, up to a least 8 cm across, areolate, at least in young parts, sorediate. Prothallus not evident. Esorediate areolae sparse, soon becoming more or less contiguous to confluent, greyish to pale yellow, rounded, strongly convex, up to 0.2 mm in diameter, soon becoming completely dissolved into soredia. **Soralia** pale yellow to pale yellow-green, diffuse, soon becoming confluent forming a more or less continuous, leprose crust. Soredia loosely arranged; fine to coarse, 30-65 µm in diameter; wall distinct. Medulla not evident. Photobiont green, coccoid, up to 12 µm in diameter.

Apothecia sparse, discrete, sometimes tending to form groups, dark aeruginose, adnate to sessile, flat, but convex when young, emarginate or, sometimes, with a glossy brown margin which was flush with the level of the disc, up to 0.4 mm in diameter. In sections: Proper exciple apically with deposits of brownish, crystals (shining distinctly in polarized light), K+ dissolving; otherwise dirty olivaceous above, pale brown to more or less colourless below; hyphae embedded in a gelatinous matrix; interconnected. Epihymenium minutely granular; deposits dissolving in K. Hymenium pale aeruginose, especially in upper part, more or less colourless in lower part; 40-50 µm deep; pigment K-, N+ violet. Paraphyses simple, slender, not markedly swollen at apices, 1.5 µm wide, embedded in a gel coat. Asci of *Lecanora* type with a well-developed K/I+ blue tholus and a distinct ocular chamber, 12-15 × 30-45 µm; 8-spored. Spores simple, colourless, ellipsoid, sometimes slightly curved, 10-15 × 4-5 µm, wall 0.05 µm wide. Subhymenium colourless, 40 µm deep. Pycnidia not seen.

Chemistry: Usnic acid, flavoleprosa unknown, zeorin, a range of unidentified terpenoids in trace amounts. Crystal needles, sparingly present on the surface, indicate the presence of terpenoids other than zeorin. TLC: Fig. 18.

Substratum. *Lecanora flavoleprosa* has been collected on *Alnus incana* in open situations. In Austria *Lecanora flavoleprosa* has been collected on wood of *Picea abies* and *Ulmus*.

Distribution. *Lecanora flavoleprosa* was found once at 160 m altitude in western Norway. **County:** Sogn og Fjordane. In Austria *Lecanora flavoleprosa* has been found at an altitude of 1400 m.

Discussion. The presence of the xanthone flavoleprosa unknown and the range of terpenoids make *Lecanora flavoleprosa* distinct from the other species considered. Morphologically it is similar to *L. expallens*. *Lecanora strobilina* (Sprengel) Kieffer which also produces crystal needles on the surface is ecorticate, but rarely sorediate (Laundon 1976, Wirth 1980). It differs further by the greyish yellow to brown apothecial disc (see Laundon 1976). The type of *Lecanora sublivescens* (Nyl.) Mudd (syn. *Lecidea sublivescens* (Nyl.) P. James) is also devoid of soredia and has brownish apothecia (P.M. Jørgensen pers. comm. 1991).

A specimen from Rogaland (Skjolddal 289) was similar to *Lecanora flavoleprosa* in all characters, including the presence of crystal needles, except that it lacked flavoleprosa unknown. That specimen may prove to represent a flavoleprosa unknown-deficient chemotype of *Lecanora flavoleprosa*. However, for the time being it was left out of *Lecanora flavoleprosa*.

Lecanora flavoleprosa is so far known only from Norway and Austria.

Other specimens seen: Austria: Kärnten, Gurktaler Alpen, 1988, Türk & Wittmann (herb. R. Türk 10328, 10329, 10330).

Lecanora flavopunctata Tønsb. sp. nov.

Thallus areolatus, sorediatus. Soralia flavida, punctiformia. Apothecia brunneola vel pallide fumosa, adnata, immarginata. Hymenium crystallis magnis. Sporae hyalinae, simplices ad uni-septatae, plerumque anguste ellipsoideae, 7.5-10.5 × 2.5-4 µm. Thallus acidum usnicum, isousnicum, sticticum et atranoricum continens.

Type: Norway, Nordland, Skjerstad, Mt Tverrbrennfjellet, along brook Mølneelva, UTM grid ref.: 33W VQ 9733 (map 2029 II), on *Betula nana*, 22 July 1986, alt. 530 m, Tønsberg 9733 (BG - holotype).

Figs 46-47.

Thallus (Fig. 47) crustose, mostly delimited, usually forming small rounded patches up to 1.5(-2) cm in diameter, typically areolate, occasionally partly more or less continuous, sorediate. Prothallus usually indistinct, sometimes, especially on dark bark, visible as a whitish stain. Areolae mostly distinct, endo- to episubstratal, whitish to greenish grey, greyish green,

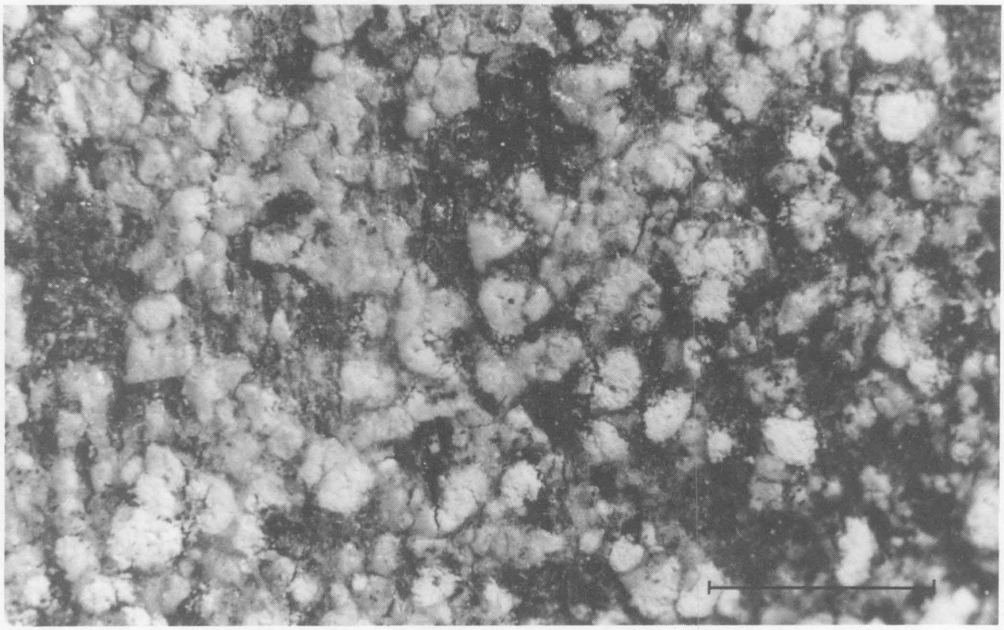


Fig. 47. *Lecanora flavopunctata*. Tønsberg 11167. Scale 1 mm.

sometimes pale yellow or yellowish grey; persistently discrete or becoming contiguous or, rarely, fused; sparse to numerous, more or less rounded to elongate, flat to convex, up to 0.2(-0.4) mm across. Continuous parts weakly tuberculate, cracked. **Soralia** central or marginal on the areolae or tuberculae, pale yellow to greenish yellow, persistently discrete or a few becoming fused, delimited at first, later often becoming somewhat diffuse, more or less punctiform, flat to convex, up to 0.2(-0.3) mm in diameter. Soredia fine, 10-20 (-25) µm in diameter; wall distinct. Photobiont green, unicellular or with 2-3 cells (in a state of division?), globular to ellipsoid, 9-12(-18) µm in diameter.

Apothecia present in 30 (47%) of the specimens, emarginate, pale brown to flesh coloured, sometimes with a yellow tinge; slightly convex, adnate, up to 0.2(-0.7) mm in diameter. Excipulum proprium colourless, composed of firmly conglutinated, outwardly radiating hyphae; without crystals. Epihymenium dilute straw-coloured to colourless, minutely granular in H_2O; granules K+ dissolving. Hymenium colourless, 30-45 µm deep, with large crystals which not or very slowly dissolve in K; I- except for asci. Paraphyses firmly conglutinated, simple to slightly branched, 2 µm wide; individual cells irregular in thickness; apical cell not thickened or, sometimes, irregularly swollen to 3 µm; asci clavate when mature, 22-25 × 10-12 µm, with a well-developed, amyloid tholus, a non-amyloid wall and an outer amyloid cap, 8-spored. Spores colourless, simple to 1-septate, mostly narrowly ellipsoid, sometimes oblong with obtuse apices or somewhat bean-shaped, 7.5-10.5 × 2.5-4 µm. Subhymenium indistinctly delimited, 40-60 µm deep, K/I+ violet blue.

Chemistry: Atranorin, usnic acid, isousnic acid, ± stictic acid (trace to moderate amounts), ± cryptostictic acid (trace), flavopunctata unknown (trace), possible traces of other unidentified terpenoids. Constictic acid was not observed (neither by one-dimensional nor by two-dimensional (G×A) chromatography).

Substratum. *Lecanora flavopunctata* was mostly collected on subalpine/low-alpine shrubs of *Salix* spp. (e.g. *S. glauca,* and *S. lapponum*) (43 specimens). Other phorophytes included *Betula nana, B. pubescens/pendula,* and rarely *Alnus incana, Picea abies* (twig), *Populus tremula,* and *Salix caprea.* It usually grew at the base of the phorophyte, often somewhat hidden among grasses and large mosses (e.g. *Sphagnum*). Frequent associates included *Caloplaca sorocarpa, Lecidea porphyrospoda, L. pullata, L. vacciniicola,* and *Parmeliopsis ambigua.*

Distribution. *Lecanora flavopunctata* has been found throughout the country, especially in subalpine/low-alpine regions (Fig. 46). In southern Norway south of Trondheimsfjorden its known vertical distribution ranged from about 400 m to 1150 m (Oppland: Vang); in northern Norway it extended down to sea-level in Finnmark (Vardø). **Counties:** Hedmark - Buskerud, Telemark - Sogn og Fjordane, Sør-Trøndelag - Finnmark.

Discussion. *Lecanora flavopunctata* belongs to the *L. symmicta* complex which comprises species with lecanorine to biatorine apothecia, narrowly ellipsoid spores, a more or less yellowish thallus due to usnic acid and often also xanthones, in addition to zeorin and other terpenoids. *Lecanora flavopunctata* is a distinctive species on account of the sorediate thallus containing stictic acid, and in living on subalpine or low-alpine shrubs. Outside Norway it has been collected in Sweden (Åsele Lappmark, Lycksele Lappmark and Torne Lappmark).

Specimens seen (selected): **Norway:** He: Tynset 1983, Tønsberg 8191. - Op: Vang 1985, Tønsberg 9319b. - Bu: Hol 1984, Tønsberg 9036. - Te: Vinje 1984-1987, Tønsberg 8905a, 10319. - AA: Bykle 1984, Tønsberg 8911, 8912, 8913. - Ro: Suldal 1986, Odland. - Ho: Odda 1984, Tønsberg 8904; 1986, Odland. - SF: Balestrand 1984, Tønsberg 7938. Flora, 1983, Tønsberg 7899. - ST: Melhus 1982, Tønsberg 6659, 6663. Rissa 1983, Tønsberg 7827b. - NT: Grong 1981, Tønsberg 6200. Leksvik 1984, Tønsberg 5910. Namsskogan 1980-1983, Tønsberg 5093, 8095. Røyrvik 1983, Tønsberg 8091b. - No: Beiarn 1986, Botnen 86/47. Grane 1983, Tønsberg 8058, 8059; 1983, Tønsberg 8113. Hattfjelldal 1980-1988, Tønsberg 5155, 5158, 5165, 6080, 11273, 11295. Narvik 1982-1986, Tønsberg 7421, 7424, 9801, 9802. Rana 1982, Tønsberg 7653; 1982, Tønsberg 7654, 7655, 7657a, 7658. Skjerstad 1986, Tønsberg 9620. Vestvågøy 1987, Tønsberg 10520, 10522. - Tr: Gratangen 1982, Tønsberg 7425, 7426, 7427, 7428. - Fi: Alta 1988, Tønsberg 11159, 11167. Vardø 1982, Tønsberg 7198, 7202a, 7202b. A total of 64 Norwegian specimens seen. **Sweden.** Åsele Lappmark 1991, Tønsberg 17329. - Torne Lappmark, 1986, Tønsberg 9785. - Lycksele Lappmark 1988, Tønsberg 11271.

Lecanora impudens Degel.

Svensk bot. Tidskr. 38: 50 (1944), nom. nov. for *Pertusaria farinacea* Magnusson, in Bot. Not. 1942: 15. Type: Sweden, Södermanland, Huddinge, Tullinge gård, on *Ulmus* in an avenue, 16.04.1938 ("1935"), Magnusson no. 16125 (UPS!). TLC: atranorin, a range of terpenoids, fatty acids; no chloroatranorin. (Non *Lecanora farinacea* Fée (1825 ("1824")).)

Pertusaria maculata Erichs., in Rabenh. Kryptog. Flora Deutschl., ed. 2, 5 (1): 646 (1936). Type: Malme: Lich. Suec. Exs. no 868 (HBG - holotype; O! - isotype). TLC: atranorin, fatty acid, a range of terpenoids (traces), no chloroatranorin. *Lecanora maculata* (Erichsen) Almb. Bot. Not. 1952: 251 (1952). (Non *Lecanora maculata* Magnusson 1944.) Notes: Brodo (1984) recorded chloroatranorin in the holotype specimen (HBG) of *Pertusaria maculata.* The types of *Lecanora impudens* and *Pertusaria maculata* studied by me seemed to have similar terpenoid patterns. In the type of the latter species, the substances occurred in trace amounts only and some substances were absent or apparently occurred in amounts too low to allow their detection.

Figs 20, 48.

Thallus crustose, episubstratal, with indistinct margin, forming irregularly spreading to more or less rounded patches up to about 5 cm in diameter, continuous, sorediate. Prothallus whitish, mostly indistinct. Esorediate surface whitish with grey-green tuberculae in fresh material, becoming grey to yellowish grey in old herbarium specimens, weakly to distinctly tuberculate, sometimes tending to become plicate, sometimes cracked. Tuberculae rounded, up to 0.2 mm in diameter. **Soralia** greyish green to creamy yellowish green or, occasionally, green in fresh material, becoming whitish in the herbarium, variable, mostly rounded, rarely, when developing along cracks, elongate, more or less discrete and distinctly delimited or tending to become confluent forming, especially towards the centre, a leprose thallus surface, plane and flush with the level of the thallus to distinctly convex and more or less efflorescent, up to 0.8 mm in diameter. Soredia loosely arranged, mostly fine, 15-30 (-40) µm in diameter; wall distinct. Medulla distinct in thick specimens. Photobiont green, coccoid, 15(-20) µm in diameter.

Apothecia (of *Allophana*-type, see Degelius 1944, Brodo 1984a) not seen. Pycnidia observed in one specimen (Tønsberg 13163); ostioles brown; conidia filiform, slightly to distinctly curved, 15-22 × 1µm.

Chemistry: Atranorin, ± chloroatranorin (2 specimens), impudens unknowns, unidentified fatty acid(s) (traces) (R_F-class 6 in solvent C). TLC: Fig. 20.

Substratum. *Lecanora impudens* has been collected on *Acer platanoides* and *Fraxinus excelsior* and, more rarely, *Populus tremula* and *Ulmus glabra*. Associated lichen genera included *Caloplaca*, *Candelariella*, *Phaeophyscia*, *Physcia*, *Physconia* and *Xanthoria*. Noteworthy associated species were *Acrocordia gemmata*, *Lecanora allophana* (f. *allophana* and "f. *sorediata*") and *Gyalecta truncigena*.

Distribution. *Lecanora impudens* occurred in southeast Norway (Fig. 48) at altitudes of 100 to 360 m (Oppland: Nord-Aurdal). The material from Rogaland cited by Degelius (1948), could not be located. **Counties:** Akershus - Telemark.

Discussion. *Lecanora impudens* is reminiscent of species of *Ochrolechia* and *Pertusaria*, but can easily be recognized by the presence of large amounts of the cortical para-depside atranorin and the absence of medullary phenolic carboxylic acid derivatives. In *Ochrolechia* and *Pertusaria* atranorin, if produced, is only present in trace amounts (Dibben 1980, Hanko 1983, Hanko et al. 1985).

The terpenoid pattern of *Lecanora impudens* is different from that of the morphologically similar *L. allophana* "f. *sorediata*" (see Fig. 20). This agrees with Brodo's concept of *L. impudens* as distinct from the sorediate morphotype of that species (see also discussion under *L. allophana* "f. *sorediata*").

The primary counterpart of *Lecanora impudens* is not known.

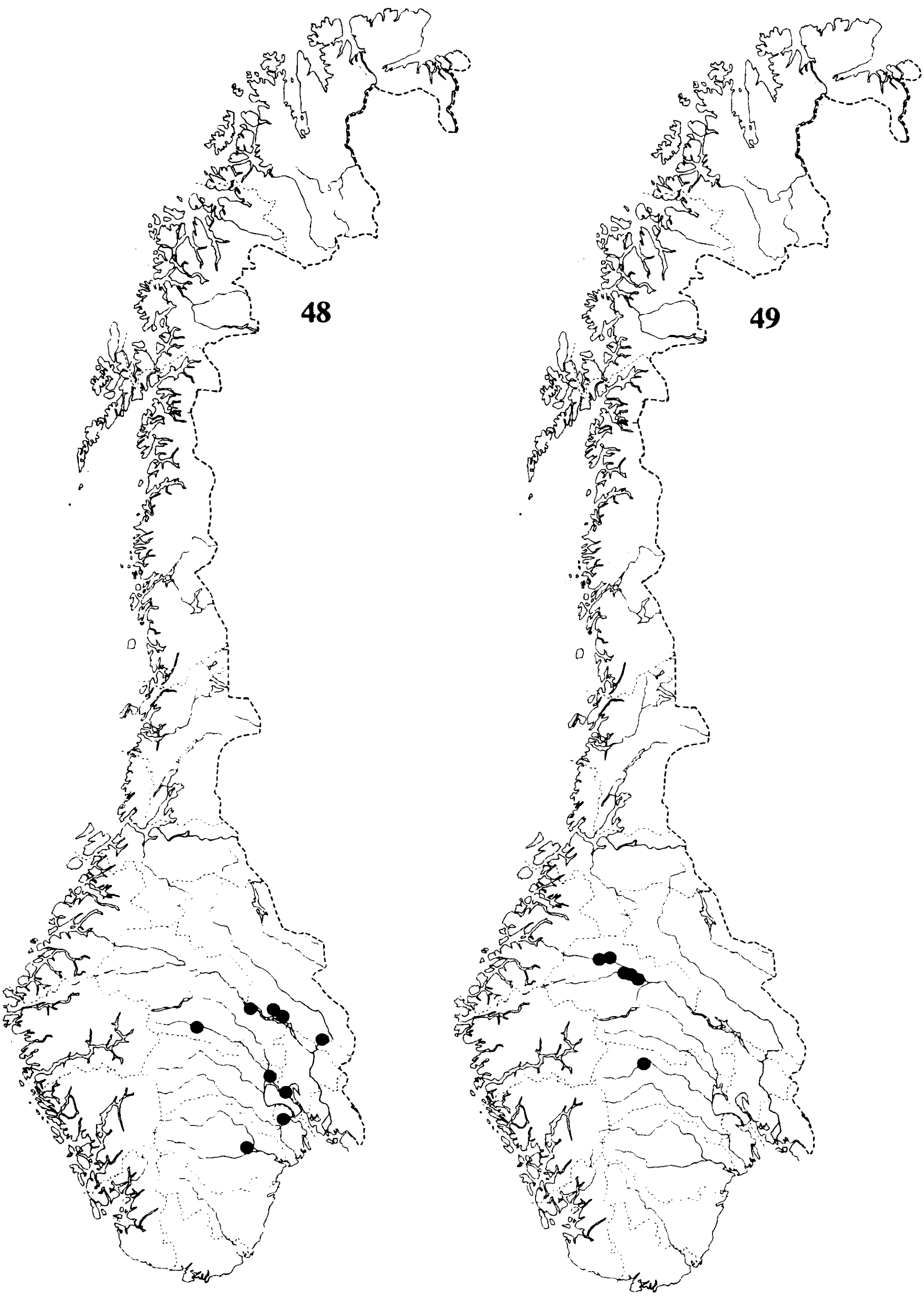
Lecanora impudens appears to be a species of eutrophic bark in southeastern parts of the country. The specimen from Rogaland cited by Degelius (1948) could not be traced.

Specimens seen (selected): Ak: Asker 1979, Botnen 79/240. - He: Sør-Odal 1990, Tønsberg 13275. - Op: Gjøvik 1923, Lynge (TRH, 2 specimens). Nord-Aurdal 1923, Lynge (TRH). - Bu: Ringerike 1990, Tønsberg 13298. - Vf: Hof 1990, Tønsberg 13685. - Te: Bø 1990, Tønsberg 13036. A total of 19 specimens seen.

Lecanora norvegica Tønsb. sp. nov.

Thallus plus minusve rosulans, pusillus ad 2 cm diametro, plerumque thallis vicinis crustae areolatae vel contiguae formans, cinereus vel sub viridis coloratus, acidum atranoricum vel protocetraricum continens; prothallus perspicuus, albus. Soralia saepe effusa, confluescentia, maculae leprosae formantia; soredia ad 25 µm diametro. Apothecia et pycnidia ignota.

Type: Norway, Oppland, Sel, Sjoa, UTM grid ref.: 32V, NP 2839 (map 1718 III), alt. 280-300m, on *Pinus sylvestris*, 22 June 1990, T. Tønsberg 13145 (BG - holotype; E - isotype).



Figs 48-49. Distribution maps. Fig. 48. *Lecanora impudens*. Fig. 49. *Lecanora norvegica*. Known distribution.

Figs 49-50.

Thallus (Fig. 50) crustose, episubstratal, more or less delimited, more or less rosette-forming, up to a few cm in diameter, often becoming contiguous and/or fused with neighbouring specimens, areolate and/or, especially towards the thallus centre, continuous, sorediate. Prothallus usually evident, white, between the areolae and as a delimiting border around the thallus, endosubstratal or, along the thallus margin, sometimes well-developed, episubstratal and felty. Areolae pale grey to pale green-grey, minute, up to 0.2 mm in diameter, slightly convex, persistently discrete on a more or less endosubstratal prothallus or becoming fused. Continuous parts minutely tuberculate, concolorous with the areolae, sometimes cracked; tuberculae up to 0.2 mm in diameter, more or less rounded, slightly convex. **Soralia** pale green to grey-green, sometimes with a faint yellow tinge, often diffuse, flat to convex, discrete at first, regularly rounded and then up to 0.3 mm in diameter, later often expanding irregularly, sometimes becoming fused with neighbouring soralia forming patches with a leprose surface up to several mm in diameter. Soredia fine, up to 25 µm in diameter, sometimes with only one algal cell, sometimes in consoredia up to 50 µm in diameter; soredial wall distinct. Medulla mostly absent, occasionally present in the thickest thallus parts, white. Photobiont green, coccoid, up to 15 µm in diameter.

Apothecia and pycnidia not observed.

Chemistry: Atranorin, protocetraric acid.

Substratum. *Lecanora norvegica* has been collected on trunks of *Pinus sylvestris* in open *Pinus* forests. Associated lichens included *Buellia arborea*, *Hypocenomyce scalaris*, *Lecidea nylanderi*, *Parmeliopsis ambigua* and *Usnea hirta*.

Distribution. *Lecanora norvegica* occurred in the continental valleys Gudbrandsdalen

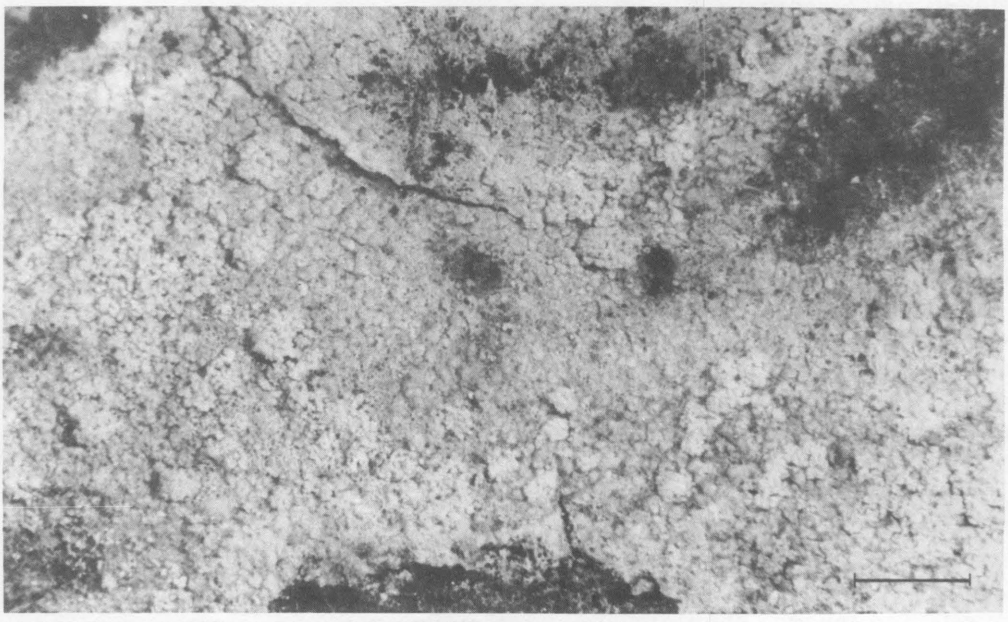


Fig. 50. *Lecanora norvegica*. Holotype. Scale 1 mm.

and Hallingdalen (central southeast Norway)(Fig. 49) at altitudes between 280-300 and 600 m (Buskerud: Ål). **Counties:** Oppland, Buskerud.

Discussion. *Lecanora norvegica* is a distinctive species on account of its chemical constituents. Among the species considered here, protocetraric acid as a major substance occurred only in *Lepraria eburnea* (constant) and in *Pertusaria amara* (accessory).

Lecanora norvegica may resemble *Loxospora elatina* morphologically. That species usually has a thicker thallus and larger, often globular soralia. Chemically, they are very different. These species seems to be allopatric, being restricted to continental and coastal areas, respectively. *Lecanora norvegica* may also be mistaken for a poorly developed *Ochrolechia* or *Pertusaria*. However, no species belonging to these genera are known to produce atranorin as a major constituent (see Dibben 1980, Hanko 1983, Hanko et al. 1985). I assign the new species to *Lecanora* as a provisional measure; the detection of fruiting specimens is necessary before its generic affinity can be finalized.

Lecanora norvegica appears to be a species of conifers in continental sites. However, as it has only recently been recognized, more field work is necessary to determine its substratum preferences and its range.

Specimens seen: Op: Dombås 1986, Tønsberg 9596. Lesja 1991, Tønsberg 17358. Sel 1990, Tønsberg 13137, 13145 (type collection). Vågå 1990, Tønsberg 13131b. - Buskerud: Ål 1991, Tønsberg 17226.

Lecidea Ach.

The corticolous species of *Lecidea* s. lat. are in urgent need of revision. None of the 10 lecideoid species treated here is congeneric with *Lecidea fuscoatra* (L.) Ach., the type species of *Lecidea* s. str.

Lecidea cinnabarina Sommerf.

K. sv. vetensk.-akad. handl. 823: 114-115 (1824). Typus: Norway, Saltdalen, corticolous on dead *Juniperus communis* [in Jun: com: emort], September 1818, leg. S. C. Sommerfelt, (O! - lectotype, here selected). TLC: Atranorin, fumarprotocetraric acid.

Thallus crustose, episubstratal, weakly delimited, forming rosettes or irregular patches up to about one dm in diameter, areolate or more or less continuous, sorediate. Prothallus white, more or less distinct. Corticate parts greyish, often whitish green-grey, often turning pale yellowish brown in the herbarium. Areolae mostly distinct, rounded, weakly convex, persistently discrete or becoming contiguous or fused, up to about 0.2 mm in diameter. Continuous thallus parts cracked and often tuberculate. **Soralia** variable, pale yellowish white, greyish or greenish, often becoming tinged pale brown in the herbarium, persistently discrete or becoming locally fused, orbicular or somewhat irregular in outline, delimited to diffuse, flat to convex, sometimes surrounded laterally by a sheet of the cortex; well delimited soralia up to 0.8 mm in diameter. Soredia mostly coarse, 35-70 µm in diameter; wall distinct, sometimes minutely papillate. Photobiont green, coccoid, up to 15 µm in diameter.

Apothecia present in 184 (94%) of the specimens, lecideine, cinnabar-red, with anthraquinones, K+ purple-red, up to 2 mm in diameter; disc strongly convex; proper margin concolorous with or somewhat paler than the disc, disappearing with age.

Chemistry: Atranorin, chloroatranorin, fumarprotocetraric acid, protocetraric acid (trace), ± cph-2.

Substratum. *Lecidea cinnabarina* was collected most frequently on *Juniperus communis* (89 specimens), *Betula pubescens* (53), and *Picea abies* (40), but it was also found on *Betula nana*, and rarely, on *Alnus incana*, *Pinus sylvestris*, subalpine/low-alpine shrubs of *Salix* spp., and *Sorbus aucuparia*. *Lecidea cinnabarina* was frequently associated with *Lecidea pullata*, *Parmeliopsis ambigua*, *P. hyperopta* and *Varicellaria rhodocarpa*.

Distribution. *Lecidea cinnabarina* was most commonly found above the forest limit. More than one half of the specimens were from northern Norway (mostly Finnmark). In southern Norway it occurred as far south as Telemark: Tokke and was completely absent in the lowlands of westernmost Norway (Vestlandet). Its vertical distribution ranged from about sea-level to 1405 m (Sogn og Fjordane: Luster). *Lecidea cinnabarina* usually occurred in open situations, but it was also found in shaded *Picea* forests. **Counties:** Akershus - Buskerud, Telemark, Hordaland - Finnmark.

Discussion. *Lecidea cinnabarina* varies greatly in colour, thallus form (being areolate or continuous), and shape and size of the soralia.

Lecidea cinnabarina is characterized by a pale greyish surface, delimited to indeterminate, mostly pale yellowish white soralia and the production of the β-orcinol constituents atranorin, chloroatranorin, and fumarprotocetraric acid. The chemically concordant *Mycoblastus fucatus* is distinguished by the distinct bluish tinge of its over-all thallus (cortex, soralia, prothallus). Some sterile specimens erroneously filed under the name *L. cinnabarina* in the herbaria proved to be *Pertusaria pupillaris*. With its smooth, continuous, mostly endosubstratal thallus lacking atranorin and chloroatranorin, that species should not be confused with *Lecidea cinnabarina*.

Lecidea cinnabarina has until recently been regarded as containing only fumarprotocetraric acid as the only major chemical constituent (see Culberson et al. 1977, James 1978, Hanko 1983). However, Brodo (1984b), Tønsberg (1986), and Coppins & James (1989) demonstrated the presence of atranorin in *Lecidea cinnabarina*.

Pertusaria chloropolia var. *planiuscula* was placed in synonymy with *Lecidea cinnabarina* by Laundon (1963), Hawksworth et al. (1980), and Hanko (1983). However, the type specimen of that taxon is morphologically and chemically (atranorin and chloroatranorin are lacking) concordant with *Pertusaria pupillaris* with which it should be placed in synonymy.

Lecidea cinnabarina is mainly a corticolous species, but it sometimes spreads on to wood of *Juniperus communis*.

Specimens seen (selected): Oslo 1870, Moe (O) - He: Tynset 1983, Tønsberg 8167. - Op: Gausdal, Norman (O). - Bu: Krødsherad 1982, Tønsberg 6951. - Te: Notodden 1891, Kiær (O). - Ho: Eidfjord 1907, Havaas. - SF: Jølster 1976, Balle. - MR: Molde 1902, Havaas. - ST: Oppdal 1982, Tønsberg 7040. - NT: Namsskogan 1981, Tønsberg 6280. - No: Grane 1983, Tønsberg 8050. - Tr: Tromsø 1874, Norman (O). - Fi: Berlevåg 1920, Lynge (O). Exsiccata examined; Havaas, Lich. Norv. 312 (BG, O, UPS); Th. M. Fries, Lich. Scand. 17 (O, S, UPS). A total of 195 specimens seen.

Lecidea efflorescens (Hedl.) Erichsen

Lecidea helvola (Körber) Hedl. f. *efflorescens* Hedl., in Bih. K. svenska Vetensk.-Akad. Handl. III (3): 61 (1892). Type: Sweden: Flousund prope Upsaliam, Aug. 1891, Hedlund (S! - lectotype, here selected). TLC: argopsin (major), norargopsin.

Lecidea epizanthoidiza Nyl., in Flora 58: 10 (1875), nom. rejic. prop. Type: Finland: Tavastia australis, Luhanka, Nyystölä, Mädällä puulla, 1872, E. Lang 206 (H! - lectotype, here selected). TLC: Argopsin (major), norargopsin.

Figs 19, 51.

Thallus crustose, indeterminate, usually forming rounded to irregular patches up to a few cm in diameter, rarely becoming up to one dm or more across, thin to thick, areolate or, very rarely, more or less continuous, sorediate. Prothallus rarely distinct, sometimes visible as a whitish network of hyphae between the areolae. Areolae, if present, mostly marginal on the thallus, persistently discrete or becoming contiguous, greyish or greyish green, up to 0.2 mm in diameter, flat or slightly convex, rounded, entire to more or less incised, adnate or sometimes free (more or less subsquamiform) from the substratum along a marginal zone, rarely more or less edge on to the substratum. **Soralia** pale yellow, bright yellowish green or green, bursting from the apices or margins of the areolae, or originating beneath the surface of the substratum, diffuse, often efflorescent, variably sized, up to 0.5 mm in diameter, more or less circular in outline or irregular, often only slightly raised above substratum level and with the upper surface usually plane, more rarely distinctly prominent with a plane or convex upper surface, persistently discrete or becoming confluent forming a leprose sorediate crust which may become thick and crack into angular, variably sized portions. Soredia fine, 15-30 (-40) µm in diameter; wall distinct. Medulla indistinct. Photobiont green, unicellular, but often aggregated, globular, up to 7.5(-10) µm in diameter.

Apothecia present in 62 (31%) of the specimens, biatorine, up to 0.9 mm in diameter, pale reddish-brown, glossy; margin slightly paler than the disc, disappearing with age; disc plane to strongly convex.

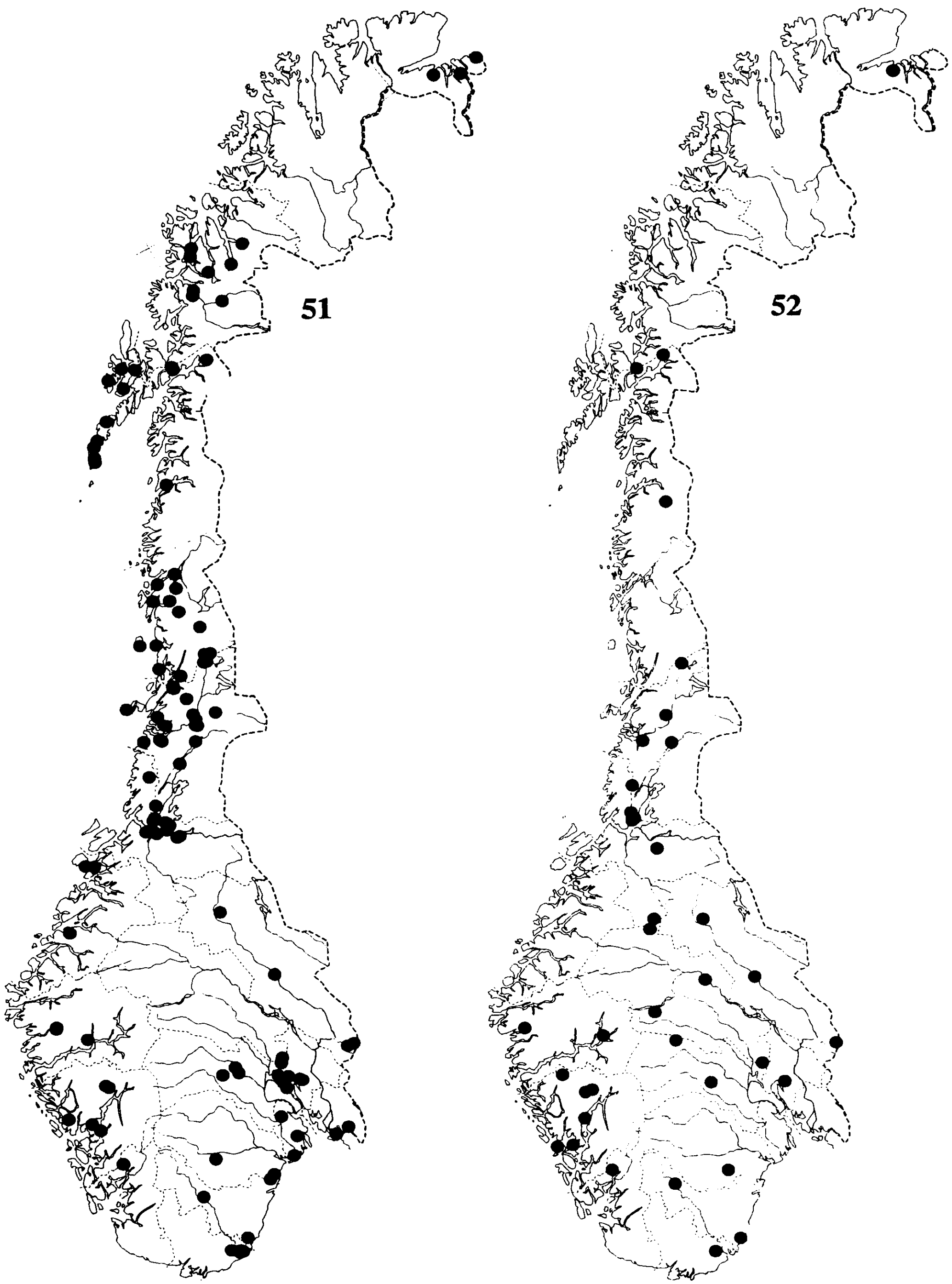
Chemistry: Argopsin (major substance), norargopsin. Soralia PD+ immediately rust-red, K-, C-, KC-; UV-. TLC: Fig. 19.

Substratum. *Lecidea efflorescens* has been collected most commonly on *Alnus incana* (71 specimens) and *Sorbus aucuparia* (35), *Betula pubescens/pendula*, *Juniperus communis*, *Picea abies*, and *Salix caprea*, and more rarely, on *Acer platanoides*, *Acer* sp., *Alnus glutinosa*, *Corylus avellana*, *Fagus sylvatica*, *Populus tremula*, *Prunus padus*, *Quercus*, *Salix aurita*, *Salix* spp., and *Ulmus glabra*.

Distribution. *Lecidea efflorescens* occurred throughout most of the country, especially in northern and eastern sites; on the southern and southwestern coasts it seemed to be sparse (Fig. 51). Its vertical distribution ranged from about sea-level to 620 m (Nordland: Grane). **Counties:** Østfold - Finnmark.

Discussion. *Lecidea efflorescens* is variable especially regarding the morphology of the soralia. In its most reduced state it consists of discrete, punctiform soralia on a otherwise endosubstratal thallus. When well-developed the soralia are contiguous, or confluent forming a thickish leprose crust. Most specimens are intermediate between these extremes. When growing on shaded tree-trunks in sheltered woodlands the colour of the soralia is mostly green, whereas specimens in more open situations usually have a distinct yellowish hue. This variation is probably a response to various amounts of illumination at the sites.

Material of *Lecidea efflorescens* is not always easily determinable on morphology alone. Forms with pale yellowish soralia may be very similar in thallus characters to species in the *Lecanora symmicta*-complex, particularly *L. flavopunctata*. Forms with a pure green, leprose sorediate thallus strongly resemble *Lecidella flavosorediata*. *Lecidea efflorescens* may also be confused with *Bacidia epixanthoides* and *Lecidea gyrophorica*, but is usually distinguished by its finer soredia and corticolous habit. *Lecidea efflorescens* is, however, easily distinguished chemically from those taxa on account of its content of argopsin and norargopsin. Argopsin



Figs 51-52. Distribution maps. Fig. 51. *Lecidea efflorescens*. Fig. 52. *Lecidea gyrophorica*.

is a rare substance. Among crustose species it is only known from *Halecania viridescens*, *Phyllopsora* species, *Micarea leprosula*, *M. lignaria* v. *lignaria*, and *Lecidea efflorescens* (Coppins 1983a, 1989b, Huneck & Tønsberg 1982, Swinscow & Krog 1981).

Lecidea efflorescens is usually corticolous on acidic bark. Sometimes it may spread on to corticolous bryophytes. *Lecidea efflorescens* is a widespread species with an eastern affinity.

Specimens seen (selected): Øf: Hvaler 1983, Tønsberg 7774. - Oslo: M.N. Blytt (O). - He: Åmot 1982, Tønsberg 7589. - Op: Lunner 1982, Tønsberg 7540. - Bu: Sigdal 1981, Tønsberg 6406. - Vf: Andebu 1921, Høeg (TRH). - Te: Kragerø 1986, Tønsberg 9580. - AA: Birkenes 1986, Tønsberg 9571. - VA: Songdal 1987, Tønsberg 10080. - Ro: Sauda 1986, Botnen 86/22. - Ho: Voss 1987, Tønsberg 10119. - SF: Førde 1984, Tønsberg 8702. - MR: Vestnes 1979, Tønsberg 3859. - ST: Trondheim 1980, Tønsberg 5256. - NT: Grong 1980, Tønsberg 4702. - No: Flakstad 1987, Tønsberg 10540. - Tr: Skånland 1982, Tønsberg 7380a. - Fi: Sør- Varanger 1982, Tønsberg 7219a. A total of 203 specimens seen.

Lecidea gyrophorica Tønsb. sp. nov.

L. epizanthoidiza auct. non Nyl.

[*L. incana* sensu Sommerf. non Ach., in Sommerf. Suppl.: 164 (1826).]

Thallus corticola vel muscicola, areolatus, sorediatus. Areolae crustosae vel subsquamiformes, acidum gyrophoricum continens. Soralia flavida, irregularia, saepe confluenscentia; soredia farinosa. Apothecia rara, subcarnea vel brunnea, maturis convexis et immarginatis. Excipulum proprium incoloratum ex hyphis radiatis luminibus distinctis constans. Asci typo *Biatora* (vide Hafellner 1984: 267). Sporae simplicae vel 1-septatae, ellipsoideae vel oblongae, 10-15(-16.5) × (3.5-)4.5-6 µm.

Type: Norway, Sør-Trøndelag, Melhus, NW of lake Håen, along brook Sæterbekken just W of Granhaugvollen, UTM grid ref.: 32V, NR 7600 (map 1621 III), alt. 400-420 m, on *Alnus incana*, naked and mossy trunk, 23 May 1982, Tønsberg 6657 (BG - holotype, E - isotype). TLC: gyrophoric acid, lecanoric acid trace.

Fig. 52.

(Description based on Norwegian and Scottish material.)

Thallus crustose to subsquamulose, endo- to episubstratal in non-sorediate parts, indeterminate, forming rosettes or irregular patches up to several dm in diameter, areolate, sorediate. Prothallus indistinct, or absent. Areolae greyish green, discrete to contiguous, 0.1-0.3 mm in diameter, convex, often constricted at base, sometimes subsquamiform, bursting apically to form soralia. **Soralia** yellowish green, becoming straw-coloured in the herbarium, irregular, discrete at first but - in older parts of the thallus - soon becoming confluent forming a thick leprose crust. Soredia mostly fine, often in consoredia up to 40 µm in diameter, with a distinct wall. Photobiont green, coccoid or often aggregated, up to 10(-17.5) µm in diameter.

Apothecia present in 6 (14%) of the Norwegian specimens, pale flesh-coloured to reddish-brown, with a whitish brown margin flush with the level of the disc, up to 0.8 mm in diameter, often becoming emarginate and strongly convex with age. In section: Proper exciple colourless, composed laterally of radiating hyphae with distinct lumina 1.5-2.5 µm wide, embedded in a gel matrix, in lower part (below the subhymenium) up to 380 µm deep. Epihymenium more or less colourless to brown. Hymenium more or less colourless to pale brown, 50-60 µm deep; K+ pale olivaceous. Paraphyses sometimes tending to be bifurcately divided in uppermost part, otherwise simple or sparingly branched, conglutinated in H_2O, but free in squash preparations with a drop of K added, 1.5-2.0 µm wide; apical cell sometimes slightly swollen, up to 3 µm wide. Asci (similar to that illustrated for *Biatora vernalis* by Hafellner 1984) clavate, 9-10µm wide, surrounded by K/I+ blue hymenial gelatine; ocular chamber narrow, poorly developed; tholus K/I+ blue, with a K/I+ deeply blue "masse-axial". Spores simple to 1-septate, ellipsoid to oblong-ellipsoid, 10-15(-16.5) × (3.5-)4.5-6 µm. Subhymenium more or less colourless, K/I+ blue, up to 100 µm deep (in K/I) in convex apothecia. Pycnidia not seen.

Chemistry: Gyrophoric acid, lecanoric acid (trace).

Substratum. *Lecidea gyrophorica* was collected on corticolous mosses or, more rarely, on naked bark of trunks of *Picea abies* (7), *Betula pubescens/pendula* (6 specimens), *Juniperus communis* (6), and more rarely *Alnus incana*, *Quercus*, *Populus tremula*, *Salix caprea*, *Sorbus aucuparia*, and *Ulmus glabra*. It often occurred at the base of the phorophyte, sometimes in dry cavities.

Distribution. *Lecidea gyrophorica* occurred mainly in the inland (Fig. 52). Its vertical distribution ranged from about sea-level to 1080 m altitude (Oppland: Vang). **Counties:** Akershus - Buskerud, Telemark - Sogn og Fjordane, Sør-Trøndelag - Finnmark.

Discussion. *Lecidea gyrophorica* resembles *Bacidia epixanthoides* in thalline characters. Both species usually grow on corticolous mosses and have a greenish or yellowish thallus which becomes more or less leprose with age. Sterile specimens are best separated by chemistry: gyrophoric acid in *Lecidea gyrophorica*, no substances in *Bacidia epixanthoides*. *Lecidea gyrophorica* may also be confused with *Lecidea efflorescens*, with which it is sometimes associated. That species usually has more discrete soralia often with a more vivid greenish or yellowish colour, and contains argopsin and norargopsin (PD+ rust-red). A specimen from Nordland (Tønsberg 7430) with very coarse soredia (45-100 µm) was only tentatively assigned to *L. gyrophorica*.

Lecidea gyrophorica is known from northern and northwestern Europe and North America (see, e.g., Vainio 1934, Wetmore 1981, Diederich 1989). In Norway it is a species of acidic bark, mainly in continental sites. *Lecidea gyrophorica* was found once on a mossy rock wall.

Specimens seen (selected): **Norway:** Oslo 1991, Tønsberg 17431. - He: Kongsvinger 1985, Tønsberg 9447. - Op: Lunner 1982, Tønsberg 7529. Ringebu 1984, Tønsberg 9027. - Bu: Sigdal 1981, Tønsberg 6332. - Te: Drangedal 1987, Tønsberg 10272. - AA: Grimstad 1990, Tønsberg 13523. - VA: Songdal 1987, Tønsberg 10079. - Ro: Sauda 1988, Tønsberg 10808. - Ho: Voss 1987, Tønsberg 10127. - SF: Luster 1990, Anonby 495. - ST: Melhus 1982, Tønsberg 6657. - NT: Leksvik 1981, Tønsberg 5421, 5876a, 5914. Namsskogan 1982, Tønsberg 7449 - No: Narvik 1982, Tønsberg 7430. Saltdal 1982, Tønsberg 7663. - Tr: Skånland 1982, Tønsberg 7347b. - Fi: Sør-Varanger 1982, Tønsberg 7219b. A total of 43 Norwegian specimens seen. **U.K.**: Scotland, Mid Perth (V.C. 88), Glen Lyon woods, 1976, Coppins 3781 & Tibell (E); Dunkeld, 1984, Coppins 10588 (E); Drummond Park, Coppins 3583 (E). - Westerness (V.C. 97), Loch Quoich, 1972, Coppins 4210 (E). - Dunbarton (V.C. 99), Loch Lomond, Oct. 1978, Topham (E).

Lecidea leprarioides Tønsb. nom. et stat. nov.

Lecidea turgidula var. *pulveracea Th.* Fr., in Lich. Scand. II: 470 (1874). Type: Sweden, Lule lappmark, Aktse, 1864, P.J. Hellbom (UPS! - lectotype, here selected). TLC: pseudoplacodiolic acid.

Fig. 19.

Thallus crustose, greyish white, yellowish grey, or pale green, sometimes with a pale brown tinge, endosubstratal in non-sorediate parts or, rarely, entirely endosubstratal, indeterminate, forming irregularly spreading patches up to several dm across, sorediate or rarely esorediate. Prothallus indistinct or absent. **Soralia** bursting here and there through the uppermost cell layers of the substratum, diffuse, irregular, forming a discontinuous leprose crust. Soredia fine, 10-30 µm in diameter, often in aggregations, but easily free in squash preparations; wall distinct. Medulla absent. Photobiont green, coccoid, up to 10 µm in diameter.

Apothecia present in all collections seen, lecideine, black, often with a distinct bluish pruina, emarginate, strongly convex, sometimes tuberculate, up to 0.4(0.6) mm in diameter. Pycnidia not seen.

Chemistry: Pseudoplacodiolic acid. TLC: Fig. 19.

Substratum. Corticolous specimens of *Lecidea leprarioides* were found on *Picea abies*. In Finnmark it occurred on *Picea abies* ssp. *obovata*.

Distribution. *Lecidea leprarioides* occurred in scattered sites in eastern areas. Its vertical distribution ranged from 140 m (Finnmark: Sør-Varanger) - 700 m (Hedmark: Engerdal). **Counties:** Corticolous specimens: Hedmark, Buskerud, Telemark, Sør-Trøndelag - Nordland, Finnmark. All specimens: Hedmark, Buskerud, Telemark, Hordaland, Sør-Trøndelag - Finnmark.

Discussion. *Lecidea leprarioides* is usually distinctly sorediate. However, a few endoxylic specimens were esorediate. *Lecidea leprarioides* is closely related to *L. turgidula* and was originally described as a sorediate variety of that species. These species seem to be similar in apothecial characters, but the presence of soredia in the former species, makes them morphologically distinct. In addition to this morphological difference the species are chemically distinct. All specimens examined of *Lecidea turgidula* s. str. from Norway and Sweden, including the holotype (E. Fries, Lich. Suec. no 25 (UPS)), contained placodiolic acid. A few lignicolous specimens with an endosubstratal, apparently esorediate thallus, contained pseudoplacodiolic acid and were assigned to *L. leprarioides*. All specimens with a distinct (episubstratal), esorediate thallus contained placodiolic acid. Pseudoplacodiolic acid is a rare substance. Previously it was known to occur only in a chemotype of *Rhizoplaca chrysoleuca* (Leuckert et al. 1976) and in *Haematomma* (Rogers & Bartlett 1986). No species is known to produce placodiolic and pseudoplacodiolic acid jointly (see Leuckert et al. 1976, Rogers & Bartlett 1986, McCune 1987).

Lecidea leprarioides is distinguished by its usually greyish yellow, discontinuous, leprose thallus and its chemistry including pseudoplacodiolic acid. Based on thallus morphology alone it may be difficult to separate from sterile specimens of *Lecanora expallens*, with which it sometimes occurs. However, the latter is usually more distinctly yellow and differs chemically by the content of xanthones and zeorin. Leprose specimens of *Hypocenomyce sorophora* differ, e.g., by the production of alectorialic acid.

The specimen from Møre og Romsdal (Magnusson 20823 (UPS)) cited by Magnusson (1948) as *L. turgidula* var. *pulveracea* is *Lecidea pullata*.

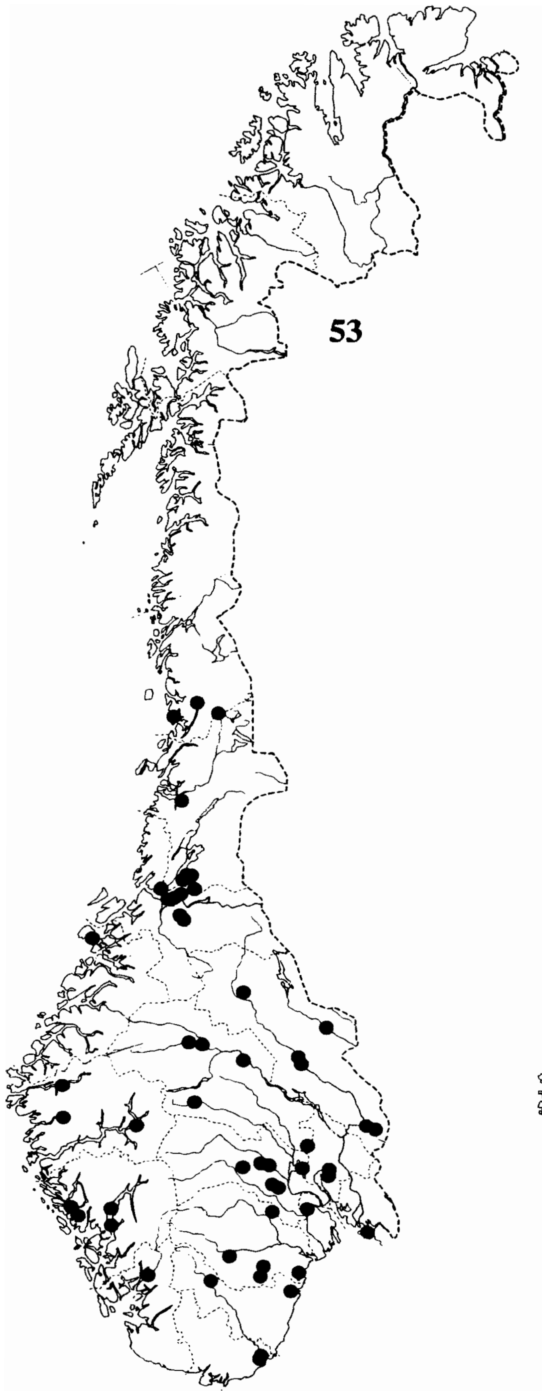
Lecidea leprarioides is a species of bark of conifers. Three lignicolous specimens were from *Pinus sylvestris*.

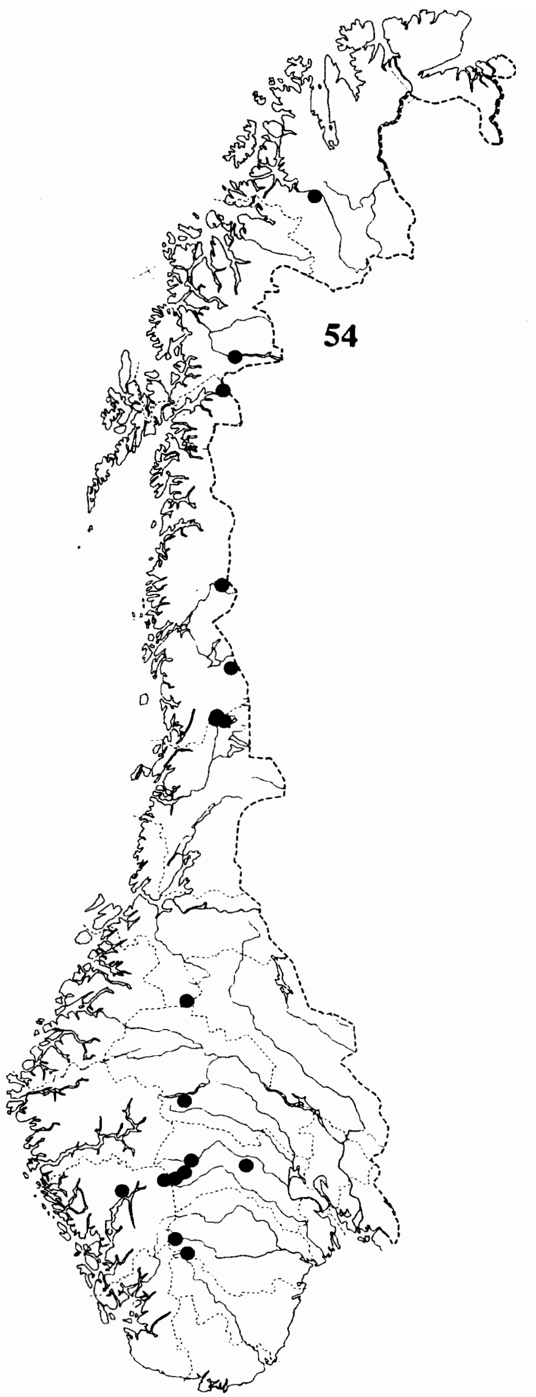
Specimens seen (selected): He: Engerdal 1988, Tønsberg 11034. - Bu: Sigdal 1987, Tønsberg 10358. - Te: Drangedal 1987, Tønsberg 10273. - ST: Trondheim 1987, Tønsberg 10013. - NT: Namsskogan 1983, Tønsberg 7987. - No: Grane 1983, Tønsberg 7994. - Fi: Sør-Varanger 1987, Øvstedal. A total of 15 collections seen, in addition to three from wood.

Lecidea nylanderi (Anzi) Th. Fr.

Fig. 53.

Thallus crustose, episubstratal, but in young parts sometimes with areolae and soralia developed beneath the uppermost layers of the substrate, indeterminate, irregularly spreading





Figs 53-54. Distribution maps. Fig. 53. *Lecidea nylanderi*. Fig. 54. *Lecidea porphyrospoda*.

to several dm in diameter, usually thin, areolate, sorediate. Prothallus often distinct, blue, K- or K+ greenish, N+ violet. Esorediate areolae bluish grey, sparsely present in young parts or, more often, indistinct or absent, discrete or a few grouped together, up to 0.2 mm in diameter, rounded in outline, convex, soon bursting apically to form soralia. **Soralia** mostly bluish grey, greenish or whitish in shaded niches, sometimes tinged with brown due to pigmentation of the external soredia, diffuse, discrete, or becoming confluent forming a leprose crust; pigment N+ red-brown. Soredia fine, sometimes in consoredia up to 50 µm in diameter; wall distinct, sometimes papillate. Medulla indistinct. Photobiont green, coccoid, up to 10(-15) µm in diameter.

Apothecia sparse in 7 (9%) of the specimens, lecideine, to 0.8 mm in diameter; margin light brown, thin; disc brown, flat.

Chemistry: Divaricatic acid.

Substratum. *Lecidea nylanderi* has most commonly been collected on *Picea abies* (24 specimens), *Pinus sylvestris* (19), *Juniperus communis* (12) and *Betula pubescens/pendula* (11); other phorophytes included *Alnus glutinosa*, *A. incana*, *Populus tremula*, *Prunus padus*, *Quercus*, and *Sorbus aucuparia*.

Distribution. *Lecidea nylanderi* was common in southern Norway (Fig. 53). In northern Norway it was found only in the southernmost parts (Nordland: Brønnøy & Sømma). Its vertical distribution ranged from about sea-level to 600 m (Hedmark: Tynset). **Counties:** Østfold - Nordland.

Discussion. The soralia of *Lecidea nylanderi* vary considerably from small and discrete to confluent forming a leprose crust. Specimens with no distinct esorediate areolae may superficially resemble *Lepraria incana*. Both have a bluish-grey thallus of discrete or confluent soralia. *Lecidea nylanderi* is distinguished from that species morphologically by the soredia which are more densely packed and more firmly attached to the substratum, by the bluish, often conspicuous prothallus, and, chemically, by the absence of zeorin. For further details, see under *Lepraria incana*.

Lecidea nylanderi is a southern species of acidic bark.

Specimens seen (selected): Øf: Hvaler 1983, Tønsberg 7720. - Oslo: 1983, Tønsberg 7845. - He: Åmot 1982, Tønsberg 7564. - Op: Lunner 1982, Tønsberg 7536. - Bu: Hole 1981, Tønsberg 6444. - Vf: Hof 1990, Tønsberg 13089. - Te: Kviteseid 1987, Tønsberg 10285. - AA: Valle 1987, Tønsberg 10184. - VA: Songdalen 1991, Tønsberg 17408. - Ro: Suldal 1988, Tønsberg 10854. - Ho: Kvinnherad 1987, Tønsberg 10787. - SF: Førde 1984, Tønsberg 8665. - MR: Smøla 1983, Tønsberg 8310b. - ST: Trondheim 1983, Tønsberg 8132. - NT: Frosta 1983, Tønsberg 8424. - No: Brønnøy 1987, Tønsberg 10580. A total of 82 specimens seen.

Lecidea porphyrospoda (Anzi) Th. Fr.

Fig. 54.

Thallus crustose, with a brownish or, when growing in shade, green over-all colour, episubstratal, indeterminate, areolate, sorediate. Prothallus whitish, between the areolae and surrounding the thallus as a border. Areolae indistinct or, more rarely, distinct, especially in richly fertile specimens, discrete to contiguous, convex, rounded, sometimes incised and/or subsquamiform, up to 0.4 mm in diameter, soon bursting to form soralia. **Soralia** greyish brown or pale brown due to pigmentation of the external soredia, or greenish, especially in shaded niches, irregularly punctiform at first, but soon tending to become confluent forming a leprose crust with no distinct corticate parts. Soredia fine, 20-40(-50) µm in diameter; wall distinct. Medulla indistinct. Photobiont green, unicellular, globose to broadly ellipsoid, up to 15(-20) µm in diameter.

Apothecia present in 22 (76%) of the specimens, lecideine, distinctly constricted at base, up to 1.2 mm in diameter, red-brown, glossy; margin distinct or disappearing with age; disc flat to convex.

Chemistry: Lobaric acid.

Substratum. *Lecidea porphyrospoda* has been found on *Betula pubescens/pendula* (11 specimens) and *Juniperus communis* (8), and more rarely on *Betula nana, Picea abies,* and *Salix* sp. (low-alpine shrub). It usually occurred the base of the phorophytes. Common associates included *Caloplaca sorocarpa* and *Lecidea pullata.*

Distribution. *Lecidea porphyrospoda* has largely been collected in subalpine/low-alpine and northern areas (Fig. 54). Its vertical distribution ranged from 280 m (Nordland: Grane) to 1150 m (Buskerud: Hol). In southern Norway south of Trondheimsfjorden all collections were from an altitude of 500 m or above. **Counties:** Oppland, Buskerud, Telemark, Aust-Agder, Hordaland, Sør-Trøndelag - Finnmark.

Discussion. The colour of *Lecidea porphyrospoda* varies from green to brown, probably as a response to various amounts of illumination. The soralia may be discrete, but more often the thallus is sorediate throughout. Richly fertile specimens may almost lack soredia, at least in parts of the thallus. The more or less brownish, sorediate thallus and the content of lobaric acid are diagnostic characters for sterile specimens of *L. porphyrospoda.*

Lecidea porphyrospoda is a species of acidic bark in lowalpine/sub-alpine situations.

Specimens seen (selected): Op: Vang 1985, Tønsberg 9292b. - Bu: Sigdal 1982, Tønsberg 7021a. - Te: Vinje 1991, Tønsberg 17415. - AA: Bykle 1984, Tønsberg 8907b. - Ho: Granvin 1944, Havaas (BG, O, UPS). - ST: Oppdal 1982, Tønsberg 7038a. - NT: Namsskogan 1983, Tønsberg 7982. - No: Grane 1983, Tønsberg 8103. - Tr: Bardu 1910, Lynge (O). - Fi: Alta 1988, Tønsberg 11162. Exsiccata examined: Havaas, Lich. Norv. 656 (BG, O, UPS). A total of 29 specimens seen.

Lecidea praetermissa Tønsb. sp. nov.

Thallus areolatus, sorediatus. Areolae indistinctae, cinereo-albae vel viridae. Soralia punctiformia, plerumque cinereo- vel brunneo-viridia. Excipulum proprium prominens, pallidum vel atrobrunneum; discus plus minusve concolorans, interdum carneobrunneum. Excipulum proprium crystallis acido fumarprotocetrarico. Sporae hyalinae, simplices, late ellipsoideae vel globosae, 5-10 × 5-7 µm. Thallus acidum fumarprotocetraricum continens.

Type: Norway, Nordland, Grane, Austervefsna, 1 km W of Kløvmoen, alt. 120-150 m. UTM grid ref.: 33W VN 3567 (map 1926 III), 9 August 1983, on twig of *Picea abies*, Tønsberg 8065 (BG - holotype).

Figs 55-56.

Thallus (Fig. 55) crustose, endo- to episubstratal in non-sorediate parts, indeterminate, usually forming irregularly spreading patches between other crustose lichens, up to a few cm across, areolate, sorediate. Prothallus usually indistinct, but sometimes forming a pale to dark brown or pale greyish blue border around the areolae and soralia. Areolae rare, greyish white to green, discrete to more or less contiguous, rounded and convex, up to 0.3 mm in diameter. **Soralia** usually greyish brown to brownish green, rarely with a yellowish tinge, green in shaded niches, punctiform, up to 0.2(-0.3) mm in diameter, diffuse or sometimes surrounded laterally by a thin, irregular sheet formed by the uppermost bark cells of the substrate, plane to convex, discrete or, with age, some becoming more or less contiguous or fused, forming in these parts a more or less leprose sorediate crust. Soredia fine, 15-20 µm in diameter; wall distinct. Photobiont green, unicellular, globose to more or less ellipsoid, up to 10 µm in diameter.

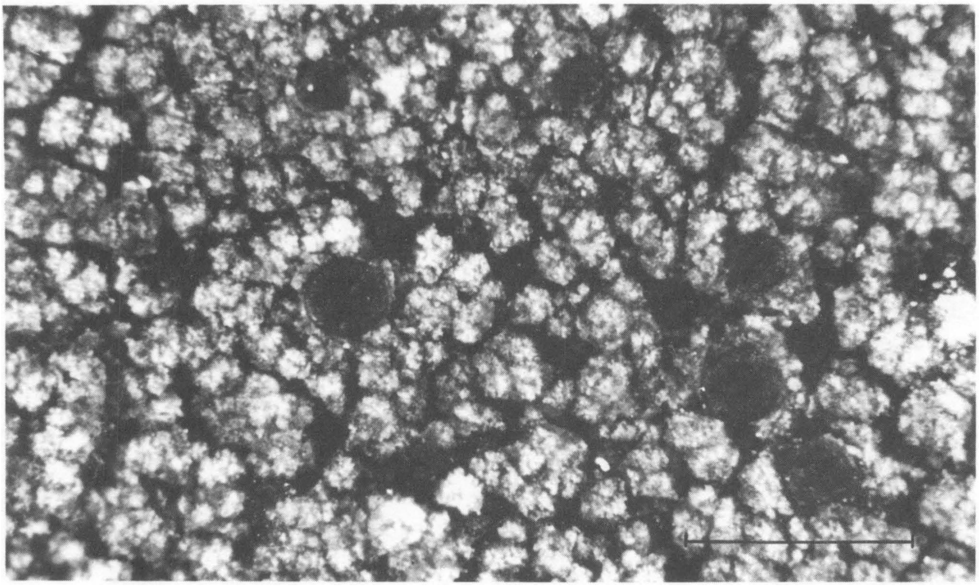


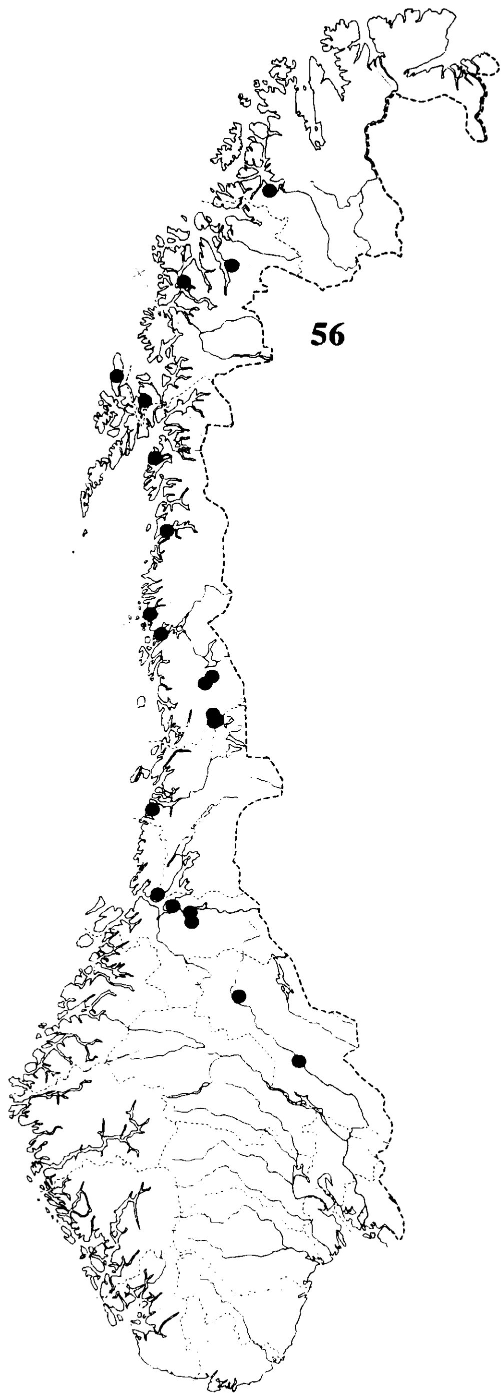
Fig. 55. *Lecidea praetermissa*. Tønsberg 8066. Scale 1 mm.

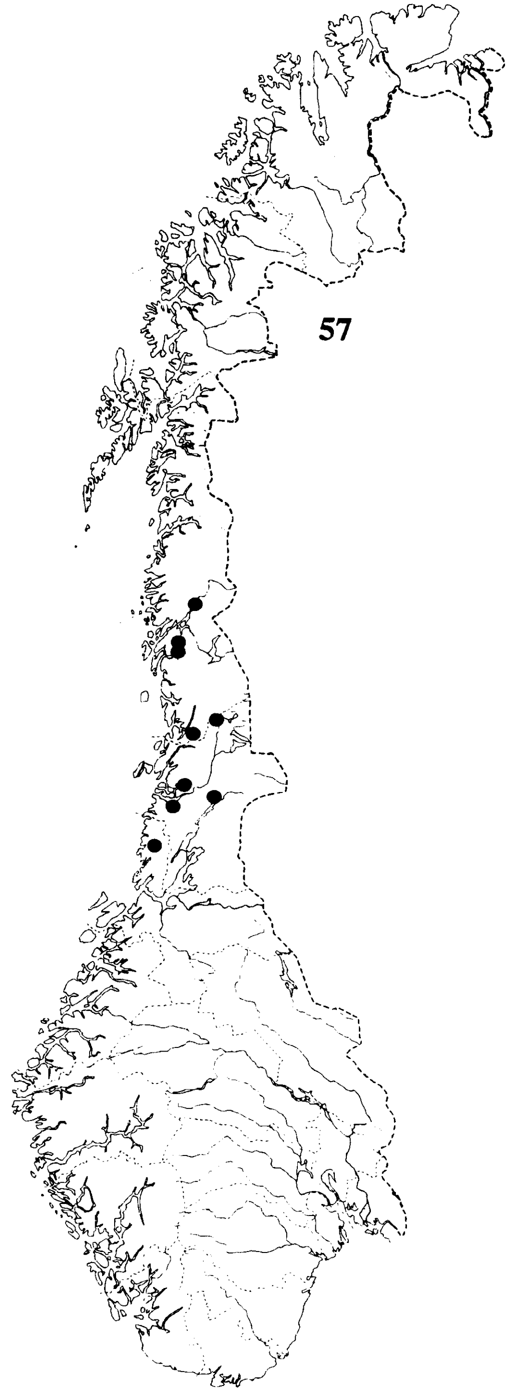
Apothecia present in 13 (46%) of the specimens, lecideine, sessile, up to 0.3 (-0.5) mm in diameter; proper margin pale to blackish brown, glossy, up to 0.15 mm wide, persistent; disc pale to dark brown, sometimes more or less carneous brown or black, mostly matt, plane. In sections: Proper exciple colourless or pale brown, but outer rim dirty green, K- or K+ intensifying, N+ pale reddish brown, with crystals of fumarprotocetraric acid (PD+ red); hyphae strongly conglutinated in outer and lower part, less so in inner part. Epihymenium brown, sometimes with a greenish tinge; pigment amorphous, green pigment K+ dark green. Hymenium 40-70 µm deep, colourless, K/I- except for asci. Paraphyses simple, or slightly branched in uppermost part, 1.5-2.0 µm wide, with a brown pigment in the wall of the apical cell. Asci clavate, 40-60 × 12-20 µm, 8-spored, surrounded by a K/I+ blue cap; wall not amyloid; tholus well developed, K/I+ deep blue, with a distinct "masse axiale"; ocular chamber absent. Spores colourless, simple, often immature and of different form and size within a single ascus, broadly ellipsoid to globose when mature, 5-10 × 5-7 µm. Subhymenium colourless, 20 µm deep, K/I+ bluish violet. Pycnidia not seen.

Chemistry: Fumarprotocetraric acid, protocetraric acid, ± cph-2.

Substratum. *Lecidea praetermissa* has been collected on *Alnus incana* (9 specimens), *Betula pubescens/pendula* (7), and *Sorbus aucuparia* (7) and, more rarely, on *Picea abies*, *Salix caprea*, and *Salix* sp. On the latter phorophyte it occurred on twigs and branches on a dead, but still corticate tree. Most collections were from rather shaded habitats. Associated lichens included *Buellia griseovirens*, *Bryoria fuscescens*, *Cetraria pinastri*, *C. sepincola*, *Hypocenomyce leucococca*, *Hypogymnia physodes*, *Japewia subaurifera*, *Lecanora* sp., *L. efflorescens*, *L. pullata*, *L. tornoënsis*, *Mycoblastus affinis*, *M. fucatus*, *Parmelia sulcata*, *Parmeliopsis ambigua*, *P. hyperopta*, *Pertusaria borealis*, *P. carneopallida* and *Placynthiella dasaea*.

Distribution. *Lecidea praetermissa* occurred in eastern parts of Norway (Fig. 56). Its vertical distribution ranged from about sea-level to 600 m (Hedmark: Tynset). **Counties.**





Figs 56-57. Distribution maps. Fig. 56. *Lecidea praetermissa*. Fig. 57. *Lecidea subcinnabarina*. Known distribution.

Hedmark, Sør-Trøndelag - Finnmark.

Discussion. *Lecidea praetermissa* may superficially be rather similar to *L. porphyrospoda* in thallus characters and external features of the apothecia. However, the latter species is distinct by the often more reddish-brown apothecia which become markedly convex with age, the asci which appear to lack a distinct "masse axiale", the larger spores (12-16 × 7-9 µm (9-16 × 6-7 µm according to Vainio 1934)), and the production of lobaric acid in the thallus. When sterile *L. praetermissa* may also resemble *L. pullata* with which it often occurs. That species usually has smaller soralia, a distinct brownish or bluish prothallus and a chemistry involving sphaerophorin and isosphaeric acid (UV+, PD-).

Lecidea praetermissa is a species of acidic bark in eastern sites.

Specimens seen: Norway: He: Tynset 1983, Tønsberg 8168a, 8180. Åmot 1982, Tønsberg 6896b, 6897. - ST: Klæbu 1981, Tønsberg 5942. Melhus 1982, Tønsberg 6656. Rissa 1983, Tønsberg 8194, 8197a. Trondheim 1983, Tønsberg 8144, 8146. - NT: Flatanger 1983, Tønsberg 8467. Namsskogan 1979-1981, Tønsberg 4281, 5812. - No: Andøy 1987, Tønsberg 10443. Bodø 1986, Tønsberg 9602. Grane 1981-1983, Tønsberg 6042b, 6048, 8057, 8065, 8066. Hamarøy 1986, Tønsberg 9766. Hattfjelldal 1991, Tønsberg 17336. Nesna 1986, Tønsberg 9698. Rødøy 1986, Tønsberg 9672. - Tr: Kvæfjord 1987, Tønsberg 10416. Kåfjord 1983, Tønsberg 7290a. Tromsø 1983, Øvstedal, Spjelkavik & Elvebakk 83:053 (TROM). - Fi: Alta 1982, Tønsberg 7246b. A total of 28 Norwegian specimens seen. **Sweden**: Åsele Lappmark, Risbäck parish 1991, Tønsberg 17319.

Lecidea pullata (Norman) Th. Fr.

Fig. 19.

Thallus crustose, indeterminate, forming rosettes or irregular patches, up to a dm or more in diameter, endo- to episubstratal in non-sorediate parts, thin, areolate, sorediate. Prothallus usually distinct, blue or, more rarely, brown; blue pigment K- or K+ greenish, N+ red. Areolae indistinct to distinct, or absent, minute, 0.1-0.3 mm in diameter, rounded, convex, green to pale brown, discrete, but usually some becoming contiguous, soon bursting apically to form soralia. **Soralia** minute, irregularly punctiform, mostly 0.1 mm in diameter, but often with some larger ones (to 0.3 mm in diameter) intermixed, green or tinged with brown, due to pigmentation of the external soredia, randomly spaced, mostly discrete, but sometimes becoming locally contiguous or, very rarely, forming a leprose crust throughout, flat or slightly elevated with the upper surface more or less plane. Soredia fine, up to 20-30 µm in diameter; wall distinct. Photobiont green, coccoid, up to 12 µm in diameter.

Apothecia present in 95 (41%) of the collections, usually sparse, but sometimes numerous, biatorine, emarginate, often strongly convex, up to 0.6 mm in diameter, variously coloured, usually bluish or brownish, rarely blackish.

Chemistry: Sphaerophorin (usually major substance), ± isosphaeric acid (usually in trace amounts, rarely in a concentration more or less equal to that of sphaerophorin). Fig. 19.

One specimen (Tønsberg 6436) which was analysed by TLC and HPLC contained isosphaeric acid as the major product with an equal to moderate concentration of sphaerophorin and traces of isohyperlatolic/hyperlatolic and superlatolic acids, and probably also traces of 4-0-demethylisosphaeric acid and 4-0-demethylsphaerophorin.

Substratum. *Lecidea pullata* was found on the smooth bark of a variety of phorophytes; most commonly on *Betula pubescens/pendula* (98 specimens), *Alnus incana* (31) and *Sorbus aucuparia* (19). Other phorophytes included *Betula nana*, subalpine/low-alpine *Salix* shrubs, *Juniperus communis*, *Picea abies* and, more rarely, *Alnus glutinosa*, *Calluna vulgaris*, *Pinus sylvestris*, *Populus tremula*, *Prunus padus*, *Salix caprea*, *S. nigricans*, and *Vaccinium myrtillus*. *Lecidea pullata* occurred in open as well as in shaded habitats.

Distribution. *Lecidea pullata* occurred especially in subalpine/low-alpine and northern sites; in southern Norway it was sparse or absent in the coastal lowlands. Its vertical distribution ranged from about sea-level to 1550 m (Oppland: Lom). **Counties:** Akershus - Buskerud, Telemark - Finnmark.

Discussion. In its sterile state *Lecidea pullata* is distinguished by the often distinctly blue prothallus, the mainly punctiform soralia and the production of sphaerophorin and isosphaeric acid. The prothallus is often very conspicuous in specimens growing on light-coloured bark, e.g., of *Betula*. *Lecidea nylanderi* and *Mycoblastus caesius* resemble *Lecidea pullata* in having a conspicuous, blue prothallus. However *L. pullata* is easily separated from both by characters of chemistry and soralia.

Typically *Lecidea pullata* produces sphaerophorin as the major compound and isosphaeric acid in trace amounts only. In a few specimens isosphaeric acid was the major product or occurred in a concentration equal to that of sphaerophorin. One large collection (Tønsberg 6436) contained specimens where the concentration of isosphaeric acid varied from small to high. No other species of lichen is known to contain isosphaeric acid in large proportions (Culberson et al. 1984).

Lecidea pullata is mainly corticolous on acidic bark. More rarely it is lignicolous or occurs on corticolous or lignicolous bryophytes or other lichens.

Specimens seen (selected): Oslo 1984, Tønsberg 8521. - He: Eidskog 1985, Tønsberg 9448. - Op: Vang 1985, Tønsberg 9319a. - Bu: Sigdal 1981, Tønsberg 6407. - Te: Vinje 1984, Tønsberg 8906. - AA: Bykle 1984, Tønsberg 8908. - VA: Sirdal 1988, Tønsberg 10865. - Ro: Suldal 1986, Odland. - Ho: Granvin 1946, Havaas. - SF: Aurland 1987, Tønsberg 10950. - MR: Surnadal 1981, Tønsberg 5633. - ST: Oppdal 1982, Tønsberg 7050a. - NT: Namsskogan 1981, Tønsberg 5809. - No: Narvik 1982, Tønsberg 7403. - Tr: Målselv, Norman (O). - Fi: Alta 1982, Tønsberg 7254. Exsiccata examined: Havaas, Lich. Norv. 525 (BG, O, UPS). - Havaas, Lich. Norv. Occid. 265 (BG, O, S, UPS). A total of 232 specimens seen.

Lecidea subcinnabarina Tønsb. sp. nov.

Lecidea cinnabarinae similis, sed thallus duo acida pinguia continens, et ad sylvas humidas Norvegiae centralis restricta in truncis arboribus deciduis.

Type: Norway, Sør-Trøndelag, Åfjord, S of the river N of hill Tørresengåsen, alt. 140-180 m, UTM grid ref.: 32W NS 7205 (map 1623 III), 24 September 1983, on *Alnus incana*, Tønsberg 8238 (BG - holotype; UPS, BM - isotypes).

Figs 18, 57-58.

Thallus (Fig. 58) crustose, mostly endosubstratal in non-sorediate parts, sometimes appearing as a greyish violet stain on light bark, indeterminate, forming irregular patches between other lichens, up to a few cm or, rarely, one dm in diameter, areolate, sorediate; prothallus indistinct or absent. Areolae rarely distinct, pale grey, not prominent or, occasionally, convex, surrounded by the uppermost colourless layer of bark cells of the substratum, to 0.3 mm in diameter. **Soralia** pale green to greyish green or, due to pigmentation of the external soredia, more or less brownish, discrete and irregularly dispersed, delimited, punctiform to orbicular, plane to convex, often surrounded laterally by thin, colourless bark flakes of the substrate, irregularly sized, up to 0.6(-1.5) mm in diameter. Soredia fine, about 20-25 µm in diameter; external soredia sometimes becoming brown, more or less corticate, not shining in polarized light. Photobiont green, coccoid, up to 12(-15) µm in diameter.

Apothecia present in 12 (86%) of the specimens, cinnabar-red, sparse to abundant, sessile, circular or, occasionally, becoming somewhat elongate, up to 0.6(-1.1) mm in diameter; proper margin concolorous with the disc or somewhat paler, thin, often becoming flexuose by age, scarcely exceeding the level of the disc; disc plane to convex. In sections: Proper exciple distinct, orange in outer part (rim), more or less colourless in inner part, composed of radiating hyphae. Epihymenium deep orange. Hymenium yellowish orange, up to 60 µm deep, non-amyloid except for the asci. Paraphyses conglutinated in K, sparingly branched or unbranched, up to 1 µm wide; upper cell not thickened. Asci clavate, 25-50 × 8-12 µm, with a non-amyloid wall, a distinct K/I+ blue tholus with a deep blue ring, usually without an ocular chamber, 8-spored. Spores colourless, simple, narrowly ellipsoid, (5.5-) 9-10 × (2.5-) 4 µm, often immature. Upper subhymenial layer more or less colourless, composed of large-celled hyphae, largely K/I+ deep blue, but partly K/I+ violet, up to 50 µm deep; lower subhymenial layer colourless, K/I+ violet, up to 85 µm deep. Coloured parts of the apothecial section yellowish orange to orange, pigment crystalline, N-, K+ red in solution; crystals up to 4 µm in diameter. Pycnidia not seen.

Chemistry: Thallus: Subcinnabarina unknowns (trace amounts). TLC: Fig. 18. Apothecia: Unidentified anthraquinones (as in *Lecidea cinnabarina;* major pigment in R_F-classes : A 4-6 (trailing), B 5 (5-6)).

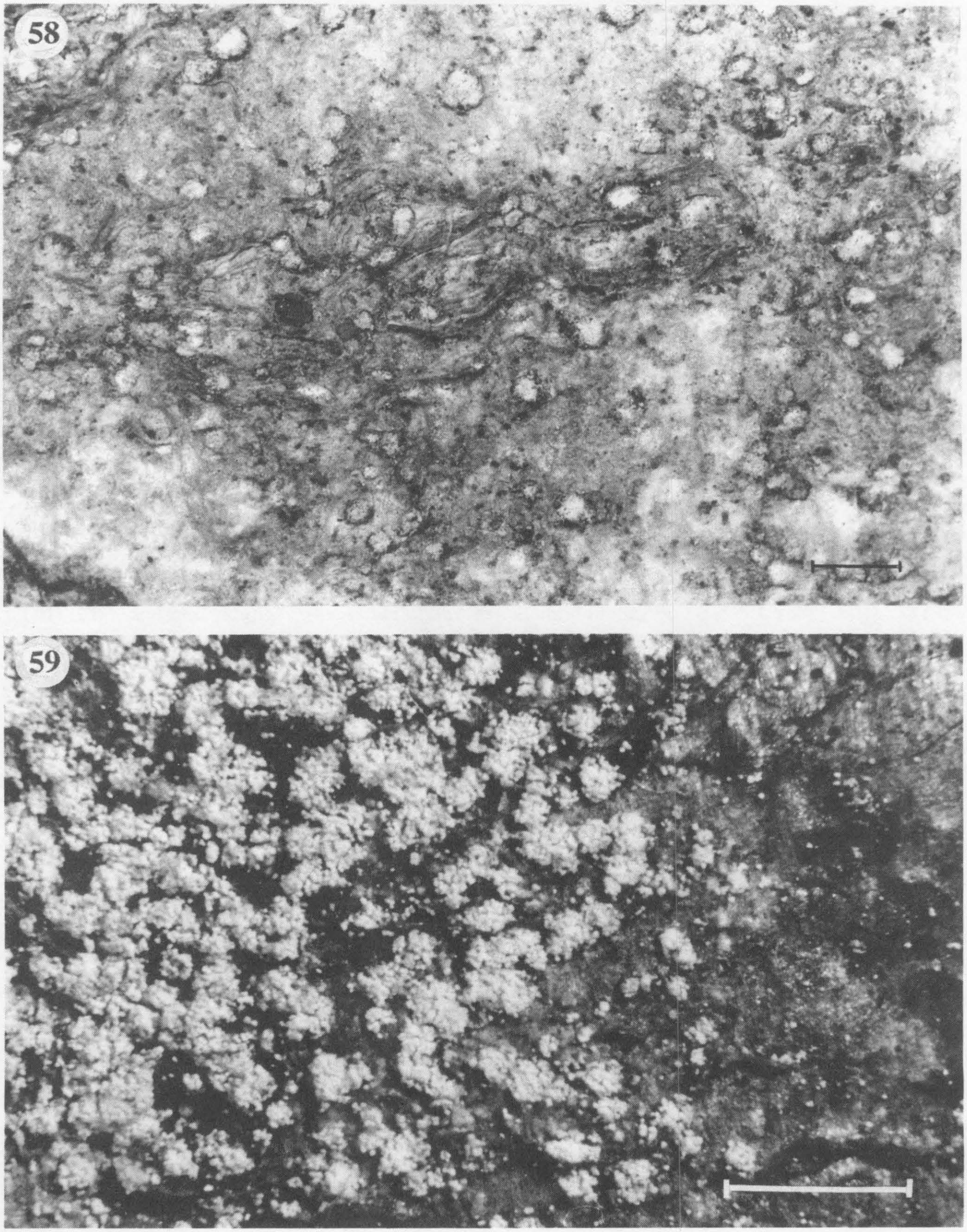
Substratum. *Lecidea subcinnabarina* was found most commonly on *Alnus incana* (12 specimens); other phorophytes included *Salix caprea* and *Sorbus aucuparia.* Close associates included *Buellia griseovirens, Hypocenomyce leucococca, Japewia subaurifera, Lecidea gyrophorica, L. roseotincta, L. pullata, Lecidella elaeochroma, Micarea cinerea, Nephroma laevigatum, Parmelia (Melanelia) glabratula, P. sulcata, Parmeliella triptophylla, Pertusaria leucostoma, Phlyctis argena, Platismatia glauca, Rinodina disjuncta,* and *Schaereria corticola.*

Distribution. *Lecidea subcinnabarina* occurred only in central Norway (Fig. 57). It usually grew in moderately shaded to shaded habitats. Its vertical distribution ranged from about sea-level to 260 m (Nord-Trøndelag: Namsskogan). **Counties:** Sør-Trøndelag - Nordland (Rana).

Discussion. *Lecidea subcinnabarina* is superficially similar to and apparently closely

Tab. 13. The distinguishing features between *Lecidea subcinnabarina* and *L. cinnabarina.*

	L. subcinnabarina	*L. cinnabarina*
external soredia	sometimes brown	unpigmented
thallus chemistry	subcinnabarina unknowns	atranorin, chloroatranorin, fumarprotocetraric acid
main phorophytes	*Alnus incana*	*Betula, Juniperus* and *Picea*
distribution	in the lowlands of central Norway, rare	widespread in sub/low-alpine areas, common



Figs 58-59. Fig. 58. *Lecidea subcinnabarina*. Holotype. Fig. 59. *Lecidea vacciniicola*. Tønsberg 7532a. Scale 1 mm.

related to *L. cinnabarina*. Both species have cinnabar-red apothecia with the same anthraquinone constitution, similar apothecial anatomy, a sorediate thallus and a corticolous habit. However, *L. subcinnabarina* is easily distinguished on closer examination. The distinguishing features between the two species are set out in Tab. 13.

Lecidea subcinnabarina appears to be a member of the group of lichens which have their only or main European occurrences in the shaded and humid, coastal *Picea abies*-forest of Trøndelag and adjacent areas. *Lecidea cinnabarina* is a species of acidic bark.

Lecidea subcinnabarina was first collected by the late Mr. S. Ahlner, who made two collections (which he identified as *L. cinnabarina*).

Specimens seen: ST: Åfjord 1983, Tønsberg 8238, 8240 (type collection). - NT: Namdalseid 1985, Tønsberg 9151. Namsos 1981, Tønsberg 5568 (mixed in a collection of *Rinodina disjuncta*). Namsskogan 1980, Tønsberg 5127, 5128, 5129. Snåsa 1938, Ahlner (S). - No: Bindal 1982, Tønsberg 6817. Hemnes 1984, Øvstedal. Rana 1982, Tønsberg 7636c. - Vefsn 1939, Ahlner (S); 1982, Tønsberg 7610, 7615b.

Lecidea vacciniicola Tønsb. sp. nov.

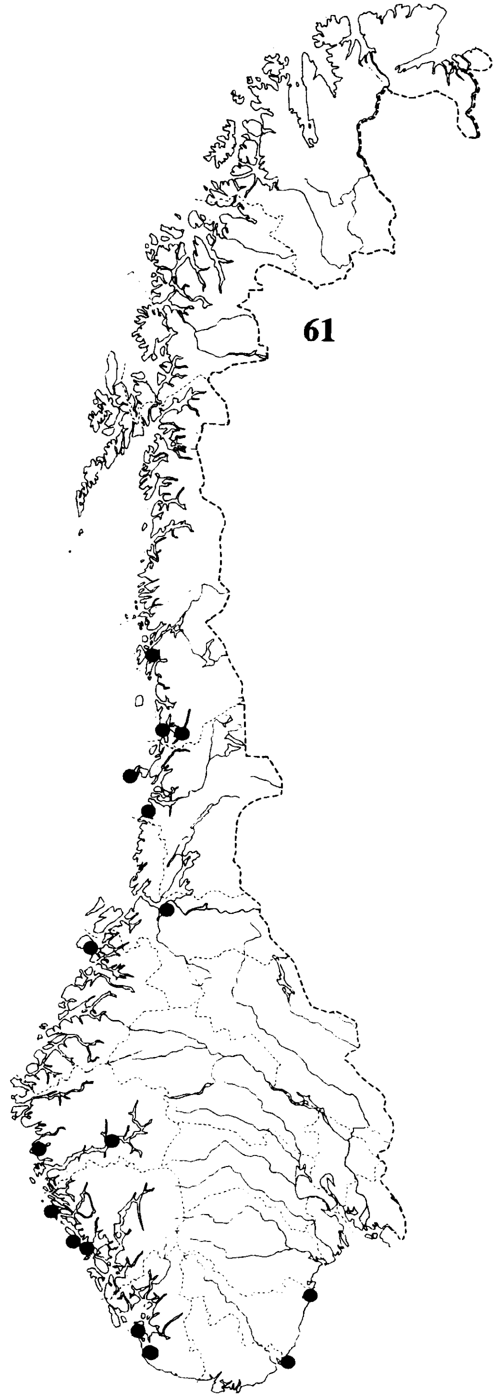
Thallus corticola, areolatus, sorediatus, acidum gyrophoricum continens. Areolae prerumque indistinctae, cinereae vel virides. Soralia punctiformia, initio discretia, demum plerumque confluentia, cinereo-eburnea vel subviridia. Apothecia adnata, immarginata, cinerea vel subfusca, usque ad 0.2(0.4) mm in diametro. Excipulum proprium infirme evolutum. Epihymenium incoloratum vel subfuscum. Paraphyses plus minusve discedentes in K, tunicis gelatinosis circumcinctae. Asci tholis amyloideis. Sporae simplicae vel 1-septatae, ellipsoideae vel oblongae (7.5-)9-10 × 2.5-4 µm.

Type: Norway, Steinkjer, N of lake Snåsavatnet, 0.4 km N of Brasset, alt. 80-100 m, UTM grid ref.: 32W PS 3820 (map 1723 II), 17 May 1982, on twigs and branches of *Betula pubescens/pendula*, Tønsberg 6633 (BG - holotype; BM, E, O, UPS - isotypes).

Figs 59-60.

Thallus (Fig. 59) crustose, endo- to episubstratal in non-sorediate parts, indeterminate, at first often as small, rounded patches up to about 1 cm in diameter, later becoming irregular and often confluent with other thalli forming more or less continuous patches up to several cm across, areolate, sorediate; prothallus indistinct or absent. Esorediate areolae present or absent, inconspicuous, often more or less covered in thin, colourless bark flakes from the substratum, greyish to greenish, mostly discrete, occasionally more or less contiguous, more or less rounded, convex, up to 0.2 mm in diameter. **Soralia** greyish yellow-white, pale green or pale yellowish green, protruding through the uppermost cell layers of the substrate, or bursting from episubstratal areolae, diffuse or, especially when young, sometimes delimited, punctiform, often becoming irregular in outline, mostly more or less flat, more or less discrete at first, but soon often becoming confluent tending to form a continuously leprose crust. Soredia fine, 12-30 µm in diameter, external soredia more or less concolorous with the internal ones; wall distinct. Photobiont green (1-)2-4 celled, globose, ellipsoid, or more or less cubic, externally with a gelatinous cap, up to 20 µm in diameter.

Apothecia present in 21 (26%) of the specimens, emarginate, greyish to pale brown, adnate, mostly slightly, rarely markedly convex, more or less rounded, inconspicuous, up to 0.2 (-0.4) mm in diameter. In sections: Proper exciple weakly developed, containing crystals of gyrophoric acid (C+ red, dissolving in K); hyphae radiating, conglutinated. Epihymenium non-granular. Hymenium with a non-amyloid gelatine, containing crystals of gyrophoric acid (C+ red), 25-40 µm deep. Paraphyses conglutinated, in K more or less separated, but still with a gel coat, simple to sparingly branched, 1.0-2.5 µm wide, often widening from base to apex; individual cells somewhat irregular (widest medially or at one end) to cylindrical, sometimes shortly cylindrical, 2.5-5.5 µm long; apical cell up to 6 µm in K. Asci clavate to cylindrical-clavate, belonging to the *Lecanora*-type of Honegger (1978) and Hafellner (1984), with a non-amyloid wall surrounded by an amyloid outer layer, and an internal staining



Figs 60-61. Distribution maps. Fig. 60. *Lecidea vacciniicola*. Fig. 61. *Lecidella elaeochroma* "f. *soralifera*".

amyloid apical dome, 8-spored, 25-35 × 9-12 µm. Spores simple or occasionally 1-septate, usually ellipsoid or oblong, rarely weakly bean-shaped, (7.5-) 9-10 × 2.3-4 µm. Subhymenium non-amyloid, 25-30 µm deep. Apothecial sections without pigments. Pycnidia not observed.

Chemistry: Gyrophoric acid, lecanoric acid (trace).

Substratum. *Lecidea vacciniicola* has most commonly been collected on shrubs of *Salix* spp. (mainly *S. glauca* and *S. lapponum*, rarely *S. caprea* and *S. nigricans)* (49 specimens), but it has also been found on *Juniperus communis* (8 specimens), *Sorbus aucuparia* (6) *Betula pubescens/pendula* (6), *Vaccinium myrtillus* (6) and, more rarely, *Betula nana, Calluna, Picea abies*, and *Vaccinium uliginosum*. On *Vaccinium myrtillus* it was usually the major epiphyte and often abundantly present. *Lecidea vacciniicola* occurred low down on the phorophytes, often more or less hidden by grasses and large mosses. Associated lichens included *Arthonia exilis, Arthopyrenia* sp., *Caloplaca sorocarpa, Catinaria atropurpurea, Cetraria pinastri, Lecanora flavopunctata, Lecidea helvola, L. pullata, Micarea prasina, Nephroma parile*, and *Pertusaria carneopallida.*

Distribution. *Lecidea vacciniicola* occurred most commonly in subalpine/low-alpine and northern areas (Fig. 60). Its vertical distribution ranged from about sea-level to 1140 m (Sogn og Fjordane: Aurland). In southeastern Norway and in western Norway (Vestlandet) it descended to 240 m and 330 m altitude, respectively, whereas in Trøndelag and northern Norway it descended to about sea-level. **Counties:** Hedmark - Buskerud, Telemark, Vest-Agder, Hordaland, Sogn og Fjordane, Sør-Trøndelag - Finnmark.

Discussion. Within *Lecidea* s. lat. *L. vacciniicola* is distinguished by the minute, pallid, emarginate apothecia containing gyrophoric acid, the thallus mainly composed of minute, diffuse, confluent soralia containing gyrophoric acid, and the corticolous habit. The emarginate apothecia are superficially similar to those of some species of *Micarea*, and *Scoliciosporum*. It is easily separated from *Scoliciosporum* by the (normally) non-septate spores. From *Micarea* it is distinguished by the excipulum hyphae which are not paraphyses-like and do not become lax in K.

Lecidea vacciniicola resembles *Lecanora flavopunctata* - a species of the *Lecanora symmicta*-group - with which it is often associated. However, that species has mostly discrete soralia, and the soredia are more clearly yellow and more firmly packed than those of *Lecidea vacciniicola. Lecanora flavopunctata* is chemically distinct (for details, see that species).

Lecidea vacciniicola is a species of acidic bark, mainly in subalpine/low-alpine and northern situations. Outside Norway *Lecidea vacciniicola* has been collected in Sweden and Spain.

Specimens seen (selected): **Norway**: He: Åmot 1982, Tønsberg 7584. Engerdal 1988, Tønsberg 11035. Tynset 1983, Tønsberg 8192. - Op: Lunner 1982, Tønsberg 7532a, 7534a. - Bu: Flesberg 1987, Tønsberg 10355. Sigdal 1982, Tønsberg 6983. - Te: Vinje 1987, Tønsberg 10320. - VA: Sirdal 1988, Tønsberg 10868. - Ho: Bergen 1988, Tønsberg 11376. - SF: Aurland 1988, Tønsberg 10920. Balestrand 1983, Tønsberg 7939a. Flora 1983, Tønsberg 7898. Vik 1988, Tønsberg 11316. - ST: Melhus 1982, Tønsberg 7479a. Trondheim 1980 - 1983, Tønsberg 5171, 8134. - NT: Grong 1981, Tønsberg 6199. Leksvik 1981, Tønsberg 5912. Namdalseid 1983, Tønsberg 8449. Namsos 1989, Tønsberg 11629. Namsskogan 1980-1982, Tønsberg 5099, 5132a, 7470. Steinkjer 1982, Tønsberg 6633. - No: Grane 1981, Tønsberg 6267. Hattfjelldal 1980-1988, Tønsberg 5154, 11272. Leirfjord 1985, Tønsberg 9261. Rana 1982, Tønsberg 7652a. Rødøy 1986, Tønsberg 9650. Vefsn 1982, Tønsberg 7598. Vestvågøy 1987, Tønsberg 10523. - Tr: Balsfjord 1982, Tønsberg 7328. Bardu 1988, Tønsberg 11075, 11089. Skjervøy 1988, Tønsberg 11141. Storfjord 1988, Tønsberg 11108. - Fi: Alta 1988, Tønsberg 11168. Båtsfjord 1988, Tønsberg 11218. Berlevåg 1988, Tønsberg 11220. Gamvik 1988, Tønsberg 11199. Sør-Varanger 1982, Tønsberg 7122b. Tana 1988, Tønsberg 11223. A total of 82 Norwegian specimens seen. - **Sweden**: Lycksele Lappmark 1988, Tønsberg 11269. - Torne Lappmark 1986, Tønsberg 9786. - Åsele Lappmark 1991, Tønsberg 17330. - **Spain**: Navarra, Bertiz, J. E. Salazar (herb. Salazar).

Lecidella Körber

The corticolous species of the genus *Lecidella* are in urgent need of a revision. Several of the species considered in the present paper have been broadly circumscribed. Saxicolous species of the genus, with emphasis on the extra-European species, have been treated by Knoph (1990).

Lecidella elaeochroma (Ach.) M. Choisy "f. ***soralifera*** (Erichsen) Hawksw."

Fig. 61.

Thallus crustose, endo- to episubstratal in non-sorediate parts, greyish green or, rarely, distinctly yellow in non-sorediate parts, indeterminate to delimited, areolate to continuous, forming rosettes or, especially when forming mosaics with other thalli, irregular patches, up to a few cm across, sorediate. Prothallus usually indistinct or absent, when growing in colonies individual thalli are often separated by a dark border line. Continuous parts more or less distinctly tuberculate and/or cracked, greyish green to yellow. Areolae, when present, discrete to contiguous or more or less confluent, rounded to irregular, flat to slightly convex, concolorous with continuous parts. **Soralia** mostly yellow, more rarely greenish, usually more or less irregularly distributed over the thallus surface, often sparse, discrete, or occasionally a few fused, diffuse to delimited, irregular or rounded, mostly distinctly convex, up to 1 mm in diameter. Soredia fine, up to 25(-40) µm in diameter, usually simple, occasionally in irregular consoredia up to 80 µm in diameter; wall distinct. Medulla indistinct. Photobiont green, coccoid, up to 10 µm in diameter.

Apothecia present in all collections seen, lecideine, marginate, black or, rarely, dark brown with a red tinge, often becoming convex and tuberculate by age.

Chemistry: (I) Arthothelin, granulosin, ± 4,5-dichloronorlichexanthone, lichexanthone (soralia only). (19 specimens from 13 sites.) Soralia C+ orange. (II) 2,5,7-trichloro-3-O-methylnorlichexanthone, isoarthothelin, thiophanic acid, aotearone (trace), lichexanthone (soralia only). (9 specimens from 4 sites.) Soralia C-.

Substratum. *Lecidella elaeochroma* "f. *soralifera*" was collected mainly on naked bark of *Sorbus aucuparia* (12 specimens). Other phorophytes included *Acer pseudoplatanus*, *Aesculus hippocastanum*, *Alnus incana*, *Fraxinus excelsior*, *Populus tremula*, and *Sorbus hybrida*. It preferred smooth bark. *Lecidella elaeochroma* f. *elaeochroma* was a constant associate.

Distribution. *Lecidella elaeochroma* "f. *soralifera*" occurred in the lowlands on the western coast (Fig. 61) in open and well-lit situations, mostly close to the sea. Its vertical distribution ranged from about sea-level to 80 m. **Counties:** Aust-Agder - Sogn og Fjordane (chemotype I), Møre og Romsdal (I and II), Sør-Trøndelag (I), Nord-Trøndelag (II), Nordland (I og II).

Discussion. A broad concept of *Lecidella elaeochroma* is taken here. *Lecidella euphorea* (Flörke) Hertel and *L. elaeochroma* seem to be closely related, differing mainly in the C-reaction of their thalli: C- in *L. euphorea*, C+ orange in *L. elaeochroma* (see Poelt & Vězda 1981). Ignoring the soralia, the specimens of chemotype II with a C- reaction of the thallus, would - according to Poelt & Vězda (1981) - have been identified as *L. euphorea*.

The presence of soralia separates "f. *soralifera*" morphologically from f. *elaeochroma*. "F. *soralifera*" is further distinguished by the production of lichexanthone giving the soralia their bright yellow colour. No lichexanthone is produced in esorediate parts of either f. *elaeochroma* or "f. *soralifera*". The soralia of "f. *soralifera*" seem to be occasionally produced, and are often sparingly and/or irregularly distributed over the thallus surface. However, in spite of the fact that the presence of soralia in *L. elaeochroma* is correlated with the presence of lichexanthone, thus causing the taxon to be both morphologically and chemically distinct from f. *elaeochroma*, an intraspecific rank seems appropriate since "f. *soralifera*" apparently arises sporadically from individuals of f. *elaeochroma*, rather than through evolution of populations (see also Hawksworth 1972 and Hawksworth et al. 1980).

Lecidella elaeochroma "f. *soralifera*" is morphologically, chemically and ecologically distinct from the other *Lecidella* species considered here, including *L. flavosorediata* (see however, Serusiaux & Rose 1984).

The presence of lichexanthone in the exposed, ecorticate soralia of *Lecidella elaeochroma* "f. *soralifera*" probably has some adaptive value, possibly as a defence against microorganisms or as a light-screening agent (see Lawrey 1986).

Lecidella elaeochroma "f. *soralifera*" appears to be a maritime taxon. At its easternmost known site in western Norway (Sogn og Fjordane: Vik) it occurred very sparingly: Only one sorediate thallus was observed among numerous esorediate ones. *Lecidella elaeochroma* f. *elaeochroma* has a much wider distribution than "f. *soralifera*", being known in a broad belt along the coast from Østfold to Finnmark (Santesson 1984). "F. soralifera" is here reported as new to Norway.

Specimens seen (selected): **Norway:** *Chemotype I.* AA: Risør 1988, Tønsberg 11016. - VA: Kristiansand 1988, Tønsberg 10881. - Ro: Klepp 1978, Tønsberg 2974, 2986. - Ho: Øygarden 1988, Tønsberg 10795. - SF: Askvoll 1989, Tønsberg 11789. - MR: Smøla 1983, Tønsberg 8326. - ST: Trondheim 1982, Tønsberg 6630. - No: Bindal 1982, Tønsberg 6841. Leirfjord 1985, Tønsberg 9246. *Chemotype II.* MR: Smøla 1983, Tønsberg 8312, 8314, 8316, 8322, 8325. - NT: Flatanger 1981, Tønsberg 5496a. No: Sømna 1985, Tønsberg 9199. A total of 28 specimens seen. - **Denmark:** *Chemotype I.* Röm, Kirkeby, 20 July 1929, C.F.E. Erichsen (BM!).

Lecidella flavosorediata (Vězda) Hertel & Leuckert

Lecidea flavosorediata Vězda in Preslia 33: 366 (1961). Type: Bohemoslovakia - Sudeti occident. (Krkonose): iugum montium "Prichovicky hreben" prope opp. Sumburk, alt. 90 m s. m., 14, VIII 1961. Ad corticem *Fraxini excelsioris*, leg A. Vězda (herb. A. Vězda - holotype; Vězda: Lich sel. 112 (UPS! - isotype). TLC: Arthothelin.

Thallus endo- to episubstratal and usually greyish white in non-sorediate parts, indeterminate to delimited, areolate to continuous, forming rosettes or irregular patches, sometimes forming mosaics with other lichens, up to a few cm, rarely up to about one dm across, sorediate. Prothallus indistinct or absent. Areolae rarely present at the edge of the thallus, up to 0.1 mm in diameter. Continuous, esorediate parts usually indistinct or absent, tuberculate, mostly cracked. **Soralia** conspicuous, green, greenish yellow or olivaceous, irregular, flat, often more or less discrete at first, later mostly becoming contiguous or confluent forming a thick, leprose crust. Soredia fine, 20-30 µm in diameter, sometimes in consoredia up to 50 µm; wall distinct. Medulla indistinct, white. Photobiont green, coccoid, up to 12 µm in diameter.

Apothecia sparse in 8 (13%) of the specimens, lecideine, black, up to 0.8 mm in diameter; margin often becoming indistinct; disc convex. Pycnidia found in one fertile specimen, partly immersed in esorediate thallus portions, black in upper part, up to 80 µm wide. Conidia filiform, markedly curved, often U-shaped, 7-5(-20) µm between tips, about 25 µm long.

Chemistry: Arthothelin, granulosin (absent in one specimen).

Substratum. *Lecidella flavosorediata* has been found mainly on broad-leaved deciduous trees, including *Acer platanoides, A. pseudoplatanus, Aesculus hippocastanum, Fagus sylvatica, Fraxinus excelsior, Populus tremula, Quercus, Tilia,* and *Ulmus glabra* (altogether 36 specimens, 50%), in addition to *Alnus incana, Betula pubescens/pendula, Corylus avellana, Juniperus communis, Malus sylvestris, Pinus sylvestris, Salix caprea,* and *Sorbus aucuparia.* Close associates included *Buellia punctata, Candelaria concolor, Candelariella* spp., *Lecanora carpinea, Pannaria triptophylla, Parmelia (Melanelia) exasperatula, Pertusaria coccodes, Phaeophyscia endophoenicia, Physcia adscendens, P. tenella, Ramalina farinacea, Xanthoria candelaris,* and *X. polycarpa.* It usually occurred on isolated trunks of mature trees, often in churchyards, in parks, on road-sides, in maritime sites, and near farms.

Distribution. *Lecidella flavosorediata* occurred in the lowlands in a broad belt along the coast from Østfold to Trøndelag. Its vertical distribution ranged from about sea-level to 300 m (Sogn og Fjordane, Vik). **Counties:** Østfold - Hedmark, Buskerud - Nord-Trøndelag.

Discussion. According to the protologue (Vězda 1961), the soralia of *Lecidella flavosorediata* are characterized as yellow, not sharply delimited and becoming confluent ("soraliis sublimitatis instructus demum vulgo totus sorediosus flavidus"). Some specimens (e.g., Tønsberg 6240, 6242a, and 6248, 17223) showed all the diagnostic characters of thallus and apothecia mentioned in the protologue. These specimens at first sight looked convincingly different from some leprose, greenish, usually sterile, but chemically conformable specimens. However, when all available material was studied, no clear-cut discontinuities could be found. In the present paper, forms with greenish soralia without a distinct yellowish tinge are therefore also included in *L. flavosorediata.*

Species containing yellow pigments (e.g., usnic acids and xanthones) are often more or less green (soralia) or grey (corticate parts) when growing in shaded habitats. Poelt & Vězda (1981: 199) excluded greenish, leprose plants from *Lecidella flavosorediata.* An isotype specimen (UPS) contained only arthothelin. A specimen from the Alps (Lich. Alp. 184 (UPS) contained arthothelin and granulosin.

Lecidella flavosorediata is clearly distinguished from *L. elaeochroma* "f. *soralifera*". The latter never becomes leprose, produces lichexanthone in the soralia, is consistently fertile, has a markedly western distribution and a maritime habitat. *Lecidella flavosorediata* may resemble *Lecidella* sp. B (see that species).

Some brownish green, leprose specimens with a chemistry typical of *Lecidella flavosorediata* (e.g., Tønsberg 3634 from Sør-Trøndelag: Trondheim) strongly resemble *Pyrrhospora quernea* morphologically. These specimens were only tentatively assigned to *Lecidella flavosorediata.*

Lecidella pulveracea (Schaerer) Syd. (syn. "*Lecidea pulveracea* Flörke") is leprose and has a yellowish white to yellowish grey thallus. Of four Swedish specimens examined (including Magnusson, Lich. Sel. Scand. 31 (0)), all contained an unidentified xanthone (in R_F-classes A 5, B 5, C 5) as the only major chemical constituent. *Lecidella pulveracea* appears to be exclusively lignicolous and is so far not known without apothecia (Laundon 1963, Magnusson 1929). On the Scandinavian peninsula it is only recorded from Sweden (Santesson 1984).

Lecidella flavosorediata is a species of eutrophic bark in southern Norway. It is here reported as new to Norway.

Specimens seen (selected): Øf: Aremark 1986, Tønsberg 9457. Moss 1991, Tønsberg 17223 (richly fertile). - Ak: Frogn 1984, Timdal & Holtan-Hartwig 4231 (O). - He: Ringsaker 1990, Tønsberg 13160. - Bu: Ringerike 1990, Tønsberg 13300. - Vf: Tønsberg 1987, Tønsberg 10067. - Te: Porsgrunn 1987, Tønsberg 10091. - AA: Froland 1987, Tønsberg 10216. - VA: Kristiansand 1990, Tønsberg 13568. - Ro: Sauda 1988, Tønsberg

10823. - Ho: Odda 1984, Tønsberg 8898. - SF: Vik 1979, Tønsberg 4066. - MR: Ålesund 1987, Tønsberg 10398. - ST: Trondheim, 1981, Tønsberg 6305. - NT: Steinkjer 1981, Tønsberg 6248. A total of 61 specimens seen.

Lecidella scabra (Taylor) Hertel & Leuckert

Fig. 62.

Thallus crustose, episubstratal, forming more or less rounded patches up to 4 cm in diameter, typically continuous, in thin parts more or less discontinuous, sometimes with some marginal areolae, sorediate. Prothallus white, blue (blue pigment aeruginose in microscope, K-, N-) or not evident. Esorediate surface grey, whitish grey or green-grey, minutely tuberculate, sometimes secondarily cracked. **Soralia** greyish green or greenish yellow, sometimes greyish black, greenish or brownish due to pigmentation of the external soredia, rounded and discrete and up to 1 mm in diameter at first, later sometimes becoming partly fused forming patches with a leprose surface, rarely with a largely sorediate surface with only a few esorediate tuberculae. Soredia mostly fine, up to 25 µm; wall distinct; consoredia globose or irregular, up to 40 µm in diameter; brown pigment crystalline, soluble in K; green pigment K+ olivaceous, N+ violet. Medulla indistinct to absent. Photobiont green, coccoid, up to 15 µm in diameter.

Apothecia sparingly present in 13 (46%) of the specimens, up to 0.8 mm in diameter, black; disc flat to slightly convex; epihymenium with a greenish and sometimes also a yellowish brown, K-, N- pigment; hymenium without oil droplets, spores ovoid to ellipsoid or globose, 9-15 × 7-9 µm; subhymenium yellowish - to reddish brown. Pycnidia not seen.

Chemistry: Atranorin, arthothelin, ± thuringion (10 specimens), ± 4,5-dichloronorlichexanthone (tentatively, in traces).

Substratum. *Lecidella scabra* was collected on shaded to sun-exposed trunks of *Acer platanoides*, *A. pseudoplatanus*, *Fraxinus excelsior*, *Tilia* and *Ulmus glabra*, and on nutrient-enriched trunks of *Alnus incana* and *Salix caprea*. The specimens were mostly from man-made habitats such as avenues and churchyards. Noteworthy associates included *Caloplaca chlorina*, *C. obscurella*, *Leptogium lichenoides*, *Normandina pulchella*, *Parmelia* (*Melanelia*) *exasperatula*, *Ramalina farinacea* and species of *Buellia*, *Candelariella*, *Phaeophyscia*, *Physcia*, *Physconia*, and *Xanthoria*.

Distribution. *Lecidella scabra* occurred in southern Norway (Fig. 62). The vertical distribution ranged from about sea-level to 230 m (Hedmark: Ringsaker). **Counties:** Corticolous specimens: Østfold, Hedmark, Buskerud-Sogn og Fjordane, Sør-Trøndelag. All specimens (see Santesson 1984): Østfold, Akershus, Hedmark, Buskerud, Aust-Agder - Sogn og Fjordane, Sør-Trøndelag, Nordland.

Discussion. *Lecidella scabra* is a distinct species on account of its greyish, continuous, tuberculate thallus with more or less discrete soralia. No other sorediate, corticolous species was found to contain the xanthone thuringion. In the present material specimens with that substance were from Hedmark, Oppland, Buskerud and Sør-Trøndelag being absent in material from the westernmost and southernmost coasts. However, this accessory was found in saxicolous material from the westernmost coast.

Lecidella scabra has been considered a saxicolous species (Santesson 1984, Knoph 1990). However, it is not rare on eutrophic bark in the coastal lowlands of southern Norway. I have also seen corticolous specimens from Sweden (Halland, Magnusson 13696a (UPS)) and Germany (Schleswig-Holstein, P. Jacobsen 1116 (BG)).

Specimens seen (selected): Øf: Hvaler 1990, Tønsberg 13184. - He: Sør-Odal 1990, Tønsberg 13278. - Bu: Ringerike 1990, Tønsberg 13290. - Vf: Sande 1990, Tønsberg 13670. - Te: Bamble 1990, Tønsberg 13705. -

Figs 62-63. Distribution maps. Fig. 62. *Lecidella scabra*. Fig. 63. *Lepraria eburnea*.

AA: Grimstad 1990, Tønsberg 13508. - VA: Kristiansand 1990, Tønsberg 13567. - Ro: Eigersund 1990, Tønsberg 13497. - Ho: Bergen 1991, Tønsberg 17363. - SF: Leikanger 1990, Gaarder 185 & Anonby. - ST: Trondheim 1983, Tønsberg 8117b. A total of 28 specimens seen.

Lecidella subviridis Tønsb. sp. nov.

Thallus corticola, areolatus, sorediatus, plerumque viridis vel flavovirens coloratus, acidum atranoricum, thiophanicum, arthothelicum et substantiae ignotae continens. Apothecia infrequentia, brunnea. Excipulum proprium et epihymenium brunneum; subhymenium incoloratum. Sporae ellipsoideae, 15-21 x 7.5-9 µm.

Type: Norway, Hordaland, Os, Strøno, small peninsula E of Store Hestholmen, alt. 3 m, UTM grid ref.: 32V KM 9674 (map 1115 II), on maritime *Calluna vulgaris*, 9 April 1989, Tønsberg 11480 (BG - holotype).

Thallus crustose, endo- to episubstratal in non-sorediate parts, forming rosettes or irregular patches up to a few cm in diameter, indeterminate, areolate to more or less continuous, sorediate, sometimes more or less leprose throughout. Prothallus not evident. Areolae grey to grey green, sometimes with a brownish tinge, flat to convex, more or less rounded, up to 0.3 mm in diameter. Continuous parts concolorous with the areolae, minutely tuberculate. **Soralia** usually punctiform at first, discrete to diffuse, plane to somewhat convex, more or less rounded and up to 0.2 mm in diameter, rarely fissure-shaped and up to 0.6 mm long, sometimes becoming more or less confluent. Soredia green to yellowish green, sometimes with a brownish tinge, fine, 20-30 µm in diameter; sometimes in consoredia up to 60 µm in diameter; wall distinct. Medulla absent. Photobiont green, coccoid, up to 12(-15) µm in diam.

Apothecia rare, present in one specimen, lecideine, whitish brown to brown, sessile, up to 0.5 mm in diameter, in groups of 2-4 or, occasionally, discrete; margin 0.04-0.08 mm wide, flush with the level of the disc; disc plane. In sections: Proper exciple more or less brown in outermost and uppermost part, with a faint green tinge in thin sections, otherwise colourless, up to 40 µm wide. Hymenium brown in uppermost part (epihymenium), more or less colourless below or with pale brown vertical streaks, with a possible faint green tinge in thin sections, 90-100 µm deep; hymenial gelatine K/I + pale blue. Paraphyses simple to sparingly branched, 1.5-2 µm; apical cell 3-3.5 µm wide, surrounded by a brown pigment, more or less conglutinated in H_2O, free in K; brown pigment K+ intensifying. Asci cylindrical-clavate, of *Lecanora*-type (see Honegger 1978, Hafellner 1984), basically 8-spored, but often with fewer spores. Spores colourless, simple, broadly ellipsoid, 7.5-9 × 15-21 µm. Subhymenium colourless, 30-60 µm deep, partly K/I+ blue or violet-blue. Crystals present in lateral part of exciple and hymenium, dissolving in K. Pycnidia not seen.

Chemistry: Atranorin and thiophanic acid (major substances), arthothelin, expallens unknown.

Substratum. *Lecidella subviridis* was collected on *Calluna vulgaris* (11 specimens), *Alnus incana* (5), and *Pinus sylvestris* (4), the most common phorophytes, and on *Alnus glutinosa*, *Betula pubescens/pendula*, *Corylus avellana*, *Fagus sylvatica*, *Ilex aquifolium*, *Juniperus communis*, *Prunus padus*, *Salix aurita*, *S. caprea*, *Sorbus aucuparia*, and *Vaccinium myrtillus*.

Distribution. *Lecidella subviridis* occurred in the lowlands in a broad belt along the coast from southernmost Oppland to Trøndelag. Its vertical distribution ranged from about sea-level to 360 m (Oppland: Lunner). **Counties:** Østfold, Oppland, Telemark, Rogaland - Sør-Trøndelag.

Discussion. A broad concept of *Lecidella subviridis* is taken here. The species is chemically uniform, but morphologically and ecologically heterogeneous. Most specimens, especially those from maritime populations of *Calluna vulgaris* and, rarely, *Vaccinium* *myrtillus* and *Salix aurita* on the westernmost coast (e.g. Tønsberg 11344, 11357, 11360, 11365, 11370, 11373, 11480 (holotype), 13225, 13606, 17471) form a morphologically well-defined group characterized by a distinctly green to yellow-green overall colour, more or less punctiform soralia, and minute, but distinct areolae.

Some specimens (e.g., Botnen 86/1, 86/17, Haugen s.n., Tønsberg 7080a, Sundell 5387 (from Sweden) from well-lit, non-maritime trunks of *Pinus sylvestris* were more or less leprose, greenish yellow to brownish yellow. However, as intermediates occur between the two forms they are tentatively regarded as representing extremes of one taxon. The leprose form shows morphological affinities with *Lecanora expallens*. A few specimens from the eutrofic/eutroficated bark of *Corylus avellana* and *Fagus sylvatica* were morphologically similar to *Lecidella flavosorediata*.

With respect to xanthones, *Lecidella subviridis* is chemically similar to *Lecanora expallens*; in addition both species contain expallens unknowns. However, the presence of atranorin and the lack of usnic acid and zeorin make *Lecidella subviridis* chemically distinct from that species.

Outside Norway, *Lecidella subviridis* has been collected in Sweden.

Specimens seen (selected): **Norway: Øf**: Hvaler 1990, Tønsberg 13225. - Op: Lunner 1982, Tønsberg 7527, 7542b. - Te: Bamble 1985, Haugen. - Ro: Sauda 1986, Botnen 86/1, 86/11, 86/17. Tysvær 1986, Øvstedal. - Ho: Austevoll 1990, Tønsberg 13606. Bergen 1986-1988, Tønsberg 9480, 11370, 11373, 11390. Kvinnherad 1971, Berge. Lindås 1980, Tønsberg 5080, 5082; 1984, Tønsberg 8594. Os 1989, Tønsberg 11468, 11477, 11480 (type). Osterøy 1991, Tønsberg 17471. Stord 1980, Tønsberg 5022. Tysnes 1979, Tønsberg 4199. - SF: Gulen 1988, Tønsberg 11357, 11360, 11365. - Solund 1984, Fottland & Øvstedal. - MR: Ålesund 1987, Tønsberg 10400. - ST: Melhus 1982, Tønsberg 6616, 7080a. A total of 36 Norwegian specimens seen. - **Sweden**: Värmland 1966, Sundell 5387.

Lecidella sp. A

Thallus crustose, episubstratal in esorediate parts, dark greenish grey with a brownish or bluish tinge, more or less delimited, forming rosettes or somewhat irregular patches, up to 5 cm in diameter, continuous throughout or, occasionally areolate along the edge, sorediate. Prothallus indistinct or absent. Areolae inconspicuous, slightly convex, up to 0.2 mm in diameter. Continuous parts distinctly tuberculate and, usually, cracked, individual parts often subsquamiform and irregularly crenulate. Soralia rather sparse, pale green to straw-coloured, or bluish green due to a N+ reddish brown pigment in the external soredia, scattered, mostly discrete, unequally sized, mostly irregular, more or less plane, up to 0.2-0.3 mm across. Soredia fine, globular, 20-35 µm in diameter; wall distinct. Medulla indistinct, white. Photobiont green, coccoid, up to 10 µm in diameter.

Apothecia and pycnidia not seen.

Chemistry: Atranorin, aotearone, 2,5,7-trichloro-3-O-methyl-norlichexanthone (major compounds), 2,4,5,7-tetrachloro-3-0-methylnorlichexanthone, 4,5,7-trichloro-3-0-methylnorlichexanthone, thuringione (possible trace). (The last 3 substances observed by Knoph in two specimens analysed by him.)

Substratum. *Lecidella* sp. A was collected on nutrient-enriched trunks or stems of *Alnus incana*, *Juniperus communis*, and *Sorbus aucuparia*, which were influenced by emissions (smoke) from the local zinc smelter (Odda Smelteverk). Closely associated lichens included *Candelariella* spp., *Catillaria chalybeia* (corticolous form), *Lecidella scabra*, *Parmelia* (*Melanelia*) *glabratula*, and *Physcia tenella*.

Distribution. *Lecidella* sp. A was found in a few sites in Hordaland: Odda, where it occurred at altitudes from 80 to 200 m. **County:** Hordaland.

Discussion. *Lecidella* sp. A is a distinctive species on account of its chemistry. Its xanthone composition differs from that of the other species examined. A similar pattern of xanthones was found in two fertile, non-sorediate specimens from Trøndelag (Tønsberg 1804 & 3495a) belonging in the *L. elaeochroma* aggr., these plants lacked atranorin. Morphologically it is similar to *L. scabra* in having a largely continuous thallus and often bluish grey soralia.

Lecidella sp. A is apparently a species of eutrophic bark.

Specimens seen: Ho: Odda 1984, Tønsberg 8729a, 8741, 8901.

Lepraria Ach.

The genus *Lepraria* is a group of lichens of diverse origin, held together only by the same highly specialized thallus type and the inability to produce ascocarps (Poelt 1987b). The leprarioid state appears to be a growth form which has mainly arisen in response to a special habitat of dry surfaces (such as concave parts of base of trunks, and under-sides of leaning trunks) in sites with high humidity and low illumination (see also Jørgensen & Tønsberg 1988); convergent evolution is obviously involved. A similar case is the ecological specialization which by convergent evolution has lead to the development of a byssoid thallus in lichen genera belonging to different families (Rogers & Hafellner 1987). The byssoid and leprarioid growth form are apparently adaptations for absorption of water from the air, allowing the lichen to live on surfaces not wetted by flows of water or direct rain-fall.

Compared with other crustose lichens the *Lepraria* species have relatively few morphological characters by which the species can be defined. This applies especially to the non-lobate, non-stratified, diffuse species composed of more or less scattered aggregations of loosely arranged soredia. The morphological characters for these species are mainly colour and presence or absence of projecting hyphae on the soredia. The anatomy of the soredial wall also seems to be important. The size and colour of the soredia vary considerably within many species and are characters of limited value.

Fortunately the *Lepraria* species have a varied chemistry, probably reflecting the fact that they constitute a group of lichens with a diverse origin (see above). Morphologically rather similar taxa which are biogenetically distinct, can be distinguished by their chemistry. It is convenient to regard such taxa as species for the time being.

Lepraria has not been recently monographed and is in need of a thorough revision. Laundon (1981) placed *L. chlorina* in the genus *Chrysothrix* comprising bright yellow species containing pulvinic acid derivatives, and (1974) *Lepraria chrysodeta* in *Leproplaca* (perhaps better in *Caloplaca* (see Jørgensen & Tønsberg 1988, Kärnefelt 1989, Eriksson & Hawksworth 1991a).

Laundon (1989) transferred all species containing dibenzofurans to *Leproloma* which he further characterized by the presence of a hypothallus and marginal lobes. However, for the present I assign the species belonging to the *Lepraria neglecta* group to *Lepraria,* regardless of the presence or absence of dibenzofurans (see the discussion under *Lepraria neglecta* below).

Laundon is presently revising the genus in the British Isles, and his results will, when published, also be of interest also for Norway.

Most of the *Lepraria* species seem not to have high substratum specificities; thus species normally preferring rock may occasionally occur on trees, and *vice versa*. During the present investigation non-corticolous material was only occasionally examined. The present account deals with 12 species (11 of which are named).

The taxonomy of the *Lepraria neglecta* group is in need of revision. Although chemically complex, the group is well characterized morphologically by the small, rosette-forming, minutely lobed, often muscicolous thalli. The soredia are commonly aggregated in large consoredia, especially at the edge of the thallus. With the exception of *L. caesioalba*, which appears to be a corticolous lowland species, the members of the group occur mostly on exposed mossy rock, often in alpine situations. A chemotype with psoromic acid, 2'-O-demethylpsoromic acid, roccellic acid and atranorin has only been found on mossy rock, and is not included here. As most members are saxicolous, the present treatment of the *L. neglecta*-group should be regarded as provisional.

Lepraria species often grow 2 or 3 intermixed. What in the field may superficially be taken for a single species often proves on closer examination to be a mixture.

Lepraria caerulescens (Hue) Botnen & Øvstedal

Polar Research 6: 130 (1988).

Lepraria angardiana Øvstedal, Nova Hedwigia 37:687 (1983). Type: Antarctica, Dronning Maud Land, Sverdrupfjella, Sørhausane, on soil, 31 December 1970, J. Angard (BG! - holotype). TLC: atranorin, porphyrilic acid, roccellic acid.

Thallus crustose, episubstratal, whitish grey to bluish grey, forming small rosettes or irregular patches to 4 mm in diameter, soon becoming fused with adjacent thalli, with minute marginal lobes usually consisting of 1-2 consoredia, sorediate. Hypothallus sparse, of colourless to brownish hyphae. **Soredia** coarse, up to 50(-100) µm in diameter, simple or in more or less rounded consoredia up to 125 µm in diameter, with a distinct wall of mostly globose cells giving the soredia a papillate appearance, occasionally with short hyphal projections. Photobiont green, coccoid, up to 20 µm in diameter.

Chemistry: Atranorin, porphyrilic acid, roccellic acid. Thallus UV- or UV+ dull greyish.

Substratum. Corticolous specimens were found on *Juniperus communis* and low-alpine shrubs of *Salix* sp(p). The specimens grew on naked bark and on corticolous foliose lichens.

Distribution. The present corticolous material was found at altitudes between 380-400m (Finnmark: Kautokeino) and 1405 m (Sogn og Fjordane: Luster) in scattered localities.
Counties: Corticolous specimens: Oppland, Sogn og Fjordane, Nordland, Finnmark.

Discussion. According to Øvstedal (pers. comm. 1989) the concentration of porphyrilic acid in *Lepraria caerulescens* varies from low (detectable only with difficulty using TLC) to high. Botnen & Øvstedal (1989) reduced *L. angardiana* to synonymy with the morphologically similar *L. caerulescens* (Hue) Botnen & Øvstedal (the lectotype of which contains atranorin and roccellic acid (Botnen & Øvstedal 1989)) regarding the latter species as representing a porphyrilic acid-deficient strain of the former, see also Øvstedal (1983). According to Leuckert & Kümmerling (1991), the roccellic acid is sometimes partly or entirely replaced by angardianic acid, another, related fatty acid with the same chromatographic characteristics. Laundon (1989) transferred *Lepraria angardiana* to *Leproloma* on account of the presence of porphyrilic acid, regarding the dibenzofuran-deficient *Lepraria caerulescens* as belonging to *Lepraria* s. str. This appears to be artificial.

Lepraria caerulescens is mainly a non-corticolous species (Laundon 1989, Øvstedal

1983). Preliminary examinations of saxicolous Norwegian material indicate that *Lepraria caerulescens* is a widely distributed and common muscicolous species on rock in Norway.

Specimens seen: Op: Vang 1985, Tønsberg 9317. - SF: Luster 1988, Tønsberg 11312. - No: Narvik 1986, Tønsberg 9799. - Fi: Kautokeino 1988, Tønsberg 11267.

Lepraria caesioalba (B. de Lesd.) Laundon ined.

Thallus crustose, episubstratal, whitish grey to bluish grey, rarely greenish grey, forming rosettes up to one cm in diameter when young, later sometimes becoming confluent with other thalli forming more or less irregularly spreading, more or less continuous patches up to several cm in diameter, delimited to diffuse, sometimes with minute, marginal, reflexed lobes. Colourless anchoring prothallus hyphae sometimes present. **Soredia** mostly coarse, up to 50 µm, simple or in rounded to ellipsoidal consoredia up to 150 µm (-0.4 mm) in diameter, with a distinct wall; projecting hyphae sometimes present, short (up to about 10 µm) on central soredia, long (up to 0.2 mm) on marginal soredia. Photobiont green, coccoid, up to 19 µm. Medulla poorly developed or absent.

Chemistry: Fumarprotocetraric acid, protocetraric acid, ± cph-1, ± cph-2, roccellic acid, ± atranorin (trace, mostly absent). Thallus UV+ dull greyish; PD+ orange red.

Substratum. *Lepraria caesioalba* was found on naked or mossy bark of *Betula pubescens/pendula*, and more rarely on *Alnus glutinosa*, *A. incana*, *Fagus sylvatica*, *Quercus*, *Salix caprea*, and *Sorbus aucuparia*.

Distribution. *Lepraria caesioalba* has been found in the coastal lowlands of southern Norway and Nordland. Its vertical distribution ranged from about sea-level to 340 m (Hordaland: Bergen). **Counties:** Telemark, Aust-Agder, Hordaland, Sogn og Fjordane, Nordland.

Discussion. With its rosette-forming thallus and the marginal soredia aggregated in large consoredia, *L. caesioalba* belongs to the *L. neglecta*-complex. Contrary to other members of that group, *L. caesioalba* seems to be a corticolous lowland species. However, *L. caesioalba* was rarely found also on rock (1 specimen). *Lepraria caesioalba* is here reported as new to Scandinavia.

Specimens seen: Te: Kragerø 1983, Tønsberg 7960. - AA: Bygland 1987, Tønsberg 10189. - Ho: Austevoll 1985, Tønsberg 9407. Bergen 1983-1984, Tønsberg 7746a, 8812, 9052, 9087. Lindås 1984-1989, Tønsberg 8880, 11557. - SF: Askvoll 1989, Tønsberg 11797. Flora 1989, Tønsberg 11821. Førde 1983, Tønsberg 7930. - No: Flakstad 1987, Tønsberg 10529, 10530. Sortland 1987, Tønsberg 10455. A total of 15 specimens seen.

Lepraria eburnea Laundon ined.

Fig. 63.

Thallus crustose, episubstratal, pale greyish green, pale green or whitish grey, sometimes with a faint yellowish tinge, without marginal lobes, composed of more or less scattered groups of soredia throughout, forming an irregularly spreading, diffuse, mostly non-stratified crust, or, when well developed, forming a thick continuous, stratified, more or less delimited crust up to one dm or more across, sorediate; hypothallus not distinct. Medulla distinct in thickish specimens, white. **Soredia** fine to coarse, up to 40 µm, often in lax consoredia to 120 µm in diameter, often with some shortly projecting hyphae; wall indistinct to distinct. Soredia and consoredia more or less embedded in a hyphal matrix. Photobiont green, coccoid, up to 20 µm in diameter.

Chemistry: Alectorialic acid, barbatolic acid, protocetraric acid, unidentified substances (trace amounts, probably satellites of alectorialic\barbatolic acid complex). Thallus PD + orange.

Substratum. *Lepraria eburnea* was collected on *Alnus incana* (4 specimens) and *Sorbus aucuparia* (4), and more rarely, on *Corylus avellana, Picea abies, Populus tremula, Quercus*, and *Taxus baccata*. It usually occurred at the base of the trunks or on the under-side of leaning trunks. It grew on corticolous mosses and on naked bark.

Distribution. *Lepraria eburnea* has been found in a broad belt along the coast (Fig. 63). Its vertical distribution ranged from about sea-level to 330 m (Buskerud, Krødsherad). **Counties:** Buskerud, Vestfold, Aust-Agder, Vest-Agder, Hordaland, Sogn og Fjordane, Sør-Trøndelag, Nord-Trøndelag, Troms.

Discussion. *Lepraria neglecta* s. str. also produces alectorialic acid. However, that species contains roccellic acid and no barbatolic and protocetraric acids. *Lepraria eburnea* is morphologically clearly distinct from *L. neglecta;* the latter has a much smaller, bluish grey, often rosette-forming thallus, and mostly larger consoredia.

Lepraria eburnea also grows on rock. It appears to be a coastal species. It is here reported as new to Scandinavia.

Specimens seen (selected): Bu: Krødsherad 1982, Tønsberg 6929. - Vf: Sande 1922, Høeg (TRH). - AA: Grimstad 1977, Tønsberg 1706. - VA: Songdalen 1987, Tønsberg 10078a. - Ho: Odda 1990, Tønsberg 13579. - SF: Høyanger 1984, Tønsberg 8642. - ST: Melhus 1982, Tønsberg 6604. - NT: Namdalseid 1983, Tønsberg 8439. - Tr: Bardu 1976, Øvstedal. A total of 17 specimens seen.

Lepraria elobata Tønsb. sp. nov.

Thallus ubique leprosus, griseo-venetus vel viridis, effusus, acidum atranoricum, sticticum et zeorinicum continens. Soredia sine hyphis filamentosis projectis, usque ad 30(-40) µm diametro.

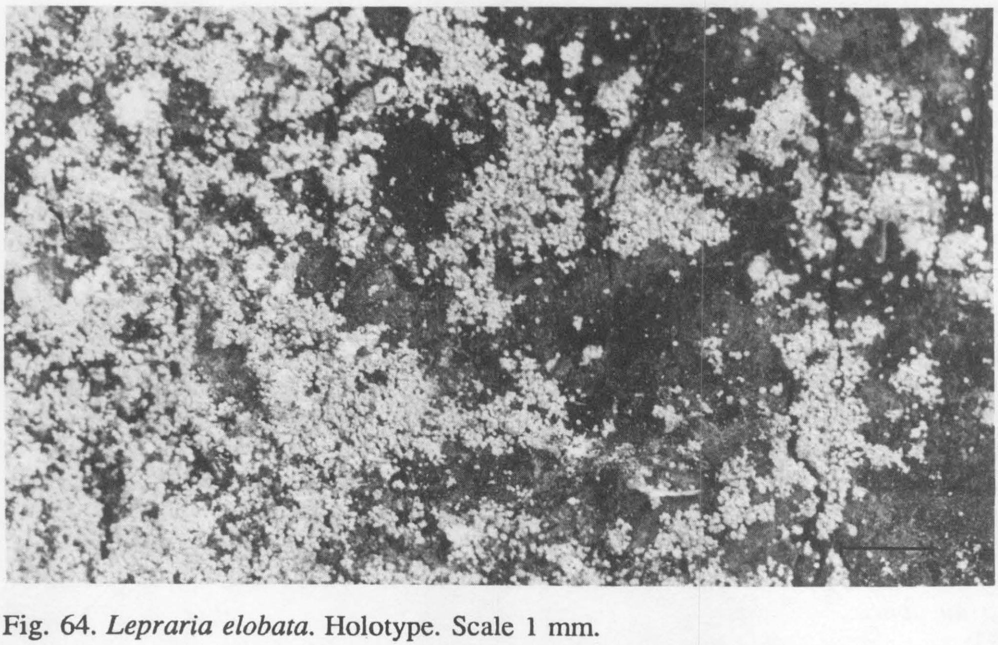


Fig. 64. *Lepraria elobata*. Holotype. Scale 1 mm.

Type: Norway, Vest-Agder, Kristiansand, Hamresand, UTM grid ref.: 32V MK 4550 (map 111 III), alt. 5 m, on *Pinus sylvestris*, 28 September 1991, T. Tønsberg 17404 (BG - holotype).

Figs 64-65.

Thallus (Fig. 64) crustose, entirely episubstratal or, rarely, more or less endosubstratal in young parts, bluish grey or greenish grey, leprose throughout, without lobes, mostly diffuse, non-stratified, forming a thin cover of discrete to more or less contiguous soredia, or a more or less continuous, thick crust, rarely forming discrete, well-defined, flattened aggregations to 1 mm in diameter of densely packed soredia, usually irregularly spreading, up to one dm or more across. **Soredia** mostly fine, up to 30(-45)µm, often in globose to ellipsoidal consoredia up to 100 µm in diameter, without projecting hyphae; wall usually not complete. Photobiont green, coccoid, up to 18 µm in diameter.

Chemistry: Atranorin, stictic acid and zeorin (major substances), cryptostictic acid, norstictic acid and constictic acid (minor constituents).

Substratum. *Lepraria elobata* has been collected on a range of phorophytes including *Betula pubescens/pendula* (11 specimens), *Picea abies* (7), and, more rarely, on *Acer* sp., *Alnus incana*, *Fagus sylvatica*, *Juniperus communis*, *Malus domestica*, *Pinus sylvestris*, *Populus tremula*, *Pyrus*, *Quercus*, *Rhododendron* cfr. *oreodoxa*, *Salix caprea*, and *Sorbus aucuparia*. It preferred naked bark at the base of the trunks.

Distribution. *Lepraria elobata* occurred both in inland, coastal, low-land and alpine regions; however, it was sparse on the southernmost and westernmost coasts and has not been found in Finnmark (Fig. 65). Its vertical distribution ranged from about sea-level to 1050 m (Oppland: Dovre). **Counties:** Akershus - Vest-Agder, Hordaland - Troms.

Discussion. *Lepraria elobata* is chemically similar to but morphologically distinct from *L. lobificans* which is lobate, distinctly stratified, and has filamentous "airy" soredia (compact in *L. elobata*). The difference in distributional range makes it further unlikely that *Lepraria elobata* actually represents an extreme form of *L. lobificans*.

Lepraria elobata is a widespread species on acidic bark. It was also found on rock.

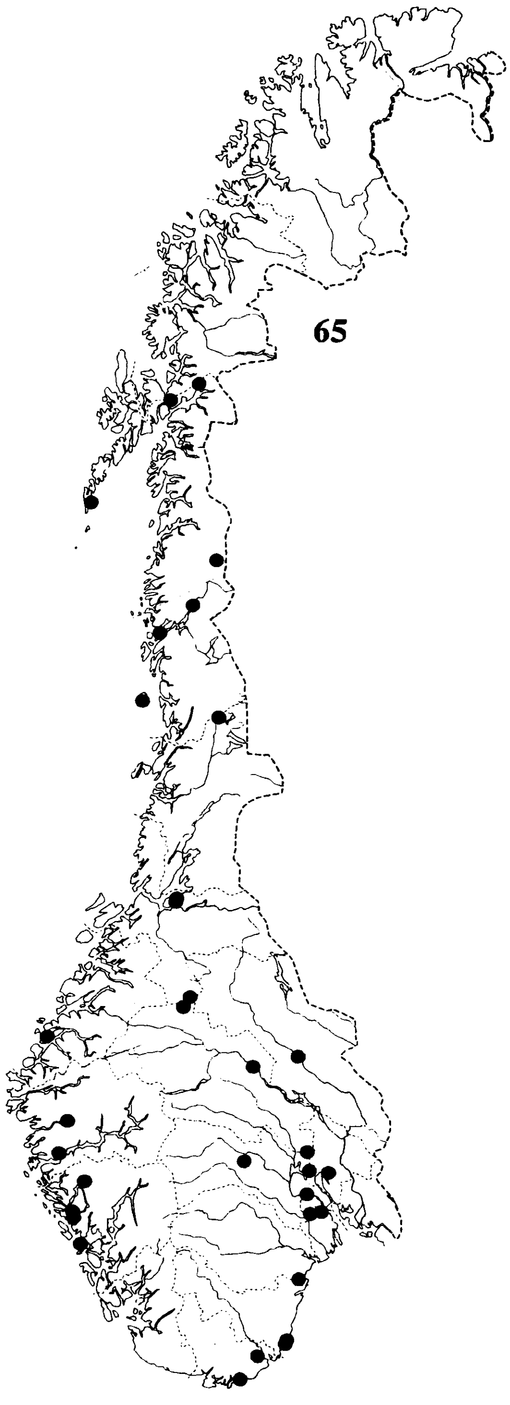
Specimens seen (selected): Oslo 1981, Tønsberg 6419. - He: Åmot 1982, Tønsberg 7582. - Op: Øyer 1982, Tønsberg 7522. - Bu: Sigdal 1982, Tønsberg 6991. - Vf: Holmestrand 1987, Tønsberg 10063. - Te: Kragerø 1983, Tønsberg 7956. - AA: Grimstad 1990, Tønsberg 13528 (type). - VA: Lindesnes 1977, Tønsberg 1739. - Ho: Bergen 1990, Tønsberg 13005; 1991, Fægri. - SF: Høyanger 1984, Tønsberg 8646. - MR: Ålesund 1987, Tønsberg 10396a. - ST: Trondheim 1983, Tønsberg 7789. - NT: Namsskogan 1982, Tønsberg 7447. - No: Rana 1982, Tønsberg 7644. - Tr: Skånland 1982, Tønsberg 7389. A total of 43 specimens seen.

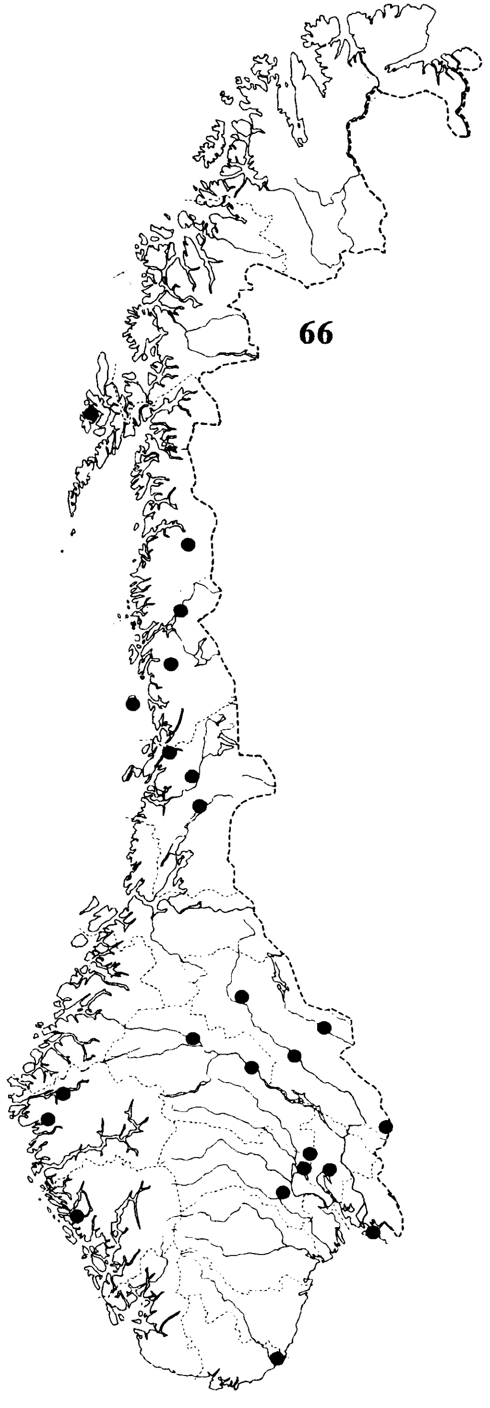
Lepraria incana (L.) Ach.

Thallus crustose, episubstratal, grey-green, blue-green or grey-blue, forming more or less irregular, continuous patches up to at least 8 cm in diameter, or small, poorly developed patches in colonies. Medulla poorly developed or absent. Surface rarely somewhat wrinkled. **Soredia** mostly fine, occasionally coarse and up to 45 µm, simple or in rounded consoredia up to 70(-110) µm in diameter, sometimes with some shortly projecting hyphae; wall usually not complete, of cylindrical cells.

Chemistry: Divaricatic acid, zeorin, ± nordivaricatic acid (faint trace), unidentified terpenoids (traces). Thallus UV+ bluish; C-.

Substratum. *Lepraria incana* has been found on more or less shaded specimens of *Alnus glutinosa*, *Betula pubescens/pendula*, *Juniperus communis*, *Picea abies*, *Pinus sylvestris*, and *Sorbus aucuparia*.





Figs 65-66. Distribution maps. Fig. 65. *Lepraria elobata*. Fig. 66. *Lepraria jackii*.

Distribution. *Lepraria incana* occurred in the coastal lowlands from Østfold to Troms at altitudes from about sea-level to 250 m (ST: Klæbu). **Counties:** Østfold, Rogaland, Hordaland, Sør-Trøndelag, Troms.

Discussion. Morphologically *Lepraria incana* resembles the more common species *L. elobata*. Chemically these two species agree in producing zeorin, but differ in their phenolic constituents: divaricatic acid in *L. incana*, stictic acid in *L. elobata*. Divaricatic acid is present also in *L. crassissima*, a thick, stratified, strongly wrinkled crust growing on shaded, probably somewhat calciferous rock walls; that species is chemically characterized by the presence of large amounts of nordivaricatic acid (C+ red). *Lepraria crassissima* was placed in synonymy with *L. incana* by Kümmerling et al. (1991).

Lepraria incana may resemble *Lecidea nylanderi* morphologically. That species differs, e.g., in being devoid of zeorin (for further details, see that species).

When corticolous, *Lepraria incana* appears to be a coastal species of acidic bark. It has also been found on rock walls under overhangs.

Specimens seen: Øf: Hvaler 1983-1990, Tønsberg 7726, 7853, 7867, 13232. - Ro: Sauda 1986, Botnen 86/2. - Ho: Lindås 1987, Tønsberg (mixed in *L. umbricola* 10616). - ST: Klæbu 1983, Tønsberg 8398. - Troms: Kvæfjord 1987, Tønsberg 10426.

Lepraria jackii Tønsb. sp. nov.

Thallus ubique leprosus, plerumque non stratosus, sed in exemplis crassis albido-medullosis; effusus, usque ad aliquot dm diametro, acidum atranoricum, roccellicum, rangiformicum et norrangiformicum continens. Soredia farinosa, plerumque subviridia vel straminea.

Type: Norway, Nord-Trøndelag, Grong, W of Abrahammyra, UTM grid ref.: 33W UM 73-74.62 (map 1824 III), alt.: 80-100 m, on *Picea abies*, 16 September 1981, T. Tønsberg 6176 (BG - holotype; BM - isotype). TLC: Roccellic acid, rangiformic acid, norrangiformic acid, atranorin.

Figs 11, 66.

Thallus crustose, episubstratal, pale green, greyish green, yellowish green, straw-coloured or, rarely, bluish green, diffuse, forming a thin to thick more or less continuous, irregularly spreading crust up to several dm across, unlobed, unstratified, or in thick specimens, with a white medulla. **Soredia** (Fig. 11) fine to coarse, up to 50 µm, simple or in consoredia up to 80 µm in diameter, often with some shortly (mostly about 10 µm long) projecting hyphae; wall distinct, of globose to more or less cylindrical cells. Photobiont green, coccoid, up to 15 µm in diameter.

Chemistry: Roccellic acid, rangiformic acid, norrangiformic acid, atranorin. (No chloroatranorin found.)

Substratum. *Lepraria jackii* has most commonly been collected on *Picea* (14 specimens), and other phorophytes included *Alnus glutinosa, A. incana, Betula pubescens/pendula, Malus domestica, Pinus sylvestris, Quercus*, and *Sorbus aucuparia*. *Lepraria jackii* grew usually on naked bark at or near the base of the trunks.

Distribution. *Lepraria jackii* proved to be widely distributed in eastern parts of southern Norway; in northern Norway it occurred as far north as Nordland: Bø (Fig. 66). Its vertical distribution ranged from about sea-level to 600 (Hedmark, Tynset); many collections were from altitudes above 200 m. **Counties:** Østfold - Buskerud, Vest-Agder, Hordaland, Sogn og Fjordane, Nord-Trøndelag, Nordland.

Discussion. *Lepraria jackii* and *L. rigidula* both contain atranorin as the only phenolic acid derivative. The two species differ chemically in their content of higher aliphatic acids.

Morphologically they are easily separated by the colour and structure of their soredia (greenish and without or with shortly projecting filaments in *L. jackii*; bluish grey and with very long, projecting filaments in *L. rigidula*.

Lepraria jackii was found in one site mixed with *L. eburnea* and *L. elobata*. There were obvious morphological differences between them. The specimen of *Lepraria jackii* (Tønsberg 6685) had pale green soredia, lacking projecting filaments. In *L. eburnea* the soredia were greyish green and had projecting hyphal filaments. The soredia of *L. elobata* were bluish grey and lacked projecting filaments.

Lepraria jackii seems to be an eastern species of acidic bark.

Lepraria jackii is named in honour of Mr. Jack Laundon, London, a monographer of *Lepraria*.

Specimens seen (selected): Øf: Hvaler 1983, Tønsberg 7727. - Oslo 1982, Tønsberg 6548. - He: Kongsvinger 1985, Tønsberg 9437. - Op: Sel 1982, Tønsberg 7514. - Bu: Hole 1981, Tønsberg 6431a. - VA: Kristiansand 1991, Tønsberg 17403. - Ho: Bergen 1984, Tønsberg 8567. - SF: Gloppen 1990, Anonby 429. - NT: Grong 1981, Tønsberg 6176 (type collection). Nærøy 1982, Tønsberg 6685. - No: Saltdal 1982, Tønsberg 7665. Vefsn 1982, Tønsberg 7595. A total of 34 specimens seen.

Lepraria lobificans Nyl.

Observ. Lich. Pyren., 1873: 49. Type: Pyren. Orient., 4 Juil. 1872, W. Nylander (H-NYL!).

Crocynia finkii B. de Lesd., in Hue, Bull. Soc. Bot. France 71: 334 (1924). Type: Iowa, Fayette, 7 July 1894, B. Fink, Cummings et al. 93 & 161 (MICH! - isotypes).

Figs 67-68.

Thallus (Fig. 67) crustose, episubstratal, greenish, often with a grey to bluish grey tinge, diffuse to more or less delimited, more or less distinctly lobed, forming thick continuous, rounded to irregular patches up to one dm or more across, stratified, sorediate. Medulla white, thick. **Soredia** more or less embedded in a hyphal matrix, mostly fine, usually in lax consoredia up to 100 µm (-0.2 mm) in diameter, with long (often up to 0.1 mm) projecting hyphae; wall not evident or poorly developed, of cylindrical cells. Photobiont green, coccoid, up to 18 µm diameter.

Chemistry: Atranorin, stictic acid, zeorin (major constituents), cryptostictic acid, norstictic acid, and connorstictic acid, unidentified terpenoids (traces). Consoredia and medulla PD+ orange.

Substratum. *Lepraria lobificans* has been collected on *Acer platanoides, Alnus incana, Betula pubescens/pendula, Fraxinus excelsior, Populus tremula, Quercus, Salix caprea, Sorbus aucuparia, Tilia* and *Ulmus glabra*. The species grew on naked bark and on corticolous mosses.

Distribution. *Lepraria lobificans* occurred in some scattered localities in the coastal lowlands; the only known inland site was the shaded and moist Rolla river gorge in Gudbrandsdalen (Fig. 68). Its vertical distribution ranged from about sea-level to 250 m (Nord-Trøndelag: Leksvik). **Counties:** Oppland, Vestfold, Aust-Agder - Møre og Romsdal, Nord-Trøndelag - Troms.

Discussion. *Lepraria lobificans* is chemically conformable with *L. elobata*. However, the two species are easily distinguished morphologically. The tendency to form lobes, the presence of a stratified thallus with a well-developed medulla and soft soredia with protruding hyphae make *L. lobificans* distinct from *L. elobata*. Even minute thalli with only a few soredia already have a medulla. The lobes formed by *L. lobificans* are very fragile and therefore easily

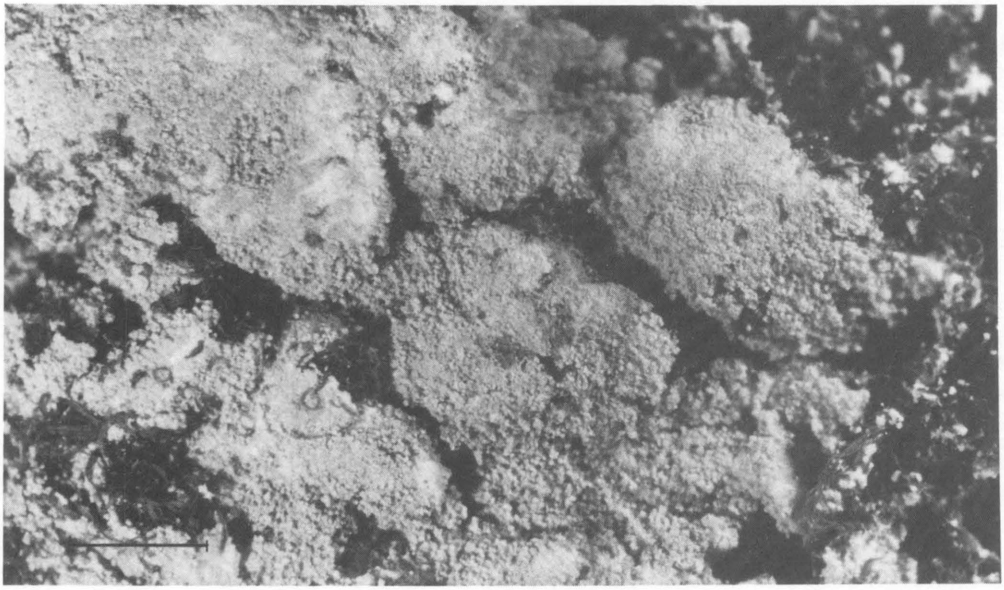


Fig. 67. *Lepraria lobificans*. Tønsberg 10078c. Scale 2 mm.

broken on herbarium specimens. *Lepraria lobificans* strongly resembles *L. crassissima* morphologically. That species seems to be saxicolous and confined to (calciferous?) rock walls. It differs chemically from *L. lobificans* in that the stictic acid complex is replaced by divaricatic and nordivaricatic acids.

Lepraria lobificans is a coastal species. When corticolous, it seems to have a preference for bark of broad-leaved trees. It also occurs on calciferous rocks. In the city of Bergen it was found on soil between stones in walls, and on naked mortar.

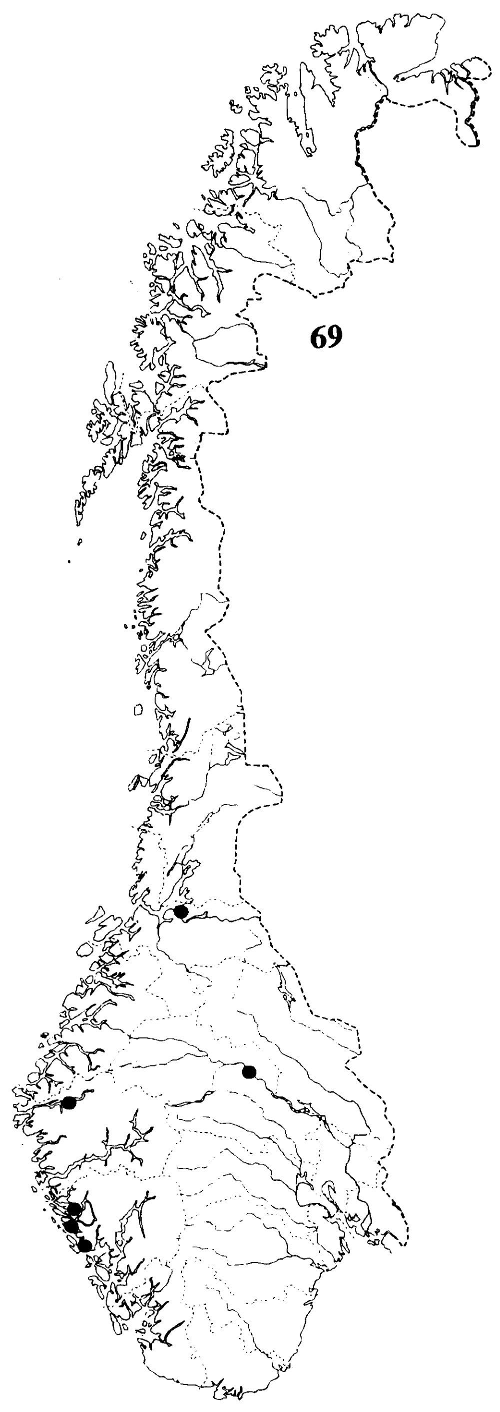
Specimens seen: Op: Øyer 1984, Tønsberg 9000. - Vf: Hof 1990, Tønsberg 13059. - AA: Lillesand 1990, Tønsberg 13561. - VA: Farsund 1978, Tønsberg 2919. Songdalen 1987, Tønsberg 10078c. - Ro: Sauda 1988, Tønsberg 10819. - Ho: Lindås 1984, Tønsberg 8597. Sund 1953, Naustdal. - SF: Lærdal 1991, Anonby 520 & Gaarder. - MR: Smøla 1983, Tønsberg 8286, 8289, 8311. - NT: Leksvik 1980, Tønsberg 4860b. - No: Vega 1975, Degelius V-1389 (pro parte). - Tr: Lyngen 1976, Øvstedal. A total of 17 corticolous specimens seen.

Lepraria neglecta (Nyl.) Lettau

Lecidea neglecta Nyl., in Not. Sällsk. Fauna Flora Fenn. Förh. 4: 233 (1859). Type: Nylandia, Helsingfors (Helsinki), ad rupes prope urbem, 1858. Leg. & det. W. Nylander (H-Nyl 10867!). TLC: The type material was a mixture of two chemical entities: 1) with alectorialic acid and roccellic acid (regarded as the type by Laundon 1989: 20). 2) fumarprotocetraric acid, roccellic acid, atranorin.

(Description based on a sparse corticolous material as well as on non-corticolous specimens collected by the author.)

Thallus crustose, episubstratal, whitish grey to bluish grey, turning pink in the herbarium due to the presence of alectorialic acid, mostly leprose throughout, rarely, in thick specimens, with a white medulla, usually forming delimited rosettes up to 1 cm in diameter, with minute, sometimes raised marginal lobes, often becoming confluent with adjacent thalli



Figs 68-69. Distribution maps. Fig. 68. *Lepraria lobificans*. Fig. 69. *Lepraria obtusatica*. Known distribution.

forming more or less continuous patches up to a few cm in diameter. Hypothallus sparse, of brown hyphae. **Soredia** coarse, up to 100 µm in diameter, simple or in firm, rounded to ellipsoidal consoredia up to 200 µm in diameter or, at the edge of the thallus, up to 0.3 mm; wall distinct, of globose to somewhat irregular cells. Photobiont green, coccoid, to 15(-20) µm in diameter.

Chemistry: Alectorialic acid with satellites, roccellic acid. No barbatolic acid was observed.

Substratum. *Lepraria neglecta* was found on low-alpine, exposed shrubs of *Betula nana* and *Salix* sp.

Distribution. Corticolous material of *Lepraria neglecta* was found in a single locality at 510 m altitude in Nordland. Non-corticolous specimens were found growing on saxicolous mosses at altitudes from 500-1070 m. **Counties:** Corticolous specimens: Nordland. All specimens: Buskerud, Hordaland, Nordland.

Discussion. *Lepraria neglecta* is apparently a common saxicolous species which only occasionally occurs on bark.

Specimens seen: No: Narvik 1986, Tønsberg 9797, "9799" (the latter mixed in and filed under *Lepraria caerulescens*).

Lepraria obtusatica Tønsb. sp. nov.

Thallus plus minusve ubique leprosus, sorediatus viridulus in herbario cinereo flavescens, sine lobis. Soredia tenuia, 10-25 µm in diameter. Thallus acidum obtusaticum continens.

Type: Norway, Hordaland, Askøy, S of lake Askvatn, alt. 0-20 m, UTM grid ref.: 32V KN 9010 (1115 I), 14 June 1984, on shaded bark of *Corylus avellana* under overhanging rock, T. Tønsberg 8832 (BG - holotype; DUKE, E - isotypes).

Figs 19, 69-70.

Thallus (Fig. 70) leprose throughout, or composed of soredia mixed with some colourless medullary hyphae, episubstratal, pale green with a grey-yellow tinge, becoming more distinctly grey-yellow in the herbarium, diffuse, unlobed, discontinuous to partly continuous, forming irregular patches up to several cm across, usually unstratified, rarely, in thickish parts of thallus with an indistinct white medulla. **Soredia** fine, up to 25(-35) µm in diameter, sometimes in loosely packed, more or less irregular consoredia up to 50 µm in diameter, very fragile; wall poorly developed. Photobiont green, coccoid, up to 10 µm in diameter.

Chemistry: Obtusatic acid, ± an unidentified yellow pigment with R_F-classes A 3-4, B 5, C 3). One specimen (Tønsberg 8832) which was analysed by TLC & HPLC contained obtusatic acid (major substance), barbatic acid (trace), and an unidentified substance soluble in toluene, with R_F-classes A 6, B 5, C 5-6, turning pale pink after charring. Thallus UV+ dull pink. PD+ yellow. TLC: Fig. 19.

Substratum. *Lepraria obtusatica* has been collected on shaded trunks of *Corylus avellana* and *Sorbus aucuparia* adjacent to overhanging rock, and on the shaded, concave part of the base of a trunk of *Picea abies*. Associated lichens included *Lepraria umbricola* and *Psilolechia lucida* (coastal sites), and *Calicium subquercinum* and *Lecanactis abietina* (inland sites).

Distribution. *Lepraria obtusatica* occurred in scattered localities in coastal and inland areas of southern Norway (Fig. 69). Its vertical distribution ranged from about sea-level to 450 m (Oppland: Ringebu). **Counties:** Oppland, Hordaland, Sogn og Fjordane, Sør-Trøndelag.

Discussion. *Lepraria obtusatica* is characterized by the usually minute soredia and the production of obtusatic acid. Obtusatic and barbatic acids, both para-depsides of the β-orcinol series, appear not to have been previously reported in *Lepraria* (see Culberson 1969, 1970, Culberson et al. 1977). Obtusatic acid is a rather rare substance previously known only in *Parmelia* (*Hypotrachyna*) and *Ramalina* according to Culberson (1969, 1970), Culberson et al. (1977) and in the *Cladonia miniata* group (Stenroos 1989). Atranorin is the only other β-orcinol para-depside known to occur in *Lepraria*.

Lepraria obtusatica seems to be a suboceanic species.

Specimens seen: Op: Ringebu 1984, Tønsberg 9016. - Ho: Askøy 1984, Tønsberg 8832 (type collection). Bergen 1984, Tønsberg 8813. Lindås 1987, Tønsberg 10615. - SF: Gloppen 1989, Tønsberg 11941b. - ST: Trondheim 1983, Tønsberg 8127.

Lepraria rigidula (B. de Lesd.) Tønsb. comb. nov.

Crocynia rigidula B. de Lesd., in Hue, Bull. Soc. bot. Fr. 71: 331-332 (1924). Type: U.K.: Scotland, Perth, Pitlochry, byside of R. Tummel, June 1914, J. Mc Andrew (E! - holotype). TLC: atranorin, rigidula unknown.

Figs 12, 18, 71.

Thallus crustose, episubstratal, whitish grey or bluish grey, diffuse, soft, usually forming a thick, more or less continuous, irregularly spreading crust, up to several dm across, unlobed, or in young specimens, sometimes with obscure lobes, usually unstratified, occasionally with a distinct, white medulla forming a lax, felty mat. **Soredia** (Fig. 12) fine to coarse, up to 60 µm in diameter, simple or, more often, in consoredia up to 300 µm in diameter, with up to 120 µm long, projecting, simple hyphae; wall usually distinct, of globose to cylindrical cells. Photobiont green, coccoid, to 20 µm in diameter.

Chemistry: Atranorin, rigidula unknown. (No chloroatranorin found.) Thallus UV- (or

Fig. 70. *Lepraria obtusatica*. Holotype. Scale 1 mm.

UV+ dull pink). TLC: Fig. 18.

Substratum. *Lepraria rigidula* was found mainly on deciduous trees, most commonly on *Alnus glutinosa* (10 specimens) and *Sorbus aucuparia* (9); other phorophytes included *Acer platanoides*, *A. pseudoplatanus*, *Alnus incana*, *Betula pubescens/pendula*, *Corylus avellana*, *Fagus sylvatica*, *Fraxinus excelsior*, *Malus domestica*, *Picea abies*, *Pinus sylvestris*, *Quercus*, *Rhododendron catawbiense*, *Salix caprea*, *Tilia*, and *Ulmus glabra*. *Lepraria rigidula* grew on naked bark, or more rarely, on corticolous mosses. In several sites it grew on the under side of leaning trunks, associated with *Cystocoleus ebeneus*. The species often formed conspicuous, extensive patches high up on the trunks. It usually preferred the shaded side of the trunks.

Distribution. *Lepraria rigidula* occurred commonly in the lowlands along the coast as far north as Nordland; it was rare inland (Fig. 71). In the city of Bergen, it was fairly common and among the dominant lichen species. Its vertical distribution ranged from about sea-level to 600 m (Oppland : Lom). **Counties:** Østfold, Akershus, Oppland - Nordland. All substrates: Østfold, Akershus, Oppland - Nordland, Finnmark.

Discussion. *Lepraria rigidula* is readily distinguished morphologically on account of the presence of long, projecting filaments on the bluish grey soredia.

The type is terricolous amongst mosses. The projecting hyphae are less conspicuous than those of the Norwegian corticolous material. A Norwegian muscicolous specimen from rock (Tønsberg 7213, from Finnmark) was, in this respect, intermediate between the holotype and the Norwegian corticolous specimens.

In Hordaland: Bergen, *Lepraria rigidula* (leg. Tønsberg 8566) occurred closely associated with *L. jackii* (leg. Tønsberg 8567). The morphological differences between them were evident. The soredia of *L. rigidula* were bluish grey and the protruding hyphal filaments were distinct, up to 100 µm long. In *L. jackii* the soredia were green, and without or with only very short (less than 10 µm) hyphal filaments.

Lepraria rigidula appears to be a toxitolerant lichen with a preference for coastal sites. It may also grow on mosses on rock.

Specimens seen (selected): Øf: Aremark 1985, Tønsberg 9465. - Ak: Frogn 1983, Tønsberg 7847. - Op: Øyer 1984, Tønsberg 8996. - Bu: Ringerike 1990, Tønsberg 13292. - Vf: Hof 1990, Tønsberg 13075. - Te: Bamble 1983, Tønsberg 7948. - AA: Grimstad 1977, Tønsberg 1693. - VA: Lindesnes 1977, Tønsberg 1740. - Ro: Sokndal 1978, Tønsberg 2953. - Ho: Bergen 1984, Tønsberg 8566. - SF: Gloppen 1983, Tønsberg 7890. - MR: Smøla 1983, Tønsberg 8290. - ST: Hemne 1983, Tønsberg 8335. - NT: Grong 1981, Tønsberg 5821. - No: Hadsel 1987, Tønsberg 10484. (Fi: Sør-Varanger 1982, Tønsberg 7213 (on mosses on rock). A total of 66 specimens seen in addition to one from rock.

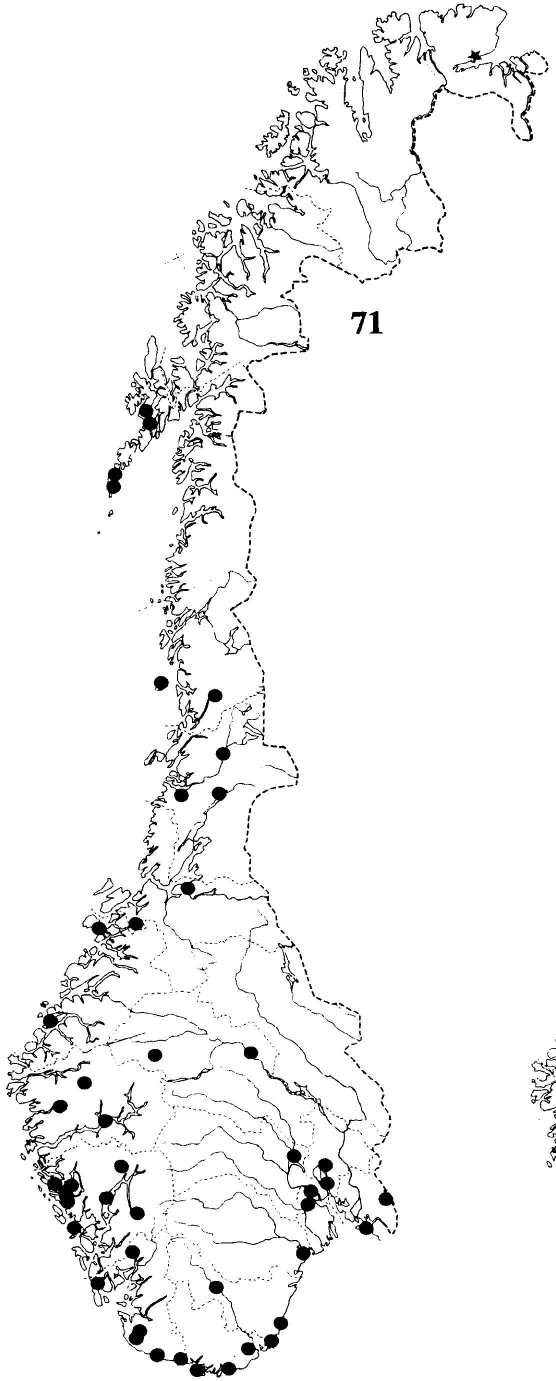
Lepraria umbricola Tønsb. sp. nov.

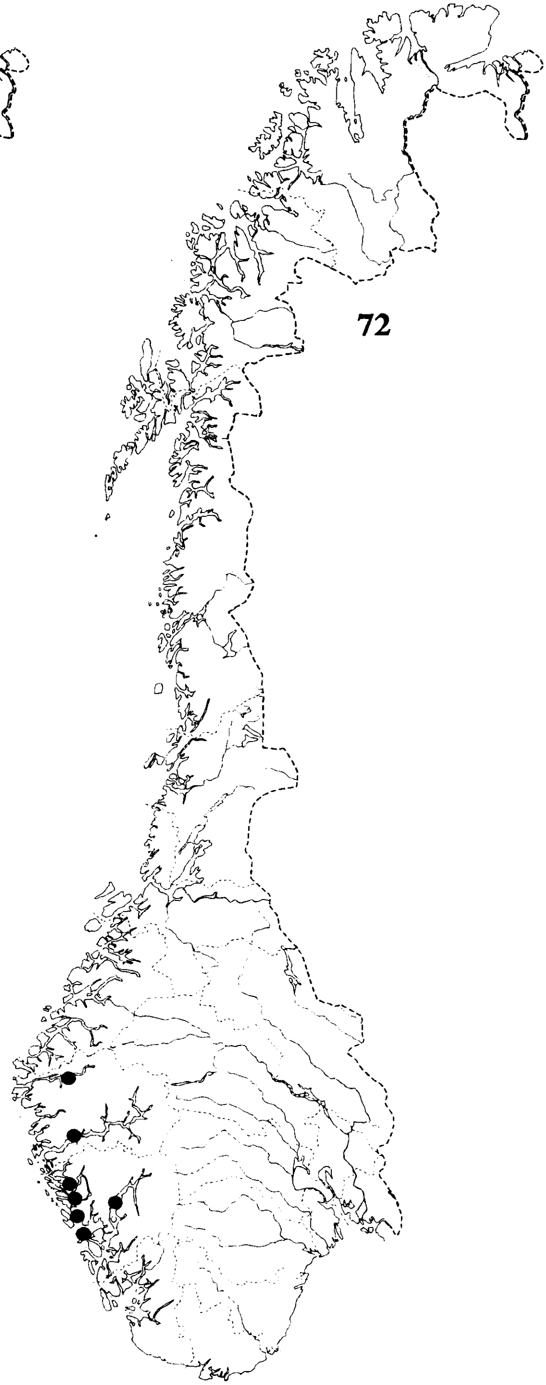
Thallus plus minusve ubique leprosus, sorediatus griseo-viridus vel viridus. Soredia ad 20-35 µm in diameter. Thallus acidum thamnolicum continens.

Type: Norway, Hordaland, Bergen, Milde, Brandaneset, UTM grid ref.: 32V KM 9386 (map 1115 I), alt. 0-20 m, on *Betula pubescens/pendula*, shaded decayed bark of trunk, 25 September 1990, T. Tønsberg 13635 (BG - holotype).

Fig. 72.

Thallus crustose, episubstratal, grey green to green, diffuse, forming a thin to thick, irregularly spreading crust up to one dm or more in diameter, unlobed, usually unstratified, sometimes with a white medulla. **Soredia** fine, simple or in rounded consoredia up to 40(-60) µm in diameter, sometimes with shortly projecting hyphae; wall indistinct to distinct.





Figs 71-72. Distribution maps. Fig. 71. *Lepraria rigidula*. Fig. 72. *L. umbricola*.

Photobiont green, coccoid, up to 15 µm in diameter.

Chemistry: Thamnolic acid. Thallus PD+ orange, K+ yellow.

Substratum. *Lepraria umbricola* has been collected on shaded bark of *Betula pubescens/pendula, Sorbus aucuparia, Calluna vulgaris*, and *Pinus sylvestris*. The specimens were found in cavities formed by roots and tree bases and on trunks of phorophytes growing under overhanging rock. Associated species were *Lecanactis abietina, Lepraria crassissima, L. obtusatica, Lecidella* sp., *Psilolechia lucida* and *Trapeliopsis pseudogranulosa*.

Distribution. *Lepraria umbricola* was collected in westernmost Norway (Fig. 72), at altitudes between 20 and 160 m. **Counties:** Hordaland, Sogn og Fjordane.

Discussion. *Lepraria umbricola* is characterized by the production of thamnolic acid. Thamnolic acid is a meta-depside of the β-orcinol series. Meta-depsides of that series appear not to have been previously reported from *Lepraria* (see Culberson 1969, 1970; Culberson et al. 1977). Other characteristic features of *L. umbricola* are the deep green colour and the ability to inhabit extremely shaded niches.

Outside Norway *L. umbricola* is frequent in western Britain where it occurs on shaded bark and wood of *Alnus glutinosa, Betula pubescens* and *Quercus petraea* (Mr Orange in litt. 1989). *Lepraria umbricola* was also found on deeply shaded wood inside a hollow trunk of an old *Quercus*. *Lepraria umbricola* is a species of deeply shaded bark and wood in coastal habitats.

Specimens seen: Norway: Ho: Austevoll 1990, Tønsberg 13619, 13620, 13621, 13626. Bergen 1989-1990, Tønsberg 12026, 12975 (type collection), 12976, 13634, 13635. Kvam 1979-1987, Tønsberg 4117, 10037 (both on wood). Lindås 1987, Tønsberg 10616. - SF: Høyanger 1989, Tønsberg 11967. Gloppen 1989, Tønsberg 11940b. A total of 12 corticolous and 2 lignicolous Norwegian specimens seen. **U.K.**: Scotland, Wigtownshire 1989, Orange 7646 and 7657 (BG, NMW (not seen)). Wales, Radnorshire 1988, Orange 7379 (BG, NMW (not seen)).

Lepraria sp. A

Thallus crustose, greyish white, forming minute rosettes up to 2 mm in diameter which may fuse to form patches up to a few cm in diameter, occasionally with minute, obscure marginal lobes, unstratified or with a whitish medulla or a layer of whitish soredia beneath, servediate. Hypothallus sparse, of colourless hyphae. **Soredia** fine to coarse, up to 75 µm in diameter, simple, or in consoredia up to 100 µm (-0.16 mm) in diameter, sometimes with shortly projecting hyphae; wall indistinct to distinct. Photobiont green, coccoid, up to 15(-20) µm.

Chemistry: Atranorin, rangiformic acid, ± norrangiformic acid. (No chloroatranorin (3 specimens tested).) Thallus UV+ dull pink.

Substratum. Corticolous specimens of *Lepraria* sp. A were found on *Betula pubescens/pendula, Picea abies, Populus tremula*, and *Sorbus aucuparia* (root). The corticolous specimens were from habitats protected from direct sun.

Distribution. *Lepraria* sp. A has been found in a few sites in southernmost Norway at altitudes between 160 m (Telemark: Drangedal) and 450-460 m (Aust-Agder: Valle). **Counties:** Telemark - Vest-Agder. All substrates: Telemark-Vest-Agder, Hordaland, Nord-Trøndelag.

Discussion. *Lepraria* sp. A is probably mainly a species of mossy rock. With its small, rosette-forming thallus and the tendency to form obscure lobes, it apparently belongs to the *L. neglecta* group. Specimens from rock had mostly coarser consoredia (up to 0.3 mm) and, sometimes, a stratified thallus with a whitish medulla. One saxicolous specimen contained roccellic acid in addition to atranorin, rangiformic and norrangiformic acids. *Lepraria* sp. A might prove to be an undescribed species.

Specimens seen: Te: Drangedal 1987, Tønsberg 10269. - AA: Bygland 1987, Tønsberg 10204a. Valle 1987, Tønsberg 10168. - VA: Vennesla 1990, Tønsberg 13572.

Leproloma Nyl. ex Crombie

The genus *Leproloma* has been revised by Laundon (1989).

Leproloma membranaceum (Dickson) Vainio

Thallus crustose to sub-foliose, episubstratal, pale yellowish grey, delimited, leprose, marginally lobed, continuous, forming more or less rounded patches up to 3 cm in diameter, often becoming contiguous or confluent with other thalli, stratified, with a distinct medulla and hypothallus. Lobes rounded, up to 2 mm broad and 2 mm long; margin entire, usually distinctly raised. Medulla white. Hypothallus distinct, brown to greyish black, sometimes white along thallus margin, forming a more or less thick tomentum. **Soredia** fine to coarse, up to 60 µm in diameter, without or with shortly projecting hyphae, often in consoredia up to 125 (-200) µm in diameter; wall indistinct to distinct. Photobiont green, coccoid, up to 15 µm in diameter.

Chemistry: Pannaric acid, roccellic acid, ± atranorin (trace). Soredia/consoredia and medulla PD+ reddish orange, K+ yellow.

Substratum. Corticolous specimens of *Leproloma membranaceum* occurred mostly on trunks growing in the vicinity of overhanging rock. When growing on free-standing trees, *Leproloma membranaceum* usually occurred on the under side of leaning trunks, often near the base. It grew in shaded as well as sun-exposed situations. *Leproloma membranaceum* has been collected on *Betula pubescens/pendula* (5 specimens) and on *Alnus glutinosa, Fagus sylvatica, Juniperus communis, Picea abies, Populus tremula,* and *Quercus.*

Distribution. *Leproloma membranaceum* occurred inland as well as in coastal areas. Corticolous specimens have been collected at altitudes between about sea-level and 400 m (Oppland: Sel). **Counties:** Corticolous specimens: Østfold, Akershus, Oppland - Vest-Agder, Hordaland, Sogn og Fjordane. All substrates: Østfold - Finnmark.

Discussion. *Leproloma membranaceum* is morphologically an easily recognized species on account of its yellowish, markedly lobed, stratified thallus with a distinctly pigmented hypothallus contrasting with the white medulla. The presence of a distinct hypothallus makes *L. membranaceum* morphologically distinct from all the other species treated here. Chemically it is distinguished by the presence of large amounts of pannaric acid. *Leproloma vouauxii* also has a yellowish grey thallus, but that species differs in lacking distinct marginal lobes and a distinct hypothallus, and by its different chemistry involving methyl pannaric acid.

Leproloma membranaceum is usually a saxicolous or, more rarely, muscicolous species on shaded rock under overhangs. The saxicolous form has been collected up to 910 m altitude (Sør-Trøndelag, Oppdal). *Leproloma membranaceum* appears to be less restricted to trees near rock than other saxicolous species, e.g., *Enterographa zonata* and *Opegrapha gyrocarpa.*

Leproloma membranaceum appears to be a widespread, substratum indifferent species preferring habitats not wetted by direct rain.

Specimens seen (selected): Øf: Hvaler 1983, Tønsberg 7737. - Ak: Asker 1922, Høeg (TRH). - Op: Sel

1982, Tønsberg 7510. - Bu: Sigdal 1987, Tønsberg 10374. - Vf: Brunlanes 1922, Høeg (TRH). - Te: Drangedal 1987, Tønsberg 10265. - AA: Bygland 1987, Tønsberg 10203. - VA: Songdalen 1978, Tønsberg 3203. - Ho: Bergen 1984, Tønsberg 8620. - SF: Førde 1983, Tønsberg 7895. A total of 21 specimens seen.

Leproloma vouauxii (Hue) Laundon

Lichenologist 21: 13 (1989).

Crocynia arctica Lynge, in Skrifter Svalbard og Ishavet 81: 19 (1940). Type: East Greenland: Hudsonland, Moskusoksefjorden, 10 m o.h., 6.8.30, leg. P. F. Scholander (O - holotype!). TLC: A pink spot in R_F-classes A 5, B 2-3, C 5 in long wave UV-light before charring (in addition to the substances occurring in corticolous material).

Fig. 18.

(Description based on corticolous as well as non-corticolous material.)

Thallus crustose, episubstratal, pale yellowish grey, sometimes with a greenish tinge, diffuse to delimited, often with a delimited main thallus surrounded by scattered groups of soredia; without marginal lobes; usually forming thick, more or less continuous, more or less rounded patches, up to 4(-6) cm in diameter, sorediate, stratified with a distinct white medulla. Hypothallus brown, distinct in well-developed specimens. **Soredia** usually coarse, up to 100 µm in diameter, often in globose to ellipsoidal consoredia up to 150 µm (-0.2 mm) in diameter, with or without projecting hyphae; wall usually poorly developed. Photobiont green, coccoid, up to 16 µm in diameter.

Chemistry: Pannaric acid-6-methylester, vouauxii unknown 1 and 2, pannaric acid (trace). Soredia/consoredia and medulla PD+ reddish orange, K+ pale yellow. TLC: Fig. 18.

Substratum. *Leproloma vouauxii* was found mainly on trees closely associated with shaded rock. The phorophytes were *Alnus incana*, *Fraxinus excelsior*, and *Picea abies*. The specimens grew on naked bark as well as on corticolous mosses.

Distribution. *Leproloma vouauxii* occurred in scattered sites in coastal areas. The vertical distribution ranged from about sea-level to 180 m; saxicolous specimens have been collected up to 2400 m altitude (Op: Lom (according to Laundon 1989). **Counties:** Corticolous specimens: Østfold, Hordaland, Sør-Trøndelag, Nord-Trøndelag, Troms. All specimens: Østfold, Akershus, Oppland, Hordaland, Sogn og Fjordane, Sør-Trøndelag - Finnmark.

Discussion. *Leproloma vouauxii* may resemble *L. membranaceum* morphologically in having a thick, often continuous, more or less delimited, yellowish thallus. It is distinct from that species in lacking marginal lobes and in having a quite different chemistry; its hypothallus is also less prominent.

Leproloma vouauxii is usually a muscicolous species on shaded, calciferous rock under overhangs.

Specimens seen: Øf: Onsøy 1990, Tønsberg 13249, 13253. - Ho: Ulvik 1990, Tønsberg 13328. - ST: Trondheim 1983, Tønsberg 8126b. - NT: Frosta 1983, Tønsberg 8429b. - Tr: Ibestad 1976, Øvstedal. A total of 6 corticolous (and 13 muscicolous or saxicolous) specimens seen.

Loxospora Massal.

The genus *Loxospora*, commonly included in *Haematomma*, was reinstated (but not further treated) by Wirth 1987.

Loxospora elatina (Ach.) Massal.

Figs 19, 73-75.

Thallus (Figs 73-74) crustose, episubstratal, but sometimes partly endosubstratal in younger parts, thin or more usually thick, delimited to weakly delimited, usually continuous, but sometimes areolate in young parts, forming rosettes or irregular patches up to a dm or more in diameter, sorediate. Prothallus often distinct, whitish, felty. Esorediate surface grey or bluish grey, rarely yellowish, smooth to coarsely tuberculate, often fissured; tuberculae sometimes bullate. Areolae greyish, rounded, up to 0.3 mm in diameter. **Soralia** bursting from the apices of the tuberculae, yellowish white, yellowish green or light green, often constricted at base, regular and more or less semiglobular or, more often, irregular, variably sized, diffuse, tending to coalesce locally on the thallus. Soredia mostly coarse, 25-55 µm in diameter; wall distinct; consoredia common, mostly rounded, up to 80 µm or more. Medulla mostly distinct. Photobiont green, coccoid, to 12 µm in diameter.

Apothecia present in 31 (20%) of the specimens, lecanorine, up to 1 mm in diameter, sessile or elevated on a thalline tuberculum, sometimes distinctly constricted at base; thalline margin sorediate, disappearing with age; disc reddish brown, sometimes pruinose, becoming convex with age.

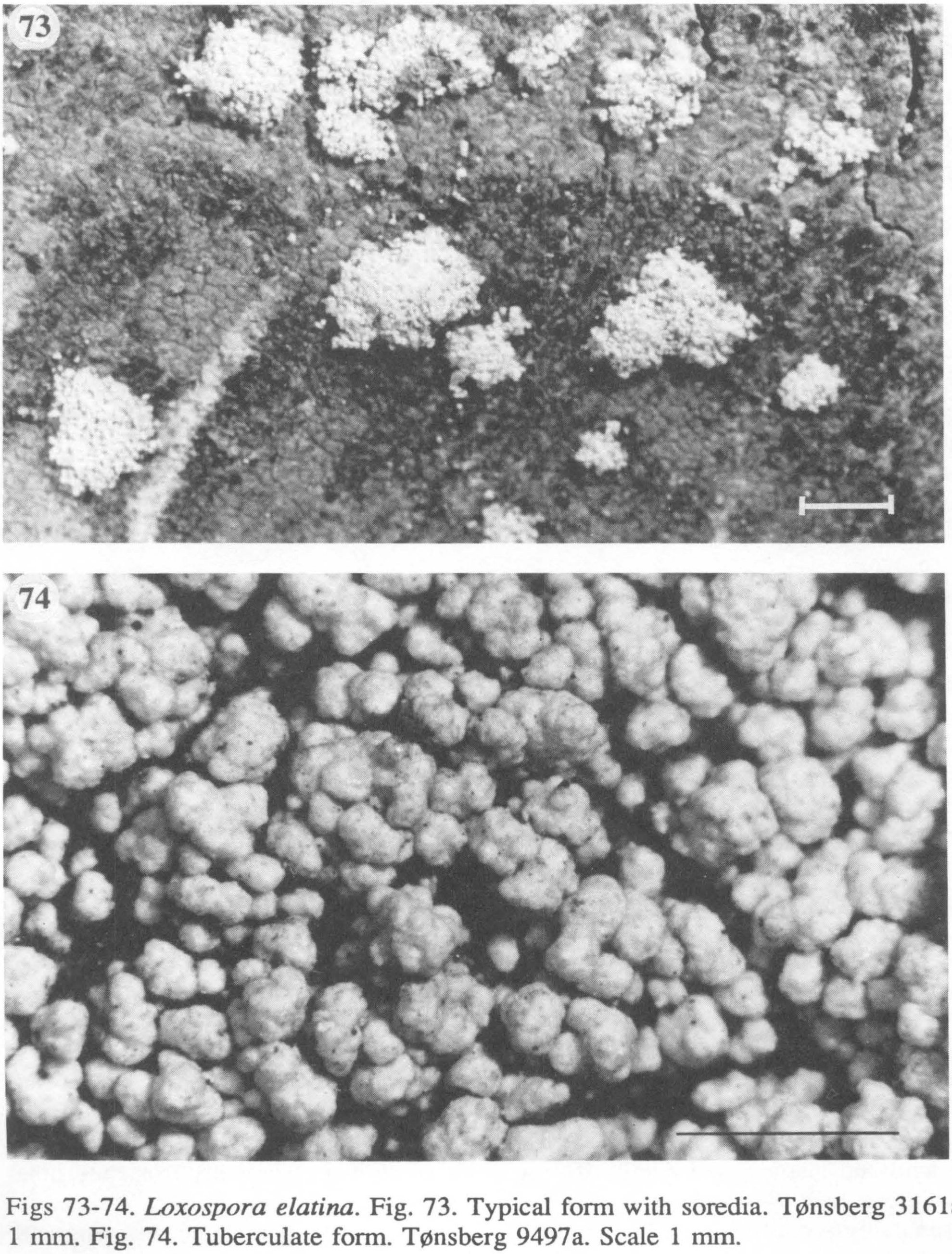
Chemistry: Thamnolic acid, elatinic acid, ± squamatic acid (trace). (Sometimes also the artefact decarboxythamnolic acid, see Culberson (1969).) TLC: Fig. 19.

Substratum. *Loxospora elatina* has been collected most commonly on *Picea abies* (58 specimens); other phorophytes included *Betula pubescens/pendula* (16), *Pinus sylvestris* (15), and *Alnus incana* (12), and, more rarely, *Alnus glutinosa, Calluna vulgaris, Corylus avellana, Fagus sylvatica, Ilex aquifolium, Juniperus communis, Populus tremula, Prunus, Quercus, Salix aurita, S. caprea, Sorbus aucuparia, Thuja, Tilia,* and *Ulmus glabra. Loxospora elatina* is, together with *Mycoblastus sanguinarius, Ochrolechia androgyna* s. lat., *O. microstictoides, Pertusaria amara,* and *P. borealis,* among the most common lichens on trunks and branches of *Picea abies* in moist *Picea abies* forests. More than half of the specimens were from conifers.

Distribution. *Loxospora elatina* has been found in a broad belt along the coast from Østfold to southernmost Nordland (Brønnøy) (Fig. 75). The only specimen known from Oppland grew under humid conditions in Bergdøla river gorge. The vertical distribution ranged from about sea-level to 680 m (Buskerud: Kongsberg). **Counties:** Østfold - Nordland (Brønnøy).

Discussion. Although rather variable, *Loxospora elatina* is usually a distinctive species. Particularly diagnostic are the soralia which often have a soft appearance, are more or less constricted at the base and irregularly distributed over the thallus surface. The presence of thamnolic acid and elatinic acid readily distinguishes *L. elatina* chemically from any other species discussed here. The surface varies from even to coarsely tuberculate. Soredia are usually abundantly produced (Fig. 73). However, some coarsely tuberculate specimens with bullate tuberculae (e.g., Tønsberg 4113b, 5903, 9497a) were esorediate to sparingly sorediate (see Fig. 74).

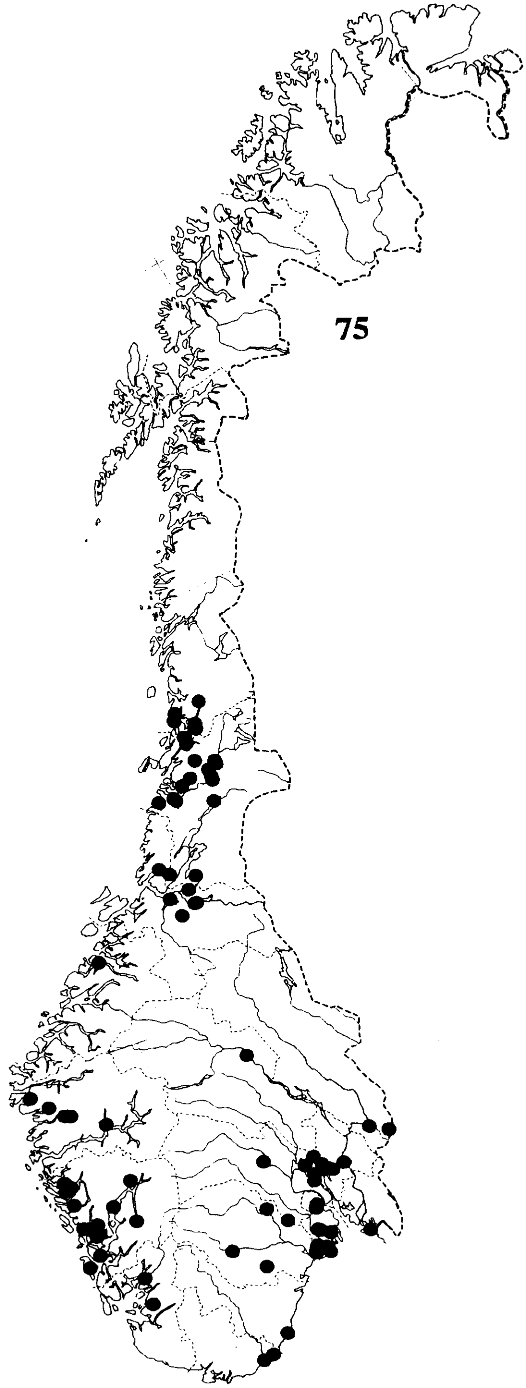
Loxospora pustulata (Brodo & W. Culberson) R.C. Harris (syn. *Haematomma pustulatum* Brodo & W. Culberson) was described to accommodate a similar tuberculate ("pustulate") extreme form of *Loxospora elatina* occurring in eastern North America on angiosperm trees (see Brodo & W. Culberson 1986). According to Brodo & W. Culberson (1986), *L. pustulata* is morphologically distinct from *L. elatina* by its coarsely tuberculate,

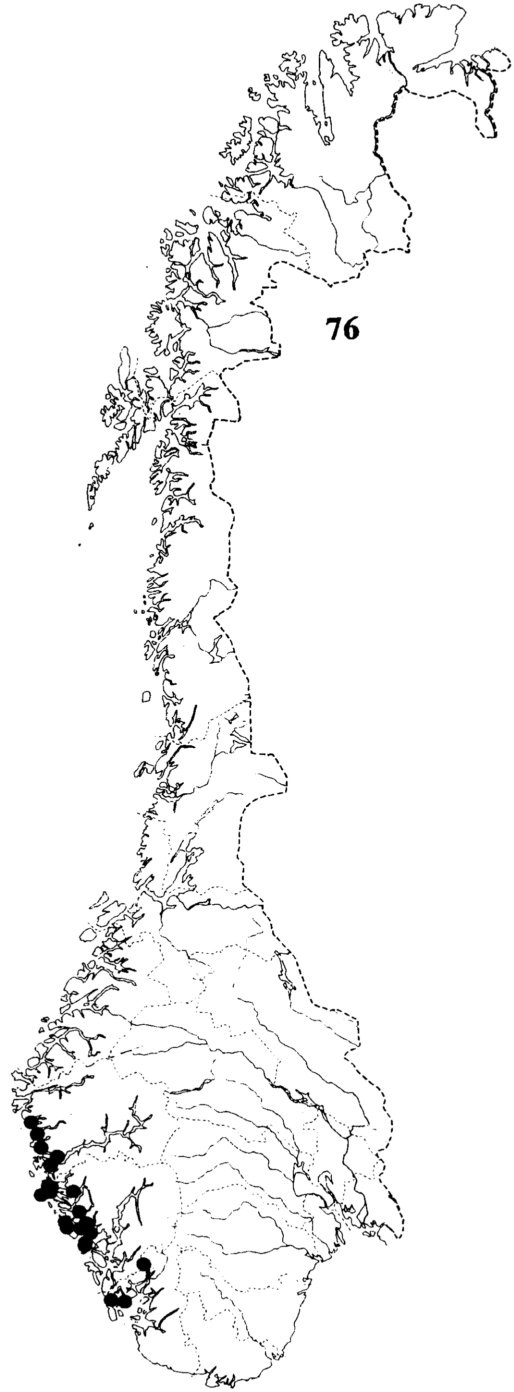


Figs 73-74. *Loxospora elatina*. Fig. 73. Typical form with soredia. Tønsberg 3161a. Scale 1 mm. Fig. 74. Tuberculate form. Tønsberg 9497a. Scale 1 mm.

infrequently sorediate thallus; old specimens have a pinkish tinge and elatinic acid is a rare accessory. On the tuberculae are coarse fragments from the eroding pustule summit. In North America, *L. elatina* never has a pinkish tinge, contains elatinic acid as a constant substance and occurs on conifers (Brodo & W. Culberson 1986).

Four Norwegian specimens of the typical morphotype were carefully analysed





Figs 75-76. Distribution maps. Fig. 75. *Loxospora elatina*. Fig. 76. *Micarea coppinsii*.

chemically by running thallus parts with soredia and thallus parts without soredia. Two specimens contained elatinic acid in the esorediate as well as in the sorediate thallus parts, whereas the two other specimens contained no elatinic acid in esorediate parts. A strongly tuberculate specimen (Tønsberg 9497a)(Fig. 74)) with both esorediate and sorediate tuberculae contained no elatinic acid in thallus fragments with esorediate tuberculae; in sorediate tuberculae, however, elatinic acid was present in easily detectable amounts. These findings, which indicate that elatinic acid is a constant substance only where soredia are present, would explain the fact that elatinic acid is rare in the largely esorediate, tuberculate morphotype. Secondly: A pinkish tinge was observed in a few collections of typical *L. elatina* (e.g., in a specimen from Oslo (Christiania), leg. Th. M. Fries (S)). Finally: In the present Norwegian material of *Loxospora elatina*, most of the specimens from deciduous trees belonged to the typical *L. elatina* morphotype. Apparently, *L. pustulata* is absent in Norway. The tuberculate form is best treated as falling within the variation range of *Loxospora elatina*. The tuberculate form probably represents a parallel to the quasi-isidiate form occurring in several other lichen species, e.g., in *Phlyctis argena*, *Pertusaria albescens* and *P. amara*. As all specimens with bullate tuberculae were collected in recent years by the author, it might be that this form, with its suppressed soredia and apothecia production (see below), is a result of stress due to increasing levels of air pollution.

Loxospora elatina shows a remarkable decrease in the number of fertile specimens over the years from 1826 when it was first collected. Nowadays, fertile specimens are very rare. Of the 29 collections made during the 19th century, 24 (83%) were fertile, mostly abundantly so. Of the remaining 126 specimens from the 20th century only 7 specimens (6%) were fertile, and only some collections from 1927 were richly fertile. The old, fertile herbarium specimens were from Oslo (most collections), Telemark (Notodden) and Hordaland (Granvin). Recently-collected fertile specimens were from Hordaland (Lindås) and Nord-Trøndelag (Stjørdal and Namdalseid).

The specimen from Nordland (Saltdalen) cited by Sommerfelt (1826; leg. Sommerfelt (O)), see also Fries (1871: 299) and Høeg (1923: 145), is *Lecanora expallens*. *Loxospora elatina* is a southern species in Norway.

Specimens seen: (selected). Øf: Hvaler 1983, Tønsberg 8271. - Oslo 1868, Moe (O). - He: Kongsvinger 1985, Tønsberg 9410. - Op: Ringebu 1984, Tønsberg 9025. - Bu: Krødsherad 1982, Tønsberg 6921. Vf: Tjølling 1922, Høeg (TRH). - Te: Notodden 1891, Kiær (O). - AA: Grimstad 1978, Tønsberg 3214. - VA: Søgne 1978, Tønsberg 3163. - Ro: Suldal 1978, Tønsberg 3065a. Ho: Granvin 1897, Havås; Kvam 1979, Tønsberg 4113b; Odda 1986, Tønsberg 9497a. - SF: Førde 1984, Tønsberg 8664. - MR: Tingvoll 1979, Tønsberg & James. - ST: Klæbu 1981, Tønsberg 5930. - NT: Leksvik 1981, Tønsberg 5903; Stjørdal 1981, Tønsberg 6151. - No: Sømna 1985, Tønsberg 9202.

Exsiccata examined: Havaas, Lich. Norv. 565 (BG, O, S, UPS), - Th. M. Fries. Lich. Scand. 33 (O, S, UPS). A total of 155 specimens seen.

Megalospora Meyen

A monographic treatment of the lichen family Megalosporaceae has been published by Sipman (1983).

Megalospora tuberculosa (Fée) Sipman

Thallus crustose, endosubstratal or, more commonly, episubstratal in esorediate parts, yellow, becoming dull greyish yellow to almost bluish in the herbarium due to the deposition of numerous crystal needles developing from the thallus surface giving it a somewhat woolly appearance, indeterminate, forming irregular patches up to about a dm in diameter, areolate, sorediate. Prothallus not evident. Areolae scattered to contiguous, sometimes becoming confluent forming small, more or less continuous patches, flat to convex, up to 0.2-0.4 mm wide, sometimes more or less free from the substratum, more or less spherical and 0.1-0.2 mm in diameter. **Soralia** developing from episubstratal or, more rarely, endosubstratal areolae, at first sometimes more or less discrete, but soon becoming confluent forming a more or less continuous sorediate crust, irregular, minute, 0.1 mm in diameter at first, later usually becoming confluent with other soralia, forming a more or less continuous, sorediate crust. Soredia fine to coarse, usually in rounded to irregularly elongate consoredia up to 80 µm in diameter, often with needle-shaped to filiform, projecting crystals; wall distinct. Medulla yellow. Photobiont green, coccoid, up to 12 µm in diameter.

Apothecia absent in Norwegian material. According to Sipman (1983) they are sessile, brown to black, up to 2.8(-4) mm in diameter; margin distinct; disc flat to convex.

Chemistry: Usnic acid and zeorin (major substances), a range (10 or more) of unidentified terpenoids in trace amounts.

Substratum. *Megalospora tuberculosa* has been collected on corticolous mosses and, more rarely, on naked bark of *Quercus*. Associated lichens included *Catillaria pulverea*.

Distribution. *Megalospora tuberculosa* occurred on the oceanic island of Tysnes on the southwestern coast at 50 m altitude. **County:** Hordaland.

Discussion. The chromatographic terpenoid pattern observed in the present specimen is similar or identical to that of a specimen from U.K.: Scotland studied for comparison. *Megalospora tuberculosa* may resemble *Haematomma ochroleucum* var. *ochroleucum*, which also has coarse, yellow, usnic acid- containing consoredia which develop crystals in the herbarium. *Megalospora tuberculosa* is distinguished from that species by the absence of atranorin and porphyrilic acid. In northwest Europe *M. tuberculosa* is very rarely fertile (see Rose 1988). In the British Isles, *M. tuberculosa* is an indicator of old hardwood forests (Rose 1976).

Megalospora tuberculosa is a widespread, mainly tropical species (Sipman 1983). In Europe it is an oceanic species (Schauer 1965). It was previously known as far north as the west coast of U.K.: Scotland (James 1978: 14.61, Coppins 1984b) and is here reported as new to Scandinavia. Tysnes is a new northern limit for the species. Another mainly tropical species which extends in Europe as far north as southern Norway is the epiphyllous *Fellhanera bouteillei* (see Tønsberg 1992).

Specimens seen: - **Norway**: Ho: Tysnes 1979, Tønsberg 4209. - **U.K.**: Westerness, V.C. 97, 1983, P.M. Jørgensen 9319.

Micarea Fr.

A monograph of the genus *Micarea* in Europe has been published by Coppins (1983).

Micarea coppinsii Tønsb. sp. nov.

Micareae peliocarpae (Anzi) Coppins & R. Sant. similis, sed thallo sorediato, apotheciis stipitatis, sporis majoribus, 20-28 µm longis; microconidiis minoribus, 4.5-6 µm longis, et thallus acidum 5-O-methylhiascicum producens pro substantia principalibus.

Type: Norway, Sogn og Fjordane, Askvoll, UTM grid ref.: 32V KP 8601 (map 1117 IV), alt. 20-48 m, on *Calluna vulgaris*, 4 August 1989, T. Tønsberg 11781 (BG - holotype; E - isotype).

Figs 19, 76-77.

Thallus (Fig. 77) crustose, episubstratal, indeterminate, forming irregular to rounded patches up to 1-2 (-10) cm in diameter, areolate, sorediate. Prothallus not evident. Esorediate areolae usually sparse, mostly discrete, greyish to greyish green, rounded to some what elongate, constricted below, distinctly convex, often hemispherical to subglobose, up to 0.2(-0.3) mm in diameter, soon bursting apically to form soralia. Soralia green, sometimes flecked with bluish green due to pigmentation of the external soredia, flat to capitate, 0.3(-0.5) mm in diameter; blue-green pigment K-, N+ red. Soredia fine, 12-25 µm in diameter, often a few aggregated in consoredia up to 30 µm; wall usually poorly developed; enveloping hyphae not forming a complete cortex. Medulla absent. Photobiont micareoid.

Apothecia present in 10 (21%) of the collections, sparse to abundant, discrete, or grouped and more or less contiguous, pallid (when young) to blue with a whitish margin (when well developed), adnate, or constricted below, often shortly stipitate, plane to convex, sometimes with an indistinct margin that is flush with the level of the disc, up to 0.2 mm in diameter, C+ red. In sections: Excipulum of *M. peliocarpa* type, well-developed, colourless, of richly branched and interconnected radiating hyphae. Hymenium 45-70 µm deep, in part with a green, K-, N+ red pigment, with crystals. Paraphyses numerous, richly branched, conglutinated, but separated in K, 1-2 µm wide (in K), apical part sometimes slightly incrassate. Asci with a well-developed, K/I+ deep blue tholus, a non-amyloid wall, surrounded by an outer K/I+ deep blue coat, 8-spored, 30-44 x 12-20 µm (in K). Spores colourless, 3-septate, fusiform, sometimes clavate fusiform, sometimes curved, 20-28(-31) x 4(-5) µm (water). Subhymenium colourless, 40-75 µm deep. Pycnidia sometimes present, more or less sessile, pallid, 60-70 µm wide; conidia (microconidia) narrowly fusiform-cylindrical, 4.5-6 x 0.6-0.8 µm.

Chemistry: 5-O-methylhiascic acid (major substance), gyrophoric acid (trace), lecanoric acid (faint trace), unidentified substance (probably a satellite in the gyrophoric acid complex) in R_F-classes A 2, B 3, C 2. Thallus UV-; C+ orange or orange red. TLC: Fig. 19.

Substratum. *Micarea coppinsii* has been found mainly in maritime *Calluna* heath on *Calluna vulgaris* (35 specimens), *Salix aurita*, *Juniperus communis*, and *Erica cinerea*; other phorophytes included *Alnus glutinosa*, *Sorbus aucuparia*, *Pinus mugo*, *Populus tremula*, and *Vaccinium uliginosum*. Associated lichens in the herbarium packets included *Buellia griseovirens*, *Gyalideopsis anastomosans*, *Lecidella subviridis*, *Micarea lignaria* var. *endoleuca*, *M. lignaria* var. *lignaria*, *M. peliocarpa*, *M. prasina*, *Mycoblastus fucatus*, *Parmelia saxatilis*, and *Trapelia corticola*.

Distribution. *Micarea coppinsii* occurred on the westernmost coast (Fig. 76) at altitudes from about sea-level to 290 m. **Counties:** Rogaland - Sogn og Fjordane.

Discussion. *Micarea coppinsii* seems to be most closely related to *M. peliocarpa*. Both species have numerous, branched, 1-1.5 m wide paraphyses, a well-developed excipulum, mostly 3-septate spores, fusiform-cylindrical microconidia, and gyrophoric acid and 5-O-methylhiascic acid as chemical constituents. However, *M. coppinsii* is easily distinguished by the presence of soredia. In addition there are several minor, yet significant differences; the distinguishing features are set out in Tab. 14.

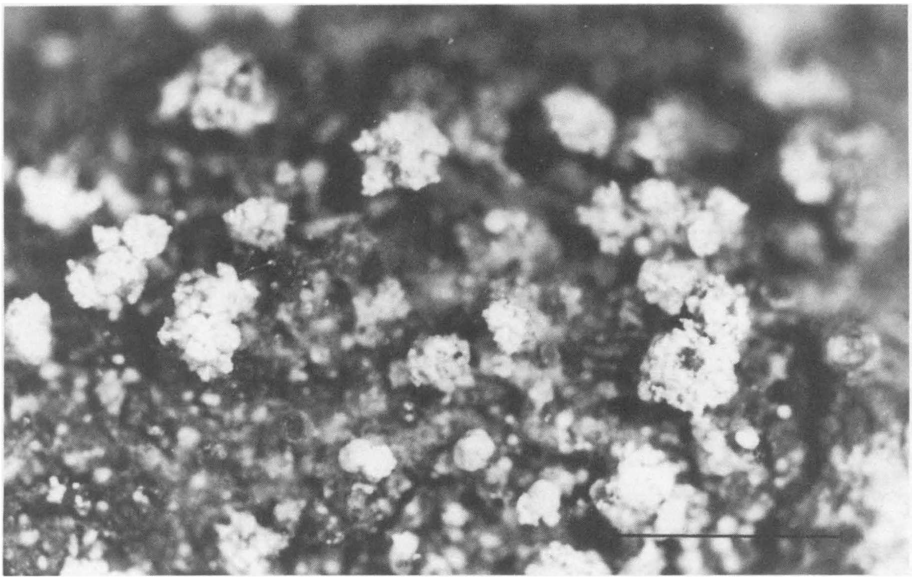


Fig. 77. *Micarea coppinsii*. Tønsberg 11347. Apothecia and capitate soralia. Scale 1 mm.

Other sorediate, often sterile species of *Micarea* include *M. leprosula*, *M. granulans* (Vainio) Timdal (syn. *M. subleprosula* (Vĕzda) Vĕzda, see Timdal 1991) and *M. prasina*. *Micarea leprosula* and *M. granulans* have blue-grey, very fragile and often crowded, areola-like aggregations of consoredia. *Micarea granulans* is further distinguished from *M. coppinsii* by the much larger, 7-septate spores and the production of alectorialic acid; *M. leprosula* has

Tab. 14. Distiguishing features betweeen *Micarea coppinsii* and *M. peliocarpa*.

	M. coppinsii	*M. peliocarpa*
soredia	present	absent
apothecia	often stipitate	very rarely stipitate
spore length	20–28(–31) µm	(11–)15–23 (–24) µm
microconidia	4.5–6 µm long	mostly 6–7 µm long
chemistry	5-O-methylhiascic acid, gyrophoric acid (trace)	gyrophoric acid major compound, 5-O-methylhiascic acid (moderate amounts)

apothecia rather similar to those of *M. coppinsii*, but in the excipulum and the subhymenium is a dull brown pigment; further, the chemical constituents are argopsin and gyrophoric acid. *Micarea prasina* is entirely sorediate, contains micareic acids or related substances; the apothecia are very different from those of *M. coppinsii*, having, for example a poorly developed excipulum, a K+ violet pigment, and 0-1 - septate spores (for further details, see Coppins (1983a).

When sterile, *Micarea coppinsii* could be confused with *Trapelia corticola*. However, that species has flat to only slightly convex areolae, has no aeruginose, N+ red pigment in the external soredia and produces gyrophoric acid as the major substance with 5-O-methylhiascic acid in trace amounts.

The presently known distribution of *Micarea coppinsii* indicates that it is dependant on very frequent precipitation and relatively high winter temperatures. Outside Norway *M. coppinsii* is so far known from U.K.: Scotland where it has been rarely collected on *Calluna vulgaris* and *Myrica*.

Micarea coppinsii is named in honour of Dr. Brian Coppins, Edinburgh, a monographer of *Micarea*.

Specimens seen (selected): **Norway**: Ro: Haugesund 1988, Øvstedal. Sauda 1988, Tønsberg 10814. Tysvær 1985 & 1988, Øvstedal. - Ho: Austevoll 1990, Tønsberg 13591. Austrheim 1981, Øvstedal. Bergen 1988, Tønsberg 11325, 11331, 11343, 11374. Fedje 1981, Røsberg & Øvstedal. Fjell 1988, Tønsberg 11322. Lindås 1987-1988, Tønsberg 10613, 11352, 11353, 11355. Meland 1988, Tønsberg 11347, 11349, 11350. Os 1989, Tønsberg 11465, 11483, 11524, 11540, 11548. Øygarden 1988, Øvstedal; 1989, Tønsberg 11430. - SF: Florø 1989, Tønsberg 11823. Gulen 1988, Tønsberg 11356, 11359, 11361, 11363, 11366, 11367. A total of 47 Norwegian specimens seen. **U.K.**: Scotland, Fife, Kincardine, Devilla Forest, 1988, Coppins s. n. (E). - West Perth, Flanders Moss, 1988, Coppins 12840 & Rose (E).

Micarea leprosula (Th. Fr.) Coppins & A. Fletcher

(Description partly adapted from Coppins 1983.)

Thallus crustose, episubstratal, indeterminate, forming thick, irregular patches up to a few cm in diameter, sorediate (largely consorediate). Consoredia more or less scattered at the edge of thallus, usually contiguous and forming thick aggregations towards the centre, blue-grey with minute white flecks, white to greenish blue in unexposed parts, matt and with minutely roughened surface, convex, subglobose, sometimes stipitate, usually with proliferations, up to 0.3 mm in diameter, fragile and here and there on the thallus breaking down to form greenish irregular sorediate patches. **Soredia** green, in exposed parts with a dark green, K-, N+ red pigment, irregularly rounded, fine; wall poorly developed or not evident. Photobiont micareoid, 4-7 µm in diameter. Pycnidia not observed.

Apothecia not observed in corticolous material (but sparsely present in one specimen from mossy rock), black, more or less tuberculate, emarginate, up to 0.8 mm.

Chemistry: Argopsin, gyrophoric acid, lecanoric acid (trace). Thallus UV-. C+ red, PD+ rust-red.

Substratum. *Micarea leprosula* has been found on *Alnus incana*, *Betula pubescens/pendula*, *Calluna vulgaris*, and *Pinus sylvestris*.

Distribution. *Micarea leprosula* occurred on the westernmost coast in microclimatically humid sites, e.g., in a shaded gorge and in the spray zone of a waterfall. The vertical distribution ranged from 60-160 m. **Counties:** Corticolous specimens: Rogaland, Hordaland. All specimens: Vest-Agder - Sogn og Fjordane.

Discussion. *Micarea leprosula* appears to be areolate and without soredia, but actually it is consorediate throughout. It is a very distinctive species on account of the bluish aggregations of consoredia and the joint occurrence of argopsin and gyrophoric acid. The related species *M. granulans*, here reported as new to Norway from Rogaland, Hordaland and Nord-Trøndelag, has not been found on bark.

Micarea leprosula is muscicolous on more or less sloping rock, corticolous or muscicolous on tree trunks or terricolous in ericaceous heath. Non-corticolous material has been collected up to 330 m altitude.

Specimens seen: Ro: Sauda 1988, Botnen 1653, 1657, 1659; Tønsberg 10820. - Ho: Os 1989, Tønsberg 11543.

Micarea prasina Fr.

Thallus crustose, variable in colour, mostly light to dark green, sometimes olivaceous or bluish green, episubstratal, indeterminate, thin to medium thick, forming minute or extensive, more or less continuous patches up to several dm in diameter, consorediate throughout. Prothallus not evident. Consoredia rounded to elongate, up to 100 µm in diameter, irregularly aggregated, forming a more or less continuous or patchy leprose crust. Soredia fine, round to irregular; external soredia rarely with a dark green K+ violet, N+ violet pigment (e.g., in Magnusson 16667); wall usually poorly developed or not evident. Medulla absent. Photobiont micareoid. Pycnidia, according to Coppins (1983), inconspicuous, white, immersed to sessile, of two types: (a) 50-120 µm in diameter, emergent to sessile; conidia (mesoconidia) more or less cylindrical or narrowly obpyriform, often biguttulate and slightly constricted near the middle, (3.5-)4-6 × 1.2-1.7 µm; (b) 30-60(-100) µm, usually immersed in surrounding soredia; conidia (microconidia) cylindrical or narrowly fusiform, (5-)5.5-8 × 0.7-1 µm. Pycnidia with microconidia were observed in the Norwegian material.

Apothecia present in 52 (72 %) of the specimens, whitish to grey-black, matt, emarginate, slightly to distinctly convex, up to 0.4 mm in diameter.

Chemistry: (I) Methoxymicareic acid (56 specimens). (II) Micareic acid (6). (III) Acid deficient/too scanty for TLC. A trace of gyrophoric acid was present in several specimens of chemotype I and II. The possibility that it was due to a contaminant could not be entirely ruled out.

Substratum. *Micarea prasina* has most commonly been collected on *Alnus glutinosa* (20 specimens, 38%); other phorophytes included *Calluna vulgaris, Alnus incana, Betula pubescens/pendula, Fraxinus excelsior, Juniperus communis, Picea abies, Pinus sylvestris, Prunus padus, Quercus, Rhododendron catawbiense, Salix aurita, S. caprea, Sorbus aucuparia*, and *Vaccinium myrtillus*. It usually occurred on naked bark, in the crevices or on the outer surfaces; occasionally it had spread on to corticolous mosses. It showed most vigorous growth on shaded parts of the trunks. In moist districts it often covered conspicuous areas from the base to high up on the trunks.

Distribution. In southern Norway *Micarea prasina* occurred commonly in the lowlands in a broad belt along the coast. In northern Norway it was sparse and seemed to be absent in the northernmost parts. Inland it occurred in microclimatically moist habitats. Specimens with micareic acid (chemotype II above) were found in Akershus, Hedmark, Vestfold, Sogn og Fjordane and Nordland, whereas specimens with methoxymicareic acid (chemotype I, the commonest chemotype) were collected as far north as Nord-Trøndelag. The vertical distribution of *M. prasina* ranged from about sea-level to 260-280 m. *Micarea prasina* was often found close to the centres of towns and cities where it was associated with the toxitolerant *Lecanora conizaeoides*. **Counties:** Østfold - Nordland.

Discussion. In thalline morphology *Micarea prasina* may superficially resemble *Scoliciosporum gallurae* and *S. sarothamni*. However, these species do not have a micareoid photobiont and never produce micareic or methoxymicareic acids. In the British Isles chemotype I is much more common than chemotype II (Coppins 1983a), the latter being largely restricted to old woodland habitats.

Micarea prasina is a coastal species of acidic bark.

Specimens seen (selected; unless otherwise stated the specimens represent chemotype I): Øf: Hvaler 1989, Tønsberg 11463. - Oslo 1982, Tønsberg 6545a. - He: Kongsvinger 1985, Tønsberg 9445 (chemotype II). - Op: Lillehammer 1989, Tønsberg 11656. - Bu: Hole 1981, Tønsberg 6431b. - Vf: Hof 1990, Tønsberg 13070 (chemotype II). - Te: Porsgrunn 1978, Tønsberg 3345b. - AA: Grimstad 1990, Tønsberg 13525. - VA: Songdalen 1939, Magnusson 16667 (S); 1987, Tønsberg 10076. - Ro: Haugesund 1983, Øvstedal. - Ho: Bergen 1984, Tønsberg 8565. - SF: Fjaler 1989, Tønsberg 11776 (chemotype II). - MR: Sande 1989, Tønsberg 11910. - ST: Malvik 1987, Tønsberg 9991b (too scanty for TLC). - NT: Frosta 1983, Tønsberg 8414. - No: Saltdal 1982, Tønsberg 7664 (chemotype II). A total of 72 specimens seen.

Mycoblastus Norman

The genus *Mycoblastus* has been revised by Schauer (1964) and James (1971), see also Poelt & Vězda (1977).

Mycoblastus alpinus (Fr.) Kernst.

Lecidea sanguinaria β. *alpina* Fr., in L. Eur.: 335 (1831).

Type: Fennia [Lapponia inarensis] ad Storforsen fluminis Tanaelv, Norman (BG - neotype (here selected); UPS - isoneotype). [The material cited by E. Fries in Lich. Eur.: 335 (1831) as "Ad terram in alpibus Norvegiæ meridionalis copiosissime. Blytt!" could not be located.] TLC: atranorin, usnic acid, isousnic acid, planaic acid.

Fig. 19.

Thallus crustose, episubstratal, indeterminate to delimited, forming rosettes or irregular patches, up to about one dm in diameter, areolate or continuous, becoming thick, sorediate. Prothallus usually indistinct, forming a whitish, rarely greenish blue, network of hyphae between the areolae, and a border surrounding the thallus. Areolae greenish to greyish white, discrete or contiguous, often tending to fuse, more or less circular in outline, often strongly convex, variably sized, up to 0.6 mm in diameter. Surface of continuous thalli or thallus parts concolorous with the areolae, tuberculate, often cracked. **Soralia** bursting from the areolae or tuberculae, distinctly yellow or yellowish green, strongly contrasting with the colour of corticate parts of the thallus, discrete or occasionally a few fused, variably sized, up to 2.5 mm in diameter, crateriform, plane or convex, distinctly semiglobular and constricted at the base in well-developed specimens. Soredia mostly fine, in globose to ellipsoidal consoredia up to 50(-110) µm in diameter; wall indistinct to distinct. Medulla distinct, white.

Apothecia present in one (6%) of the corticolous specimens, lecideine, bluish black, glossy, up to 0.8 mm in diameter, emarginate, strongly convex with age.

Chemistry: Atranorin, chloroatranorin, planaic acid, usnic acid, ± isousnic acid. The two latter substances only in the soralia. By running portions consisting of soralia and esorediate thallus parts separately (2 specimens tested) atranorin was found to occur in both parts, but usnic and isousnic acids only in the soralia. Planaic acid was present in both esorediate samples, but absent in one of the samples comprising soredia. TLC: Fig. 19.

Substratum. *Mycoblastus alpinus* was collected on naked bark of *Betula pubescens/pendula* (6 specimens) and *Picea abies* (4) and also on *Alnus glutinosa*, *Juniperus communis*, and *Pinus sylvestris*.

Distribution. *Mycoblastus alpinus* was found in scattered sites between about sea-level and 660-690 m altitude (Aust-Agder: Bykle). **Counties:** Corticolous specimens: Akershus, Hedmark, Buskerud, Telemark, Aust-Agder, Hordaland, Sogn og Fjordane, Sør-Trøndelag, Nordland - Finnmark. All specimens: Akershus - Buskerud, Telemark, Aust-Agder, Hordaland, Sogn og Fjordane, Sør-Trøndelag, Nordland - Finnmark.

Discussion. *Mycoblastus alpinus* is a variable species. Specimens from shaded habitats have a green overall colour of the thallus, whereas specimens growing in open situations are greyish white in corticate parts, and green to more or less vivid greenish yellow in sorediate parts. This variation in colour is probably a response to different amounts of illumination at the sites. *Mycoblastus alpinus* varies considerably in the degree of production of soralia (see below).

Mycoblastus affinis and *M. alpinus* both contain planaic acid, atranorin, and chloroatranorin. The soralia of *M. alpinus* contain usnic and isousnic acids in addition, making the two taxa chemically different. The occurrence of usnic acids in *M. alpinus* is strictly coupled with the production of soredia. In non-sorediate parts the two subspecies are chemically concordant. Planaic acid and chloroatranorin are here reported as new substances in *Mycoblastus* (see Culberson 1969, 1970, Culberson et al. 1977, Elvebakk & Tønsberg 1992).

Mycoblastus alpinus is currently regarded as distinct from *M. affinis* anatomically in having asci with a single thick-walled spore, morphologically in having yellowish soralia, and ecologically and geographically by inhabiting terrestrial mosses in alpine and arctic areas (James 1971, Poelt & Vězda 1977). *Mycoblastus affinis* is characterized by an esorediate thallus, asci with two thin-walled spores and a corticolous habit. In the present study both *M. alpinus* and *M. affinis* were found to have spores which were thick-walled when young and becoming thin-walled upon maturity. In the sorediate *M. alpinus*, the asci often only contain immature or abortive spores. Although there seems to be a tendency for *M. alpinus* to produce monosporous asci more frequently, bisporous asci were found in nearly all richly apotheciate specimens examined, and mature asci contained thin-walled spores. As the two taxa are morphologically and chemically concordant in esorediate parts they apparently constitute a taxon pair. In contrast to *Lecidella elaeochroma* "f. *soralifera*", *Mycoblastus alpinus* is not confined to a particular habitat. In fact it occurs in the lowlands as well as in the mountains, and has been found on bark of living trees, on wood, on plant debris on the ground and on shaded rock walls. It occurs throughout most of the country, but is rare or absent in the lowlands of westernmost Norway. Apothecia are rare or absent in corticolous and saxicolous material, but are frequent in lignicolous material. In Europe, *M. alpinus* is known from the northern parts including Svalbard (see Poelt & Vězda 1977, Clauzade & Roux 1985, Elvebakk & Tønsberg 1992); I have also examined specimens from Switzerland (herb. M. Dietrich). *Mycoblastus affinis* is not known to occur in Svalbard. The North American record of *Mycoblastus alpinus* in Egan (1987) is uncertain, since it is apparently based on Thomson (1979); I have examined parts of this material (WIS) and regard it as belonging to *M. affinis*. Thus, at least in northern Europe, *M. alpinus* appears to have a broader range than *M. affinis*. I tentatively ascribe specific rank to *M. alpinus*. However, in occasional herbarium packets containing lignicolous material from northern Norway, sorediate and esorediate thalli formed mosaic populations; this might indicate that at least in these populations the sorediate form arises from individuals of the local, fertile population. Obviously the *M. alpinus*/*M. affinis* taxon pair is in need of further study which should include material from all substrata throughout the ranges of both taxa.

Mycoblastus alpinus may resemble a rare form of *Ochrolechia androgyna* A with greenish yellow soralia. However, that species is readily distinguished chemically from the present taxon by the production of gyrophoric acid (C+ red) as the only major substance.

Mycoblastus alpinus is mainly lignicolous (especially on *Pinus sylvestris*) or terricolous (muscicolous and on plant debris); occasionally it is corticolous and, rarely, saxicolous on shaded vertical rock. The species is very common in northern Norway (especially in Troms and Finnmark).

Specimens seen (selected): Oslo 1982, Tønsberg 6538. - He: Kongsvinger 1985, Tønsberg 9408. - Bu: Krødsherad 1982, Tønsberg 6931b. - Te: Kviteseid 1987, Tønsberg 10287. - AA: Bygland 1987, Tønsberg 10200. - Ho: Odda 1986, Tønsberg 9497b. - SF: Vik 1990, Anonby 504b. - ST: Trondheim 1983, Tønsberg 8115b. - No: Rana 1986, Tønsberg 9704. - Tr: Skånland 1986, Tønsberg 9812. - Fi: Sør-Varanger 1982, Tønsberg 7175. A total of 16 specimens seen.

Mycoblastus caesius (Coppins & P. James) Tønsb. comb. nov.

Haematomma caesium Coppins & P. James, in Lichenologist 10: 200 (1978). Type: Britain, V.C. 11, South Hants: New Forest, Lyndhurst, Mark Ash Wood, 41/24.07, ad corticem Fagi cum *Parmelia dissecta*, October 1971, B.J. Coppins & F. Rose (BM! - isotype). TLC: perlatolic acid.

Fig. 78.

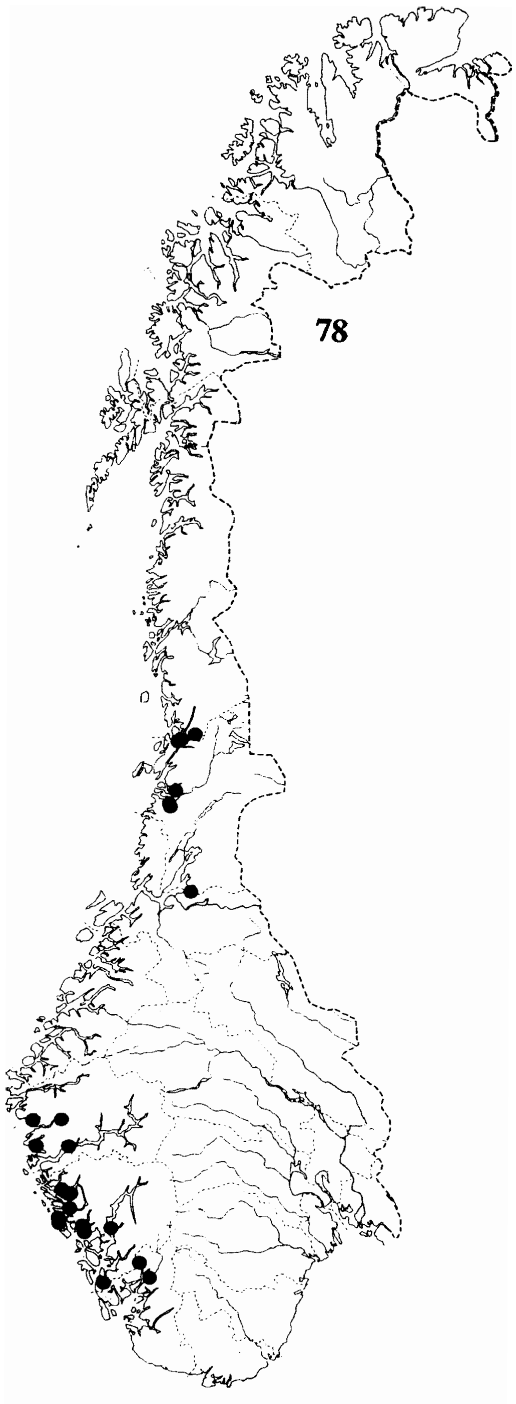
Thallus crustose, endo- to episubstratal in non-sorediate parts, forming rosettes or spreading irregularly, often forming small patches between other crustose lichens, up to 5(-10) cm in diameter, areolate or more or less continuous, sorediate. Prothallus usually distinct, bluish, forming a network of hyphae around and between the areolae, and a border surrounding the thallus. Areolae mostly distinct, bluish grey, discrete or more or less contiguous, rounded, convex, to c. 0.5 mm in diameter. Continuous parts rimose-cracked and minutely tuberculate. **Soralia** bursting from the areolae or tuberculae, greyish green, pale bluish green or, rarely whitish, often flecked with blue due to pigmentation of the exposed part of the external soredia, sometimes sparingly present, irregularly distributed over the thallus surface, discrete or occasionally a few fused, diffuse, more or less convex, often with the upper surface more or less plane, of variable size, up to 1.5 mm in diameter. Soredia mostly fine, 20-35(-50) µm in diameter; wall distinct, fragile. Medulla distinct in well-developed specimens, white. Bluish pigment of areolae, soredia and prothallus aeruginose in LM, N+ violet. Photobiont green, coccoid, up to 12 µm in diameter.

Apothecia and pycnidia not observed.

Chemistry: Perlatolic acid.

Substratum. *Mycoblastus caesius* has most frequently been found on the smooth bark of *Sorbus aucuparia* (10 specimens) and *Betula pubescens*/*pendula* (7). Other phorophytes included *Alnus incana*, *Calluna vulgaris*, *Fraxinus excelsior*, *Ilex aquifolium*, *Juniperus communis*, *Picea abies* (trunks and twigs), *Pinus sylvestris*, and *Vaccinium uliginosum*.

Distribution. *Mycoblastus caesius* occurred in the lowlands on the western coast (Fig. 78). It has mostly been collected between sea-level and about 100 m altitude, but has been found up to 450 m altitude (Hordaland: Os). **Counties:** Rogaland - Sogn og Fjordane, Sør-Trøndelag - Nordland.



Figs 78-79. Distribution maps. Fig. 78. *Mycoblastus caesius*. Fig. 79. *Ochrolechia alboflavescens*.

Discussion. *Mycoblastus caesius* is characterized by the bluish grey colour of the over-all thallus, the diffuse, irregularly sized and irregularly spaced soralia and the content of perlatolic acid. It is usually easily recognized by morphology alone.

Buellia arborea, B. griseovirens and *Lecidea pullata* are similar to *Mycoblastus caesius* in having a bluish prothallus; the two former species also have bluish soralia. *Mycoblastus caesius* is distinct from all these specimens by the production of perlatolic acid.

Some recently-collected fertile specimens of *Mycoblastus* from the Pacific coast of North America (British Columbia 1989, Washington 1991, Tønsberg leg.) were chemically and morphologically similar to the Norwegian specimens and probably represent fertile *Mycoblastus caesius*. Apparently, *Haematomma caesium* is best placed in the genus *Mycoblastus*. The North American specimens will be discussed in a forthcoming paper. *Mycoblastus caesius* is here reported as new to Norway.

Mycoblastus caesius is a species of acidic bark in coastal sites.

Specimens seen (selected): Ro: Suldal 1988, Tønsberg 10853. - Ho: Os 1984, Tønsberg 8765. - SF: Førde 1983, Tønsberg 7800. - ST: Malvik 1987, Tønsberg 9959. - NT: Namdalseid 1986, Tønsberg 9157. - No: Bindal 1982, Tønsberg 6780. A total of 35 specimens seen.

Mycoblastus fucatus (Stirton) Zahlbr.

Cat. Lich. Univ.4: 3 (1926). *Lecidea fucatus* Stirton, in Scott. Nat. 5: 16 (1879). Type: U.K.: Scotland, V.C. 88, Mid Perth; Tyndrum, on wood, July 1878, Stirton (BM! - holotype). TLC: atranorin, chloroatranorin, fumarprotocetraric acid.

Mycoblastus sterilis Coppins & P. James, in Lichenologist 11: 158 (1979). Type: Britain, Wales, Merioneth, Ffestiniog, Coed Cymerau, on *Betula*, April 1971, B. J. Coppins 2772. (E - holotype!). TLC: Atranorin, chloroatranorin, fumarprotocetraric acid, protocetraric acid (trace), unknown cph-2 (trace).

Thallus crustose, episubstratal, greyish white to bluish grey in non-sorediate parts, indeterminate to delimited, areolate to more or less continuous, forming rosettes or irregular patches up to 3(-10)cm in diameter, sorediate, often with a distinct prothallus of blue or brown hyphae ramifying over and through the uppermost cell layer(s) of the substrate, sometimes, especially when forming mosaics with associated lichens, a delimiting, often black, marginal zone up to 0.5 mm, may border the thallus; blue pigment K-, N+ red. Areolae discrete to contiguous, more or less rounded to irregular in outline, adnate, convex, up to c. 0.3 mm in diameter. Continuous parts usually distinctly tuberculate and more or less fissured. **Soralia** bursting from apices of the areolae or tuberculae, green or pale yellowish green, often bluish grey due to a pigment in the external soredia, discrete to contiguous, occasionally a few becoming fused, never forming a leprose crust throughout, mostly more or less orbicular, sometimes irregular in outline, concave to convex, usually of variable size, up to 1.5 mm in diameter. Soredia mostly fine, simple or in more or less rounded consoredia up to 90 µm in diameter, with a distinct wall; external soredia sometimes with a brown, K+ intensifying, N+ reddish brown pigment. Medulla distinct, white. Photobiont green, coccoid, up to 12 µm in diameter.

Apothecia present in three (3%) of the corticolous specimens (and in one lignicolous specimen), closely adpressed, emarginate, plane to convex, up to 1 mm in diameter.

Chemistry: Atranorin, chloroatranorin, fumarprotocetraric acid, protocetraric acid (trace), cph-2 trace. Medulla and soralia PD+ orange red.

Substratum. *Mycoblastus fucatus* has most commonly been collected on *Alnus incana* (27 specimens), *Betula pubescens/pendula* (17), *Sorbus aucuparia* (14), and *Alnus glutinosa*

(13). Other phorophytes included *Acer* sp., *Calluna vulgaris, Fagus sylvatica, Frangula alnus, Fraxinus excelsior, Ilex aquifolium, Juniperus communis, Picea abies, Pinus sylvestris, Populus tremula, Prunus padus, Quercus,* and *Salix aurita.*

Distribution. *Mycoblastus fucatus* has been found in coastal areas as far north as Troms. It was sometimes found in polluted sites in or near larger towns. It was once found closely associated with *Lecanora conizaeoides.* Its vertical distribution ranged from about sea-level to 460 m (Aust-Agder: Valle). **Counties:** Østfold - Troms.

Discussion. *Mycoblastus fucatus* is morphologically a rather variable species. One form has scattered areolae surrounded by a more or less conspicuous bluish prothallus giving the thallus its over all-colour. Another form is more or less continuous and has a less distinct prothallus. Most specimens were intermediate between these extremes. The soralia vary in colour from greenish to blue-grey.

Morphologically *Mycoblastus fucatus* may resemble some other species with a bluish pigment in the prothallus and/or external soredia, e.g., *Buellia griseovirens* and *Mycoblastus caesius.* The bluish pigment of the latter also reacts K-, N+ red, but the presence of perlatolic acid (PD-, UV+) makes that species distinct. *Buellia griseovirens* usually has smaller and more regularly sized soralia, the bluish pigment is K+ fuscous brown, N-, the cortex lacks chloroatranorin, and the diagnostic medullary substance is norstictic acid.

Mycoblastus fucatus has commonly been regarded as an exclusively lignicolous species (James 1971, Poelt & Vězda 1977, and Coppins & James 1979b). The thallus of the lignicolous and richly fertile type specimen is largely endosubstratal except for the soralia which are mostly flush with the level of the wood or slightly immersed; only a few esorediate areolae are present. The type specimen of *M. sterilis* is corticolous and sterile; the thallus is episubstratal with well-developed areolae and soralia. The fertile, corticolous specimens of *M. fucatus* have thalli similar to that of the type of *M. sterilis* but apothecia (including the characteristic blue-violet, K+ aeruginose pigment) similar to those of *M. fucatus.* I therefore regard the recently described *M. sterilis* as being merely a predominately sterile and, mostly, corticolous form of *M. fucatus.*

The thallus of *Mycoblastus fucatus* is often host to the lichenicolous fungi *Tremella lichenicola* Diederich (see Coppins & James 1979b, Diederich 1986) and/or, more rarely, *Skyttea gregaria* Sherw., D. Hawksw. & Coppins (see e.g. Hawksworth 1983).

Mycoblastus fucatus is a species of acidic bark and of wood (*Calluna vulgaris, Pinus sylvestris)* in coastal habitats.

Specimens seen (selected): Øf: Halden 1977, Tønsberg 1970. - Oslo 1982, Tønsberg 6540a. - He: Åmot 1982, Tønsberg 6893. - Op: Lunner 1982, Tønsberg 7554. - Bu: Flesberg 1987, Tønsberg 10372. - Vf: Hof 1990, Tønsberg 13086. - Te: Kviteseid 1987, Tønsberg 10290. - AA: Birkenes 1986, Tønsberg 9573b. - VA: Songdalen 1987, Tønsberg 10083b. - Ro: Tysvær 1986, Øvstedal. - Ho: Fjell 1978, Øvstedal (fertile). - SF: Askvoll 1989, Øvstedal (fertile); 1989, Tønsberg 11779 (fertile). - Flora 1983, Tønsberg 7902. - MR: Vestnes 1979, Tønsberg 3866b. - ST: Trondheim 1980, Tønsberg 5369. - NT: Røyrvik 1983, Tønsberg 8085b. - No: Sørfold 1986, Tønsberg 9739. - Tr: Storfjord 1982, Tønsberg 7304. A total of 103 specimens seen.

Mycoblastus sanguinarius (L.) Norman "f. *leprosus* Nadv."

Thallus crustose, episubstratal, greyish green or grey and often glossy in non-sorediate parts, indeterminate to delimited, areolate, especially towards the margin, or continuous, forming rounded to irregular patches up to 7 cm across, sorediate. Prothallus indistinct. Medulla distinct, white, here and there with patches of rhodocladonic acid; pigmented parts K+ bright or carmine red. Areolae discrete to contiguous, rounded, slightly convex, up to 0.2 mm in diameter. Continuous parts distinctly tuberculate. Soralia greyish yellow to yellowish green, usually irregularly distributed on the thallus surface, often more or less concentrated to one part of the thallus, bursting from the apices or margins of the areolae and tuberculae, rounded to irregular and discrete at first, later often becoming confluent forming leprose patches, rarely the thallus was leprose throughout. Soredia fine, irregular, mostly simple, sometimes in consoredia up to 40 µm in diameter; wall poorly developed, sometimes of globose cells. Photobiont green, coccoid, up to 10 µm in diameter.

Apothecia present in all specimens seen, emarginate, black, distinctly convex, up to 2 mm in diameter; hypothecium usually with rhodocladonic acid.

Chemistry: - I. Atranorin, chloroatranorin, caperatic acid; 16 specimens. - II. Atranorin, chloroatranorin, rangiformic acid, norrangiformic acid; (5 specimens). Rhodocladonic acid and an accessory fatty acid in R_F-classes A 5, B 5-6, C 5-6 occurred in both chemotypes. Soralia UV+ dull pink.

Substratum. *Mycoblastus sanguinarius* "f. *leprosus*" has most commonly been collected on bark of *Picea abies* (10 specimens), and on other phorophytes including *Alnus glutinosa, Betula pubescens/pendula, Juniperus communis, Populus tremula*, and *Sorbus aucuparia*.

Distribution. *Mycoblastus sanguinarius* "f. *leprosus*" occurred in scattered sites as far north as Nordland: Hamarøy. Most collections were from Trøndelag and Nordland. Its vertical distribution ranged from about sea-level to 760 m (Oppland: Østre Toten). **Counties:** Akershus, Oppland, Buskerud, Hordaland, Sør-Trøndelag - Nordland. All substrates: Akershus, Buskerud, Hordaland, Sør-Trøndelag - Troms.

Discussion. Within the genus *Mycoblastus*, *M. sanguinarius* is a distinctive species on account of the blood-red pigment rhodocladonic acid in the hypothecium and medulla, and the production of aliphatic acid(s). Phenolic carboxylic acids other than the para-depsides atranorin and chloroatranorin, are absent.

Soralia appear to be only occasionally developed in restricted parts of the thallus. The production of soredia seems not to be correlated with other characters. Sorediate specimens are always still fruiting. Poelt (1974) recommends the rank of form for such occasional soralia-bearing individuals.

Mycoblastus sanguinarius "f. *leprosus*" occurs on acidic bark and on wood of *Picea abies* and *Pinus sylvestris* in scattered sites throughout most of the country.

Specimens seen (selected): Oslo 1982, Tønsberg 6547. - Op: Østre Toten 1991, Gaarder 273. - Bu: Flesberg 1987, Tønsberg 10350. - Ho: Bergen 1984, Tønsberg 8807. - ST: Trondheim 1980, Tønsberg 5319. - NT: Fosnes 1981, Tønsberg 6184. - No: Brønnøy 1987, Tønsberg 10575. A total of 21 specimens seen.

Ochrolechia Massal.

Due to their conspicuous thalli, fertile as well as sterile *Ochrolechia* specimens have been frequently collected by many lichenologists. There is no modern monographic treatment of *Ochrolechia* in Europe and the genus is in urgent need of a revision. The chemistry of the European species was studied by Hanko et. al (1985). The corticolous *Ochrolechia* species of North America have recently been monographed by Brodo (1991). *Ochrolechia androgyna* (Hoffm.) Arnold s. lat. is highly variable with respect to morphology, chemistry, substratum preferences and distribution. Apparently it comprises several taxa. The taxonomy of that species complex can only be clarified by a monographic treatment including material from various substrates throughout the range of the group. In the present account *Ochrolechia androgyna* s. lat. is divided into 4 species which are referred to below as *O. androgyna* A -

D. Each species has a distinct chemistry tending to be correlated with certain characteristic morphological, distributional and/or ecological traits.

Ochrolechia alboflavescens (Wulf.) Zahlbr.

Figs 79-80.

Thallus (Fig. 80) crustose, episubstratal, delimited, mostly irregularly spreading, up to a dm or more in diameter, continuous, unzoned, sorediate. Prothallus indistinct. Esorediate part of surface straw-coloured, pale yellow, greyish yellow or greenish yellow, sometimes with a brownish tinge, rarely grey, matt, mostly distinctly tuberculate, sometimes rugose-plicate, often cracked. **Soralia** whitish, yellowish or bluish grey, sparse or abundant, irregularly dispersed, usually discrete and delimited, more or less orbicular to ellipsoid, crateriform to hemispherical, mostly surrounded by a distinct corticate rim, variously sized, up to 2 mm in diameter. Soredia fine to coarse, up to 50 µm in diameter, usually in rounded to subcylindrical consoredia up to 100(-150) µm; wall distinct. Medulla distinct, white. Photobiont green, globose to broadly ellipsoid, up to 14 µm in diameter.

Apothecia present in 13 (42%) of the specimens, mostly sparse, but occasionally abundant and more or less concealing the thallus surface, up to 5 mm in diameter; margin esorediate; disc pruinose, (C+ red).

Chemistry: Variolaric acid with accessory satellites, lichesterinic acid, protolichesterinic acid, ± atranorin (trace). Gyrophoric acid present in the apothecia. Thallus UV+ bluish white. Cortex and soralia C+ orange yellow; medulla C- or C+ pale yellow.

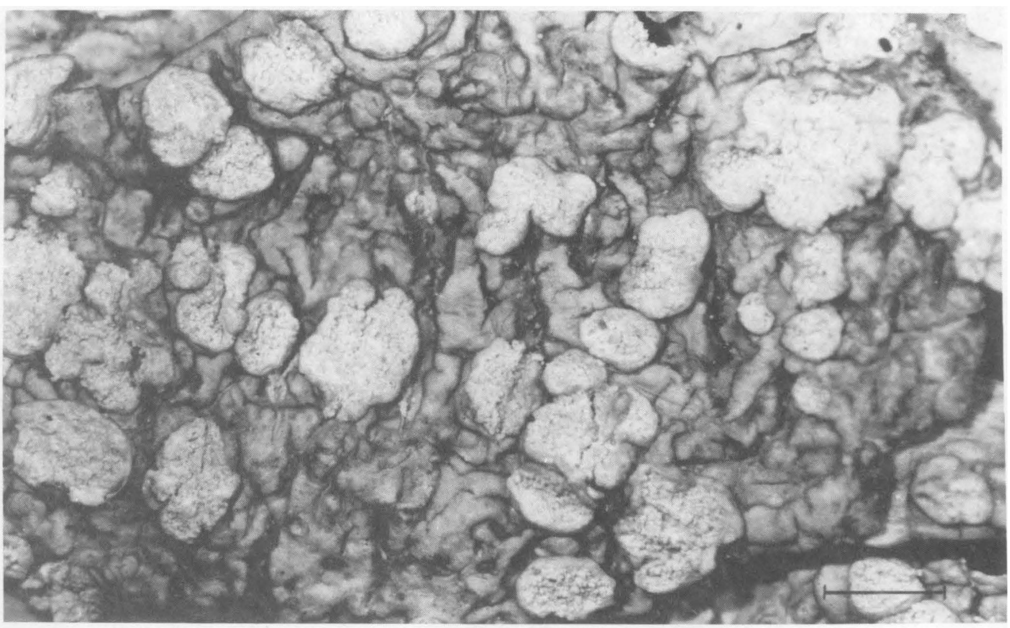


Fig. 80. *Ochrolechia alboflavescens*. Tønsberg 6564. Scale 1 mm.

Substratum. *Ochrolechia alboflavescens* has most commonly been collected on *Pinus sylvestris* (14 specimens) and *Picea abies* (11), but has also been found on *Betula pubescens\pendula* and *Juniperus communis*.

Distribution. *Ochrolechia alboflavescens* occurred in eastern Norway as far west as easternmost Vestlandet (Fig. 79). Its vertical distribution ranged in southern Norway from 120 m (Sogndal) to 1030 m (Oppland: Gausdal); most specimens were from above 400 m. In northern Norway the species descended to about sea-level. A specimen from Nordland: Saltdal (leg. Sommerfelt) cited by Verseghy (1962) could not be located. **Counties:** Hedmark - Buskerud, Telemark, Aust-Agder, Sogn og Fjordane, Sør-Trøndelag, Nord-Trøndelag, Troms. All specimens: Hedmark - Buskerud, Telemark, Aust-Agder, Sogn og Fjordane, Sør-Trøndelag - Troms.

Discussion. *Ochrolechia alboflavescens* is not a very variable species. In young specimens the soralia vary from more or less plane to hemispherical. In old, well-developed specimens the soralia are often crateriform and more or less destitute of soredia. *Ochrolechia alboflavescens* is distinguished by its straw-coloured cortex; the delimited, more or less orbicular soralia; the coarse soredia/consoredia and the chemistry. *Ochrolechia alboflavescens* is chemically similar to *O. microstictoides* with which it is likely to occur and to *O. turneri*. All these species produce variolaric acid. It is distinct from both by the straw-coloured cortex, the distinctly delimited, large soralia and the production of protolichesterinic acid. The features distinguishing the three species are summarized in Tab. 15.

Ochrolechia alboflavescens has also been found on wood (*Juniperus communis*, *Picea abies*, and *Pinus sylvestris*). *Ochrolechia alboflavescens* is a species of acidic bark in subalpine, continental areas.

Tab. 15. Distinguishing features between *Ochrolechia alboflavescens*, *O. microstictoides*, and *O. turneri*.

	O. alboflavescens	*O. microstictoides*	*O. turneri*
Cortex	straw-coloured	mostly grey	mostly grey
Soralia	regular, orbicular, discrete, usually up to 2 mm diam.	irregular, becoming confluent	orbicular to irregular, ± discrete, up to about 0.5 mm diam.
Diagnostic constituents	variolaric, protolichesterinic and lichesterinic acids	variolaric and lichesterinic acids	variolaric acid
Apothecia	not rare, up to 5 mm diam.; margin esorediate	very rare, up to 1.3 mm diam.; margin sorediate	very rare, up to 2 mm diam.; margin sorediate
Substratum	on acidic bark (*Picea* and *Pinus*)	on acidic to eutrophic bark	on eutrophic bark
Distribution	in subalpine and northern sites; in S Norway at altitudes between 120 and 1030 m	widespread at altitudes up to 600 m	in the coastal lowlands of S Norway, up to 160 m

Specimens seen (selected): He: Ringsaker 1937, Ahlner (S). - Op: Lillehammer 1916, Lynge (O). - Bu: Gol 1989, Tønsberg 11435. - Te: Vinje 1987, Tønsberg 10316. - AA: Bykle 1987, Tønsberg 10136. - SF: Luster 1990, Anonby 491. - ST: Melhus 1982, Tønsberg 6564. - NT: Namsskogan 1983, Tønsberg 7983. - Tr: Målselv, Norman (TRH). A total of 31 specimens seen, in addition to 3 lignicolous specimens.

Ochrolechia androgyna A

?*O. androgyna* var. *pergranulosa* Räsänen, in Ann. Bot. Soc. Zool. Bot. Fenn. Vanamo 20(3): 9 (1944). Type: Finland: Ostrobottnia borealis. Simo, Pahnilankas, ad corticem *Juniperi communis*, 15 July 1936, Räsänen (H! - holotype, isotype). TLC: gyrophoric acid, lecanoric acid (trace).

?*O. mahluensis* Räsänen, in Ann. Bot. Soc. Zool. Bot. Fenn. Vanamo 21: 5 (1947). Type: Finland, Tavastia borealis. Saarijärvi, Papillansaari ("Mahlu, Pappilanniemi"), ad basin *Pini sylvestris*, 17 October 1944, Koskinen (UPS! - isotype). TLC: gyrophoric acid, lecanoric acid (trace).

Figs 81, 84, 86.

Thallus (Fig. 81) crustose, episubstratal, rarely endosubstratal in esorediate parts, mostly thin (up to 1 mm), occasionally distinctly zoned towards the margin, typically continuous, sometimes areolate, sorediate. Esorediate parts mostly pale grey, sometimes whitish, greenish grey, straw-coloured, yellowish or greenish brown, more or less even, or more rarely tuberculate in continuous parts; tuberculae moderately to distinctly convex, sometimes subglobose, up to 1 mm in diameter. Areolae moderately to distinctly convex, sometimes subglobose. **Soralia** often more or less yellowish, sometimes beige, occasionally more or less concentrically arranged, mostly discrete and delimited, sometimes diffuse, rarely becoming confluent forming patches with a leprose surface, up to 0.5-1 mm in specimens with delimited soralia. Soredia fine, or more commonly coarse, up to 50 µm in diameter, usually in rounded to subcylindrical consoredia up to 100 µm in diameter; wall distinct, sometimes with shortly projecting hyphae. Photobiont green, coccoid, to 15 µm in diameter.

Apothecia present in 42 (21%) of the specimens, usually somewhat stipitate, up to 2(-2.8) mm in diameter and often shaped as an inverted, truncated cone; thalline margin usually sorediate, often becoming excluded; proper margin distinct, often becoming completely detached from the thalline margin; disc pale beige, pinkish brown to pale yellowish brown, becoming more distinctly brown in the herbarium, flat to convex, often cracked. Spores becoming yellowish in the herbarium, 37-63 x 17-38 µm. Pycnidia usually immersed in tuberculae, rarely protruding from the centre of the soralia. Conidia rod-shaped, 4-6 x $\leq$ 1 µm.

Chemistry: Gyrophoric acid, lecanoric acid (trace), rarely with a distinct yellow pigment in R_F-classes A 2-3 (trailing), B 2, C 1. Thallus UV+ bluish white. Cortex C+ red. Soralia C+ red, often PD+ brownish-orange. Medulla C-.

Substratum. *Ochrolechia androgyna* A has most commonly been collected on *Betula pubescens/pendula* (56 specimens), *Alnus incana* (34), *Picea abies* (23) and *Pinus sylvestris* (17); other phorophytes included *Acer* sp., *Alnus glutinosa, Betula nana, Corylus avellana, Fagus sylvatica, Loiseleurea procumbens, Prunus padus, Populus tremula, Quercus, Salix caprea, Sorbus aucuparia*, and *Juniperus communis*. It seemed to prefer smooth, naked bark.

Distribution. *Ochrolechia androgyna* A occurred throughout most of the country, inland as well as along the coast (Fig. 84), but seemed to be most abundant in subalpine *Betula* forests. A total of 73 (37%) of the specimens were from northern Norway. Its vertical distribution ranged from about sea-level to 1070 m (Buskerud: Sigdal)(see Fig. 86). **Counties:** Akershus - Aust-Agder, Rogaland - Finnmark.

Discussion. *Ochrolechia androgyna* A is polymorphic. The typical form has a more or

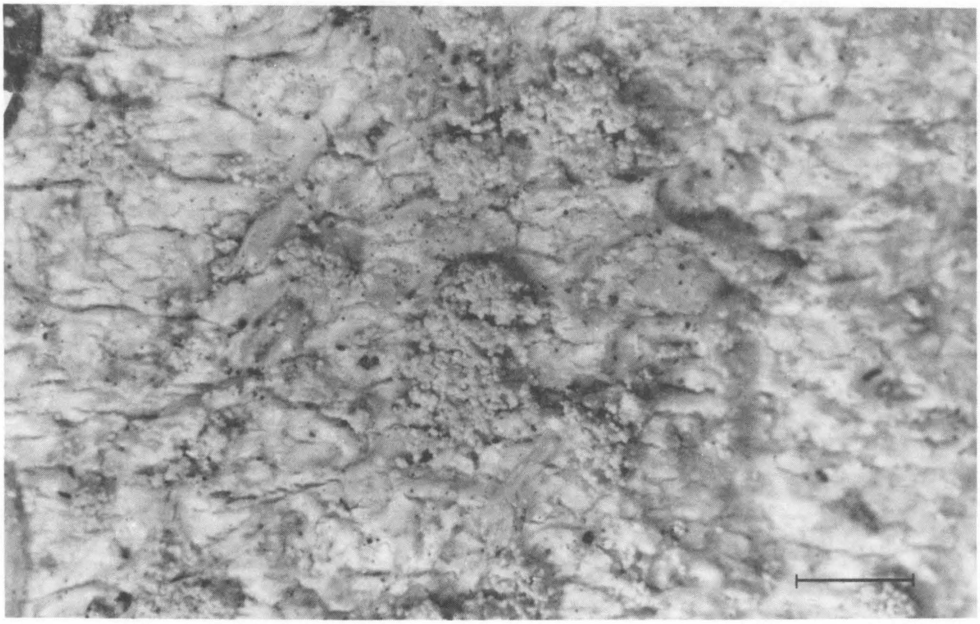


Fig. 81. *Ochrolechia androgyna* A. Tønsberg 4531. Thallus ± even, cracked. Scale 1 mm.

less thin, continuous thallus and delimited, scattered soralia and grows on tree trunks, mostly *Betula*.

A morphologically deviating form, often found on tree bases of *Betula pubescens* and *Pinus sylvestris* and on *Juniperus communis* and *Betula nana* in northern sites (especially in Finnmark) is more or less areolate or continuous; the areolae or tuberculae are often strongly convex and the surface is often patchily sorediate with a distinct brownish or brownish yellow tinge. This form (represented, e.g., by Tønsberg 7115, 7144, 7266, 9703, 11241) was found to be very similar to type material of *Ochrolechia androgyna* var. *pergranulosa* and also showed affinities with *O. mahluensis*. It might be that this form represents a distinct taxon with an alpine and northern distribution. Another possibility is that it represent a form of *O. frigida* "f. *lapuensis*" lacking spinulose projections. However, as intermediates seem to exist between this form and the typical form of *O. androgyna* A, it is tentatively included here. The features distinguishing *Ochrolechia androgyna* A, *O. androgyna* B, *O. androgyna* C, and *O. androgyna* D are set out in Tab. 16.

Ochrolechia androgyna A is morphologically rather similar to *O. arborea*. However, that species contains lichexanthone in addition to gyrophoric acid and is therefore easily distinguished chemically.

Ochrolechia androgyna is currently regarded as reacting negatively with PD (see, e.g., Hanko et al. 1985). However, the soralia of are often PD+, as recorded by Howard (1970).

Ochrolechia androgyna A is a widespread species of acidic bark.

Specimens seen (selected): **Norway**: Oslo 1982, Tønsberg 6539. - He: Åmot 1982, Tønsberg 6883a. - Op: Lunner 1982, Tønsberg 7546a. Sel 1982, Tønsberg 7512. - Bu: Sigdal 1982, Tønsberg 7017. - Vf: Tjølling 1922, Høeg (TRH). - Te: Tinn, F. Høeg (TRH). - AA: Bykle 1955, Degelius (O). - Ro: Sauda 1991, Botnen 2141. - Ho: Kvam 1979, Tønsberg 4113c. - SF: Balestrand 1979, Tønsberg 4012. - MR: Gjemnes 1937, Ahlner

Tab. 16. *Ochrolechia androgyna* A-D: distinguishing features.

	O. androgyna A	*O. androgyna B*	*O. androgyna C*	*O. androgyna D*
Thallus	thin, ± even to moderately tuberculate; cortex pale grey, to yellowish grey; soralia often yellowish	thick; distinctly tuberculate, often folded; cortex medium grey to dark grey; soralia concolorous with cortex	thin to thickish, tuberculate; cortex medium grey to greenish grey; soralia green-grey	thin to thick; even to tuberculate; cortex medium grey; soralia grey, yellowish or beige
Apothecia	small (to 2(-2.8) mm diam.), stipitate; thalline margin often sorediate	large (to 7 mm diam.), sessile; thalline margin usually not sorediate	small (to 1.8 mm diam.) sessile; thalline margin usually esorediate	large (to 5 mm diam.), sessile; thalline margin sorediate
Chemistry (diagnostic substances)	substances other than gyrophoric acid absent	androgyna B unknown 2 & 3	murolic acid complex	variolaric acid
Substratum (main phorophytes)	acidic bark (*Betula pubescens*, *Alnus incana*, *Picea*)	acidic to intermediate bark (*Betula pubescens/pendula Quercus*, *Picea*)	acidic to moderately eutrophic bark (*Alnus incana*, *Quercus*, *Fagus*)	acidic bark (*Betula pubescens*, *Alnus incana*, *Salix caprea*)
Distribution	widespread, common in N Norway	mainly in the coastal lowlands of S Norway	mainly in the coastal lowlands of S Norway	northernmost Norway

(S). - ST: Trondheim 1981, Tønsberg 5389. Åfjord 1980, Tønsberg 4621. - NT: Namsos 1989, Tønsberg 11577. Værdal 1824, Blytt (O). - No: Rana 1939, Ahlner (S); 1986, Tønsberg 9703. - Tr: Senja 1910, Lynge (O). - Fi: Alta 1982, Tønsberg 7266. Karasjok 1988, Tønsberg 11241. Kautokeino 1988, Tønsberg 11249, Sør-Varanger 1982, Tønsberg 7115. A total of 198 specimens seen. **Iceland**: S. Múlasysla, 1956, Degelius (p.p.; hb. Degelius).

Ochrolechia androgyna B

?*O. roseosorediosa* Gyelnik, in Fedde Rep. 27: 391. 1930. Type: Federal Republic of Germany, Oldenburg, ad truncos *Quercuum* ad "Baumweg" prope Lethe, Sandstede, Krypt. Exs. 1039 (BP! - holotype). TLC: gyrophoric acid, lecanoric acid (trace), androgyna B unknowns 1-3.

?*O. albosorediosa* Gyelnik, in Fedde Rep. 27: 391. 1930. Type: Yugoslavia, Hercegovina, ad cort. *Pini leucodermis*, in valle "Udbar dol", alt. 1200 m, June 1918, Szatala (BP!-holotype). TLC: gyrophoric acid, lecanoric acid (trace), androgyna B unknowns 1-3.

?*O. tatrica* Gyelnik, in Fedde Rep. 27: 391. 1930. Type: Czechoslovakia, Slovakia, auf Moosen, auf der glatten Fläche eines Sandstein felsens unter der Spitze des Stösschen in der Hohen Tatra, 17 July 1917, Timko (BP! - holotype). TLC: gyrophoric acid, lecanoric acid (trace), androgyna B unknowns 1-3.

Figs 18, 82-83, 85, 87.

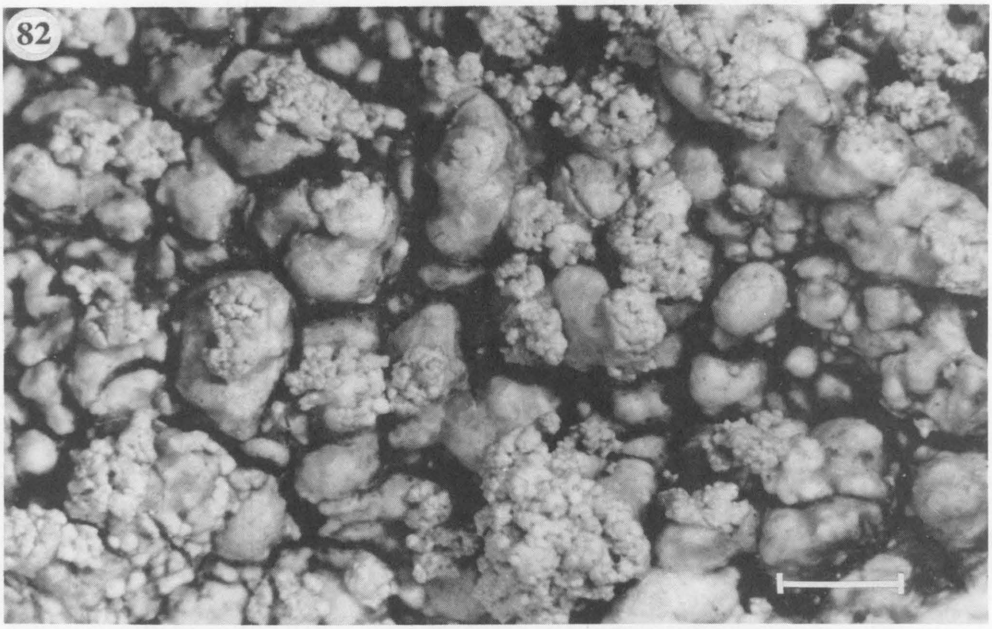
Thallus (Figs 82-83) crustose, episubstratal, thick (up to 2(-4) mm), forming more or less irregularly spreading patches, indistinctly to distinctly delimited, continuous, unzoned, sorediate. Cortex medium to dark grey, greenish grey in shaded niches, rarely whitish grey, typically distinctly tuberculate, more or less folded and cracked; tuberculae often irregularly rounded. **Soralia** more or less concolorous with the cortex, greyish yellow to greyish beige, usually 1-2 mm in diameter, often irregularly rounded, sometimes 2-3 per tuberculum. Soredia fine to coarse, up to 50 µm in diameter, mostly in rounded to elongate consoredia up to 150 µm(-0.2) mm in diameter, sometimes in rounded to subfruticose aggregations up to 0.5 mm in diameter; wall distinct, often with some shortly projecting hyphae. A quasi-isidiate form (Fig. 83) had distinct tuberculae which erode apically to form irregular soralia of coarse aggregations of efflorescent soredia mixed with irregular, attached to free, more or less corticate granules. Photobiont green, coccoid, up to 15 µm in diameter.

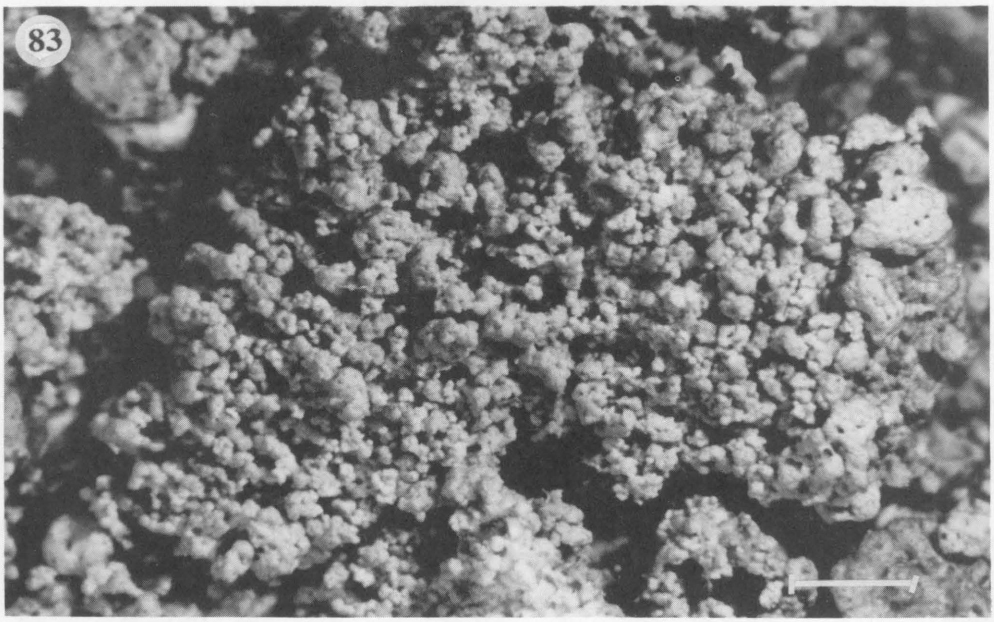
Apothecia present in 24 (22%) of the specimens, large, up to 7 mm in diameter, more or less sessile; thallus margin mostly not sorediate; proper margin indistinct to distinct; disc flat to somewhat convex, pale beige, with numerous small more or less reddish pits; pits 35-50 µm wide in upper part, 25-50 µm deep. Spores 44-50(-70)x(21-)25-30(-35) µm. Pycnidia not rare, up to 0.5 mm wide, immersed in shallow to more or less prominent and more or less cylindrical tuberculae, usually more or less flattened at the top. Conidia 4-6 x $\leq$ 1 µm.

Chemistry: Gyrophoric acid, lecanoric acid (trace), androgyna B unknown 2 (fatty acid), androgyna B unknown 3, and androgyna B unknown 1 (accessory fatty acids). In daylight after charring (especially in solvent B and C) there was a distinct orange brown base line spot (representing unresolved substances?). Thallus UV- or dull greyish blue. Cortex and soralia C+ red. Medulla C- or C+ pale pink. TLC: Fig. 18.

Substratum. *Ochrolechia androgyna* B has been found on *Betula pubescens/pendula* (25 specimens), *Quercus* (24) and *Picea abies* (12), and, more rarely, on *Alnus glutinosa, A. incana, Fagus sylvatica, Juniperus communis, Malus domestica, Pinus sylvestris, Salix caprea, Sorbus aucuparia, Taxus*, and *Ulmus glabra*. It often grew over mosses and on rough bark surfaces.

Distribution. *Ochrolechia androgyna* B occurred in the coastal lowlands from Akershus to Troms; no collections were from the inland counties Hedmark and Oppland (Fig. 85). Only 8 (7%) of the specimens were from northern Norway. Its vertical distribution ranged from

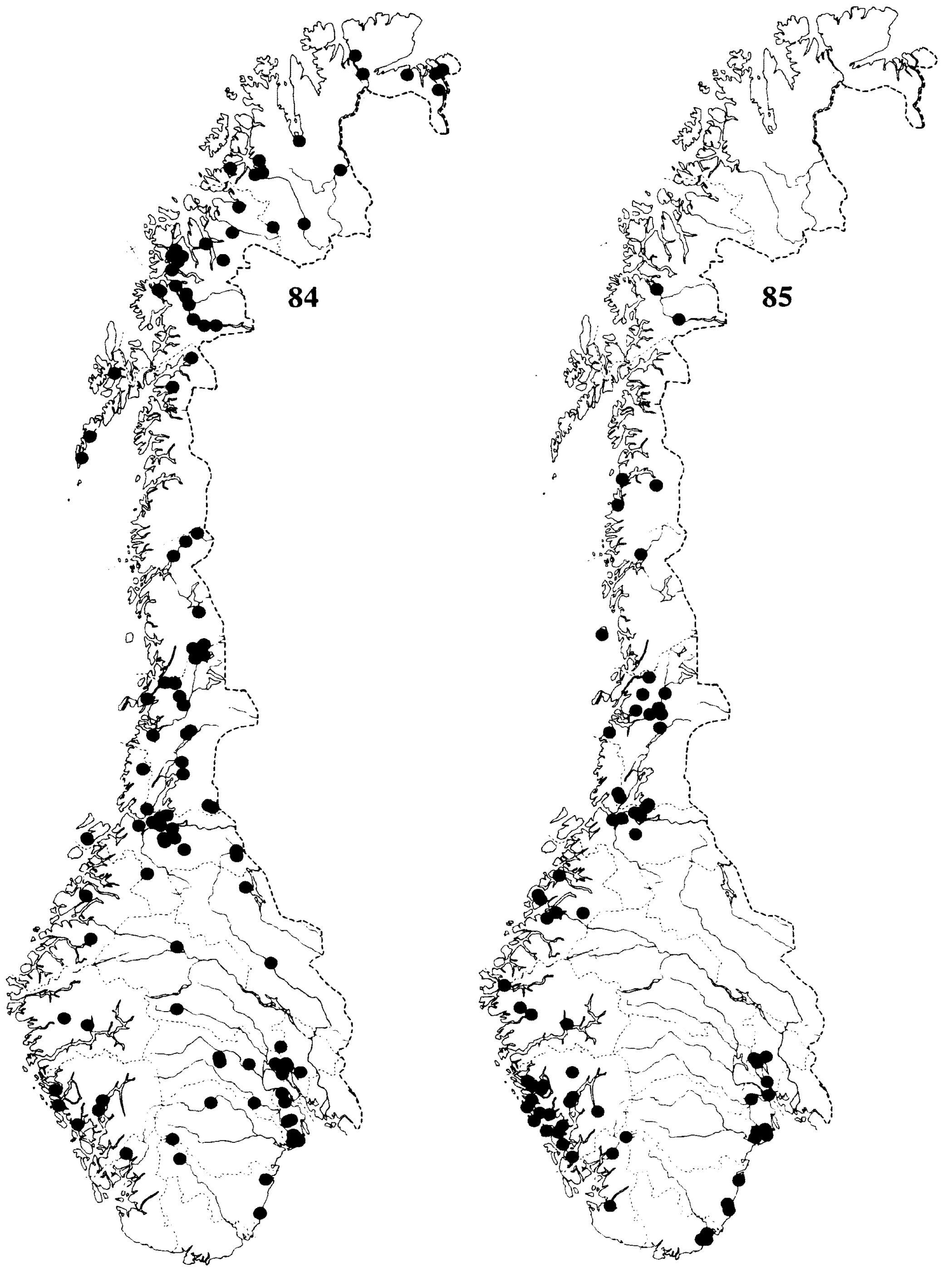




Figs 82-83. *Ochrolechia androgyna* B. Fig. 82. Typical form. Tønsberg 3831. Scale 1 mm. Fig. 83. Quasi-isidiate form. Tønsberg 3157. Scale 1 mm.

about sea-level to 650-665 m (Akershus: Eidsvoll)(see Fig. 87); only a few collections were from altitudes above 200 m. **Counties:** Akershus, Buskerud - Troms.

Discussion. *Ochrolechia androgyna* B is characterized by a thick, often dark grey,



Figs 84-85. Distribution maps. Fig. 84. *Ochrolechia androgyna* A. Fig. 85. *Ochrolechia androgyna* B.

strongly tuberculate thallus, large, sessile apothecia, and the production of *Ochrolechia androgyna* B unknowns. In southernmost Norway it proved to be common on *Quercus*. In an atypical specimen (Tønsberg 5194) the soredia were rather firmly packed in more or less elongate, verrucose to more or less flattened structures. *Ochrolechia androgyna* B has also been collected on rock. Hoffmann (1784) has a long description of his species and illustrates it as a fertile taxon with a thick, tuberculate thallus and discrete, round soralia. *Ochrolechia* sp. B seems to fit this description and figure and is most likely to represent *O. androgyna* (Hoffm.) Arnold s. str. Hoffmann says that his material is "in ligno seu scandulis putridis".

The Norwegian material of *Ochrolechia androgyna* B agree well with the holotype of *O. roseosorediosa* except that the colour of the soralia of the latter are tinged with rose. *Ochrolechia albosorediosa* has an olivaceous, somewhat glossy cortex and scattered, whitish or pale greyish soralia. The holotype of *O. tatrica* is muscicolous on saxicolous mosses and has a grey cortex and numerous, rather densely spaced, beige soralia. The type specimens of *O. albosorediosa, O. roseosorediosa* and *O. tatrica* contained large amounts of androgyna B unknown 1, whereas in most Norwegian specimens that substance occurred only occasionally in large amounts. The features distinguishing *Ochrolechia androgyna* A, *O. androgyna* B, *O. androgyna* C, and *O. androgyna* D are set out in Tab. 16.

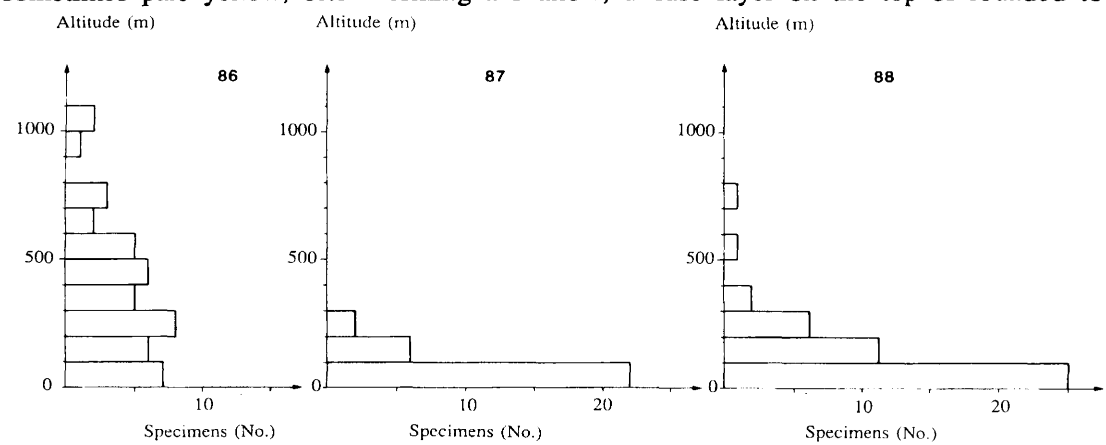
Ochrolechia androgyna B is saxicolous or corticolous. When corticolous it is a species of acidic to intermediate bark in coastal habitats.

Specimens seen (selected): Ak: Oslo 1937, Rui (O). - Bu: Hurum 1935, Hagen (O). - Vf: Larvik 1888, Norman (O). - Te: Porsgrunn 1978, Tønsberg 3346. - AA: Grimstad 1978, Tønsberg 3227. - VA: Søgne 1978, Tønsberg 3157. - Ro: Suldal 1906, Lynge (O). - Ho: Kvam 1979, Tønsberg 4115. - SF: Leikanger 1979, Tønsberg 4041. - MR: Fræna 1964, Malme (O). - ST: Trondheim 1980, Tønsberg 5194. - NT: Grong 1979, Tønsberg 4453. - No: Saltdal 1822, Sommerfelt (O). - Tr: Bardu 1910, Lynge (O). A total of 110 specimens seen.

Ochrolechia androgyna C

Figs 19, 88-90.

Thallus (Fig. 89) crustose, episubstratal, thin to thick (up to 2 mm), usually forming rosettes, delimited, continuous. Cortex grey to greenish grey, sometimes whitish, usually distinctly tuberculate; tuberculae often regularly hemispherical. **Soralia** often green-grey, sometimes pale yellow, often forming a shallow, diffuse layer on the top of rounded to



Figs 86-88. Vertical distributions. Fig 86. *Ochrolechia androgyna* A. Fig. 87. *Ochrolechia androgyna* B. Fig. 88 *Ochrolechia androgyna* C.

globose tuberculae filled with large amounts of oxalate, up to 1-2 mm in diameter. Soredia mostly coarse, up to 50 µm in diameter, simple or in more or less rounded consoredia to 65(-90) µm; wall distinct, sometimes with short projecting hyphae. Photobiont green, coccoid, up to 15 µm in diameter.

Apothecia rare, present in 6 (6%) of the specimens, up to 1.8 mm in diameter, sessile; thalline margin crenulate, mostly not sorediate; proper margin indistinct; disc pale brown. Asci with up to 8 (-10) spores. Spores 25-55 x 15-29 µm. Pycnidia rare, exposed part up to 0.1 mm wide, pale yellow. Conidia 4-5 x $\leq$ 1 µm.

Chemistry: Gyrophoric acid and lecanoric acid (trace) with satellites, murolic acid complex. Thallus UV+ whitish blue. Cortex and soralia C+ red. Medulla C-. TLC: Fig. 19.

Substratum. *Ochrolechia androgyna* C has most commonly been found on *Alnus incana* (23), *Quercus* (16), *Fagus sylvatica* (11), *Alnus glutinosa* (10), and more rarely on *Acer platanoides, Betula pubescens/pendula, Fraxinus excelsior, Picea abies, Pinus sylvestris, Populus tremula, Prunus domestica, P. padus, Salix caprea, Sorbus aucuparia*, and *Tilia*.

Distribution. *Ochrolechia androgyna* C occurred in a broad belt along the coast from Østfold to Troms (Fig. 90). Twelve (13%) of the specimens were from northern Norway. Its vertical distribution ranged from sea-level to 750-800 m (Sør-Trøndelag: Rennebu)(see Fig. 88). **Counties:** Østfold - Troms.

Discussion. Typical specimens of *Ochrolechia androgyna* C have greenish soredia on rounded tuberculae. A form of *Ochrolechia androgyna* C is morphologically similar to *O. androgyna* B; such specimens could only be correctly identified with the aid of TLC. In northern Norway *Ochrolechia androgyna* C is rare. Lich. Fenn. Exs. 76 (BG) corresponded well morphologically and chemically to *O. androgyna* C. The fatty acids found in *O. androgyna* C were similar to those found in specimens of *Usnea hirta* from Norway, Sweden and Finland. Within the genus *Ochrolechia* in Europe the murolic acid complex (including

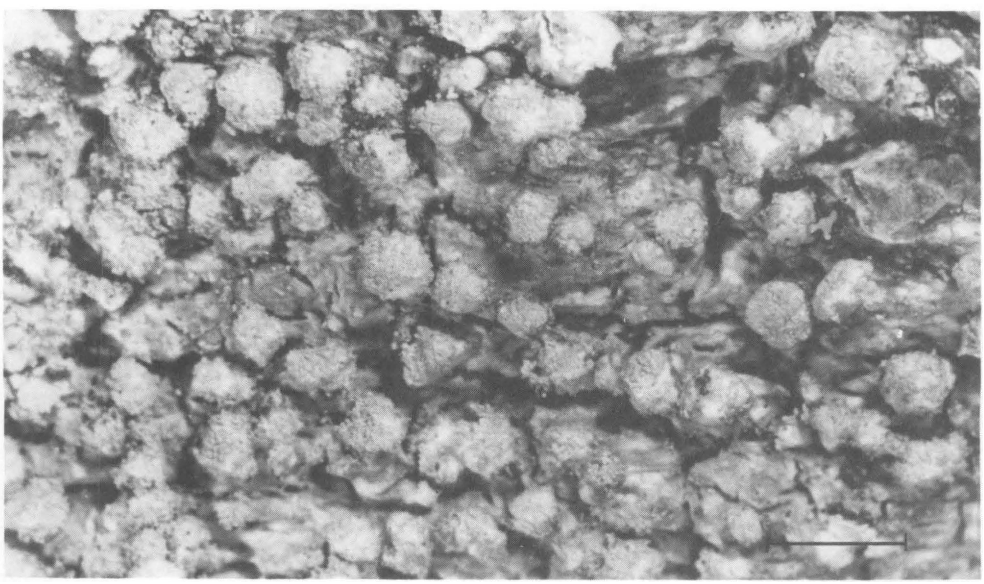
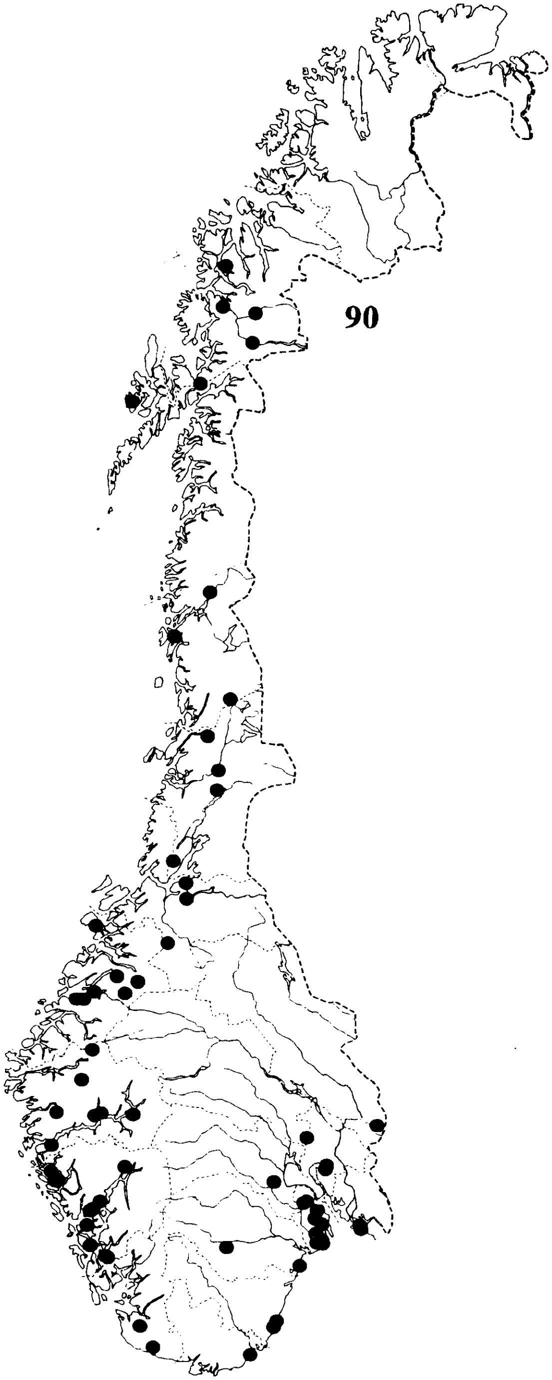
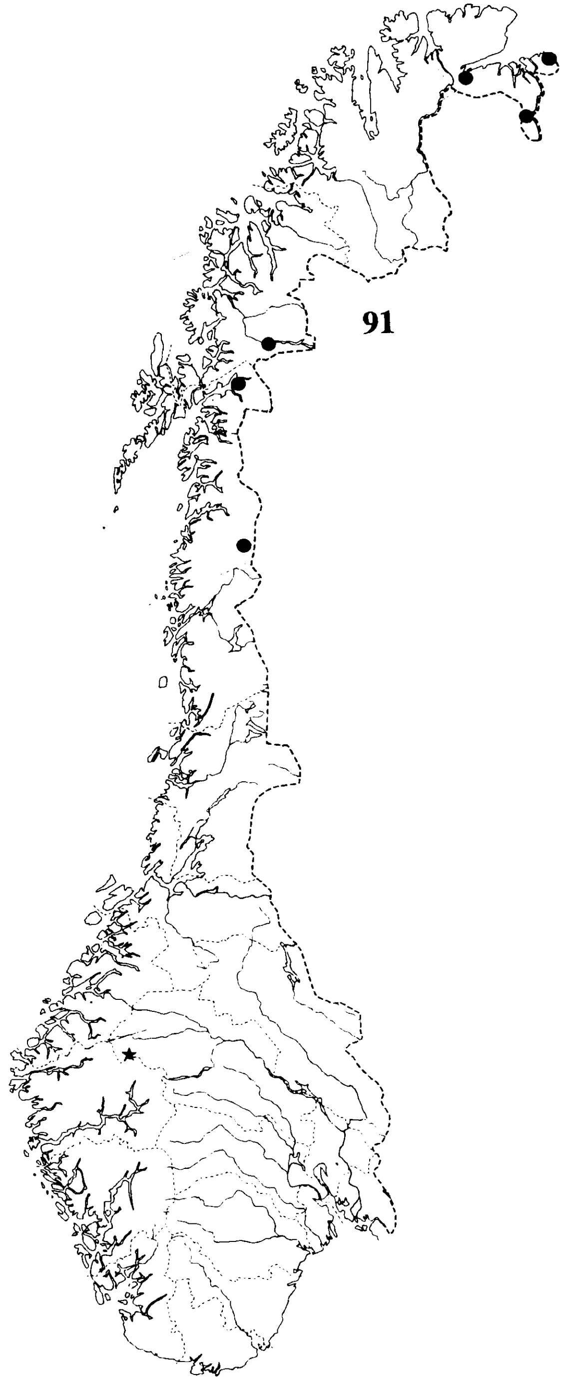


Fig. 89. *Ochrolechia androgyna* C. Tønsberg 3686. Scale 2 mm.





Figs 90-91. Distribution maps. Fig. 90. *Ochrolechia androgyna* C. Fig. 91. *Ochrolechia androgyna* D.

murolic and neodihydromurolic acids) is produced by the variolaric acid-containing species *Ochrolechia szatalaënsis* and *O. upsaliensis* (Hanko et al. 1985). The features distinguishing *Ochrolechia androgyna* A, *O. androgyna* B, *O. androgyna* C, and *O. androgyna* D are set out in Tab. 16.

Ochrolechia androgyna C is a species of acidic to intermediate bark in coastal habitats.

Specimens seen (selected): **Norway**: Øf: Trøgstad 1978, Tønsberg 3365. - Oslo 1984, Tønsberg 8511. - He: Eidskog 1985, Tønsberg 9456b. - Op: Lunner 1982, Tønsberg 7541. - Bu: Flesberg 1987, Tønsberg 10352. - Vf: Larvik 1977, Tønsberg 1761. - Te: Kviteseid 1987, Tønsberg 10283 (fertile). - AA: Grimstad 1990, Tønsberg 13521. - VA: Søgne 1978, Tønsberg 3179a. - Ro: Eigersund 1981, Gauslaa (NLH). - Ho: Lindås 1973, Øvstedal (fertile). - SF: Gloppen 1979, Tønsberg 3986. - MR: Sunndal 1979, Tønsberg 3928. - ST: Trondheim 1979, Tønsberg 3736. - NT: Leksvik 1980, Tønsberg 4851. - No: Grane 1979, Tønsberg 3686. - Tr: Målselv 1982, Tønsberg 7312. A total of 96 Norwegian specimens seen. **Sweden**: Värmland 1981, Muhr 3557 (UPS). **Finland**: Lich. Fenn. Exs. 76 (BG).

Ochrolechia androgyna D

Fig. 91.

Thallus crustose, episubstratal, rarely endosubstratal in non-sorediate parts, thin (up to 1 mm) or, rarely, very thick (up to 5 mm), pale grey, irregularly spreading to rosette-forming, continuous. **Soralia** grey to beige, sometimes with a yellowish tinge, rounded, 0.5-1.5 mm, slightly concave to globose, discrete or becoming confluent. Soredia mostly coarse, up to 50 µm in diameter, often in rounded to elongate consoredia up to 75-160(-200) µm, sometimes with shortly projecting hyphae; wall distinct. Photobiont green, coccoid, up to 15 µm in diameter.

Apothecia observed in one specimen (14%), up to 5 mm in diameter, sessile; thalline margin thick, 0.5-0.7 mm wide, with a coarsely crenulate, more or less eroded to coarsely sorediate surface; proper margin indistinct; disc slightly pruinose, plane, deeply cracked. Spores 34-60 x 19-38 µm. Pycnidia immersed in tuberculae and soralia, flesh-coloured in exposed part. Conidia rod-shaped, 3.5-4.5 x $\leq$ 1 µm.

Chemistry: Gyrophoric acid, variolaric acid, lecanoric acid (usually trace to moderate amounts; large amounts in Holien 2827). Apothecia: as for thallus. Thallus UV+ whitish blue. Two chemical types occurred: (I) Cortex and soralia C+ red, medulla C-; (6 specimens). (II) Cortex C+ orange yellow (variolaric acid), eroded tuberculae, soralia and medulla C+ red; (only in Holien 2827).

Substratum. *Ochrolechia androgyna* D has been found on *Betula pubescens*, *Alnus incana*, and *Salix caprea*.

Distribution. *Ochrolechia androgyna* D occurred in northern Norway (as far south as Nordland: Saltdal)(Fig. 91) at altitudes between about sea-level and 200 m. **Counties:** Nordland - Finnmark. All specimens: Oppland, Nordland - Finnmark.

Discussion. For the purpose of the present paper a broad concept of *Ochrolechia androgyna* D is taken. All specimens of *Ochrolechia androgyna* s. lat. with variolaric acid are referred to as *O. androgyna* D. Holien 2827, an up to about 5 mm thick, strongly tuberculate, fertile specimen differed from the other material in the chemical properties of the cortex and the medulla (see above) and in having conspicuous, more or less confluent, pale greyish-beige, irregular soralia. That specimen possibly represents a taxon of its own. The features distinguishing *Ochrolechia androgyna* A, *O. androgyna* B, *O. androgyna* C, and *O. androgyna* D are set out in Tab. 16.

A terricolous specimen has been collected from southern Norway at 1550 m altitude

(Oppland: Skjåk). *Ochrolechia androgyna* D appears to have a northern distribution. Outside Norway it has been collected in Iceland.

Specimens seen. Norway: Narvik, Norman (TRH). Saltdal 1982, Tønsberg 7661. - Tr: Bardu 1910, Lynge (O). - Fi: Nesseby 1987, Holien 2827 (BG, TRH). Sør-Varanger 1984, Søchting 4939 (C); 1982, Tønsberg 7138, 7139. Terricolous material: Op: Skjåk 1958, Ahlner (S). **Iceland:** S. Múlasysla, 1956, Degelius (pro parte; herb. Degelius).

Ochrolechia arborea (Kreyer) Almb.

Fig. 92.

Thallus crustose, endo- to episubstratal in non-sorediate parts, delimited in well-developed specimens, forming rosettes or irregularly spreading patches, up to one dm across, continuous, sorediate. Prothallus indistinct, or as a whitish, more or less glossy zone bordering the thallus. Esorediate surface grey, whitish-grey or creamy-grey, more or less tuberculate, cracked. **Soralia** greenish, greyish, whitish grey or creamy-grey, mostly discrete, delimited and orbicular or more or less diffuse, more or less plane, up to 0.5 mm in diameter. Soredia fine to coarse, up to 50 µm in diameter, often in rounded consoredia up to 60 µm in diameter; soredial wall distinct. Photobiont green, coccoid, up to 12(-20) µm in diameter.

Apothecia and pycnidia not observed.

Chemistry: Gyrophoric acid, lecanoric acid (trace), lichexanthone. Soralia UV+ orange yellow. Cortex and soralia C+ red.

Substratum. *Ochrolechia arborea* has been collected on *Alnus glutinosa, A. incana, Calluna vulgaris, Juniperus communis, Pinus sylvestris, Populus tremula, Prunus spinosa, Quercus, Salix caprea,* and *Sorbus aucuparia.* It usually grew in well-lit situations, e.g., in maritime heath on *Calluna vulgaris, Prunus spinosa,* and *Juniperus communis.*

Distribution. *Ochrolechia arborea* occurred in southern Norway as far north as Sør-Trøndelag (Fig. 92). Its vertical distribution ranged from about sea-level to 550 m (Buskerud: Sigdal). **Counties:** Østfold, Oppland, Buskerud, Telemark - Hordaland, Møre og Romsdal, Sør-Trøndelag.

Discussion. *Ochrolechia arborea* is morphologically rather similar to the much more common *O. androgyna* A, but in the former the soralia are mostly smaller (up to 0.5 mm and 1.5 mm in *O. arborea* and *O. androgyna,* respectively) and more densely spaced. Both species produce gyrophoric acid, but *O. arborea* can always be distinguished by the presence of lichexanthone.

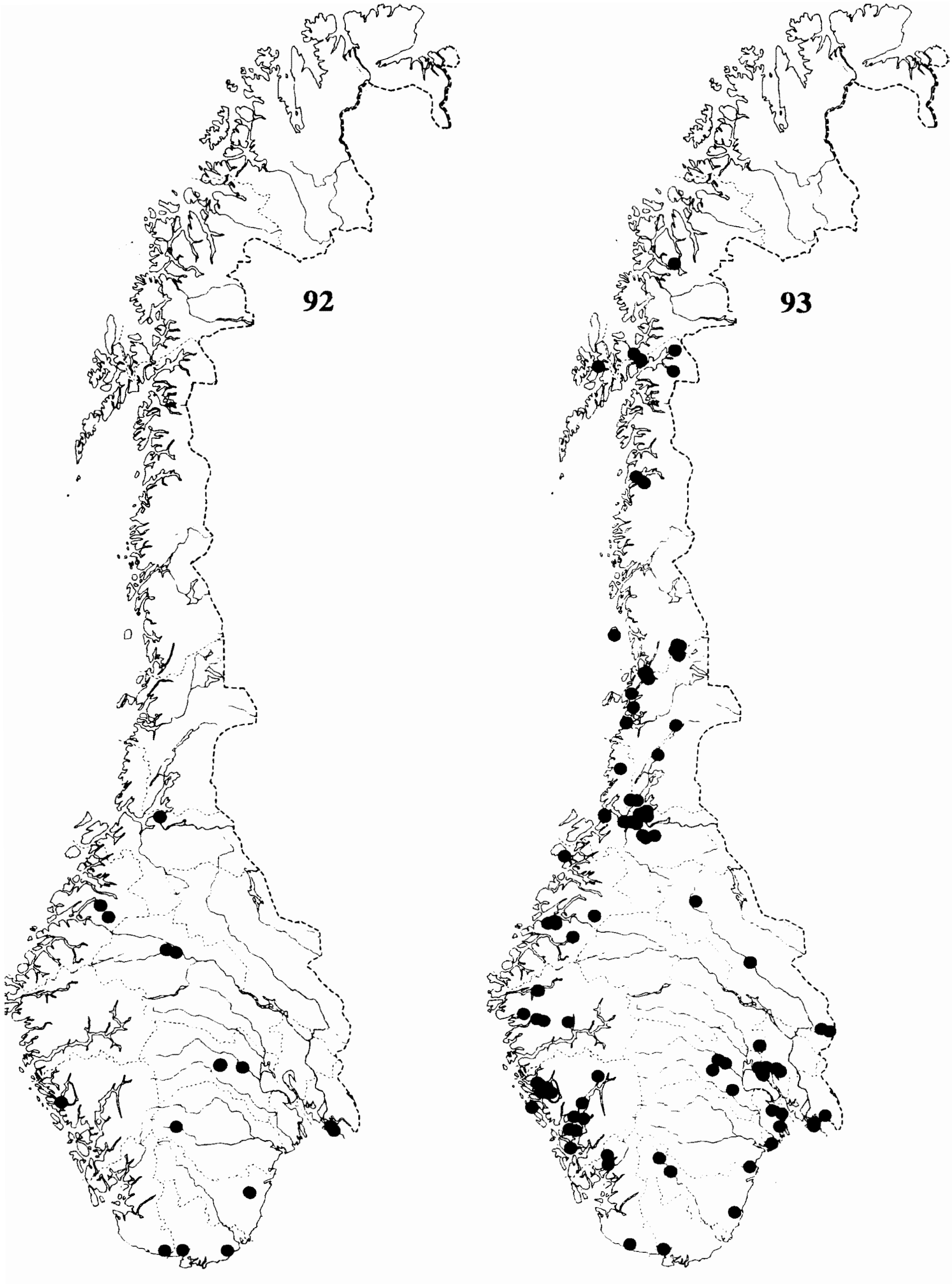
Ochrolechia arborea appears to be a species of acidic bark in southern sites.

Specimens seen (selected): Øf: Hvaler 1983, Tønsberg 7742. - Op: Vågå 1981, Santesson 14163 (UPS) - Bu: Sigdal 1981, Tønsberg 6320. - Te: Vinje 1991, Tønsberg 17425b. - AA: Åmli 1984, Skjolddal. - VA: Søgne 1983, Øvstedal. - Ro: Sokndal 1981, Gauslaa (Ås-NLH). - Ho: Bergen 1990, Tønsberg 13445. - MR: Nesset 1979, Tønsberg 3917. - ST: Trondheim 1979, Tønsberg 3626. A total of 22 specimens seen.

Ochrolechia frigida (Swartz) Lynge "f. *lapuensis* (Vainio)"

Ochrolechia tartarea (L.) v. *lapuensis* Vainio in Räsänen, in Medd. Soc. Fauna Fl. Fenn. 46: 163 (1921). Type: Finland, Ostrobottnia australis, Lapua, Huhdanneva, 19 October 1920, Räsänen (H! - syntype). TLC: Gyrophoric acid, lecanoric acid. *Ochrolechia lapuensis* (Vainio in Räsänen) Räsänen, in Ann. Acad. Sci. Fenn., Ser. A, 34(4): 93 (1931).

Thallus crustose, episubstratal, usually forming more or less rounded patches, up to 8 cm in



Figs 92-93. Distribution maps. Fig. 92. *Ochrolechia arborea*. Fig. 93. *Ochrolechia microstictoides*.

diameter, continuous (sometimes discontinuous in poorly developed parts), composed of a basal crust from which coarse tuberculae and/or conspicuous spinulose projections arise. Prothallus only rarely evident, white, of conglutinated hyphae. Basal crust superimposing the substratum, pale grey, secondarily cracked, more or less even. Tuberculae concolorous with the basal crust, irregular, hemiglobose to subglobose or more or less clavate, sometimes more or less knobby towards the apices, crowded, forming more or less coralloid outgrowths up to 0.6 mm tall. Spinulose projections more or less erect, up to 1.8 mm long, simple to fruticose, partly lichenized, but especially towards the base, partly unlichenized; lichenized parts pale grey, more or less terete, up to 0.6 mm wide; unlichenized parts pale buff, terete to flattened, up to 0.5 mm wide, sometimes with spines; spines projecting from the surface of the tuberculae, inconspicuous, narrow, short, up to 0.3 mm, simple to sparingly branched, colourless to greyish, acute. **Soralia** whitish to pale yellowish white, sometimes with a faint brownish tinge, mostly in the apices of or inside hollow tuberculae, more rarely on conspicuous spinulose projections, irregular to rounded in outline, mostly more or less concave, up to 0.3 mm in diameter, occasionally becoming confluent and forming patches up to a few mm with a leprose surface. Soredia mostly coarse, up to 50 µm in diameter, often in cylindrical to rounded consoredia up to 120 µm in diameter, often with irregular, up to 0.4 mm fragments resulting from the eroded upper surfaces of the tuberculae; soredial wall distinct. Medulla distinct, whitish. Photobiont green, coccoid, up to 20 µm in diameter.

Apothecia absent in corticolous material, but observed in one lignicolous specimen, up to 2.5 mm in diameter, sessile, distinctly constricted below; disc up to 2.0 mm in diameter. Pycnidia sparse or absent, immersed in the apices of subglobose to subcylindrical to clavate, up to 0.2 mm wide tuberculae, more rarely on spinulose projections, pale buff. Conidia narrowly rod-shaped, 4-5 × <1 µm.

Chemistry: Gyrophoric acid, lecanoric acid (varying in concentration from lower than to more or less equal to (or possibly higher than) that of gyrophoric acid). Thallus UV+ whitish blue. Cortex and soralia C+ red. Medulla C-. Soralia often PD+ brownish orange.

Substratum. Corticolous specimens of *Ochrolechia frigida* "f. lapuensis" have been found on *Alnus incana*, *Betula nana*, *B. pubescens*, *Juniperus communis*, and *Picea abies* and on the mossy base of a trunk of *Pinus sylvestris*.

Distribution. *Ochrolechia frigida* "f. *lapuensis*" occurred in alpine or northern sites at altitudes between 20-40 m (Nord-Trøndelag: Namsos) to 1070 m (Buskerud: Sigdal). **Counties:** Buskerud, Nord-Trøndelag - Finnmark.

Discussion. *Ochrolechia frigida* is a morphologically very variable species and a number of infraspecific taxa have been described (see Verseghy 1962, Howard 1970, Thomson 1979). Sorediate forms are apparently rare. A specimen from Troms (Tønsberg 11071), growing on one single stem of *Betula pubescens*, showed alternating, morphologically very different bands, 1-3 cm wide of 1) coralloid tuberculae with soralia, 2) more or less regular tuberculae with pycnidia and 3) as for 2) but with conspicuous spinulose projections in addition (corresponding to the type of "f. *lapuensis*"). As the specimen formed a continuous cover over the substratum with no evident separating border-line between the morphologically distinct bands, the specimen may represent a single individual. However, it seems more likely that it was actually composed of several individuals, each making a band of its own. Apothecia were sparsely present on non-sorediate bands. From Sør-Trøndelag (Rennebu) there is a strongly tuberculate specimen (leg. Høeg 1934 (TRH)) where the cortex of the tips of the tuberculae was more or less eroded. This specimen possibly represents an immature form with respect to development of soredia.

Ochrolechia frigida "f. *lapuensis*" is best treated as representing a sporadically occurring form. This form has a restricted distribution within the geographical range of the main form (Hanko et al. 1985).

Ochrolechia frigida may possibly occur without spines or spinulose projections. Such specimens may be difficult to distinguish from *O. androgyna* A.

Ochrolechia frigida "f. *lapuensis*" has also been found on wood (*Pinus sylvestris*). *Ochrolechia frigida* occurs most commonly on plant remnants on the ground in alpine and northern regions.

Specimens seen (selected): Bu: Sigdal 1982, Tønsberg 7010. - NT: Namsos 1980, Holien 166-80 (TRH). Namsskogan 1979, Tønsberg 4290. - No: Grane 1983, Tønsberg 8053. - Tr: Bardu 1988, Tønsberg 11071. - Fi: Sør-Varanger 1982, Tønsberg 7117. A total of 7 specimens seen.

Ochrolechia microstictoides Räsänen

Lich. Fenn. exs. no. 226 (1936). Type: Ostrobottnia borealis, Simo, Simonkylä, Pahmilankangas. Ad corticem *Juniperus communis*. 15 July 1936, Veli Räsänen (H - lectotype! & isotype!). TLC: variolaric acid, lichesterinic acid.

Pertusaria silvatica Magnusson, in Bot. Not. 1942: 16 (1942). Type: Sweden, Västergötland, Borås, Hulta, 11 August 1941, on *Quercus*, H. Magnusson 17890 (UPS! - holotype). TLC: variolaric acid, lichesterinic acid.

Ochrolechia turneri auct., non (Sm.) Hasselrot.

Fig. 93.

Thallus crustose, endo-, or more commonly, episubstratal in non-sorediate parts, delimited, forming rosettes or irregular patches, up to a dm or more across, continuous, sorediate. Prothallus often present, whitish. Esorediate surface grey, rarely whitish, smooth to distinctly tuberculate, often cracked. **Soralia** grey, more rarely whitish or with a pale cream-yellow tinge; variform, developing along thalline cracks, from the apices of tuberculae or, in endosubstratal specimens bursting through the uppermost cell layers of the substratum, up to 0.2-0.5 mm in diameter, usually irregular and soon becoming confluent, and often, especially towards the thallus centre, forming a more or less leprose crust. Soredia usually in rounded to irregular consoredia up to 120 µm in diameter; partsoredia mostly coarse, up to 60 µm; soredial wall distinct. Medulla often distinct, white. Photobiont green, coccoid, to 12 µm in diameter.

Apothecia sparsely present in 2 (1%) of the specimens;
lecanorine, up to 1.3 mm in diameter; margin concolorous with the thallus, becoming sorediate and more or less excluded with age; disc flesh coloured; smooth, more or less plane, without or with indistinct pruina; C+ red (gyrophoric acid (in the epihymenium)). Pycnidia not seen.

Chemistry: Thallus: variolaric acid with satellite, lichesterinic acid. Thallus UV+ whitish blue. Cortex and soralia C+ yellow. Apothecia: variolaric acid with satellite, lichesterinic acid, gyrophoric acid.

Substratum. *Ochrolechia microstictoides* was collected on a variety of phorophytes including *Alnus incana* (31 collections), *Betula pubescens/pendula* (29), *Picea abies* (18), *Pinus sylvestris* (18), and *Sorbus aucuparia* (15) as the most common ones, in addition to *Acer platanoides, Alnus glutinosa, Fraxinus excelsior, Ilex aquifolium, Juniperus communis, Larix decidua, Populus tremula, Prunus avium, P. padus, Quercus*, and *Salix caprea*. Nearly one half of the specimens were from conifers. The species grew on naked bark or on mosses or other lichens.

Distribution. *Ochrolechia microstictoides* occurred commonly throughout most of the country (Fig. 93). Its vertical distribution ranged from about sea-level to 600 m (Hedmark: Tynset). **Counties:** Østfold - Troms.

Discussion. *Ochrolechia microstictoides* has until recently been regarded as synonymous with *O. turneri* (Laundon 1963, Poelt 1969, Hawksworth et al. 1980, Santesson 1984). However, as pointed out by, e.g., Hanko et al. (1985), it is distinct from that species in having soralia which usually become confluent forming a more or less leprose crust, and in producing lichesterinic acid. Further, whereas *O. turneri* is a southern species in Norway restricted to communities characteristic of eutrophic bark, *O. microstictoides* is a widespread species occurring commonly on a variety of trees, e.g., the acidic bark of *Alnus incana*, *Betula pubescens* and conifers. Distinguishing features between the two species are summarized in Tab. 15. A few strongly tuberculate specimens lacked soralia; these specimens occurred in or close to towns (e.g., Oslo and Trondheim). The presence of *Ochrolechia microstictoides* in towns indicates that it is moderately toxitolerant (see also Hanko et al. 1985).

Ochrolechia microstictoides is a widespread species. It has also been collected on wood, but appears to be mainly corticolous on acidic bark.

Specimens seen (selected): Øf: Hvaler 1983, Tønsberg 8156. - Oslo 1983, Tønsberg 7844. - He: Åmot 1982, Tønsberg 7593. - Op: Lunner 1982, Tønsberg 7538. - Bu: Krødsherad 1982, Tønsberg 6940. - Vf: Brunlanes 1922, Høeg (TRH). - Te: Kragerø 1946, Lid (O). - AA: Valle 1987, Tønsberg 10178. - VA: Flekkefjord 1981, Gauslaa (NLH). - Ro: Suldal 1988, Tønsberg 10828. - Ho: Fusa 1979, Tønsberg 4162. - SF: Balestrand 1979, Tønsberg 4000. - MR: Vestnes 1979, Tønsberg 3858a. - ST: Trondheim 1980, Tønsberg 4810.

- NT: Fosnes 1980, 4945. - No: Sortland 1987, Tønsberg 10453. - Tr: Skånland 1982, Tønsberg 7362. A total of 153 specimens seen.

Ochrolechia subviridis (Høeg) Erichsen

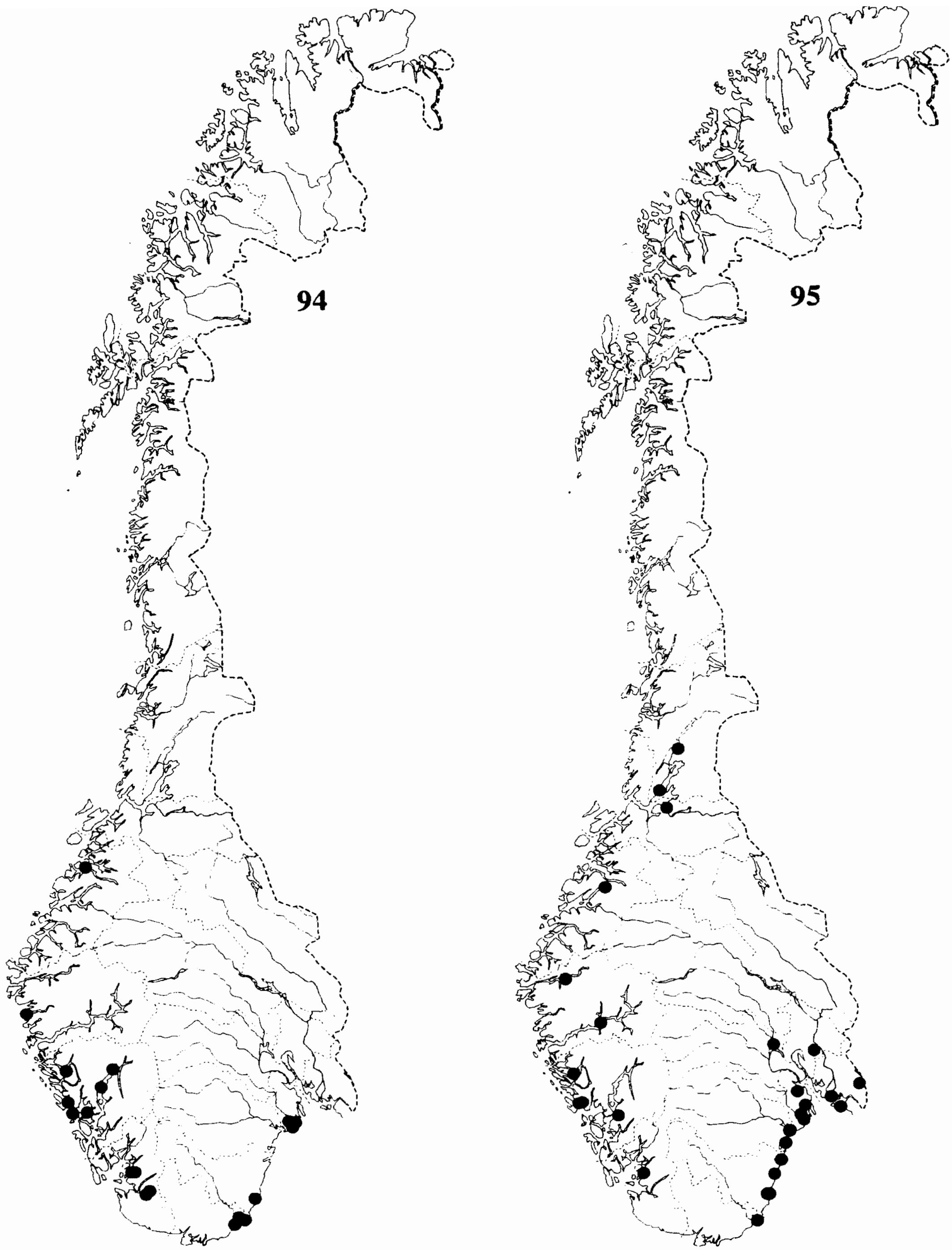
Verhandl. Bot. Ver. Brandenburg 72: 3 (1930). *Pertusaria subviridis* Høeg, in Nyt Mag. Naturv. 61: 150-151 (1923). Type: Norway, Vestfold, Larvik, Bøkeskogen, near Kilen, on *Fagus*, 22 August 1922, O. Høeg (TRH - lectotype, here selected).

Fig. 94.

Thallus crustose, episubstratal, up to 1.5 mm thick, delimited, irregularly spreading or forming rosettes, continuous, mostly isidiate, rarely with true soredia. Prothallus occasionally distinct, white, felty. Non-isidiate and non-sorediate parts of surface grey, greenish grey or whitish grey, glossy, sometimes with a paler, or faintly rose-red, marginal zone; more or less tuberculate, more or less cracked. **Isidia** often tinged pale yellow or yellowish brown and then contrasting with the colour of non-isidiate parts of the cortex, globose to elongate and more or less coralloid, often uneven and knobby, often glossy due to deposits of C+ red, K+ soluble crystals (probably of gyrophoric acid) on the surface, mostly with blunt, swollen apices, homoiomerous, up to 0.2(-0.3) mm tall and 0.1(-0.2) mm wide, irregularly dispersed, largely concentrated to tuberculae, when shed leaving non-corticate, irregular to rounded whitish scars 0.2-0.8 mm in diameter. **Soralia** greenish grey, irregular, diffuse, becoming confluent. Soredia coarse, up to 60 µm in diameter, in rounded to irregular consoredia up to 150 µm in diameter, heavily incrusted by crystals of gyrophoric acid; soredial wall distinct. Medulla distinct, white, visible on the surface as orbicular to irregular scars subsequent to detachment of isidia and soredia. Photobiont green, coccoid, up to 12-14(-16) µm in diameter.

Apothecia and pycnidia not observed.

Chemistry: Gyrophoric acid with a trace of lecanoric acid. Thallus UV+ bluish white.



Figs 94-95. Distribution maps. Fig. 94. *Ochrolechia subviridis*. Fig. 95. *Ochrolechia turneri*.

Cortex and medulla C+ red.

Substratum. *Ochrolechia subviridis* was collected on broad-leaved, deciduous trees, mainly on *Quercus* (16 specimens), but also on *Fagus sylvatica* (9) and *Fraxinus excelsior* (6) and, more rarely, *Acer* sp., *Prunus avium*, and *Populus tremula*. It preferred well-lit, mature trunks. It was often found growing over the bryophyte *Hypnum cupressiforme*.

Distribution. *Ochrolechia subviridis* occurred in the coastal lowland in southern and western parts of southern Norway (Fig. 94). Its northernmost site (Møre og Romsdal: Tingvoll) was a *Quercus robur* grove at the northern limit of the range of the phorophyte. The vertical distribution of *Ochrolechia subviridis* ranged from about sea-level to 150 m (Hordaland: Lindås). **Counties:** Vestfold, Aust-Agder - Møre og Romsdal.

Discussion. *Ochrolechia subviridis* is a variable species. The isidia vary greatly in form and size and in characters of the surface, but were usually of one type on each specimen. One form has diffuse aggregations of isidia irregularly dispersed over the thallus surface. In some well-developed specimens the whole surface was broken down to a mixture of isidia and fragments of a more or less eroded cortex. Most specimens were intermediate between these extremes. In one specimen the isidia were entirely disintegrated into coarse soredia.

Specimens of *Ochrolechia subviridis* with distinct isidia are readily distinguished. Forms with soredia, or with isidia heavily incrusted by crystals may strongly resemble *O. microstictoides* morphologically, but are easily recognized from that species chemically.

Ochrolechia subviridis is a species of eutrophic to intermediate bark in the coastal lowlands of southern Norway. The scarcity of suitable phorophytes north of the *Quercus*-limit possibly restricts its distribution northwards. It may also be that its northern limit is determined by the same climatic factors as those influencing the northern limit of *Quercus robur*. The summer temperature is regarded as being a major factor (see Dahl 1950).

Specimens seen (selected): Vf: Larvik 1922, Høeg (TRH - type collection). - AA: Grimstad 1978, Tønsberg 3237. - VA: Søgne 1978, Tønsberg 3185. - Ro: Hjelmeland 1978, Tønsberg 3031. - Ho: Granvin 1979, Tønsberg 4088. - SF: Flora 1991, Anonby 724, Kavlie & Hakelier. - MR: Tingvoll 1979, Tønsberg 3932b. A total of 35 specimens seen.

Ochrolechia turneri (Sm.) Hasselrot

Pertusaria globulifera f. *isidiata* sensu Høeg (1923) pro parte (see under *P. albescens*).

Fig. 95.

Thallus crustose, episubstratal, delimited, continuous, forming rosettes or, more commonly, irregular patches, up to 1 dm across, sorediate. Prothallus indistinct or, rarely, forming a distinct, whitish, marginal zone. Corticate surface mostly grey, sometimes whitish, smooth to tuberculate, sometimes folded, usually distinctly cracked. **Soralia** greyish white and more or less concolorous with esorediate parts, or with a distinct creamy yellow tinge, variable in form, mostly more or less discrete, rarely becoming confluent throughout the thallus, orbicular to irregular, usually more or less plane, up to about 0.5 mm across. Soredia coarse up to 75 µm, simple, or in more or less rounded to irregular consoredia up to 130 µm in diameter; wall distinct. Medulla distinct, white. Photobiont green, coccoid, up to 15 µm in diameter.

Apothecia present in one (3%) of the specimens, lecanorine, up to 2 mm in diameter. Margin greenish grey, prominent, persistent, sorediate, about 0.5 mm wide. Disc distinctly white pruinose, rough, slightly concave to flat, C-. In sections: Epihymenium and parts of uppermost hymenium C+ fugitive red (gyrophoric acid). Mature spores not seen. Pycnidia not seen.

Chemistry: Thallus: variolaric acid with satellite; alectoronic acid (faint trace in a few specimens). Apothecia: variolaric acid with satellite, gyrophoric acid, lecanoric acid (trace). Thallus UV+ bluish white. Soralia and eroded tuberculae C+ yellow; cortex C± yellow; medulla C-.

Substratum. *Ochrolechia turneri* grew on broad-leaved deciduous trees, mainly *Quercus* (11 specimens), but also on *Fraxinus excelsior* (7) and on *Acer platanoides, A. pseudoplatanus, Aesculus hippocastanum, Carpinus betulus, Fagus sylvatica, Populus tremula, Tilia, Salix caprea, Sorbus aucuparia*, and *Ulmus glabra. Ochrolechia turneri* grew on well-lit, mature boles of isolated trees, e.g., road-side trees and trees growing in churchyards and parks. Noteworthy, closely associated species were *Acrocordia gemmata, Anaptychia ciliaris, Caloplaca obscurella, Lecanora impudens, Lecidella elaeochroma, Opegrapha vermicellifera, Parmelia (Melanelia) exasperatula, Pertusaria albescens, P. coccodes, P. flavida, Ramalina farinacea*, and *Xanthoria polycarpa*.

Distribution. *Ochrolechia turneri* occurred in the coastal lowlands from Østfold to Nord-Trøndelag (Fig. 95). Its vertical distribution ranged from about sea-level to 160 m (Østfold: Aremark). **Counties:** Østfold, Akershus, Buskerud - Nord-Trøndelag.

Discussion. *Ochrolechia turneri* has until recently been regarded as synonymous with *O. microstictoides* (see, e.g., Laundon 1963, Poelt 1969, Hawksworth et al. 1980, Santesson 1984). However, the two species are distinguished by morphological, chemical, ecological and distributional traits (see Tab. 15 and discussion under *O. microstictoides*), and should clearly be considered as distinct from each other. In well-developed specimens the soralia of *Ochrolechia turneri* may occasionally become confluent.

Ochrolechia alboflavescens also has discrete soralia and produces variolaric acid in addition to lichesterinic acid and
protolichesterinic acid. *Ochrolechia turneri* is distinct from that species by the much smaller, irregular soralia; the greyish cortex and the absence of fatty acids (see also Tab. 15). These two species differ markedly in their vertical distribution. In southern Norway (*O. turneri* being absent in North Norway), *O. alboflavescens* occurred at altitudes between 120 and 1030 m, whereas *O. turneri* is a lowland species.

The accessory depsidone alectoronic acid which was found in a few specimens, is an accessory also in the fertile, non-sorediate, variolaric acid producing species *O. pallescens*, *O. parella*, and *O. szatalaënsis* (Hanko et al. 1985). A specimen from Møre og Romsdal (Tønsberg 3869) was infested with the lichenicolous fungus *Dactylospora parasitica* (Flörke ex Sprengel) Zopf.

Ochrolechia turneri is a species of eutrophic bark in coastal habitats. It has rarely been found also on wood (*Sorbus aucuparia*). The specimen from Finnmark cited as *Ochrolechia turneri* by Alstrup & Søchting (1986) proved to belong to *O. androgyna* D.

Specimens seen (selected): Øf: Aremark 1985, Tønsberg 9463. - Ak: Enebakk 1990, Gauslaa (NLH). - Bu: Ringerike 1990, Tønsberg 13309. - Vf: Tjølling 1930, Høeg (TRH). - Te: Bamble 1983, Tønsberg 7950. - AA: Arendal (Moland) 1987, Tønsberg 10224. - VA: Kristiansand 1981, Gauslaa (NLH). - Ro: Hjelmeland 1981, Gauslaa (NLH). - Ho: Bergen 1984, Tønsberg 8783. - SF: Gloppen 1989, Tønsberg 11936. - MR: Nesset 1979, Tønsberg 3868. - ST: Trondheim 1983, Tønsberg 8120. - NT: Leksvik 1980, Tønsberg 4838a. A total of 33 specimens seen.

Opegrapha Ach.

The genus *Opegrapha* is in urgent need of a revision. The genus was recently revised for parts of the Mediterranean area by Torrente & Egea (1989).

Opegrapha gyrocarpa Flotow

Thallus crustose, episubstratal, delimited, forming more or less rounded patches up to 2 cm in diameter, areolate or continuous, sorediate. Prothallus distinct, forming a brown to blackish brown border at the edge of the thallus and between individual areolae. Areolae greenish or brownish, often a mixture of these colours, often indistinct, discrete or, more often, some becoming contiguous or fused, mostly irregular in outline, flat to convex, up to 0.2 mm in diameter. Esorediate surface of continuous specimens coloured as above; smooth to weakly tuberculate, more or less cracked. **Soralia** more or less brown when young due to pigmentation of the external soredia, later, when most of the soredia have been shed, often becoming pure white due to deposits of large amounts of crystals; persistently discrete or becoming confluent towards the thallus centre; rounded to irregularly elongate, in continuous thalli often developing along cracks; more or less plane to convex; irregularly sized, up to 0.3 mm across. Soredia fine; wall indistinct to distinct; unpigmented soredia with crystals; surface of brown-pigmented soredia without crystals; pigment K+ greyish to brownish black, N-. Medulla distinct in thick specimens, white. Photobiont *Trentepohlia*.

Apothecia unknown in Norwegian corticolous material but occasionally present in saxicolous material, black, marginate, varying from more or less rounded and up to 0.7 mm in diameter to lirelliform and up to 0.8 × 0.5 mm. Pycnidia not observed.

Chemistry: Gyrophoric acid with a trace of lecanoric acid, ± schizopeltic acid with satellites. Thallus UV+ bluish white or UV-. Soralia and medulla C+ red.

Substratum. *Opegrapha gyrocarpa* was found on smooth, shaded bark at the base of trunks of *Sorbus aucuparia* (4 specimens) and *Betula pubescens* (1) growing adjacent to shaded north-facing overhangs inhabited by saxicolous specimens of the species. Close associates included *Arthonia didyma*, *A. radiata*, *Arthopyrenia ranunculospora*, *Belonia russula*, *Enterographa zonata*, *Lecanactis abietina*, *Thelotrema lepadinum*, and an apparently undescribed sorediate species with psoromic acid.

Distribution. Corticolous specimens of *Opegrapha gyrocarpa* were found along the western coast and in Setesdalen (Aust-Agder), at altitudes between 30 and 450 m altitude. **Counties:** Corticolous specimens. Aust-Agder, Hordaland, Nordland. All specimens: Akershus, Oppland, Buskerud, Telemark - Finnmark.

Discussion. *Opegrapha gyrocarpa* is a polymorphic species especially when considering saxicolous material. In one form the thallus is indeterminate and consists of scattered, pinkish to rust-red (fading to pale yellow in the herbarium), diffuse soralia. In another form the thallus is delimited, thick, continuous and surrounded by a conspicuous, brown prothallus; the soralia are whitish to brown and often delimited. However, most specimens were intermediate between these extremes. The present corticolous material did not exhibit the range of variation seen in saxicolous material.

In saxicolous material 3 chemotypes occur: one with gyrophoric acid, one with schizopeltic acid, and one with both gyrophoric acid and schizopeltic acid.

Opegrapha gyrocarpa often grows in colonies, with the individuals usually separated by a blackish brown bordering line. Large areolate specimens may actually be a result of a fusion of several small thalli, each of which originally consisted of one areola surrounded by a prothalline border.

Opegrapha gyrocarpa often occurs with *Enterographa zonata*. That species has smaller, more regularly sized, often lilac-tinged soralia and a different chemistry including 2'-O-methylmicrophyllinic acid.

Opegrapha gyrocarpa is a saxicolous species on shaded rock under overhangs. It only rarely occurs on bark. James et al. (1977) assigned *Opegrapha gyrocarpa* to *Opegraphae horistico-gyrocarpae* Wirth, an association of shaded rock underhangs. *Opegrapha gyrocarpa* is most frequent in the coastal lowlands (see Botnen & Tønsberg 1988); inland the species is largely restricted to humid river gorges.

Specimens seen: AA: Valle 1987, Tønsberg 10161a. - Ho: Os 1984, Tønsberg 8718b. - No: Leirfjord 1985, Tønsberg 9242a, 9243. A total of 5 specimens from 3 localities seen.

Opegrapha multipuncta Coppins & P. James ined.

Fig. 96.

Thallus crustose, endo- to episubstratal in esorediate parts, thin, forming irregular patches up to a few cm in diameter, sorediate. Esorediate parts absent or evident as a thin, green to brown-green tinge on smooth bark. **Soralia** numerous, at first discrete, punctiform and up to 0.3 mm in diameter, more rarely elongate, often some becoming confluent, crateriform to slightly efflorescent, orange in fresh material, fading to dull straw in the herbarium. Soredia fine, irregularly rounded; wall poorly developed or not evident; external soredia orange (in fresh material). Photobiont *Trentepohlia*.

Apothecia and pycnidia not observed.

Chemistry: No substances observed.

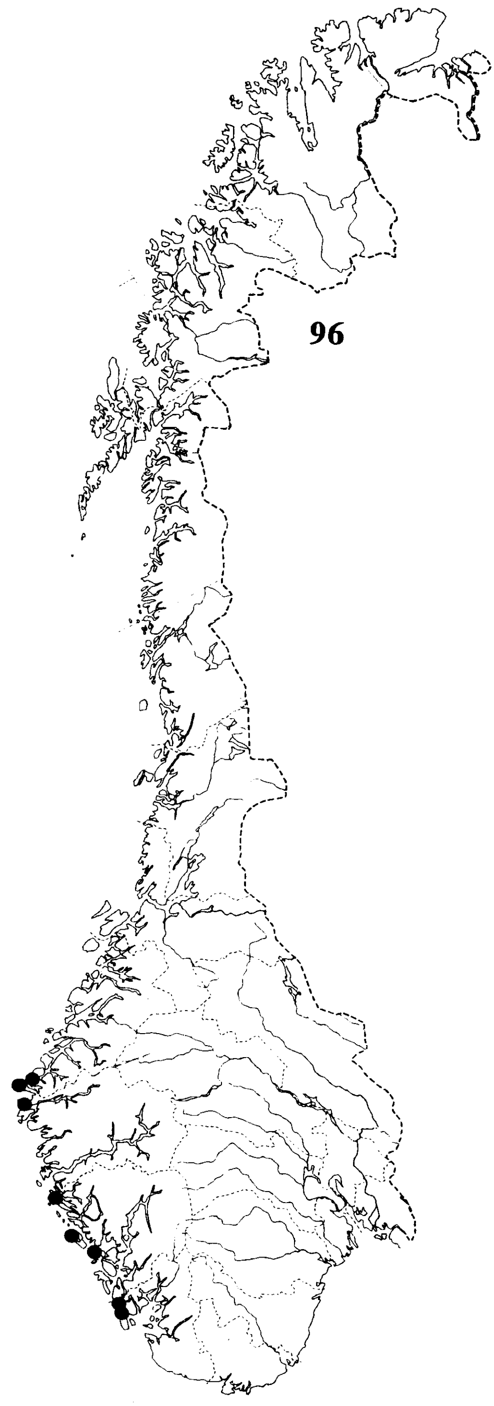
Substratum. *Opegrapha multipuncta* was found on sheltered stems of *Calluna vulgaris*, *Empetrum* sp., and *Juniperus communis* in steep rock faces or on ledges in cliffs. It was also found on shaded trunks of *Acer pseudoplatanus*, *Picea abies* and *Pinus sylvestris* and on the shaded side of a more or less horizontal branch of *Malus domestica*. A particularly well-developed specimen covered an extensive area on the shaded under-side of a leaning trunk of *Acer pseudoplatanus*. On *Pinus sylvestris* it was found in bark fissures on the shaded grass-covered bases of trunks in a churchyard. Associated lichens included *Dimerella pineti*, *Lecanora expallens*, *Lepraria* sp., *Micarea prasina* and *Parmelia saxatilis*.

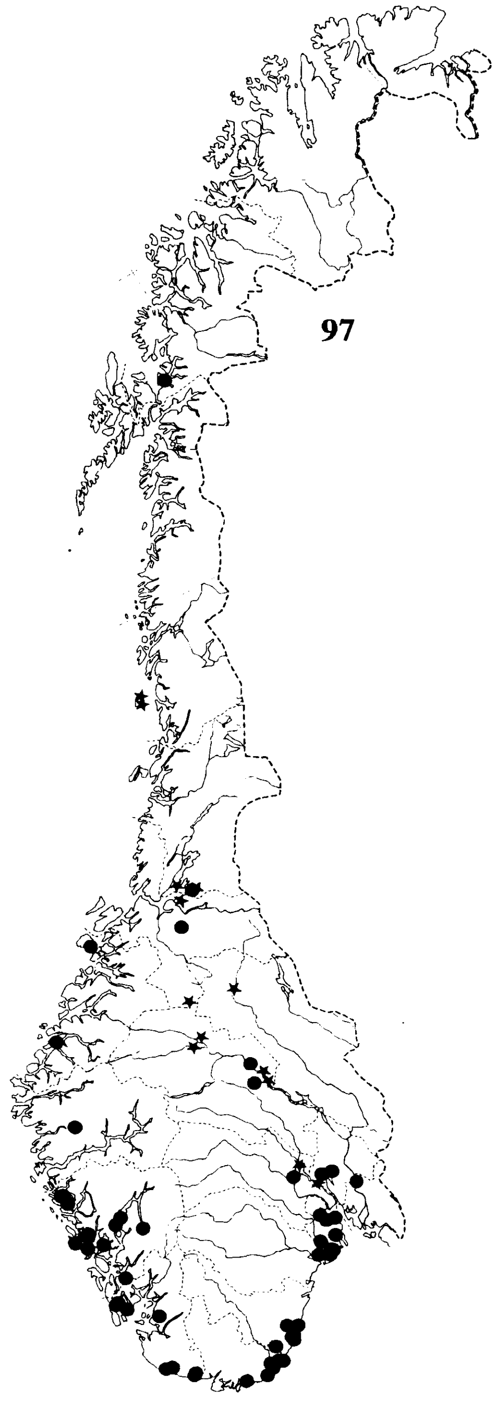
Distribution. The specimens were from coastal sites; most habitats were strongly maritime (Fig. 96). The specimens were collected at altitudes below 50 m. **Counties:** Rogaland - Møre og Romsdal.

Discussion. *Opegrapha multipuncta* is a characteristic species on account of the thin thallus and the orange, punctiform soralia which lack lichen substances. Outside Norway it is known from northern and western Scotland, the Scilly Islands (Pentecost & Coppins 1983) and the Faroe Islands (Alstrup & Alstrup 1989). *Opegrapha multipuncta* has not previously been reported from Scandinavia.

Opegrapha multipuncta is a species of coastal lowland habitats.

Specimens seen: Ro: Haugesund 1990, Tønsberg 13455b, 13470, 13472. Karmøy 1990, Tønsberg 13475. - Ho: Austevoll 1990, Tønsberg 13598. Austrheim 1990, Tønsberg 13009. Fjell 1989, Tønsberg 12010, 12013, 12024. - SF: Selje 1989, Tønsberg 11928. Vågsøy 1989, Tønsberg 11858. - MR: Sande 1989, Tønsberg 11908. A total of 12 specimens seen.





Figs 96-97. Distribution maps. Fig. 96. *Opegrapha multipuncta*. Fig. 97. *Pertusaria albescens*.

Opegrapha sorediifera P. James

Thallus crustose, episubstratal, indeterminate, thin and indistinct, following the contours of the substrate, forming small, irregular patches up to about one cm in diameter between other crustose lichens, continuous, sorediate. Prothallus indistinct or absent. Non-sorediate parts of surface pale greenish brown, becoming pale greyish brown in the herbarium. **Soralia** yellowish brown or yellowish orange due to pigmentation of the external soredia, becoming dull straw-coloured in the herbarium, diffuse, rounded in outline or somewhat elongate, crateriform to slightly convex, up to 0.3 mm in diameter, occasionally 2-3 becoming confluent. Soredia fine, up to 20 µm in diameter; wall indistinct to distinct. Medulla sometimes distinct beneath the soralia. Photobiont *Trentepohlia*.

Apothecia not observed.

Chemistry: Gyrophoric acid.

Substratum. *Opegrapha sorediifera* was found in a small, humid and sheltered woodland where it grew abundantly (about 10 specimens) on the shaded, north-facing side of a trunk of *Quercus*. It grew on rough parts of the bark, partly in crevices. Closely associated species included *Catillaria pulverea, Hypogymnia physodes, Lepraria* spp., *Loxospora elatina, Micarea prasina, Parmelia saxatilis, P. sulcata, Parmeliella jamesii, Ramalina farinacea, Ropalospora viridis*, and *Rinodina efflorescens*. On boles of various trees in the vicinity were *Arthonia tumidula, Degelia atlantica, Lobaria virens, Opegrapha vermicellifera, Pachyphiale cornea*, and *Sticta limbata*.

Distribution. *Opegrapha sorediifera* was found in a single site in western Norway (Vestlandet) at about 30 m altitude. **County:** Hordaland.

Discussion. *Opegrapha sorediifera* is most likely to be confused with *O. gyrocarpa*, but that species has usually a thicker and more distinct thallus, and a different chemistry including the accessory schizopeltic acid in addition to gyrophoric acid. Moreover, *O. gyrocarpa* belongs in the normally saxicolous association *Opegrapha horistico-gyrocarpae*; corticolous specimens of that species appear to be restricted to trees growing next to shaded rock under overhangs. *Opegrapha sorediifera* has only been found sterile in Scandinavia (see also Christiansen et al. 1979). In other parts of northwest Europe *O. sorediifera* has been found on several species of deciduous phorophytes (James & Coppins 1979). Outside Norway the species has been reported from the British Isles, northern France, Denmark and Sweden (see, e.g., James 1962, Christiansen et al. 1979, Arvidsson et al. 1988). *Opegrapha sorediifera* is new to Norway.

Specimen seen: Ho: Austevoll 1985, Tønsberg 9400.

Pertusaria DC

The genus *Pertusaria* in Europe was monographed by Erichsen (1936), see also Erichsen (1940), but is now in urgent need of a thorough revision. The corticolous *Pertusaria* species have been studied for Norway by Høeg (1923). The chemistry of the European species has been studied by Hanko (1983). The genus has been monographed for North America and Japan by Dibben (1980) and Oshio (1968), respectively.

Pertusaria albescens (Huds.) M. Choisy & Wern.

Pertusaria globulifera f. *isidiata* Høeg., in Nyt Mag. Naturv. 61:155 (1923). Type: Norway, Vestfold, Brunlanes, 16 January 1922, Høeg (TRH! - lectotype; here selected). The specimens cited in the protologue belonged to *Pertusaria albescens* (about one half) and *Ochrolechia turneri*.

Figs 8, 97.

Thallus crustose, episubstratal, distinctly delimited, continuous, forming rosettes or irregular patches up to several dm in diameter, usually sorediate, sometimes quasi-isidiate (true isidia absent), often distinctly zoned towards margin (Fig. 8), alternating bands usually greenish and whitish grey, outermost band white (not felty). Esorediate surface smooth to highly tuberculate or rugose-plicate, often fissured, sometimes radiately so towards the margin; cortex ash-grey to green-grey. **Soralia** conspicuous, whitish grey, variable, usually orbicular, concave, more or less plane or convex, sometimes semiglobose, often locally fused, but not forming a continuous, leprose crust, up to 3(-4) mm in diameter. Soredia coarse, globose to broadly ellipsoidal, up to 200 µm, simple or in elongate, projecting, simple to sparingly branched consoredia up to 0.3 mm long; wall distinct. A quasi-isidiate form had distinct tuberculae each of which had eroded apically to form more or less corticate, isidioid granules; these cortex-derived granules were often mixed with soredia and consoredia. Medulla distinct, white. Photobiont green, coccoid, up to 15(-19)µm in diameter.

Apothecia and pycnidia not observed.

Chemistry: Allo-pertusaric and dihydropertusaric acids with decomposition products. The chromatographic pattern, as revealed in long-wave UV-light after charring, indicated a complex chemistry apart from the identified fatty acids, including a number of ± pinkish substances possibly representing terpenoids (major spots in R_F-classes: A 3, B 3, C 2-3), and one UV+ blue spot (R_F-classes: A 3, B 3, C 3). Thallus UV+ whitish blue.

Substratum. *Pertusaria albescens* has been found on trunks of broad-leaved trees, especially *Quercus* (45 specimens), *Fraxinus excelsior* (29), *Fagus sylvatica* (19), *Acer pseudoplatanus* and *Acer* sp. (12), and, less often, on *Sorbus aucuparia* and *Tilia*, and, very rarely, on *Alnus incana*, *Betula pubescens/pendula*, *Picea abies*, *Populus tremula*, and *Prunus avium*.

Distribution. Fig. 97. Corticolous specimens were largely restricted to the coastal lowlands of southern Norway where they occurred in open situations. The only known inland stations were humid river gorges in Oppland. The vertical distribution for corticolous specimens ranged from about sea-level to 420 m (Oppland: Gausdal); few collections were from altitudes above 100 m. **Counties:** Corticolous specimens: Østfold, Akershus, Oppland - Nord-Trøndelag, Troms. All specimens: Østfold - Troms.

Discussion. *Pertusaria albescens* may strongly resemble *P. amara* morphologically. Several herbarium specimens of *P. albescens* were originally incorrectly named *P. amara* and *vice versa*. The saxicolous specimen from Nordland, Saltdalen, leg. Sommerfelt (O) cited by Høeg (1923; as *P. scutellata)* is *P. amara*. However, there are some distinguishing morphological trends. *Pertusaria amara* has only rarely a distinctly zoned margin, and the soralia are often pure white. *Pertusaria albescens* commonly has a zoned margin and the soralia are usually greyish. In collections where both species occur together on the same small piece of bark (e.g., Tønsberg 8304) these differences were obvious. *Pertusaria albescens* is easily separated from *P. amara* by chemistry as the latter contains picrolichenic acid. The quasi-isidiate form (= var. *corallina* (Zahlbr.) Laundon) seems to be of no taxonomic significance. Although the extremes of this and the typical form are quite different, there is continuous intergradation of form between them. Almborn (1948: 76) was apparently right in stating that this form is not much more than a modification induced by a dust-impregnated habitat. The "isidiate" form occurs mainly on eutrophicated trees subjected to wind-blown dust from roads and farms. All specimens from sea-shore rocks, which are subjected to salt spray, belonged to this form. All alpine, terricolous specimens belonged to the typical, sorediate form. A similar "isidiate" form is also developed by *P. amara*, *Ochrolechia androgyna* B, *O. microstictoides* and *Phlyctis argena*.

Dibben (1980) found no lichen substances in North American and Eurasian material of *Pertusaria albescens*. However, the presence of fatty acids in European material has recently been well documented (Holien et al. 1980, Hanko 1983, Huneck et al. 1986, Kümmerling 1991).

Non-corticolous material (altogether about 20 specimens seen) has been found at altitudes from about sea-level (maritime rocks) up to 1000 m (Oppland: Sel, leg. M.N. Moe (O)). The only known specimens from Hedmark (Tynset, leg. Lynge (O)) and Nordland (Vega, leg. Degelius 1982) were muscicolous (on non-corticolous mosses) and saxicolous, respectively. *Pertusaria albescens* is apparently able to grow in different habitats in several quite different regions. The main habitat is, however, eutrophic bark in the coastal lowlands.

Specimens seen (selected): Øf: Trøgstad 1978, Tønsberg 3361. - Oslo, M.N. Blytt (O). - Op: Øyer 1984, Tønsberg 8992. - Bu: Modum 1839, Moe (O). - Vf: Borre 1934, Høeg (TRH). - Te: Porsgrunn 1978, Tønsberg 3349. - AA: Froland 1987, Tønsberg 10218. - VA: Audnedal 1932, Degelius (herb. Degelius). - Ro: Tysvær 1978, Tønsberg 3118. - Ho: Tysnes 1986, Tønsberg 9514. - SF: Førde 1984, Tønsberg 8709. - MR: Smøla 1983, Tønsberg 8304. - ST: Melhus 1982, Tønsberg 6652. - NT: Stjørdal 1936, Høeg (TRH). - Tr: Ibestad 1981, Elvebakk (TROM). A total of 133 corticolous specimens seen.

Pertusaria amara (Ach.) Nyl.

Thallus crustose, usually episubstratal, distinctly delimited, thin to thick, forming rosettes or irregular patches up to several dm in diameter, continuous, sorediate, rarely quasi-isidiate, sometimes distinctly zoned towards the margin, alternating bands usually greenish and whitish to pale greyish brown; outermost band white to yellow-white. Esorediate surface even to coarsely tuberculate, rarely distinctly rugose-plicate, rarely fissured; cortex grey, sometimes greenish, rarely whitish. **Soralia** conspicuous, purely white to greyish, lighter than the corticated parts of the thallus, discrete or, sometimes, locally fused, orbicular, rarely more or less elongate/sublinear, concave to more or less semiglobular and constricted at base, up to 4 mm in diameter. Soredia mostly coarse, globose to broadly ellipsoidal, up to 100 µm in diameter, simple or in globose to elongate consoredia up to 0.2 mm in diameter; wall distinct, sometimes with short projections. A quasi-isidiate form has distinct tuberculae each of which erode apically forming a soralium with soredia and consoredia mixed with more or less corticate, isidioid granules from the fragmented, surrounding cortex. Medulla distinct. Photobiont green, coccoid, up to 15(-20) µm in diameter.

Apothecia rare, present in 6 (2%) of the specimens; in more or less sorediate and/or pruinose, poly- to monocarpic tuberculae, up to 4 mm in diameter; disc rose-coloured, up to 2 mm in diameter; four specimens contained mature asci; asci one-spored; spores 144-250 × 38-80 µm. Pycnidia usually sparse or absent, immersed in the tuberculae; centre pale flesh-coloured, colourless in microscopical sections; conidia rod-shaped, 4 x <1 µm.

Chemistry: Picrolichenic acid, ± unknown with picrolichenic acid (rarely traces of one or two other substances in the picrolichenic acid complex), ± protocetraric acid. Unknown with picrolichenic acid was present in 29 (8%) of the specimens and occurred in amounts lower than or, rarely, more or less equal to that of picrolichenic acid.

51 specimens (14%) were PD+ distinctly orange-red to red due to the presence of the β-orcinol depsidone protocetraric acid. Fertile tuberculae always contained protocetraric acid in large amounts in the tissues directly surrounding the hymenia. Soredia sometimes occurring on the fertile tuberculae reacted PD-, as did most other parts of the thallus including soralia which lacked apothecia, except for some minute areas in the centre of some soralia. Minute, protocetraric acid-containing areas were also sometimes found in the interior of soralia on completely sterile specimens. Medulla PD-, KC+ violet. Thallus UV+ whitish blue.

Substratum. *Pertusaria amara* has commonly been collected on a number of phorophytes, both deciduous trees and conifers, including *Acer platanoides*, *A.* sp., *Alnus glutinosa*, *A. incana*, *Betula pubescens/pendula*, *Fagus sylvatica*, *Fraxinus excelsior*, *Juniperus communis*, *Picea abies*, and *Pinus sylvestris*, *Populus tremula*, *Prunus domestica*, *P. padus*, *Quercus*, *Salix caprea*, *Sorbus aucuparia*, *Tilia*, and *Ulmus glabra*. *Pertusaria amara* occurred in sun-exposed as well as in shaded habitats.

Distribution. *Pertusaria amara* occurred in the lowlands in a broad belt along the coast. It only rarely occurred in inland areas of southern Norway. The vertical distribution of corticolous specimens ranged from sea-level to 600 m (Buskerud, Krødsherad). Saxicolous specimens were collected up to 950 m altitude (Sogn og Fjordane: Aurland). The fertile specimens were from Akershus, Vestfold, Sør-Trøndelag and Nord-Trøndelag. **Counties:** Østfold - Troms.

Discussion. *Pertusaria amara* is easily recognized on account of the presence of the depsone picrolichenic acid. Morphologically *Pertusaria amara* may be confused with *P. albescens* (see discussion under that species).

Pertusaria amara has a quasi-isidiate form (= *P. pulvinata* Erichsen) which does not seem to merit taxonomic recognition. In the present material that form was represented by 8 specimens. It occurs on dust-impregnated roadside trees, and is linked with the main form by transitional forms. A corresponding form also occurs in *Ochrolechia androgyna*, *O. microstictoides*, *P. albescens* and *Phlyctis argena*, when growing in eutrophicated habitats.

The chemistry of *Pertusaria amara* was recently discussed by Dibben (1980), Hanko (1983), and Holien et al. (1980). Unknown with picrolichenic acid was present in occasional specimens throughout most of the range of the species and is considered to be of no taxonomic value. It also occurs in other picrolichenic acid-producing species of *Pertusaria* (Hanko 1983: 213).

The presence of protocetraric acid in *Pertusaria amara* appears to be related to the occurrence of apothecia. The presence of protocetraric acid in sorediate tuberculae of completely sterile thalli indicates that these tuberculae represent rudimentary fertile tuberculae (see also Dibben 1980: 3). Further evidence can be added to this hypothesis: *Pertusaria amara* may also occur in an esorediate, consistently fertile form (=*Pertusaria slesviciensis* Erichsen; not known to occur in Norway). In that form, protocetraric acid, which is a constant substance in addition to picrolichenic acid (Hanko 1983), is restricted to the fertile tuberculae.

Pertusaria amara has been the most commonly collected species of sorediate, crustose corticolous lichen in Norway. It is mainly a coastal lowland species and occurs on acidic to eutrophic bark. It has occasionally been collected on rocks.

Specimens seen (selected): Øf: Trøgstad 1978, Tønsberg 3363. - Oslo 1906, Lynge (O; fertile). - He: Kongsvinger 1985, Tønsberg 9430. - Op: Lunner 1982, Tønsberg 7551. - Bu: Krødsherad 1982, Tønsberg 6968c. - Vf: Hedrum 1922, Høeg (TRH; fertile). Larvik, Norman (O; fertile). - Te: Bamble 1978, Tønsberg 3345a. - AA: Grimstad 1978, Tønsberg 3226. - VA: Søgne 1978, Tønsberg 3146a. - Ro: Hjelmeland 1978, Tønsberg 3036. - Ho: Kvam 1979, Tønsberg 4100. - SF: Leikanger 1979, Tønsberg 4053. - MR: Tingvoll 1979, Tønsberg 3942.

- ST: Malvik 1985, Tønsberg 9132 (fertile). - NT: Namdalseid 1979, Holien (TRH; fertile). - Snåsa 1983, Tønsberg 8500 (fertile). - No: Brønnøy 1987, Tønsberg 10583. - Tr: Målselv 1988, Tønsberg 11100. Exsiccata examined: Havaas, Lich. Norv. 329 (BG, O, UPS). A total of 359 specimens seen.

Pertusaria borealis Erichsen

Ann. Mycol. 36: 354 (1938). Type: Alaska, Kodiak Island, Kodiak, 27 April 1932, E. Hultén 5062 (UPS! - lectotype). TLC: fumarprotocetraric acid (major substance), protocetraric acid (faint trace), succinprotocetraric acid (faint trace), cph-2 (trace).

Fig. 98.

Thallus (Fig. 98) crustose, endo- or, more commonly, episubstratal in non-sorediate parts, delimited, continuous, forming rosettes up to about 7 cm in diameter, or more or less irregularly spreading patches up to a few dm diameter, sorediate. Prothallus indistinct, sometimes evident as a whitish, 1-2 mm wide, glossy zone bordering the thallus. Corticate parts pale grey to pale green-grey, sometimes with a blue tinge, rarely whitish, greenish grey in shade, even to distinctly tuberculate, sometimes wrinkled, often fissured. Tuberculae rounded, up to 0.5 mm in diameter. **Soralia** pale green-grey, blue-green, yellowish white or white, sparse to abundant, mostly delimited, usually convex, often hemispherical to subglobose, sometimes excavate, but then usually with a prominent margin, rounded to somewhat irregular, mostly discrete, occasionally a few fused, but never forming a leprose crust, variable in size, up to 1.5 (-3 mm) in diameter. Soredia mostly coarse, up to 80 µm in diameter, often in rounded consoredia up to 0.2 mm in diameter; wall distinct. Medulla white, distinct in thickish specimens. Photobiont green, coccoid, up to 18 µm in diameter.

Apothecia (Fig. 98) rare, observed in 3 (2%) of the collections, immersed in the soralia and at first entirely covered in soredia, later becoming expanded and more or less exposed,

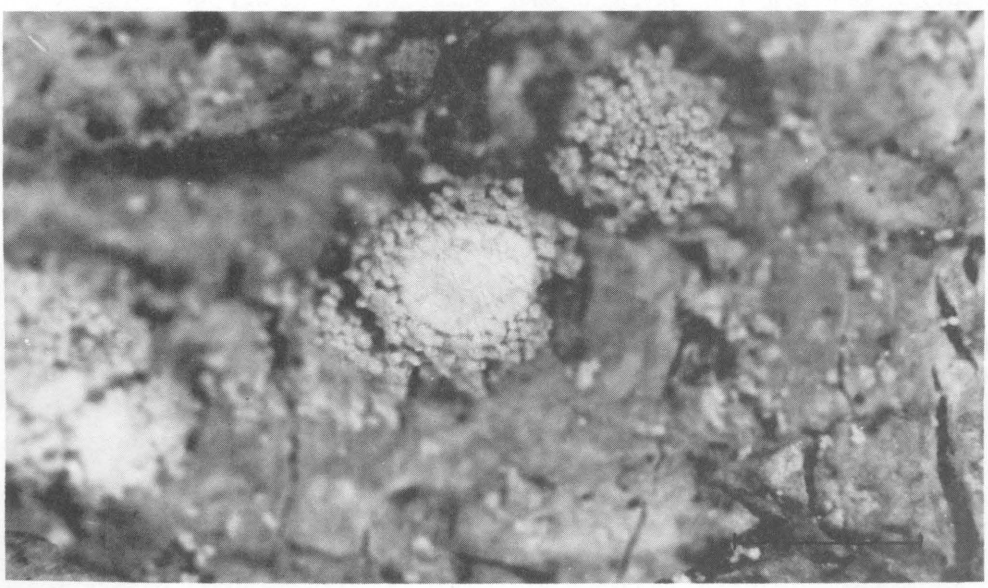


Fig. 98. *Pertusaria borealis*. Tønsberg 8452. Apothecium and soralia. Scale 1 mm.

monocarpic, disciform; disc pale pink, more or less white-pruinose due to deposits of calcium oxalate, up to 0.7 mm in diameter. Hymenium about 120 µm deep. Asci 120 × 28 µm, mostly 6-spored. Spores broadly ellipsoid, 18-20 × 10-14 µm; wall simple, 1 µm wide. Paraphysoids branched, 1.5-2 µm wide. Pycnidia rare (observed in Tønsberg 3836), immersed in the soralia, pale pink. Conidia narrowly fusiform to rod-shaped, 5-7.5 × 1 µm.

Chemistry: Fumarprotocetraric acid (major substance), protocetraric acid (trace, occasionally not observed), cph-2, succinprotocetraric acid (absent in a few specimens, in trace amounts, rarely in a concentration more or less equal to that of fumarprotocetraric acid, e.g., in Tønsberg 6889, 10452). Medulla and soralia PD+ orange red. Thallus UV- or UV+ faintly bluish.

Substratum. *Pertusaria borealis* has been collected on *Alnus incana* (67 specimens), *Sorbus aucuparia* (27), *Betula pubescens/pendula* (21), *Picea abies* (20), *Alnus glutinosa*, *Corylus avellana*, *Fagus sylvatica*, *Juniperus communis*, *Pinus sylvestris*, *Populus tremula*, *Prunus padus*, *Salix aurita*, *S. caprea*, and *Ulmus glabra* (smooth-barked, young branch). A noteworthy close associate was *Gyalideopsis alnicola.*

Distribution. *Pertusaria borealis* occurred throughout most of the country. Most collections were from the coastal lowlands. Inland it occurred mainly on banks of rivers and near lakes. Its vertical distribution ranged from about sea-level to 600 m (Hedmark: Tynset). **Counties:** Akershus - Finnmark.

Discussion. *Pertusaria borealis* is characterized by a usually sterile, grey, corticolous thallus with discrete, convex soralia, and the production of the β-orcinol depsidone fumarprotocetraric acid with a trace (or rarely a high concentration) of succinprotocetraric acid. A common form (represented by, e.g., Tønsberg 7469) on, e.g., *Betula* in subalpine *Betula* forests, has a thin thallus with excavate soralia. However, as this form seems to be linked to the typical form by intermediates it is tentatively included in *Pertusaria borealis.* A similar morphological variation in the soralia from convex to flat or concave, occurs in material of other *Pertusaria* species, e.g., in *P. amara.*

Morphologically *Pertusaria borealis* is similar to *P. dealbescens.* That species is saxicolous under overhanging rock and produces succinprotocetraric acid in a concentration above or equal to that of fumarprotocetraric acid.

Forms with bluish soralia (e.g., Tønsberg 13082) may resemble *Pertusaria hemisphaerica*, but in that species the soralia are composed of much more firmly packed soredia. *Pertusaria hemisphaerica* contains lecanoric acid. In the herbaria *Pertusaria borealis* has previously mostly been filed under the names *Haematomma elatinum* (syn. *Loxospora elatina*), *Pertusaria maculata* and *P. chloropolia.*

Pertusaria borealis is not always readily distinguished from *P. pupillaris.* Typical specimens of that species have an endosubstratal thallus, white, often somewhat irregularly rounded, more or less immersed and flat soralia; succinprotocetraric acid is absent. Differences in morphology between *P. borealis* and *P. pupillaris* were obvious in a mixed collection (Tønsberg 7383 b and a, respectively) including a fertile specimen of the latter. When fertile *P. pupillaris* is easily recognized by the lecanorine, black apothecia, and when pycnidiate by the dark-ostiolate pycnidia not immersed in soralia. However, several intermediate specimens, mostly poorly developed, could not with certainty be assigned to one species or the other.

The fertile specimens (Tønsberg 8384, 8452, 8457) were all from the humid and shaded coastal *Picea abies* forests of central Norway (Nord-Trøndelag: Flatanger). These specimens, along with others from similar habitats, were somewhat more abundantly sorediate and had slightly finer soredia than most specimens from well-lit situations. Apothecia were also present on a specimen from British Columbia (Crane & Noble 4052C (UBC)). Fertile specimens of *P. borealis* appear not to have been previously recorded.

Pertusaria borealis Erichsen was regarded by Dibben (1980) as being a North American endemic, corticolous lichen. According to Dibben (1980), *P. borealis* consistently lacks succinprotocetraric acid. However, occasional North American specimens examined (3 specimens from British Columbia and Alaska) and nearly all Norwegian specimens contained at least a trace of that substance. The Norwegian specimens agree well morphologically and chemically with the material from North America, including the type specimen from Alaska. On a world-wide basis *P. borealis* seems to have a western North America - northwestern Europe disjunct distribution. *Pertusaria borealis* is here recorded as new to Europe. However, Coppins & James (1989) mentioned *Pertusaria borealis* as a possible name for an unidentified species of *Pertusaria* from U.K.: Scotland. Based on their descriptions, that material most probably belongs to *Pertusaria borealis*.

Pertusaria borealis is a widespread species of acidic bark.

Specimens seen (selected): **Norway**: Ak: Bærum 1981, Tønsberg 6422. - He: Åmot 1982, Tønsberg 6889. - Op: Lunner 1982, Tønsberg 7543. - Bu: Sigdal 1981, Tønsberg 6375. - Vf: Våle 1922, Høeg (TRH). - Te: Drangedal 1987, Tønsberg 10270. - VA: Vennesla 1939, Magnusson 16650 (UPS). - AA: Bygland 1987, Tønsberg 10210. - Ro: Sauda 1978, Tønsberg 3079. - Ho: Ulvik 1979, Tønsberg 4069. - SF: Balestrand 1979, Tønsberg 4002. - MR: Vestnes 1979, Tønsberg 3836. - ST: Melhus 1982, Tønsberg 7077. - NT: Flatanger 1983, Tønsberg 8384, 8430, 8457; Namsskogan 1982, Tønsberg 7469. - No: Bindal 1982, Tønsberg 6760; Sortland 1987, Tønsberg 10452. - Tr: Skånland 1982, Tønsberg 7376, 7383b. - Fi: Tana 1982, Tønsberg 7183. A total of 159 Norwegian specimens seen. **Canada**: British Columbia, Vancouver Island 1975, A.M. Crane & W.J. Noble 4052C, 4485 (UBC). **U.S.A.**: Washington, Pierce County, Nisqually River, at Alder Lake, 1989, Tønsberg 12964.

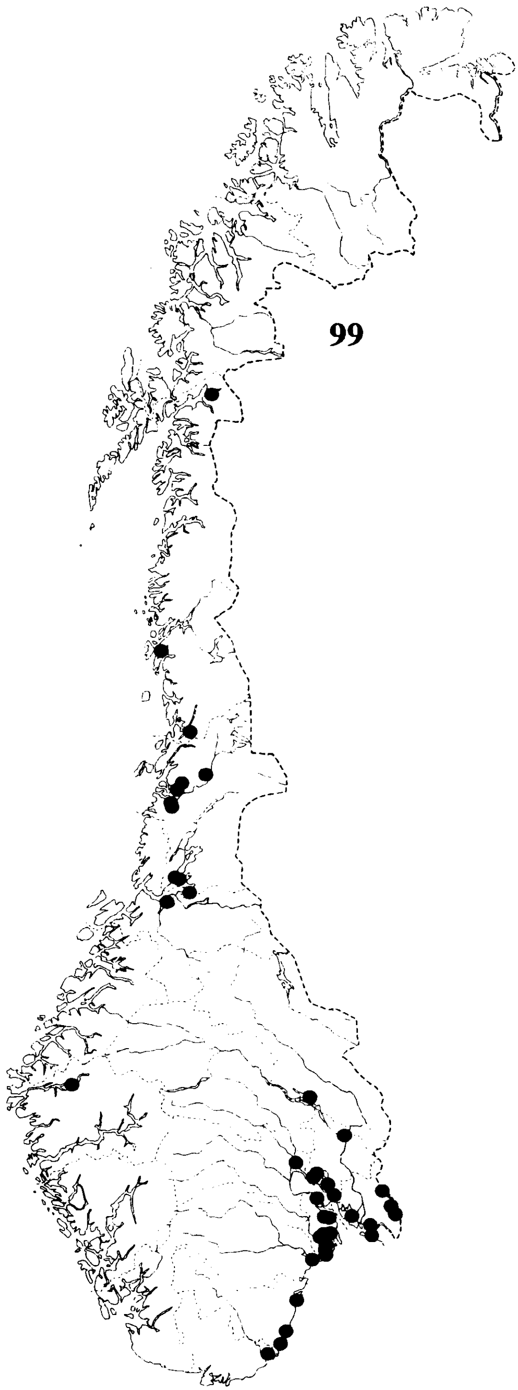
Pertusaria coccodes (Ach.) Nyl.

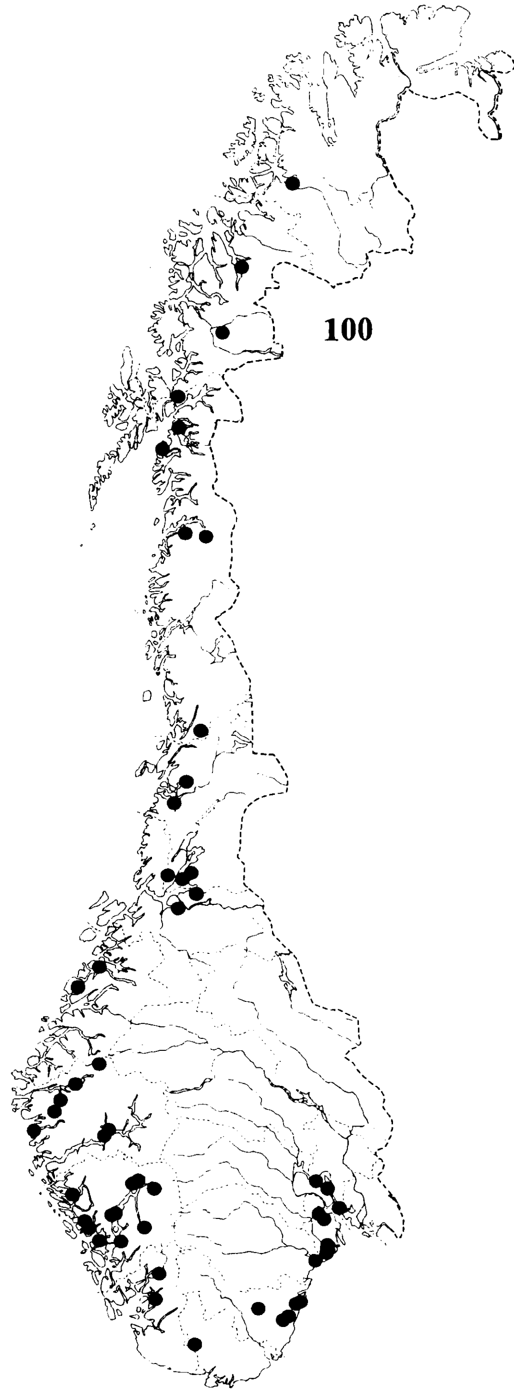
Fig. 99.

Thallus crustose, epi- or rarely endosubstratal in non-isidiate parts, delimited, thin to thick; usually forming more or less irregular patches up to one dm or more in diameter, continuous, isidiate, sometimes secondarily sorediate, sometimes distinctly zoned, alternating bands greenish or brownish and more or less whitish, outermost band (= prothallus) whitish or, rarely, greenish, felty or not. Non-isidiate parts of surface grey, yellowish grey or faintly yellowish brown; even to coarsely tuberculate and rimose cracked. **Isidia** usually more or less distinctly darkened (greyish to green-grey) towards apices; sparse to numerous; scattered to densely packed, often locally grouped, homoiomerous, varying from verruciform to cylindrical and coralloid branched, up to 0.2 mm broad and 0.5 (-1.0) mm tall. Isidia, being initiated below the thallus cortex and not firmly connected with it, frequently fall off leaving white, punctiform scars which may coalesce and form delimited or diffuse, ecorticate patches from which secondary isidia may be formed. **Soralia** rare, diffuse, pale greyish green, originating from the ecorticate scars or by eroding of the thallus cortex, becoming more or less confluent forming a more or less leprose surface. Soredia fine, 15-25 µm in diameter. Occasionally the whole surface becomes a mixture of more or less eroded isidia, cortex-fragments and ecorticate fragments. Medulla indistinct to distinct, white. Photobiont green, coccoid, up to 14 µm in diameter. In some strongly coralloid isidia (present in, e.g., Tønsberg 5302) the photobiont was mainly restricted to the apical part of the branches.

Apothecia not observed. Pycnidia not seen.

Chemistry: Norstictic acid, connorstictic acid (in trace amounts or, rarely, in a concentration that equalled that of norstictic acid). Cortex and medulla PD+ yellow, K+ yellow





Figs 99-100. Distribution maps. Fig. 99. *Pertusaria coccodes*. Fig. 100. *Pertusaria coronata*.

turning red. Thallus UV+ brownish or, in weakly pigmented specimens, UV+ blue.

Substratum. *Pertusaria coccodes* has been found on *Quercus* (23 specimens), *Fagus sylvatica* (15), *Acer platanoides* (9), *Acer* sp.(3), *Sorbus aucuparia*, *Fraxinus excelsior*, *Alnus incana*, and, rarely, *Betula pubescens/pendula*, *Juniperus communis*, *Picea abies*, *Populus tremula*, *Salix caprea*, and *Ulmus glabra*.

Distribution. *Pertusaria coccodes* has been collected in the areas around the Oslofjord, in central Norway and Nordland and in a single site in Sogn og Fjordane (Fig. 99). It usually occurred in open situations, e.g., along road-sides and in churchyards. However, in central Norway it was collected on north-facing slopes forested with *Picea abies*. In its northernmost known site (Nordland: Narvik) it grew on *Populus tremula* in a south-facing slope. The vertical distribution of corticolous specimens ranged from about sea-level to 300 m altitude (Nord-Trøndelag: Leksvik). **Counties:** Østfold - Hedmark, Buskerud - Vest-Agder, Sogn og Fjordane, Sør- Trøndelag - Nordland.

Discussion. *Pertusaria coccodes* is very variable with respect to the isidia. At least two main forms occur: a) Isidia usually abundantly present, often more or less contiguous, thick and stout, and often widening towards the apices, up to 0.2 mm in diameter and 0.3 mm tall; typical for thick specimens with a well-developed medulla, occurring on well-lit, eutrophic bark. b) Isidia cylindrical and coralloid branched, up to 0.1 mm in diameter and 0.5 (-1) mm tall; occurring throughout the range of the species. A third form which has minute, verruciform isidia 0.1 mm in diameter, might be interpreted as juvenile forms of a) and b). Most specimens found in the humid and shaded *Picea*-forests of central Norway, had isidia of the third form. In these shaded *Picea*-forests, *Pertusaria coronata* also had similar verruciform isidia indicating that some environmental factors are important in the development of the isidia of these species.

Forms with isidia of type (b) have been recognized as a separate taxon, at specific level (*P. phymatodes*) by Erichsen (1936), and at varietal level by, e.g., Almborn (1952) and Santesson (1984). However, owing to the occurrence of transitional types between this form and the others, it should not be treated as a distinct taxon (see also Hawksworth et al. 1980).

Pertusaria coccodes resembles *P. coronata* morphologically. However, these two species can easily be recognized by their chemistry. *Pertusaria coccodes* is the only isidiate species discussed here with norstictic acid as the major chemical constituent.

Previous records from westernmost parts of South Norway proved to be erroneous. Havaas: Lich. Norv. no 192, from Hordaland, Granvin, distributed as *Pertusaria coccodes* is *P. coronata*, (see also Erichsen 1936: 395). Apparently *Pertusaria coccodes* is an eastern species in Scandinavia, as it is in the British Isles (see Coppins 1976). The fertile specimen cited by Høeg (1923:167) is scanty and non-isidiate, and could not conclusively be assigned to *P. coccodes*.

Pertusaria coccodes is mainly a species of eutrophic bark.

Specimens seen (selected): Øf: Hvaler 1990, Tønsberg 13239. - Ak: Nes 1990, Tønsberg 13269. - He: Stange 1990, Tønsberg 13174. - Bu: Ringerike 1990, Tønsberg 13307. - Vf: Borre 1934, Høeg (TRH). - Te: Bamble 1983, Tønsberg 7951. - AA: Grimstad 1922, Høeg (TRH). - VA: Kristiansand 1939, Magnusson 16740 (UPS). - SF: Stryn 1990, Anonby 468. - ST: Malvik 1987, Tønsberg 9957. - NT: Namdalseid 1983, Tønsberg 8446. - No: Bindal 1982, Tønsberg 6807. Narvik 1982, Tønsberg 7419. A total of 86 specimens seen.

Pertusaria corallina (L.) Arnold

Thallus crustose, light grey or grey with a pale yellowish brown tinge towards the centre, episubstratal, thin, distinctly delimited, unzoned, rosette-forming, up to 12 cm in diameter, continuous, smooth to tuberculate and fissured cracked isidiate, without soredia. **Isidia** concolorous with non-isidiate parts of thallus surface or with the apices slightly lighter, tapering from the base or more or less cylindrical, heteromerous, usually unbranched, up to 1.1 mm high, cylindrical isidia 0.2-0.3 mm wide, Medulla distinct. Prothallus white. Photobiont green, unicellular, broadly ellipsoid to globose, to 10-15(-20) µm in diameter.

Apothecia not observed in Norwegian corticolous material, but occasionally present in saxicolous material; verrucae heavily pruinose. Pycnidia not observed.

Chemistry: Thamnolic acid. Medulla and cortex: PD+ orange, K+ deeply yellow. Thallus UV+ faintly blue.

Substratum. *Pertusaria corallina* was collected on *Betula pubescens/pendula* and *Sorbus aucuparia*, on *Picea abies* subjected to spray from a waterfall and on branches of *Picea abies* adjacent to a rock wall.

Distribution. The vertical distribution of corticolous specimens ranged from about sea-level to 240 m (AA: Bygland). Saxicolous specimens have been found up to 1680 m altitude (Sør-Trøndelag: Oppdal (O)). **Counties:** Corticolous specimens: Aust-Agder, Møre og Romsdal, Sør-Trøndelag. All specimens: Østfold, Akershus, Oppland, Vestfold - Nordland.

Discussion. *Pertusaria corallina* is a distinctive species on account of the unpigmented, heteromerous isidia and the content of thamnolic acid. No other isidiate taxon considered here contains this substance.

The present corticolous material does not exhibit much variation. Well-developed saxicolous specimens are thicker (up to 4 mm according to Erichsen (1936)), often distinctly zoned and have branched isidia.

Pertusaria corallina is mainly a saxicolous species; only rarely it is corticolous. The saxicolous form occurs commonly on silicious rock throughout most of the country.

Specimens seen: AA: Bygland 1987, Tønsberg 10207. - MR: Smøla 1983, Tønsberg 8313. - ST: Melhus 1982, Tønsberg 7075. Trondheim 1983, Tønsberg 8115a.

Pertusaria coronata (Ach.) Th. Fr.

Fig. 100.

Thallus crustose, episubstratal, delimited, forming more or less irregular patches or, rarely, regular rosettes, up to one dm or more in diameter, continuous, isidiate, without soredia, usually unzoned. Prothallus whitish, glossy, very rarely with a marginal band of free, radiating hyphae. Non-isidiate parts of cortex pale yellow to yellowish grey or, more rarely, grey or greenish grey, often glossy; even to strongly tuberculate, often fissured. **Isidia** concolorous, but usually with the apices darkened (brown to greyish green-brown), discrete and scattered to densely grouped, often more or less concentrated to the tuberculae, homoiomerous, varying from more or less globular to cylindrical, up to 0.1 mm wide and 0.1-0.5(-1) mm tall, usually unbranched, leaving pale yellowish to white punctiform scars when shed; scars tended to become confluent forming rounded to irregular, ecorticate patches. Medulla white. Photobiont green, coccoid, up to 12(-15) µm in diameter.

Apothecia present in one specimen (1%); fertile tuberculae concolorous with the thallus, mostly monocarpic (but 2-3 fertile tuberculae sometimes fused), semiglobular, usually constricted at base, up to 1-2 mm in diameter, with black, punctiform ostioles. Spores (3-)4(-5) pr. ascus, single-walled; 125-150 × 45-62 µm.

Chemistry: Coronaton and stictic acid (major substances), moderate to trace amounts of norstictic acid, cryptostictic acid and constictic acid. Thallus UV+ orange. Cortex C-. Medulla PD+ orange, K+ yellow.

Substratum. *Pertusaria coronata* has most commonly been collected on *Quercus* (24 specimens), *Fagus sylvatica* (10), *Sorbus aucuparia* (10) and *Betula pubescens/pendula* (7). Other phorophytes included *Acer platanoides*, *Alnus glutinosa*, *Fraxinus excelsior*, *Picea abies*, *Populus tremula*, *Prunus padus*, *Salix caprea*, *Tilia*, and *Ulmus glabra*.

Distribution. Corticolous specimens of *Pertusaria coronata* occurred in the coastal lowlands as far north as Troms (Fig. 100). *Pertusaria coronata* grew in open situations. However, in central Norway it was occasionally found in humid and shaded *Picea*-forests. Its vertical distribution ranged from about sea-level to 440 m altitude (Aust-Agder: Froland). **Counties:** Østfold, Akershus, Vestfold - Troms. All substrates: Østfold, Akershus, Vestfold - Finnmark.

Discussion. Greyish forms of *Pertusaria coronata*, due to small amounts of the cortical xanthone coronaton, may resemble forms of *P. coccodes*. However, that species lacks xanthones and produces large amounts of norstictic acid as the diagnostic substance. Stictic acid may rarely occur also in *P. flavida* (Chemotype III), which is a distinctive species on account of its sulphur-yellow colour due to the content of thiophaninic acid. The fertile specimen was collected in Nord-Trøndelag, Leksvik (leg. Tønsberg 5883). No apothecia were observed on the specimen from Vestfold (TRH) cited as fertile by Høeg (1923: 165-166).

Pertusaria coronata has also been found on wood (*Pinus sylvestris*). It is a coastal species on acidic and eutrophic bark.

Specimens seen (selected): Øf: Moss 1919, Lynge (TRH). - Ak: Asker 1922, Høeg (TRH). - Vf: Larvik 1925, Høeg (TRH). - Te: Bamble 1923, Høeg (TRH). - AA: Froland 1978, Tønsberg 3263. - VA: Flekkefjord 1989, B. Moe. - Ro: Suldal 1969, Ryvarden (O). - Ho: Eidfjord 1985, Tønsberg 9330. - SF: Gloppen 1983, Tønsberg 7907. - MR: Tingvoll 1979, Tønsberg 3939. - ST: Malvik 1985, Tønsberg 9127. - NT: Namdalseid 1984, Tønsberg 8936. - No: Hamarøy 1986, Tønsberg 9767. - Tr: Skånland 1986, Tønsberg 9818. (- Fi: Alta 1802, Wahlenberg UPS - on wood). Exsiccata examined: Havaas, Lich. Norv. 192 (BG, O, UPS). A total of 78 specimens seen.

Pertusaria dactylina (Ach.) Nyl.

Thallus crustose, episubstratal, delimited, forming more or less irregular patches, up to about one dm in diameter, more or less continuous, isidiate, unzoned. Prothallus white, indistinct. Non-isidiate parts of surface grey, often glossy; more or less even to indistinctly tuberculate, sometimes wrinkled. **Isidia** whitish grey, pure white towards the apices, club-shaped or more or less cylindrical, simple, heteromerous, up to 0.7 mm wide and 2 mm tall; the apices mostly flattened and heavily white-pruinose, K+ orange. Medulla white. Photobiont green, coccoid, up to 15(-19) µm in diameter.

Apothecia always present, monocarpic, disciform, embedded in the apices of the isidia. Pycnidia not seen.

Chemistry: Fumarprotocetraric acid with satellites, ± lepraric acid. Algal layer and the tissues surrounding the hymenia PD+ orange-red; medulla PD+ yellowish orange. Thallus UV+ faintly blue.

Substratum. *Pertusaria dactylina* has been collected on *Betula nana*, *Betula pubescens/pendula*, *Juniperus communis*, and *Picea abies*. It occurred mainly on horizontal branches and trunks, or on the base of trunks.

Distribution. *Pertusaria dactylina* has most frequently been collected in northern

Norway. The vertical distribution of corticolous specimens in southern Norway ranged from about 300 m to 1040 m (Buskerud: Sigdal); in northern Norway it descended to about sea-level. Terricolous specimens have been collected up to 1200 m altitude (Hardangervidda; Havaas: Lich. Norv. 352). **Counties:** Corticolous specimens: Hedmark, Buskerud, Telemark, Sør-Trøndelag, Nordland - Finnmark. All specimens: Hedmark - Buskerud, Telemark, Hordaland - Finnmark.

Discussion. *Pertusaria dactylina* is a distinctive species on account of its conspicuous, whitish, thick and apically pruinose isidia, containing immersed apothecia. *Pertusaria oculata*, with which it has been confused, has sterile, usually greyish or brownish and apically darkened, thinner isidia.

Dibben (1980) mentioned lepraric acid as a possible accessory in very low concentrations in North American and exotic collections of *Pertusaria dactylina*. In the present material, lepraric acid was present, usually in easily detectable amounts, in 12 (55 %) of the specimens.

Pertusaria dactylina is an arctic-alpine, circumpolar species (Dibben 1980). It is usually terricolous, growing over plant debris.

Specimens seen (selected): He: Alvdal 1910, Lynge (O). - Bu: Sigdal 1982, Tønsberg 6990. - Te: Vinje 1987, Tønsberg 10311. - ST: Melhus 1982, Tønsberg 7104. - No: Narvik 1982, Tønsberg 7406. - Tr: Bardu 1914, Lynge (O). - Fi: Sør-Varanger, Norman (O). A total of 20 specimens seen.

Pertusaria flavida (DC.) Laundon

Pertusaria lutescens (incl.) f. *fagicola* Høeg, in Nyt. Mag. Naturv. 61: 160 (1923). Type: Vestfold, Larvik, Bøkeskogen, 27 February 1922, Høeg (TRH! - lectotype, here selected). TLC: Thiophaninic acid, 2'-O-methylperlatolic acid.

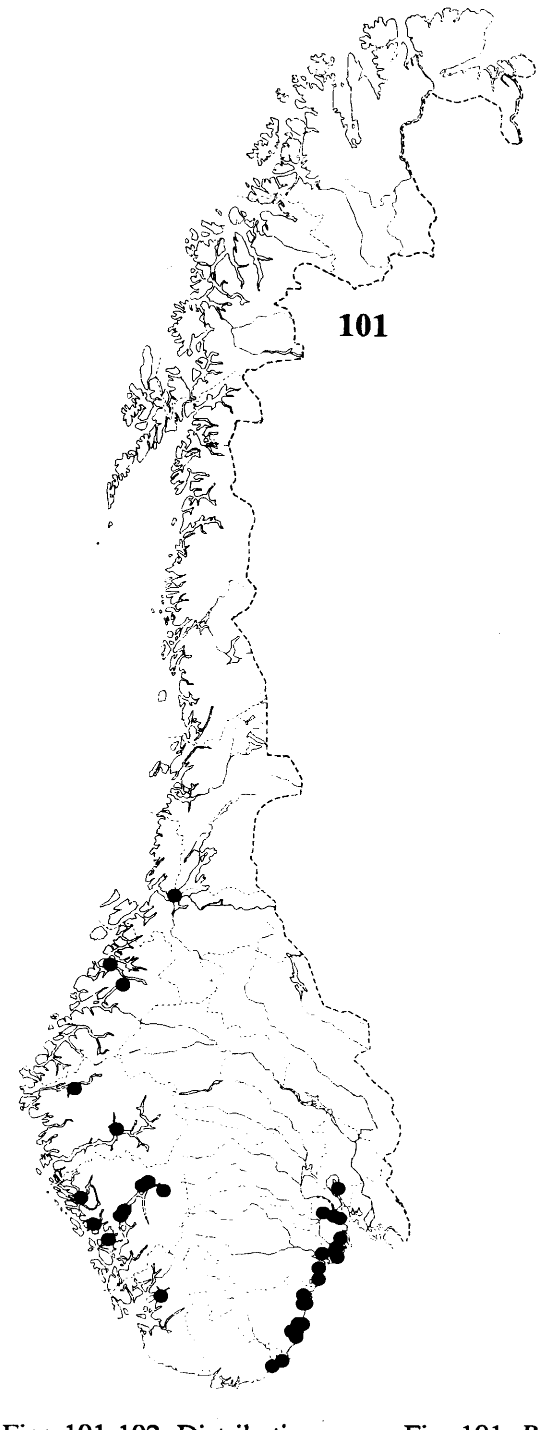
Fig. 101.

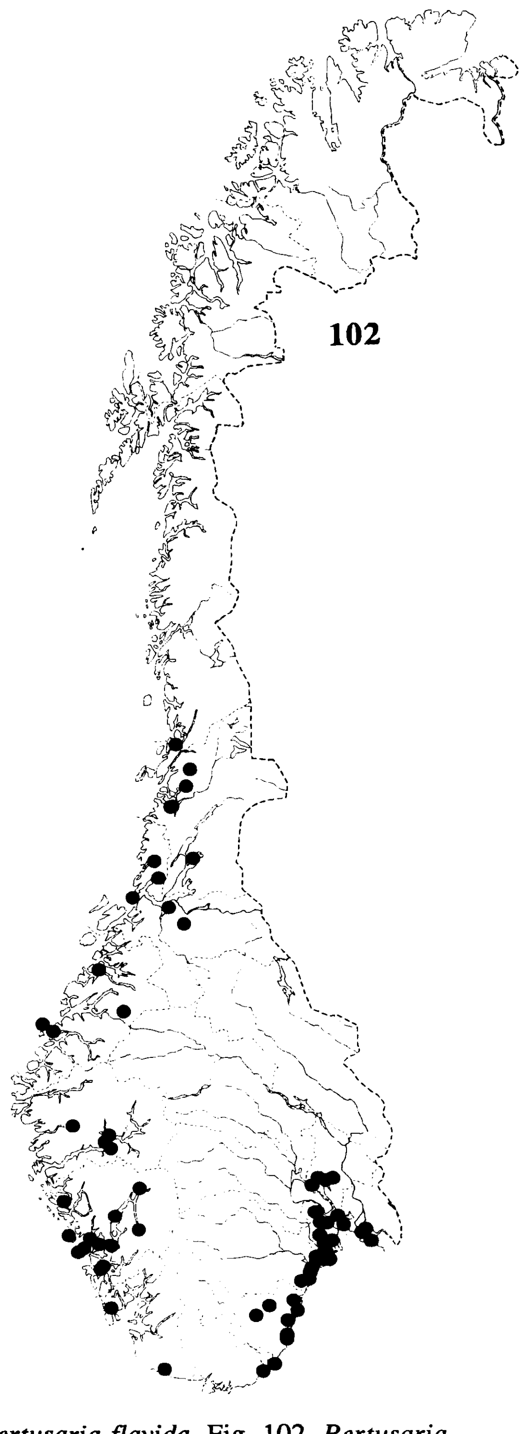
Thallus crustose, sulphur-yellow, yellowish green or, more rarely, pale yellow, rarely, grey without a yellowish tinge, episubstratal, delimited, but usually with indistinct margin, forming rosettes or irregular patches, up to one dm or more in diameter, unzoned, continuous, isidiate. Prothallus white, indistinct. Non-isidiate parts of cortex more or less tuberculate, sometimes fissured. **Isidia** more or less concolorous with non-isidiate parts, not darkened towards the apices, discrete and scattered or in groups, often more or less concentrated to the tuberculae, more or less globose to club-shaped, mostly simple, homoiomerous, up to 0.1 mm wide and 0.1-0.3(-0.4) mm tall, occasionally the cortex of the isidia was replaced by a rough layer mainly composed of crystals. The isidia had frequently fallen off leaving yellow scars, which were sometimes confluent and formed rounded to irregular, ecorticate patches. Medulla distinct, white. Photobiont green, coccoid, up to 14 µm in diameter.

Apothecia very rare, sparsely present in one (1%) of the specimens (leg. Lillefosse (O)); fertile tuberculae more or less globose; ostioles narrow at first, later becoming expanded. Pycnidia not seen.

Chemistry: (I) Thiophaninic acid. (II) Thiophaninic acid, 2'-0- methylperlatolic acid, ± confluentic acid. (III) Thiophaninic acid and stictic acid (major substance), trace to moderate amounts of menegazziaic acid, cryptostictic, constictic, and norstictic acids. A trace of O-methylmonochloronorlichexanthone occurred with thiophaninic acid in all three chemotypes. Thallus UV+ orange; C+ orange. Medulla PD- or (in chemotype III) PD+ orange.

15 specimens (16%) belonged to chemotype I, 56 (73%) to chemotype II and 8 (11%) to chemotype III. The accessory substance confluentic acid (chemotype II) was found in three





Figs 101-102. Distribution maps. Fig. 101. *Pertusaria flavida*. Fig. 102. *Pertusaria hemisphaerica*.

specimens from Aust-Agder.

Substratum. *Pertusaria flavida* was most commonly found on *Quercus* (33 specimens) and *Fagus sylvatica* (15). Other phorophytes included *Abies alba*, *Acer* sp., *Betula pubescens/pendula*, *Fraxinus excelsior*, *Sorbus aucuparia*, *Tilia*, and *Ulmus glabra*.

Distribution. *Pertusaria flavida* occurred in the coastal lowlands from Akershus as far north as Sør-Trøndelag (Fig. 101). Its vertical distribution ranged from about sea-level to 150 m (Telemark: Porsgrunn and Sør-Trøndelag: Rissa). **Counties:** Akershus, Vestfold - Sør-Trøndelag.

Discussion. *Pertusaria flavida* is not a very variable species. In well-developed specimens the cortex may become largely eroded due to fusion of scars after detached isidia. Such eroded patches may superficially resemble soralia, but true soredia are hardly present. A specimen from Vestfold (Larvik, on *Fagus sylvatica*, 1947, leg. O. Almborn (LD)) differed from the others in being distinctly zoned and grey without a yellowish tinge. Chemically it corresponded to chemotype II. That specimen was only tentatively assigned to *P. flavida*. Isidia where the cortex was replaced by crystals may be confused with soralia. Similar isidia were also observed in *Ochrolechia subviridis*.

Diagnostic features for *Pertusaria flavida* are the more or less sulphur-yellow, isidiate thallus producing the xanthone thiophaninic acid. That substance is not produced by any other species treated here.

The chemistry of *Pertusaria flavida* was studied by Hanko (1983).

The isidiate *Pertusaria coronata* resembles *P. flavida* in being yellowish due to a cortical xanthone, and in producing a medullary stictic acid complex. However, in *P. coronata* the pigment is coronaton, and stictic acid is a constant substance. It differs further in its apically pigmented isidia.

Pertusaria flavida is mainly a species of eutrophic to intermediate bark in sun-exposed sites in the coastal lowlands.

Specimens seen (selected): Ak: Frogn 1990, Tønsberg 13285. - Vf: Larvik 1977, Tønsberg 1753. - Te: Porsgrunn 1978, Tønsberg 3347. - AA: Risør 1977, Tønsberg 1679. - VA: Søgne 1978, Tønsberg 3156. - Ro: Hjelmeland 1981, Gauslaa (NLH). - Ho: Eidfjord 1985, Tønsberg 9329. - SF: Leikanger 1979, Tønsberg 4035. - MR: Nesset 1979, Tønsberg 3873. - ST: Rissa 1983, Tønsberg 7825. A total of 80 specimens seen.

Pertusaria geminipara (Th. Fr.) Brodo

Thallus crustose, episubstratal, diffuse, forming rounded to irregular patches, up to 7 cm in diameter, areolate to continuous and strongly tuberculate, sorediate. Prothallus indistinct. Areolae and tuberculae greyish, sometimes whitish apically, distinctly convex to papillate, often constricted at base, up to 0.2(-0.5) mm wide and 0.5 mm high. **Soralia** bursting from the apices of areolae and tuberculae, yellowish grey in fresh material, becoming pinkish in the herbarium, capitate, to about one mm in diameter, rather sparingly present. Soredia coarse, up to 60 µm in diameter, simple or, more often, in rounded consoredia up to 120 µm in diameter; wall distinct. Medulla distinct, white. Photobiont green, more or less globose, up to 20 µm in diameter.

Apothecia sparsely present in one (13%) of the corticolous specimens, lecanorine, up to 0.5 mm (up to 3 mm in diameter in terricolous material); thalline exciple concolorous with thallus, esorediate (more or less sorediate in terricolous material), more or less discontinuous; disc brown.

Chemistry: Alectorialic acid with satellites. Cortex, medulla and soralia PD+ sulphur-yellow. Thallus UV+ dull brown.

Substratum. Corticolous specimens of *Pertusaria geminipara* were collected on *Betula nana*, *Juniperus communis*, and *Picea abies*. It grew on naked bark and over corticolous mosses and other lichens.

Distribution. *Pertusaria geminipara* was collected in scattered sites between 510 and 1405 m altitude (Sogn og Fjordane: Luster). **Counties**: Corticolous specimens: Oppland, Buskerud, Sogn og Fjordane, Nordland, Troms. All specimens: Akershus - Buskerud, Telemark, Hordaland, Sogn og Fjordane, Sør-Trøndelag - Finnmark.

Discussion. *Pertusaria geminipara* is easily recognized by its more or less papilliform areolae and tuberculae, and the capitate soralia. The corticolous specimens were sparsely sorediate, but otherwise concordant with terricolous material. Brodo (1984b) reported alectorialic acid and barbatolic acid in Canadian material. Barbatolic acid was not observed in the present material.

Pertusaria geminipara is mainly a terricolous species on plant debris in alpine sites; it is only rarely corticolous. Like other terricolous species, corticolous specimens of *Pertusaria geminipara* usually occur on horizontal parts of the phorophyte.

Specimens seen: Op: Lillehammer 1948, Ahlner (S). - Bu: Sigdal 1981, Tønsberg 6363, 6367; 1982, Tønsberg 7013a. - SF: Luster 1988, Tønsberg 11309. - No: Narvik 1986, Tønsberg 9789, 9796. - Tr: Balsfjord 1877, Norman.

Pertusaria hemisphaerica (Flörke) Erichsen

Pertusaria speciosa Høeg, in Nyt Mag. Naturv. 61: 147-148 (1923). Type: Norway, Oslo (V. Aker), Ullernåsen, on *Tilia*, 15 October 1922, O. Høeg (TRH! - lectotype, here selected). TLC: lecanoric acid.

Figs 17, 102.

Thallus crustose, episubstratal, delimited, forming rosettes up to one dm in diameter, continuous, sorediate. Prothallus often distinct, usually white, sometimes with a brownish tinge, glossy, not felty. Corticate part of surface silver-grey, often with a faint bluish tinge, rarely whitish; even to coarsely tuberculate, often rimose-cracked. **Soralia** greyish white, light greenish grey or more or less concolorous with the cortex, usually discrete; regularly semiglobular, up to 0.2 mm in diameter. Soredia mostly coarse, up to 80 µm in diameter, usually in rounded consoredia (Fig. 17) up to 0.1 mm in diameter; wall distinct. Medulla distinct, white. Photobiont green, coccoid, to 20 µm in diameter.

Apothecia and pycnidia not observed.

Chemistry: (I) Lecanoric acid, (II) Lecanoric acid, variolaric acid. Cortex C- or C+ partly blood red, in specimens with variolaric acid sometimes C+ orange yellow. The accessory depsidone variolaric acid occurred in 48 (44%) of the specimens. Medulla and soralia C+ blood red. Thallus UV+ whitish blue.

Substratum. *Pertusaria hemisphaerica* has most frequently been collected on *Quercus* (39 specimens) and *Fagus sylvatica* (20). Other phorophytes included *Acer platanoides*, *Alnus glutinosa*, *A. incana*, *Betula pubescens/pendula*, *Crataegus calycina*, *Fraxinus excelsior*, *Juniperus communis*, *Picea abies*, *Populus tremula*, *Prunus padus*, *Sorbus aucuparia*, and *Tilia*.

Distribution. *Pertusaria hemisphaerica* was recorded in the coastal lowlands from Østfold to Nordland (Bindal) (Fig. 102). It usually grew in open, sun-exposed situations, but occurred rarely in shaded sites as well. Its vertical distribution ranged from about sea-level to

400 m (Aust-Agder: Froland). **Counties:** Østfold, Akershus, Vestfold - Nordland.

Discussion. *Pertusaria hemisphaerica* exhibits little morphological variation except that there is an intergradation from whitish grey to dark grey colour of the thallus surface, probably reflecting the illumination at the sites. Herbarium specimens sometimes had a pale brown tinge. *Pertusaria hemisphaerica* is characterized by the rosette-forming habit, the regular, semiglobular soralia, the silver-grey colour, and the presence of lecanoric acid.

Hanko (1983) excluded specimens with variolaric acid from *Pertusaria hemisphaerica*; variolaric acid-producing specimens were assigned to the predominately saxicolous *P. lactea* (L.) Arnold. In the present Norwegian material of *P. hemisphaerica* the two chemical types did not correlate with any clear differences in morphology. In *Pertusaria lactea* variolaric acid is apparently nearly always present (Leuckert & Redlich 1969, Hanko 1983). Of 12 specimens of *P. lactea* studied by me, all contained this substance. *Pertusaria lactea* is otherwise distinguished from *P. hemisphaerica* in being often white and markedly fissured, in having smaller, more or less irregular soralia with more loosely arranged soredia and a normally saxicolous habit, often under overhangs.

Pertusaria hemisphaerica has been confused with *Ochrolechia androgyna* s. lat. That species complex does not have a silver-grey surface with a bluish tinge and is further distinguished by the presence of gyrophoric acid as a major diagnostic constituent; lecanoric acid is present in trace amounts only.

Varicellaria rhodocarpa is the only other distinctly crustose species treated here which produces large amounts of lecanoric acid, but it is unlikely to be confused with *Pertusaria hemisphaerica* as its soralia often soon become confluent forming a thick sorediate crust. *Varicellaria rhodocarpa* differs chemically in containing lichexanthone (UV+ yellowish).

Pertusaria hemisphaerica is a coastal lowland species of eutrophic to intermediate bark. *Pertusaria hemisphaerica* may rarely grow on rock (Erichsen 1936, Laundon 1963).

Specimens seen (selected): Øf: Hvaler 1983, Tønsberg 7870. - Oslo 1986, Tønsberg 9475. - Vf: Tjølling 1930, Høeg (TRH). - Te: Bamble 1978, Tønsberg 3293. - AA: Froland 1978, Tønsberg 3262. - VA: Søgne 1978, Tønsberg 3167. - Ro: Eigersund 1978, Tønsberg 2963. - Ho: Kvinnherad 1987, Tønsberg 10051. - SF: Vik 1979, Tønsberg 4060. - MR: Nesset 1979, Tønsberg 3887. - ST: Melhus 1982, Tønsberg 7078. - NT: Namsos 1985, Tønsberg 9188. - No: Bindal 1982, Tønsberg 6866. A total of 109 specimens seen.

Pertusaria oculata (Dickson) Th. Fr.

Thallus crustose, episubstratal, delimited, forming rosettes or more or less irregular patches, up to one dm in diameter, continuous, isidiate. Prothallus indistinct. Non-isidiate parts of surface grey or white-grey, smooth to faintly tuberculate, sometimes cracked. **Isidia** conspicuous, concolorous with non-isidiate parts or, more often, tinged pale brown or pale yellow, often with greyish black apices reacting K+ violet, N+ violet, heteromerous, simple to bifurcately branched, more or less cylindrical throughout or, occasionally, with the apices somewhat swollen, up to 0.5 mm wide and 2-3 mm tall; frequently broken off near the base. Medulla distinct, white. Photobiont green, unicellular, globose to broadly ellipsoid, up to 10(-15) µm in diameter.

Apothecia present in 12 (63%) of the specimens; lecanorine; thalline margin distinct, occasionally isidiate; disc brown to black, epruinose, slightly concave to slightly convex. Pycnidia immersed in the apices of the isidia. Conidia not seen.

Chemistry: Fumarprotocetraric acid, cph-2, protocetraric acid, rarely a faint trace of gyrophoric acid. Spot tests, see under discussion. A trace of gyrophoric acid was found in 5 specimens; however, no positive reaction to C was observed. Thallus UV+ whitish blue.

Substratum. The corticolous specimens of *Pertusaria oculata* were collected on *Betula pubescens/pendula*, *B. nana*, *Picea abies*, and *Juniperus communis*. Corticolous specimens usually grew on more or less horizontal parts or at the base of the phorophytes.

Distribution. *Pertusaria oculata* occurred in subalpine to low-alpine and northern sites. The vertical distribution of corticolous specimens ranged in southern Norway from 350 m to 1030-1050 m (Oppland: Dovre). In northern Norway it descended to about sea-level. **Counties:** Corticolous specimens: Oppland, Sør-Trøndelag - Finnmark. All specimens: Hedmark - Buskerud, Telemark, Hordaland - Finnmark.

Discussion. *Pertusaria oculata* is not a very variable species. The apices of the isidia may rarely be unpigmented and react K+ orange (not violet).

Pertusaria oculata is a distinctive species on account of its conspicuous isidia with K+ violet apices. It has been confused with *P. dactylina*, but in that species the isidia are milky white and non-pigmented, thicker, and bear immersed apothecia.

The presence of gyrophoric acid as an accessory substance in trace amounts agrees with the results given by Dibben (1980) and Hanko (1983). Although he did not consistently observe that substance, Hanko (1983) suggested that gyrophoric acid is constant in *P. oculata*.

Pertusaria oculata is mainly a terricolous lichen growing over plant debris. The terricolous form has been found up to 1460 m (Oppland: Vågå (O)).

Specimens seen (selected): Op: Dovre 1982, Tønsberg 7501. - ST: Rennebu 1934, Høeg (TRH). - NT: Namsskogan 1982, Tønsberg 7455. - No: Narvik 1986, Tønsberg 9790. - Tr: Kvæfjord 1987, Tønsberg 10418. - Fi: Hammerfest, Norman (O). Exsiccata seen: Th. M. Fr., Lich. Scand. 34 (S - partly on bark). Rabenh., Lich. Eur. 776 (S - partly on bark). A total of 19 specimens seen.

Pertusaria pupillaris (Nyl.) Th. Fr.

?*Pertusaria chloropolia* v. *planiuscula* Magnusson, in Bot. Not. 1942: 14-15 (1945). Type: Sweden, Västergötland, Toarp, NE of Gångheste 10 Aug. 1941, A.H. Magnusson 17856 (UPS! - holotype). TLC: fumarprotocetraric acid, cph-2 (trace).

[Lecidea cinnabarina auct.]

Fig. 103.

Thallus (Fig. 103) crustose, usually endosubstratal in esorediate parts, mostly distinctly delimited, forming rosettes or irregular patches, up to a few cm in diameter, occasionally to one dm or more in diameter, continuous, sorediate, unzoned. Prothallus indistinct or absent. Esorediate parts whitish grey to dark grey, sometimes greenish, usually even. **Soralia** whitish or faintly yellow-white, discrete or, occasionally 2-3 locally fused, in rosette-forming specimens sometimes distinctly concentrically arranged, orbicular or somewhat irregularly rounded, more or less flat, rarely somewhat convex, sometimes borded by a rim of bark from the substratum, to 1(-1.5) mm in diameter. Soredia mostly fine, up to 40 µm in diameter, simple or in rounded to elongate consoredia up to 80 µm in diameter; wall distinct. Medulla usually indistinct. Photobiont green, coccoid, up to 20 µm in diameter.

Apothecia present in 17 (18%) of the specimens, lecanorine; thalline margin prominent, sometimes sorediate, often becoming eroded and excluded with age; disc black, exposed, epruinose; pigment green, K+ violet. Pycnidia seen in one fertile specimen, 0.2 mm in diameter, convex, concolorous with the thallus; ostiolum blackish, becoming widely gaping; pigment green, K+ violet; conidia rod-shaped, 4-6 × <1 µm.

Chemistry: Fumarprotocetraric acid, protocetraric acid (trace), ± cph-2 (trace, found

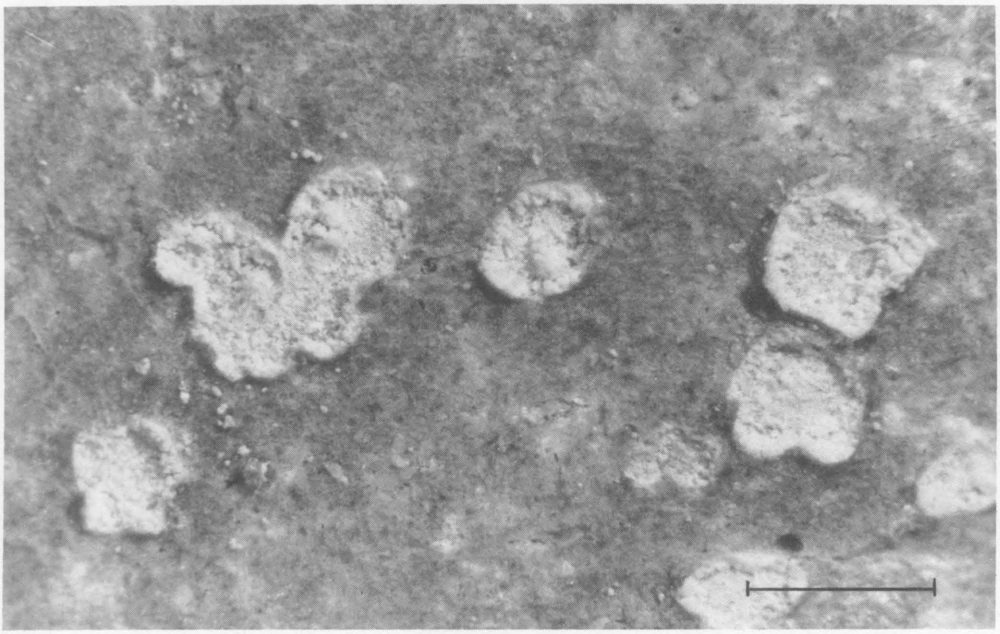


Fig. 103. *Pertusaria pupillaris*. Tønsberg 8650. Typical form on smooth bark. Scale 1 mm.

only in a few specimens), ± gyrophoric acid (possible faint trace). Thallus UV+ faintly whitish blue.

Substratum. *Pertusaria pupillaris* has most frequently been collected on *Alnus incana* (37 specimens); other phorophytes included *Betula pubescens/pendula*, *Salix caprea*, *Quercus*, *Sorbus aucuparia*, and, rarely, *Acer platanoides*, *Alnus glutinosa*, *Corylus avellana*, *Fagus sylvatica*, *Juniperus communis*, *Picea abies*, *Pinus sylvestris*, *Populus tremula*, *Prunus padus*, *Salix* sp., and *Tilia*.

Distribution. *Pertusaria pupillaris* was found in a broad belt along the coast from Akershus to Finnmark. The fertile specimens were from Aust-Agder, Hordaland - Troms. Its vertical distribution ranged from sea-level to 625 m (Aust-Agder: Bykle). **Counties:** Akershus, Buskerud - Finnmark.

Discussion. Typical specimens of *Pertusaria pupillaris* with an endosubstratal thallus and whitish, flat, somewhat sunken, soralia are readily recognized. Occasionally the species develops a distinct episubstratal thallus with flat to slightly convex soralia. Such specimens approach the chemically similar *P. borealis*. However, that species usually produces a trace of succinprotocetraric acid, a substance not known to occur in *P. pupillaris*. For further details concerning the differences between the two species, see under *P. borealis*.

Most sterile herbarium specimens of *Pertusaria pupillaris* had previously been assigned to *Lecidea cinnabarina*. However, that species is rarely sterile, and is chemically distinct in the presence of large amounts of atranorin and chloroatranorin.

The possibility that the trace of gyrophoric acid found in a few specimens was due to a contaminant could not be entirely ruled out. However, Hanko (1983) also found a trace of gyrophoric acid in *P. pupillaris*. If gyrophoric acid occurs in *P. pupillaris*, it is of little or no practical value in the identification of specimens, due to its low concentration.

Pertusaria pupillaris has rarely been found on wood (*Pinus sylvestris*). It is mainly a species of acidic bark in coastal habitats.

Some sterile specimens (e.g., Tønsberg 3994a, 5199, 6015) were close to *Pertusaria pupillaris*, but differed by having numerous, rather densely spaced, small (up to 0.4(-0.7) mm in diameter), slightly to distinctly convex soralia. Pycnidia, present on two of the specimens, were similar to those described above. These specimens were not assigned to *P. pupillaris*; they may prove to represent a distinct taxon.

Specimens seen (selected): Oslo 1947, Rui 6479 (O). - Bu: Sigdal 1981, Tønsberg 6378. - Vf: Andebu 1922, Høeg (TRH). - Te: Porsgrunn 1978, Tønsberg 3328. - AA: Bykle 1955, Degelius (herb. Degelius). - VA: Flekkefjord 1978, Tønsberg 3126. - Ro: Sauda 1978, Tønsberg 3087b. - Ho: Tysnes 1927, Degelius (herb. Degelius; with apothecia and pycnidia) - SF: Høyanger 1984, Tønsberg 8650. - MR: Nesset 1979, Tønsberg 3784. - ST: Klæbu 1979, James & Tønsberg s.n. - NT: Grong 1981, Tønsberg 6133. - No: Vega 1973, Degelius V-316 (herb. Degelius). - Tr: Skånland 1982, Tønsberg 7383a. - Fi: Alta 1982, Tønsberg 7242a. Exsiccata examined: Havaas, Lich. Norv. 486 (BG, O, UPS). A total of 96 specimens seen.

Pertusaria sp. aff. *pupillaris*. SF: Balestrand 1979, Tønsberg 3994a. - ST: Trondheim 1980, Tønsberg 5199. - No: Grane 1981, Tønsberg 6015.

Phlyctis Wallr.

Phlyctis argena (Sprengel) Flotow

Figs 104-105.

Thallus (Fig. 104) crustose, endo- to episubstratal in esorediate parts, delimited, forming rosettes or irregular patches, usually up to several cm in diameter, sometimes forming extensive patches up to a few dm in diameter, continuous, unzoned, sorediate. Prothallus

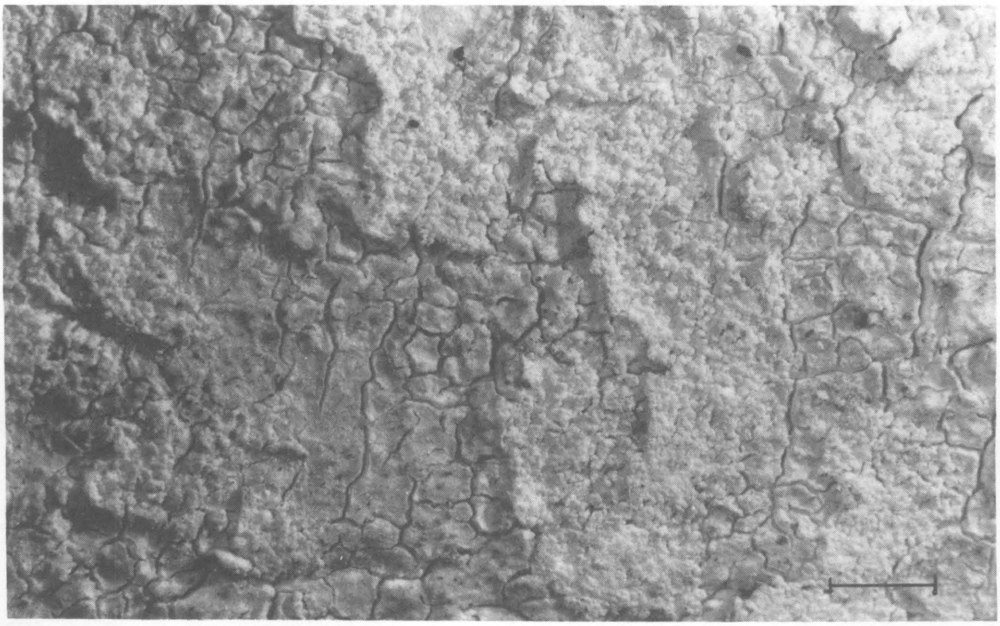


Fig. 104. *Phlyctis argena*. Tønsberg 6607. Typical form. Scale 1 mm.

white, distinct, felty, of radiating hyphae forming a border up to about 1 cm wide. Esorediate surface usually dark to light grey, sometimes bluish grey, rarely whitish, mostly more or less even, sometimes tuberculate, rarely coarsely tuberculate or tuberculate-plicate, usually distinctly cracked in thick specimens. **Soralia** usually pale yellowish white, sometimes with a greenish tinge, rarely pure white; irregular in outline, often somewhat elongate and angular, usually delimited, but sometimes diffuse, often surrounded by a more or less raised rim formed by the cortex, differently sized, up to about 1 cm or more in diameter, often becoming locally confluent or, rarely, becoming confluent throughout forming a crust with a leprose surface. Soredia in consoredia up to 90-125 µm in diameter, sometimes intermixed by fragments of an eroding cortex, especially in strongly tuberculate and plicate specimens, heavily incrusted with crystals of norstictic acid (K+ red); wall indistinct. Medulla more or less distinct, white. Photobiont green, unicellular, more or less globose, up to 12(-18)µm in diameter.

Apothecia present in 19 (7%) of the specimens, immersed in thalline tuberculae or more or less flush with the thallus; disc more or less concealed by a whitish powdery mass (pruina) of crystals (norstictic acid and calcium oxalate). Pycnidia rare (e.g., in Tønsberg 2995), semiglobose to globose, pruinose, up to 0.8 × 0.5 mm, wall blackish; conidia 3-3.5 × 0.75-1 µm.

Chemistry: Norstictic acid, connorstictic acid (usually in trace amounts).

Substratum. *Phlyctis argena* has been found on a wide range of deciduous trees, most commonly on *Quercus* (42 specimens), *Fagus sylvatica* (38), *Alnus incana* (30) and *Sorbus aucuparia* (26); other phorophytes included *Acer platanoides*, *A. pseudoplatanus*, *Aesculus hippocastanum*, *Alnus glutinosa*, *Betula pubescens/pendula*, *Corylus avellana*, *Fraxinus excelsior*, *Ilex aquifolium*, *Juniperus communis*, *Picea abies*, *Populus tremula*, *Prunus padus*, *Salix caprea*, *Tilia*, and *Ulmus glabra*.

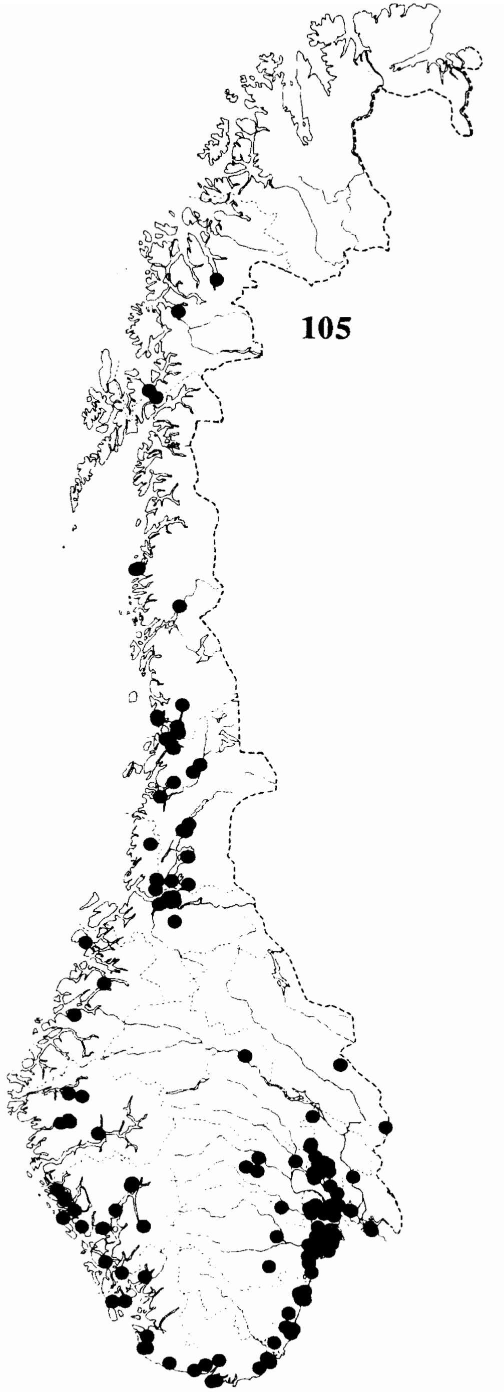
Distribution. *Phlyctis argena* occurred commonly in the lowlands along the coast, especially in southern Norway (Fig. 105). In Hedmark and Oppland it was sparse and occurred mainly in microclimatically humid sites (e.g., near water in *Picea* forests). Its vertical distribution ranged from about sea- level to 600 m (Buskerud: Krødsherad). **Counties:** Østfold - Troms.

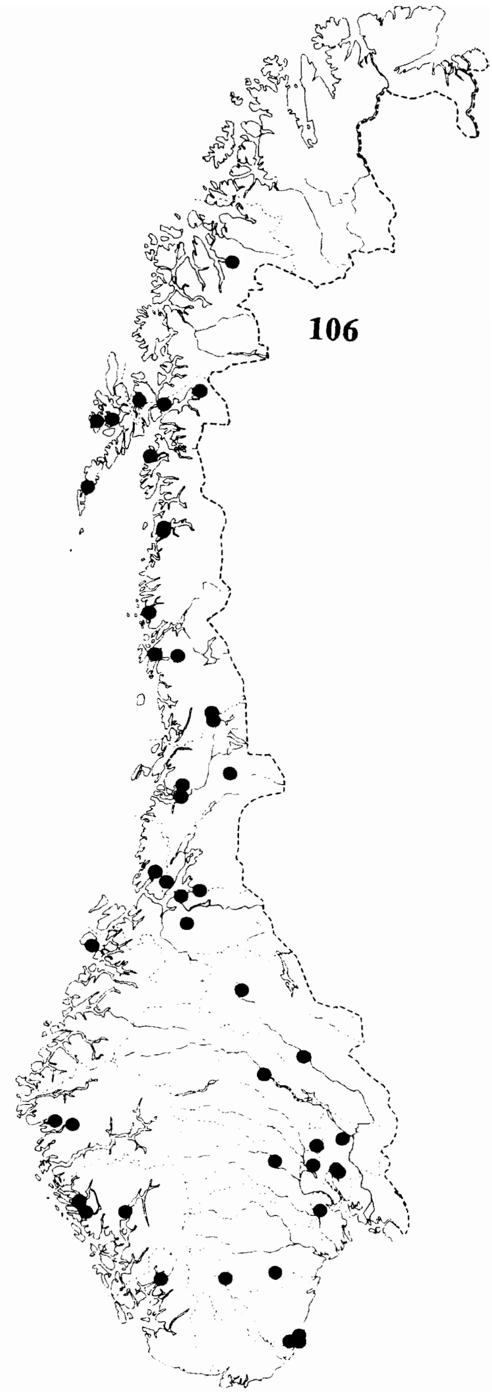
Discussion. *Phlyctis argena* is usually not a very variable species. Specimens from sites eutrophicated by agricultural dust (e.g., Tønsberg 2981), may have a very coarsely tuberculate to plicate surface and soralia containing soredia mixed with eroding fragments of the cortex. Usually the surface is more or less even or weakly tuberculate. This variation in form possibly reflects various amounts of nutrients at the sites. The largest specimens were found on shaded trunks of *Alnus incana* growing on banks of streams. In this habitat, continuous patches from the base and up to 1-2 m up the trunks were sometimes formed.

Phlyctis argena is distinguished by its large, elongate and irregular, flat soralia, with a colour contrasting to that of the cortex, and the production of norstictic acid. When typical, it is not likely to be confused morphologically with any other Norwegian corticolous species. No other sorediate species treated here contains norstictic acid as the only diagnostic substance. The rare form with a strongly tuberculate or plicate surface, probably corresponds to the quasi-isidiate form of, e.g., *Pertusaria albescens* and *P. amara*.

Phlyctis argena is a widespread and common species on acidic as well as on eutrophic bark.

Specimens seen (selected): Øf: Trøgstad 1978, Tønsberg 3362. - Oslo 1876, Kindt (TRH). - He: Kongsvinger 1985, Tønsberg 9426. - Op: Lunner 1982, Tønsberg 7539. - Bu: Krødsherad 1982, Tønsberg 6956.





Figs 105-106. Distribution maps. Fig. 105. *Phlyctis argena*. Fig. 106. *Placynthiella dasaea*.

- Vf: Stokke 1986, Tønsberg 9581. - Te: Bamble 1983, Tønsberg 7954. - AA: Grimstad 1978, Tønsberg 3235. - VA: Søgne 1978, Tønsberg 3147. - Ro: Klepp 1978, Tønsberg 2995; 2981. - Ho: Odda 1984, Tønsberg 8738. - SF: Balestrand 1979, Tønsberg 4017. - MR: Vestnes 1979, Tønsberg 3833. - ST: Melhus 1982, Tønsberg 6607. - NT: Nærøy 1982, Tønsberg 6688. - No: Bindal 1982, Tønsberg 6829. - Tr: Skånland 1982, Tønsberg 7352. Exsiccata examined: Havaas, Lich. Norv. 26 (BG, O, UPS). A total of 271 specimens seen.

Placynthiella Elenkin

The genus *Placynthiella* in the British Isles was studied by Coppins & James (1984), see also Coppins et al. (1987).

Placynthiella dasaea (Stirton) Tønsb. comb. nov.

Lecidea dasaea Stirton, in Scott. Nat. 5: 219 (1880). Type: U.K.: Scotland, Ben Lawers, August 1879, Stirton (BM! - holotype).

Figs 19, 106-107.

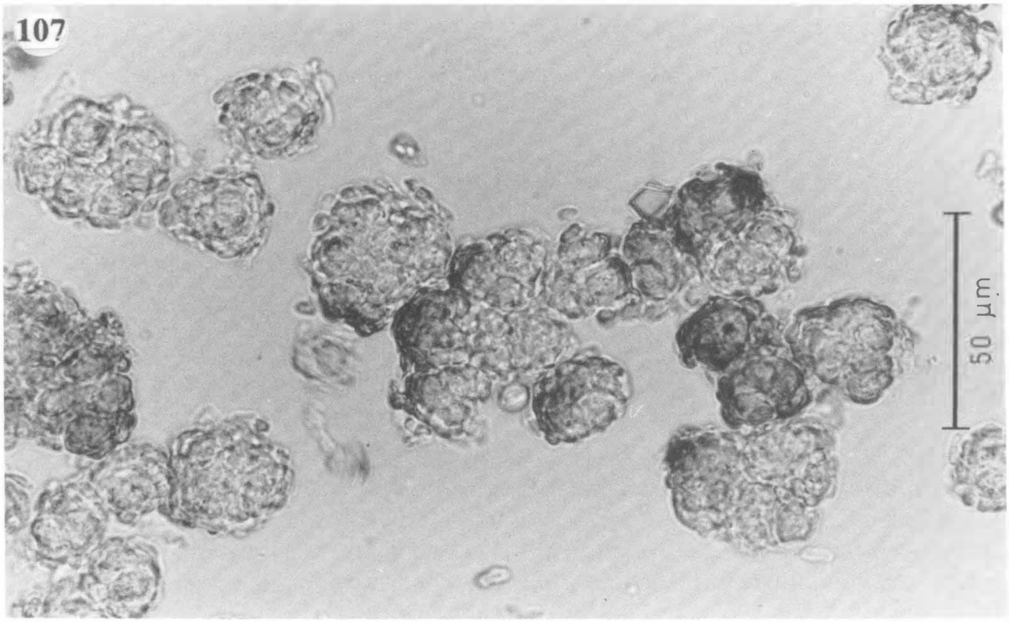
Thallus crustose, endo- to episubstratal in non-sorediate parts, indeterminate, pale to dark brown or greenish brown, forming rounded to irregularly spreading patches between other crustose lichens, usually up to a few cm across, occasionally reaching one dm or more, areolate, sorediate. Prothallus rarely distinct, of brown ramifying hyphae; cells almost globular to shortly elongate. Areolae usually indistinct or absent, discrete to contiguous, adnate, irregularly rounded, flattened to convex, up to 0.2 mm in diameter. **Soralia** brown due to pigmentation of the external soredia, or more or less green where the external soredia have been shed; diffuse, mostly discrete and more or less rounded and convex at first, later often becoming more or less confluent forming a more or less continuous, leprose, fairly thick and secondarily cracked crust. Soredia globular, mostly fine, simple or aggregated in consoredia (Fig. 107), mostly 20-30 µm in diameter, consoredia up to 45(-65) µm in diameter; external soredia more or less brown, corticate. Photobiont green, coccoid, up to 12 µm in diameter. In some specimens an additional algae was observed which was 2-4 - celled, globose to broadly ellipsoid or more or less cubic, surrounded by a thick, (3-4 µm wide) gelatinous cap, up to 15(- 17.5) µm in diameter. However, the possibility that it actually was due to a contaminant was not ruled out.

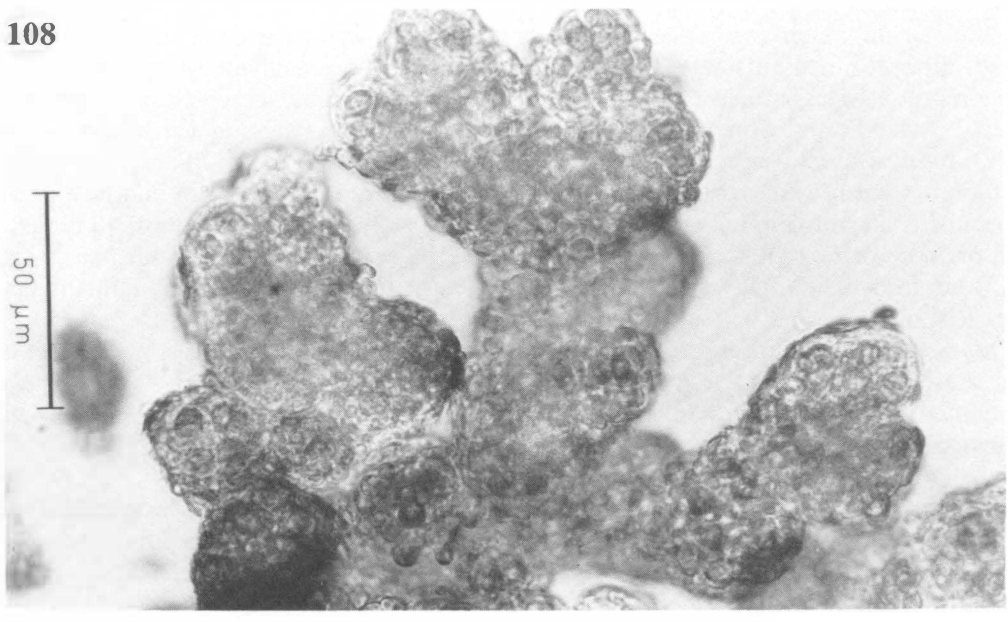
Apothecia sparingly present in two (3%) of the corticolous specimens, up to 0.3 m in diameter; disc brown; margin slightly paler, thin.

Chemistry: Gyrophoric acid, lecanoric acid (trace). Thallus UV- in distinctly brown specimens, UV+ faintly whitish blue in less pigmented specimens; C+ red. TLC: Fig. 19.

Substratum. *Placynthiella dasaea* has mostly been collected on *Betula pubescens/pendula* (24 specimens), and *Alnus incana* (18); other phorophytes included *Acer platanoides*, *Alnus glutinosa*, *Juniperus communis*, *Picea abies*, *Prunus avium*, *Rhododendron catawbiense*, *Salix caprea*, *Sorbus aucuparia*, and *Syringa vulgaris*. *Placynthiella dasaea* grew on smooth to rough bark of healthy trunks, as well as on decayed bark.

Distribution. *Placynthiella dasaea* has been recorded in the lowlands throughout most of the country (Fig. 106). Its vertical distribution ranged from about sea-level to 600 m (Hedmark: Tynset). It occurred in open and sun-exposed as well as in sheltered and shaded habitats. It has been found in polluted sites, e.g., close to the centres of towns (Oslo) and along busy state roads. In such sites it was often found associated with *Fuscidea pusilla*, *Hypocenomyce scalaris*, and *Scoliciosporum chlorococcum*. **Counties:** Akershus -





Figs 107-108. Fig. 107. *Placynthiella dasaea*. Tønsberg 5352. Slightly squashed thallus, showing consoredia and part-soredia. Fig. 108. *Placynthiella icmalea*. Tønsberg 9057. Slightly squashed thallus.

Aust-Agder, Rogaland - Troms. All specimens: Akershus - Troms.

Discussion. *Placynthiella dasaea* differs from *P. icmalea* by the globular soredia which may form rounded or somewhat irregular consoredia. In *Placynthiella icmalea* the thallus is composed of more or less coralloid, tall and slender isidia. Furthermore, *Placynthiella dasaea* never produces 5-O-methylhiascic acid. *Placynthiella dasaea* may superficially resemble *Japewia subaurifera*. However, that species can usually be recognized by a yellow pigment in the external soredia; gyrophoric acid is absent. The external soredia of *Rimularia fuscosora* and *Schaereria corticola* may be similar to those of *Placynthiella dasaea*. Those species are distinguished by their persistently punctiform, strongly convex, delimited soralia, and the presence of norstictic acid and 5-O-methylhiascic acid (in addition to gyrophoric acid), respectively.

Placynthiella dasaea seems to be able to withstand moderate levels of air pollution. Outside Norway it is known from U.K.: Scotland and from Sweden. *Placynthiella dasaea* is a widespread species on acidic bark. It has also been found on decayed wood.

Specimens seen (selected): **Norway:** Oslo 1980, Tønsberg 5347. - Ak: Ullensaker 1990, Tønsberg 13258 (fertile). - He: Åmot 1982, Tønsberg 6896a. - Op: Lunner 1982, Tønsberg 7544a. - Bu: Hole 1981, Tønsberg 6438. - Vf: Hof 1990, Tønsberg 13054. - Te: Nissedal 1987, Tønsberg 10233. - AA: Birkenes 1986, Tønsberg 9573a. - Ro: Suldal 1988, Tønsberg 10834. - Ho: Bergen 1984, Tønsberg 9063. - SF: Førde 1984, Tønsberg 8695. - ST: Trondheim 1980, Tønsberg 5366. - NT: Namsskogan 1981, Tønsberg 6082a. - No: Narvik 1982, Tønsberg 7409. - Tr: Kåfjord 1982, Tønsberg 7285. A total of 62 Norwegian specimens seen. **Sweden:** Uppland 1968, Jørgensen 2186. - Värmland 1983, Muhr 6196 (UPS); 1984, Muhr 6921 (UPS). **U.K.:** Scotland, West Perth (V.C. 87), Braco estate, on dead *Pinus*, 1982, P.M. Jørgensen 9029 (BG).

Placynthiella icmalea (Ach.) Coppins & P. James

Lecidea icmalea Ach., in K. svenska Vetensk.-Akad. Handl. 1808: 267 (1808). Type: Sweden (BM-ACH! - lectotype).

Pannularia perfurfurea Nyl., in Acta Soc. Sci. fenn. 26: 28 (1900). Type: U.K.: Scotland, New Galloway, Burnfoot Hill, over mosses, October 1898, J.M.M'Andrew (H-NYL! - lectotype). TLC: gyrophoric acid, 5-O-methylhiascic acid, lecanoric acid (trace).

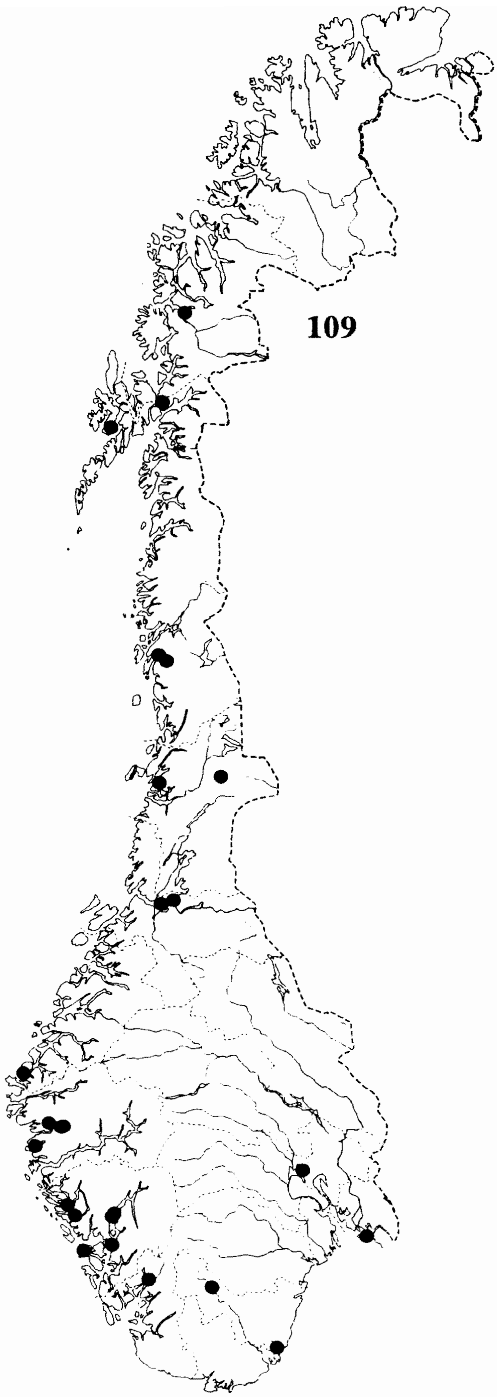
Figs 19, 108-109.

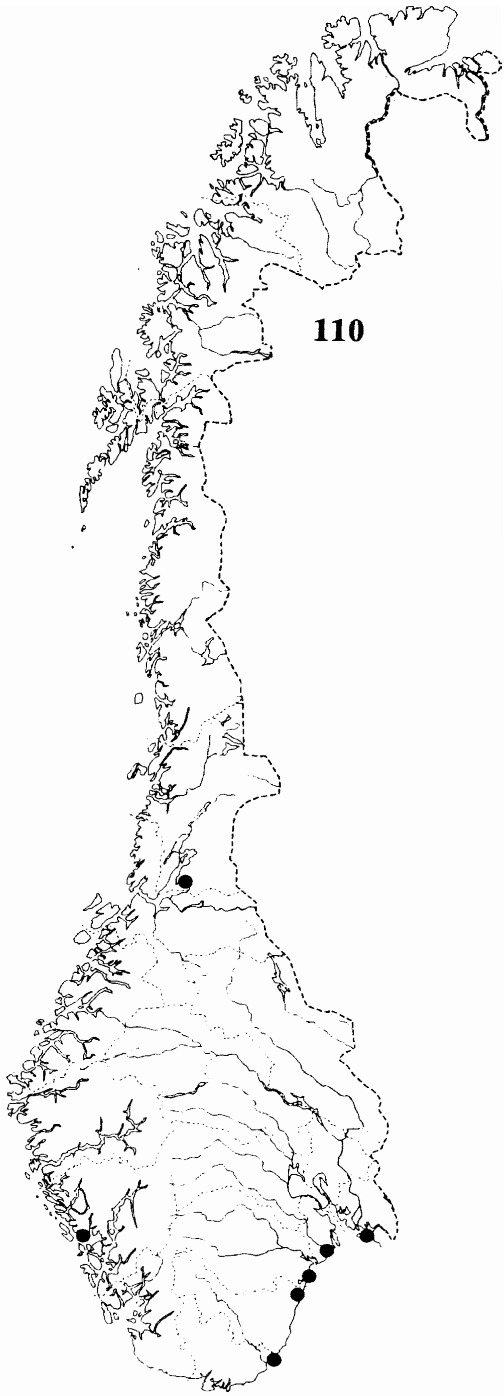
Thallus minutely subfruticose, green to brown, episubstratal, forming irregular patches up to 5-10 cm across, isidiate. Prothallus indistinct or absent. **Isidia** usually more or less discrete, distinctly elongate, simple or, more commonly, coralloid branched, up to about 50-190 µm tall; branches about 40-70 µm wide, more or less composed of globose elements up to 30 µm wide. Mixed with these elongate isidia were usually some simple (not aggregated) globose elements, 25-50 µm in diameter, probably representing young isidia. Brown pigment K+ fuscous brown, N-. Medulla absent. Photobiont green, coccoid, up to 10 µm in diameter.

Apothecia present in 12 specimens (43%), lecideine, brown to reddish brown, up to 0.9 mm in diameter; margin prominent or becoming excluded, concolorous with the disc or paler; disc plane. Pycnidia not seen.

Chemistry: Gyrophoric acid, lecanoric acid (trace), 5-O- methylhiascic acid (trace). Thallus UV-, C+ red. TLC: Fig. 19.

Substratum. *Placynthiella icmalea* has been collected on *Alnus glutinosa* (7 specimens), *Betula pubescens/pendula* (5), *Alnus incana* (4); other phorophytes include *Acer* sp., *Quercus*, *Juniperus communis*, *Picea abies*, *Pinus sylvestris*, *Prunus padus*, *Rhododendron catawbiense*,





Figs 109-110. Distribution maps. Fig. 109. *Placynthiella icmalea*. Fig. 110. *Pyrrhospora quernea*.

Sorbus aucuparia, and *Tilia*. It grew on naked rough bark as well as on corticolous mosses and other lichens, and was often found on or near the base of the phorophytes. The species seemed to prefer shaded sites.

Distribution. *Placynthiella icmalea* has been collected in coastal regions (Fig. 109). Its vertical distribution ranged from about sea-level to 460 m (Aust-Agder: Valle). It was once found on a road-side tree in a town centre (Førde). **Counties:** Østfold, Aust-Agder, Rogaland - Troms. All specimens: Østfold, Buskerud, Aust-Agder, Rogaland - Troms.

Discussion. Although rather inconspicuous, *Placynthiella icmalea* is easily recognized by the green to brown, branched isidia largely composed of globose elements. In some specimens the elongate isidia were mixed with globose elements similar to the soredia of *P. dasaea*. In *Placynthiella icmalea* these probably represent young isidia. The isidia of *P. icmalea* are structurally more complex than those of *P. dasaea* and seem never to break down upon formation of soredia. The presence and absence of 5-O-methylhiascic acid in *Placynthiella icmalea* and *P. dasaea*, respectively, agrees with Lawrey (1977), who suggested that O-methylated depsides are more commonly produced by morphologically advanced groups of lichens.

In the field *Placynthiella icmalea* might be confused with *Leptogium teretiusculum*. However, on closer examination, that species has a distinct cortex and lacks lichen substances.

Placynthiella icmalea appears to be slightly toxitolerant. It is a coastal species mainly occurring on acidic bark, but may also grow on other substrates, e.g., on mossy rock.

Specimens seen (selected): Øf: Hvaler 1983, Tønsberg 7864. - AA: Valle 1987, Tønsberg 10162. - Ro: Suldal 1988, Tønsberg 10835. - Ho: Kvinnherad 1987, Tønsberg 10056. - SF: Førde 1989, Tønsberg 11810. - MR: Sande 1989, Tønsberg 11911. - ST: Trondheim 1980, Tønsberg 4809. - NT: Grong 1981, Tønsberg 6132. - No: Hadsel 1987, Tønsberg 10483. - Tr: Målselv 1982, Tønsberg 7325. A total of 28 specimens seen.

Porpidia Körber

The genus *Porpidia* in central and northern Europe has been monographed by Schwab (1986). The genus has been revised for North America by Gowan (1989b) who also gave a character analysis of the secondary products (Gowan 1989a).

Porpidia tuberculosa (Sm.) Hertel & Knoph

Thallus crustose, episubstratal, mostly grey with a green tinge, but with a few whitish areolae and a whitish marginal zone when abutting adjacent lichens, partly areolate, but largely more or less continuous. Prothallus not evident. Areolae sparse, discrete or becoming contiguous and later confluent, mostly only slightly convex, irregularly rounded, up to 0.2 mm in diameter. Continuous parts tuberculate; tuberculae slightly convex, somewhat cracked. **Soralia** sparsely present, at thallus level or slightly raised, more or less flat in upper part, rounded, greenish, whitish when eroded, discrete to more or less contiguous, up to 0.3 mm in diameter. Soredia 20-30 µm in diameter; wall distinct. Medulla distinct in thick thallus parts, white, K/I+ blue. Photobiont green, globose to ellipsoidal, up to 20 µm in diameter.

Apothecia and pycnidia not observed, but according to Schwab (1986), black, up to 2.2 mm in diameter; disc flat to convex, often pruinose.

Chemistry: Confluentic acid.

Substratum. *Porpidia tuberculosa* has been collected once on the shaded underside of the base of a trunk of *Betula pubescens/pendula* growing on the bank of a stream. Associated species included *Opegrapha gyrocarpa* and *Porpidia* sp. A.

Distribution. *Porpidia tuberculosa* was collected at 450 m altitude at a single site in Setesdalen (Aust-Agder). **Counties:** Aust-Agder. All specimens: Østfold, Aust-Agder, Rogaland - Sogn og Fjordane, Sør-Trøndelag, Nordland (see Degelius 1982, Schwab 1986).

Discussion. *Porpidia tuberculosa* is usually a species of siliceous rock growing mainly on rock walls, sometimes underoverhangs. To my knowledge no species of *Porpidia* has previously been reported from bark (see, e.g., Inoue 1983 a-c, Santesson 1984, Schwab 1986, Wirth 1987, Gowan 1989b).

Porpidia tuberculosa is distinguished from *Porpidia* sp. A by morphological and chemical characters (for details see that species).

According to Gowan (1989a), *Porpidia tuberculosa* produces confluentic acid as the main constituent, in addition to 2'-O-methylmicrophyllinic acid and 2'-O-methylperlatolic acid. The present specimen was, apparently, too scanty to allow for detection of minor substances.

Saxicolous specimens are common in the coastal lowlands as far north as Nordland and have been collected up to 800 m altitude (see Santesson 1984, Schwab 1986).

Specimen seen: AA: Valle 1987, Tønsberg 10161b.

Porpidia sp. A

Thallus crustose, episubstratal, light grey, forming roundish patches to a few cm in diameter, continuous, sorediate, surrounded by a blackish line when abutting adjacent lichens. Prothallus not evident. Surface even to indistinctly tuberculate, finely cracked. **Soralia** pale green with a greyish brown tinge due to pigmentation of the external soredia, round to ovate, slightly prominent, sharply delimited by a thallus ring, mostly discrete, up to 1.1 mm in diameter; surface flat. Soredia fine, 12-20 µm; often 2-4 in aggregations up to 30 µm; external soredia with a brownish pigment (K-) in the walls of the external hyphae; soredial wall distinct. Medulla distinct in thick parts, white, K/I-. Photobiont green, globose to ellipsoidal, up to 20 µm in diameter.

Apothecia and pycnidia not observed.

Chemistry: Stictic acid (main constituent), trace of constictic acid and cryptostictic acid.

Substratum. *Porpidia* sp. A occurred associated with *P. tuberculosa* and *Opegrapha gyrocarpa* on the shaded base of a trunk of *Betula pubescens/pendula*.

Distribution. *Porpidia* sp. A was found at a single site in Setesdalen, southernmost Norway, at 450 m altitude. **County:** Aust-Agder

Discussion. The specimen of *Porpidia* A conforms to the description of *Porpidia pseudomelinodes* given by Schwab (1986) except that the thallus was grey (non-oxidized) and corticolous. However, the delimitation of this species and *Porpidia soredizoides*, another stictic acid-producing, sorediate species, appears to be unclear (Gowan 1989b). As it grew associated with species which are usually saxicolous and as *Porpidia* is not known to have non-saxicolous members, it probably represents a predominately saxicolous species.

Specimen seen: AA: Valle 1987, Tønsberg 10161b (mixed in a collection filed under *Porpidia tuberculosa*).

Psilolechia Massal.

A review of the genus *Psilolechia* was made by Coppins & Purvis (1987).

Psilolechia lucida (Ach.) M. Choisy

Thallus crustose, episubstratal, green to bright yellow-green, forming irregular patches up to a dm or more in diameter, more or less continuous to more or less areolate, ecorticate, usually composed of a soft mass of filaments, unstratified. Filaments simple to branched, 10-50 µm long (in slightly squashed thallus fragments) and 6-8 µm wide. True **soredia** not observed in corticolous material. Areolae 0.1-0.2 µm in diameter, rounded, slightly convex, mostly soon becoming contiguous or fused with adjacent areolae. Large continuous thallus parts often secondarily cracked. Photobiont *Stichococcus*, cells cubic to oblong, 4-8 x c.3.5 µm or globose and 4-5 µm in diameter, simple or forming chains.

Apothecia present in one (17%) of the specimens, yellow, emarginate, convex, up to 0.3 mm in diameter, or up to 0.6 mm in diameter when tuberculate.

Chemistry: Rhizocarpic acid, unidentified substances (in trace amounts), for details, see Coppins & Purvis (1987). Thallus UV+ orange, C-.

Substratum. *Psilolechia lucida* has been collected on stems of *Calluna* and shaded and sheltered roots of *Betula pubescens/pendula*, *Pinus sylvestris*, and *Populus tremula*; one collection was from a trunk of *Picea abies*. Associated lichens included *Lepraria obtusatica* and *L. umbricola*.

Distribution. Corticolous specimens of *Psilolechia lucida* have been found in the coastal lowlands of southern Norway. The vertical distribution ranged from about sea-level to 100-140 m. **Counties:** Corticolous specimens: Østfold, Hordaland, Sogn og Fjordane, Sør-Trøndelag. All specimens: Østfold - Aust-Agder, Rogaland - Sogn og Fjordane, Sør-Trøndelag.

Discussion. According to Coppins & Purvis (1987) *Psilolechia lucida* usually has ?*Trebouxia* as photobiont and is "leprose to leprose-granular", but occasionally the photobiont is *Stichococcus* and the thallus is then usually "granular-areolate". The form with ?*Trebouxia* was not observed in Norwegian corticolous material. In the present material the thallus is tartareous (not sorediate) probably due to the presence of a chain-forming, rather than a coccoid photobiont. Occasional saxicolous specimens studied all contained a coccoid photobiont (?*Trebouxia*); these specimens were distinctly sorediate with fine to coarse soredia 15-40 µm in diameter.

Psilolechia lucida is morphologically similar to *Chaenotheca furfuracea* which is another frequent inhabitant of deeply shaded bark. That species, which is rarely sterile, produces vulpinic acid and lacks rhizocarpic acid. *Chrysothrix chrysophthalma* always has a coccoid photobiont and is chemically distinct due to the presence of large amounts of chrysophthalma unknown.

Psilolechia lucida is a common saxicolous species in shaded niches under overhangs. The saxicolous form occurred frequently in the coastal lowlands. Inland it has been recorded from a shaded river gorge in Gudbrandsdalen (Øvstedal 1986, specimen not seen) and from Dovre (leg. M.N. Blytt (BG)). It only occasionally occurs on bark. One collection was from a wooden wall (*Pinus sylvestris*).

Specimens seen:. Øf: Hvaler 1990, Tønsberg 13219. - Hordaland: Bergen 1989, Tønsberg 11412; Tysnes 1986, Tønsberg 9506. - SF: Gloppen 1989, Tønsberg 11940a, 11941a. - ST: Melhus 1989, Holien 3365 (BG, TRH). (AA: Gjerstad 1989, Holien 3430 (TRH, on wood.)

Pyrrhospora Körber

Pyrrhospora quernea (Dickson) Körber

Fig. 110.

Thallus crustose, episubstratal, indeterminate, irregularly spreading, up to a few cm in diameter, rarely with esorediate areolae, mostly leprose sorediate. Prothallus mostly indistinct, but a brownish black bordering line is often visible when abutting adjacent lichen thalli. Areolae usually indistinct or absent, up to 0.1 mm in diameter, soon becoming completely dissolved into soredia. **Soralia** green, often with a yellowish brown tinge, diffuse, soon becoming confluent, forming a more or less thick leprose sorediate crust which may crack and form more or less angular portions, 1-2 mm across. Soredia in rounded consoredia up to 50 µm in diameter; wall indistinct to distinct, sometimes with shortly projecting hyphae. Medulla indistinct or absent. Photobiont green, coccoid, up to 12 µm in diameter.

Apothecia unknown in Norwegian material, but present in material examined from Sweden and Denmark, lecideine; margin becoming excluded; disc dark red-brown, convex. Pycnidia not seen.

Chemistry: Thiophanic acid and isoarthothelin (major), dichloronorlichexanthone (trace), unidentified xanthones (traces). Thallus UV+ orange; C+ orange-red.

Substratum. *Pyrrhospora quernea* has been collected on *Quercus* (6 specimens), and on *Betula pubescens/pendula, Aesculus hippocastanum, Alnus glutinosa, Picea abies*, and *Sorbus aucuparia*.

Distribution. *Pyrrhospora quernea* occurred in the coastal lowlands of southernmost Norway as far north as Hordaland and in an outpost locality in central Norway (Fig. 110). Its vertical distribution ranged from about sea-level to 100 m (Nord-Trøndelag: Stjørdal). It occurred in open, well-lit sites. **Counties:** Østfold, Vestfold - Vest-Agder, Hordaland, Nord-Trøndelag.

Discussion. *Pyrrhospora quernea* is not a variable species. The colour varied somewhat in shades of green, probably reflecting the illumination of the sites.

Pyrrhospora quernea is characterized by a leprose thallus of greenish soredia with a faint brownish tinge, the presence of isoarthothelin and thiophanic acid, and the absence of phenolic carboxylic acid derivatives. The Norwegian material of *Pyrrhospora quernea* was chemically uniform with fertile material examined from Denmark and Sweden. Morphologically it may be confused with the inland form of *Lecidella subviridis*. However, these species are easily separated by their chemistry, e.g., by the presence (*Lecidella subviridis*) or absence (*Pyrrhospora quernea*) of atranorin. *Lecanora expallens* differs from *Pyrrhospora quernea* in having a yellow thallus due to the presence of usnic acid. Thiophaninic acid ("thiophaninsäure") reported from the species by Poelt & Vězda (1981) was not observed in the Norwegian material. Arthothelin was reported from *Pyrrhospora quernea* by J. Santesson (1969).

Pyrrhospora quernea is a southern species on acidic to intermediate bark.

Specimens seen: Øf: Hvaler 1977, Tønsberg 1857a; Hvaler 1982, Holtan-Hartwig, Nordnes & Timdal 3782; Hvaler 1983, Tønsberg 7775, 7779, 7869. - Vf: Tjølling 1934, Høeg (TRH). - Te: Kragerø 1985, Holtan-Hartwig 4422 (O). - AA: Risør 1983, Tønsberg 7965b. - VA: Kristiansand 1981, Gauslaa (Ås-NLH). - Ho: Os 1984, Blom. - NT: Stjørdal 1981, Tønsberg 6235. A total of 11 specimens seen.

Rimularia Nyl.

The genus *Rimularia* has been treated by Hertel & Rambold (1990).

Rimularia fuscosora Muhr & Tønsb.

Nordic J. Bot. 8: 649 (1989).

Figs 10, 13, 111.

(Description modified from Muhr & Tønsberg 1989.)

Thallus crustose, indeterminate, forming rounded patches up to a few cm in diameter, often becoming confluent with other thalli, thin, sorediate. Esorediate parts often endosubstratal causing a pale to dark brown stain on smooth bark or, occasionally, with distinct endosubstratal to episubstratal areolae. Areolae grey to pale greyish brown, often covered in thin bark flakes from the substratum, irregularly rounded, slightly convex, discrete or becoming more or less contiguous, up to 0.2 µm in diameter, more rarely becoming fused forming a more or less continuous and rimose-cracked crust. **Soralia** bursting from endo- or episubstratal areolae, dark brown due to pigmentation of the external soredia, usually persistently discrete, punctiform, up to 0.6 mm in diameter, flat to convex; surface often papillate. Soredia (Figs 10, 13) fine, 20-30 µm in diameter, surrounded by 1-2(-3) layers of more or less isodiametric to somewhat elongate cortical cells; exposed parts brown; pigment K- or K+ fuscous brown, N-. Photobiont green, coccoid, 9-16 µm in diameter.

Apothecia sparingly present in one (14%) of the Norwegian collections, lecideine, black, sessile, at least when young somewhat constricted at base; margin persistent, 0.06 mm wide, sometimes becoming flexuose and somewhat plicate (gyrose) with age; disc plane to slightly convex, roughened.

Chemistry: Norstictic acid (trace). Areolae and internal soredia PD- or PD+ faintly yellow, K- or K+ yellow turning red, C-, KC-; UV-. TLC of some poorly developed specimens, yielded no detectable spot representing norstictic acid. However, in squash-preparations of soralia in K, blood-red crystals indicative of the presence norstictic acid were formed.

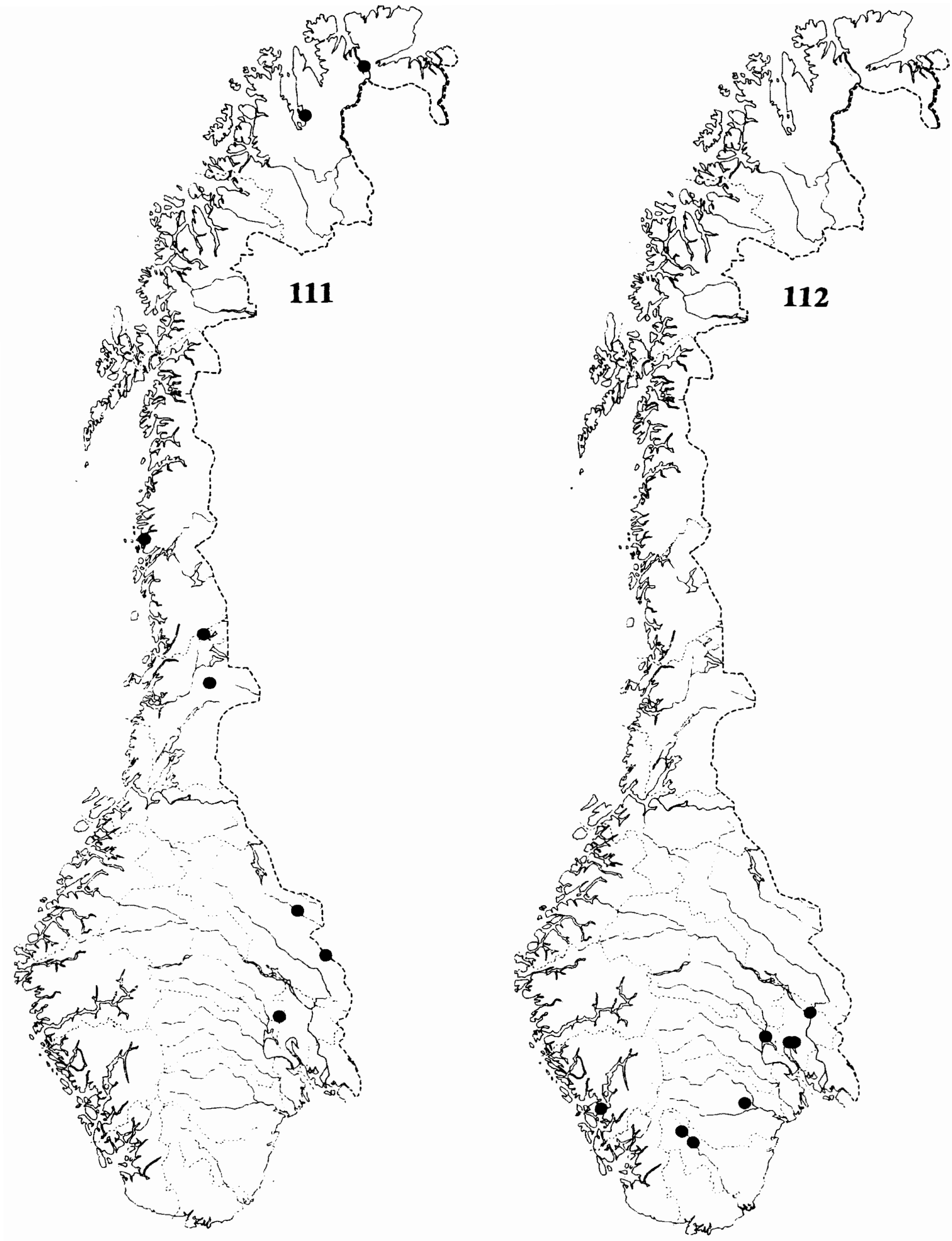
Substratum. *Rimularia fuscosora* was collected on *Alnus incana* (5 specimens), *Betula pubescens/pendula* (1), and *Sorbus aucuparia* (1). The species often occurred as small, inconspicuous patches among other crustose lichens.

Distribution. *Rimularia fuscosora* was found only in the easternmost parts of Norway (Fig. 111). Its vertical distribution ranged from about sea-level (Finnmark) to 360 m (Oppland: Lunner). *Rimularia fuscosora* occurred mostly in shaded and rather humid sites, e.g., on banks of streams and in ravines. However, it also inhabited more open sites. **Counties:** Hedmark, Oppland, Nord-Trøndelag, Nordland, Finnmark.

Discussion. Sterile specimens of *Rimularia fuscosora* are distinguished by the punctiform soralia, the dark brown, corticate, external soredia and the production of norstictic acid. In thalline characters it may superficially resemble *Schaereria corticola* which has similar soralia and distinctly corticate soredia. However, that species contains gyrophoric and 5-O-methylhiascic acids and should not be confused with *Rimularia fuscosora*.

The species is so far known from Norway, Sweden and U.K.: Scotland (Muhr & Tønsberg 1989). *Rimularia fuscosora* is an eastern species on acidic bark.

Specimens seen: He: Trysil 1988, Tønsberg 11026; Åsnes 1984, Muhr 7005 (BG, UPS). - Op: Lunner



Figs 111-112. Distribution maps. Fig. 111. *Rimularia fuscosora*. Fig. 112. *Rinodina colobina*.

1982, Tønsberg 7560b. - NT: Grong 1981, Tønsberg 6129c; Namsskogan 1978, Tønsberg 3503b. - No: Rødøy 1986, Tønsberg 9648b. - Fi: Porsanger 1988, Tønsberg 11186; Tana 1982, Tønsberg 7287b.

Rinodina (Ach.) Gray

The corticolous species of the genus *Rinodina* is in urgent need of a thorough revision. The saxicolous species in Europe have been treated by i.a. Mayrhofer & Poelt (1979).

Rinodina colobina (Ach.) Th. Fr.

Fig. 112.

Thallus crustose, episubstratal, areolate, indeterminate, forming extensive irregular patches up to several dm in diameter, sorediate. Areolae often indistinct, sometimes absent, greyish white, greyish green or greyish blue, sometimes with a brownish tinge, rounded to elongate or more or less irregular, flat to convex, up to 0.2 mm in diameter. **Soralia** grey-black to blue-grey, rarely greyish green, usually not well-defined, sometimes marginal on well-developed areolae, mostly irregular and efflorescent. Soredia mostly fine, 15-30 µm in diameter, sometimes in globose or irregularly rounded consoredia up to 60 µm.; external soredia usually with a grey-black K+, C+, N+ violet pigment; enclosing hyphae forming a cortex of more or less globular cells. Thallus sometimes entirely composed of fragile, areolae-like aggregations of consoredia and simple soredia. Medulla absent. Photobiont green, coccoid, up to 20 µm in diameter.

Apothecia present in all specimens, up to 0.6 mm in diameter; margin prominent, bluish grey, 0.1 mm wide; disc black. Pycnidia inconspicuous, immersed in the areolae; conidia rod-shaped, 8 x 1 µm. (Conidia were seen once in a thallus squash; the possibility that they belonged to a contaminant was not ruled out.)

Chemistry: Colobina unknowns (accessories in trace to moderate amounts).

Substratum. *Rinodina colobina* was found on *Fraxinus excelsior*, *Populus tremula*, *Sambucus nigra*, and *Ulmus glabra*. It occurred on naked bark and, rarely, on corticolous mosses. Close associates included species of *Caloplaca*, *Candelariella*, *Leptogium*, *Phaeophyscia*, *Physcia* and *Xanthoria*.

Distribution. *Rinodina colobina* has been found in a broad belt in the lowlands along the coast from Oslo to Hordaland (Fig. 112). Its vertical distribution ranged from about sea level to 635 m (Aust-Agder: Bykle). **Counties:** Akershus, Buskerud, Telemark - Aust-Agder, Hordaland.

Discussion. *Rinodina colobina* resembles *R. griseosoralifera* which also has greyish or sometimes bluish grey soredia; the latter species can be distinguished chemically, e.g., by the presence of atranorin and zeorin. *Rinodina colobina* may be very similar to *Caloplaca chlorina*, with which it is sometimes associated. Sterile specimens of these species can apparently not always be conclusively identified (for further details, see under *C. chlorina*). *Rinodina colobina* is a rare species. It seems to show a decline in frequency as most specimens (64%) were from the 19th century. In Norway it was first collected in Oslo in 1870 where it was apparently abundant in several sites. Now it is not known to occur in Oslo.

Rinodina colobina is a southern species on eutrophic bark.

Specimens seen (selected): Oslo 1870, Moe (O - 3 coll.) - Ak: Nes 1990, Tønsberg 13259. - Bu: Ringerike 1990, Tønsberg 13305. - Te: Bø 1976, Øvstedal; 1990, Tønsberg 13041. - AA: Bykle 1955, Degelius (herb. Degelius). Valle 1955, Degelius (herb. Degelius). - Ho: Kvinnherad ("Terø bei Bergen")(UPS). A total of 25 specimens seen.

Rinodina degeliana Coppins

Lichenologist 15: 147 (1983). Type: Sweden, Lule Lappmark, Kvikkjokk, 3 km SSW of Kvikkjokk, SE slope of Nammatj, alt. 500-525 m, on old *Salix* in *Picea* forest, 28 July 1977, B. J. Coppins 6328 & L. Tibell (E! - holotype).

Figs 113-114.

Thallus (Fig. 113) crustose to subsquamulose, episubstratal or, rarely endosubstratal in esorediate parts, indeterminate or, rarely, delimited, mostly irregularly spreading, up to 1 dm or more in diameter, areolate, sorediate. Prothallus mostly indistinct, very rarely distinct as a whitish network of interconnected hyphae between the areolae or as a brown-black border of radiating hyphae surrounding the thallus. Areolae crustose to subsquamiform, discrete or contiguous, grey-white, sometimes grey-green, matt or slightly glossy, irregularly rounded or more or less angular up to 0.7 mm in diameter, flat and adnate at first, later sometimes tending to become raised at their edge. **Soralia** persistently discrete or, more rarely, becoming more or less confluent, marginal, and on the underside of slightly raised areolae, linear at first, later often more or less labriform; some areolae often completely dissolved into diffuse soralia. Soredia fine, whitish grey to greyish green, loosely packed, often in consoredia; wall distinct. Medulla indistinct. Photobiont green, coccoid, up to 12(-20) µm in diameter.

Apothecia absent in Norwegian material, sessile, constricted at base, 1 per areola,

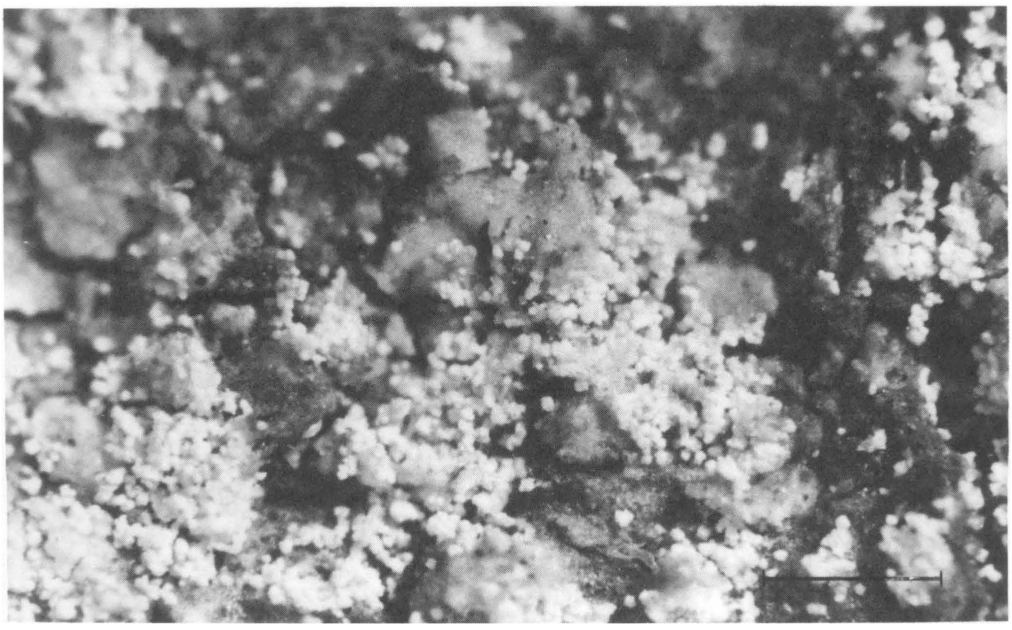
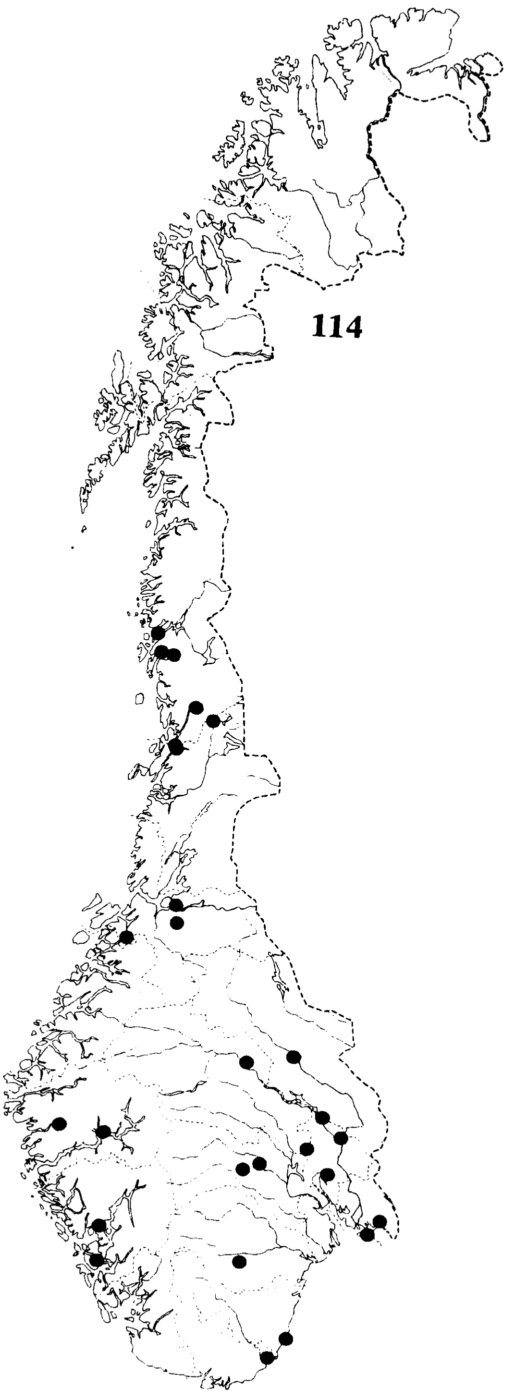
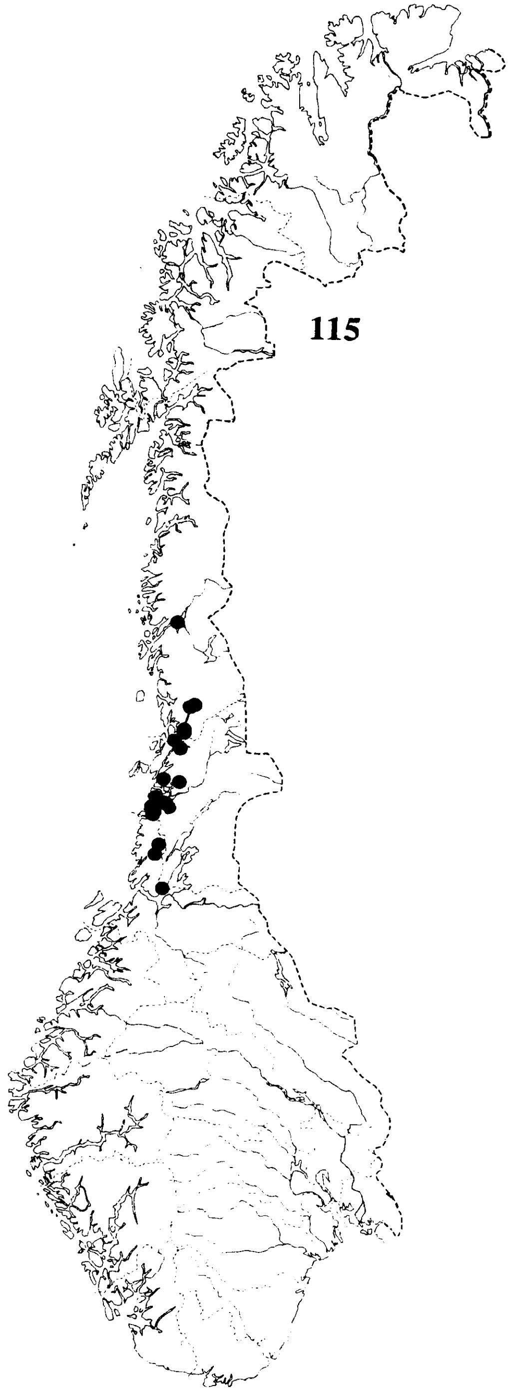


Fig. 113. *Rinodina degeliana*. Tønsberg 6584. Flat areolae with marginal soralia. Scale 0.5 mm.





Figs 114-115. Distribution maps. Fig. 114. *Rinodina degeliana*. Fig. 115. *Rinodina disjuncta*. Distribution in Europe.

0.3-0.6 mm in diameter, lecanorine; thallus margin concolorous with the areolae, sorediate or not; proper margin visible, becoming prominent, blackish brown; disc plane, blackish brown, matt. Pycnidia not observed.

Chemistry: Atranorin, chloroatranorin, zeorin, ± unidentified terpenoids (traces).

Substratum. *Rinodina degeliana* has most commonly been collected on *Alnus incana* (12 specimens); other phorophytes included *Acer platanoides*, *Alnus glutinosa*, *Betula pubescens/pendula*, *Juniperus communis*, *Quercus*, *Salix caprea*, *Sorbus aucuparia*, and *Tilia*.

Distribution. *Rinodina degeliana* has been found most commonly in eastern parts of Norway (Fig. 114). Its vertical distribution ranged from about sea level to 540 m (Buskerud: Sigdal). *Rinodina degeliana* seemed to prefer open situations, but has also been collected in a shaded and sheltered river gorge. **Counties:** Østfold - Buskerud, Telemark - Vest-Agder, Hordaland, Sogn og Fjordane, Sør-Trøndelag - Nordland (Nesna).

Discussion. *Rinodina degeliana* is not a very variable species. The prothallus, which is only rarely distinct, may form a border of radiating hyphae (as, e.g., in Tønsberg 9006) or form a whitish network (as, e.g., in Tønsberg 9259).

Rinodina degeliana is readily recognized by its flat, adnate to raised, whitish grey or greenish grey areolae, its whitish grey, marginal, more or less labriform or diffuse soralia, and its content of atranorin, chloroatranorin and zeorin.

Rinodina degeliana is here reported as new to Norway. Outside Norway it has been recorded from Sweden (Coppins 1983b). *Rinodina degeliana* is an eastern species, mainly of acidic bark.

Specimens seen (selected): Øf: Halden 1987, Tønsberg 10100. - Oslo 1980, Tønsberg 5355. - Ak: Eidsvoll 1990, Tønsberg 13177. - He: Åmot 1982, Tønsberg 6883b. - Op: Lunner 1982, Tønsberg 7537. - Bu: Krødsherad 1982, Tønsberg 6932. - Te: Kviteseid 1987, Tønsberg 10288. - AA: Grimstad 1990, Tønsberg 13510. - VA: Kristiansand 1988, Tønsberg 10637. - Ho: Fusa 1987, Tønsberg 10026. - SF: Førde 1983, Tønsberg 7824c. - ST: Hemne 1983, Tønsberg 8336b. - NT: Namsskogan 1982, Tønsberg 6584. - No: Nesna 1986, Tønsberg 9688. A total of 31 specimens seen.

Rinodina disjuncta Sheard & Tønsb. sp. nov.

Thallus areolatus, sorediatus. Areolae griseo-albidae, interdum brunnescens suffusae, dispersae. Soralia viridia vel virido-brunnea, dispersa, effusa, efflorescentia, forma et statura irregularia. Soredia in structura elongata aggregata. Apothecia ad 1.3 (-2.0) mm in diameter, margine thallino plerumque sorediato; excipulum proprium plus minusve manifestum; discus atrobrunneus. Excipulum thallinum crystallis magnis continens. Sporae brunneae, 1-septatae, glabrae, toro typo-*Physcia*, 19-31 x 10-15 µm. Acidum sphaerophoricum continens.

Type: Norway, Nord-Trøndelag, Namdalseid, north-facing slope south of lake Altvatn, alt. 110 m, 32W PS 0640 (1623 I), 5 Nov. 1983, Tønsberg 8445 (BG-holotype; E, UPS - isotypes).

Figs 19, 115-116.

(Description based on Norwegian and North American material.)

Thallus (Fig. 116) crustose, episubstratal, indeterminate, irregularly spreading, up to a dm or more across, sorediate. Prothallus distinct in some specimens, forming more or less radiating bundles of brown hyphae, ramifying on, between or below the uppermost hyaline bark cells of the substratum. Areolae usually distinct, sometimes lacking, greyish white, pale greyish green to green, sometimes with a brown tinge, discrete and scattered or, rarely, some becoming contiguous and more or less fused, circular to irregular in outline; usually convex, sometimes constricted at base, sometimes blister-like, up to 0.3 mm in diameter. **Soralia** green or greenish brown, discrete and scattered, diffuse, sometimes becoming contiguous forming a thick crust which secondarily cracks, hard, rough, not compact, efflorescent, diffuse, very

Fig. 116. *Rinodina disjuncta*. Holotype. Scale 1 mm.

irregular in form and size. Soredia in firm, irregularly elongate, sometimes more or less flattened consoredia (up to 120 × 60 µm in diameter), not easily separated in squash preparations; wall distinct, of colourless, more or less globose cells. Photobiont green, globose, up to 13 µm in diameter.

Apothecia sparsely or, more rarely, abundant in 18 (44%) of the Norwegian specimens, lecanorine, up to 1.3 (-2.0) mm in diameter; thalline margin more or less concolorous with the thallus, often crenulate, often with soralia, up to 0.2 mm wide; proper exciple sometimes distinct, up to 0.1 mm wide; disc brown to black, rarely slightly pruinose towards the centre; plane to convex in mature apothecia. In sections: Excipulum thallinum colourless throughout or dilute brown in outermost part (rim), up to 160 µm wide at the upper surface, composed of an up to 50 µm wide cortex and a well-developed medulla which, close to the upper surface contains developing soredia; medulla and inner part of cortex with large, K+ soluble, UV+ crystals (probably sphaerophorin). Excipulum proprium brown, K-, N-. Hymenium colourless beneath the epihymenium, 100-170 µm deep, I+ blue. Paraphyses conglutinated in uppermost part, even in K, otherwise free and lax, simple, 1-1.5 µm wide, apical cell swollen, up to 4 µm thick, with a distinct, dark brown pigment cap in the cell wall. Asci cylindrical, narrowly ellipsoid, or narrowly ovoid or obovoid; 85-100 × 25-32 µm; of *Lecanora*-type (see Honegger 1978 and Hafellner 1984); 8-spored. Spores irregularly arranged or tending to be uniseriate in upper and/or lower part of ascus, brown, 1-septate, with torus of the *Physcia*-type of Mayrhofer & Poelt (1979) and Poelt & Mayrhofer (1979), smooth (at × 1000 in LM), 19-31 × 10-15 µm. Subhymenium colourless, 50-75 µm deep, K/I+ blue.

Chemistry: Sphaerophorin, ± isosphaeric acid (trace). TLC: Fig. 19.

Substratum. In Norway *Rinodina disjuncta* has been collected on *Alnus incana* (21 specimens), *Sorbus aucuparia* (15) and, more rarely, *Populus tremula*, and *Salix caprea*. It occurred on smooth as well as on rough bark. *Rinodina disjuncta* usually occurred in species-rich communities, with a number of lichens with high moisture demands: *Arthothelium* *norvegicum, Catillaria pulverea, Cavernularia hultenii, Degelia plumbea, Mycoblastus caesius, Lecanora farinaria, Lecidea roseotincta, Lobaria amplissima, Nephroma laevigatum, Pannaria rubiginosa, Parmeliella jamesii,* and *Pseudocyphellaria crocata.*

On the Pacific Coast of North America it has been found on *Acer glabrum, Alnus rubra,* and *Lithocarpus densiflorus.*

Distribution. In Norway *Rinodina disjuncta* has been collected in the humid and shaded, coastal Picea forests of central Norway and adjacent parts of Nordland as far north as Hemnes (Fig. 115). The vertical distribution ranged from about sea level to 150 m. **Counties:** Sør-Trøndelag - Nordland.

Outside Norway, *Rinodina disjuncta* has been found at and near the Pacific coast of North America (U.S.A. and Canada) from northern California as far north as Alaska and as far east as western Montana. Its vertical distribution in North America ranged from about sea-level to 1275 m.

Discussion. *Rinodina disjuncta* is a very characteristic species on account of the diffuse, firm, efflorescent soralia, the aggregated soredia, and the chemical constituents sphaerophorin and isosphaeric acid. Morphologically it does not resemble any other species treated here. It is chemically concordant with *Lecidea pullata,* but that species has punctiform soralia, often a conspicuous blue prothallus, and occurs in another habitat (see that species). Sphaerophorin and isosphaeric acid are new to the genus *Rinodina.*

In North America, *Rinodina disjuncta* seemed to be restricted to coastal sites or to high rainfall areas. With its presently known range, *Rinodina disjuncta* shows a western north Europe - western North America disjunct distribution.

Rinodina disjuncta is a species of acidic bark.

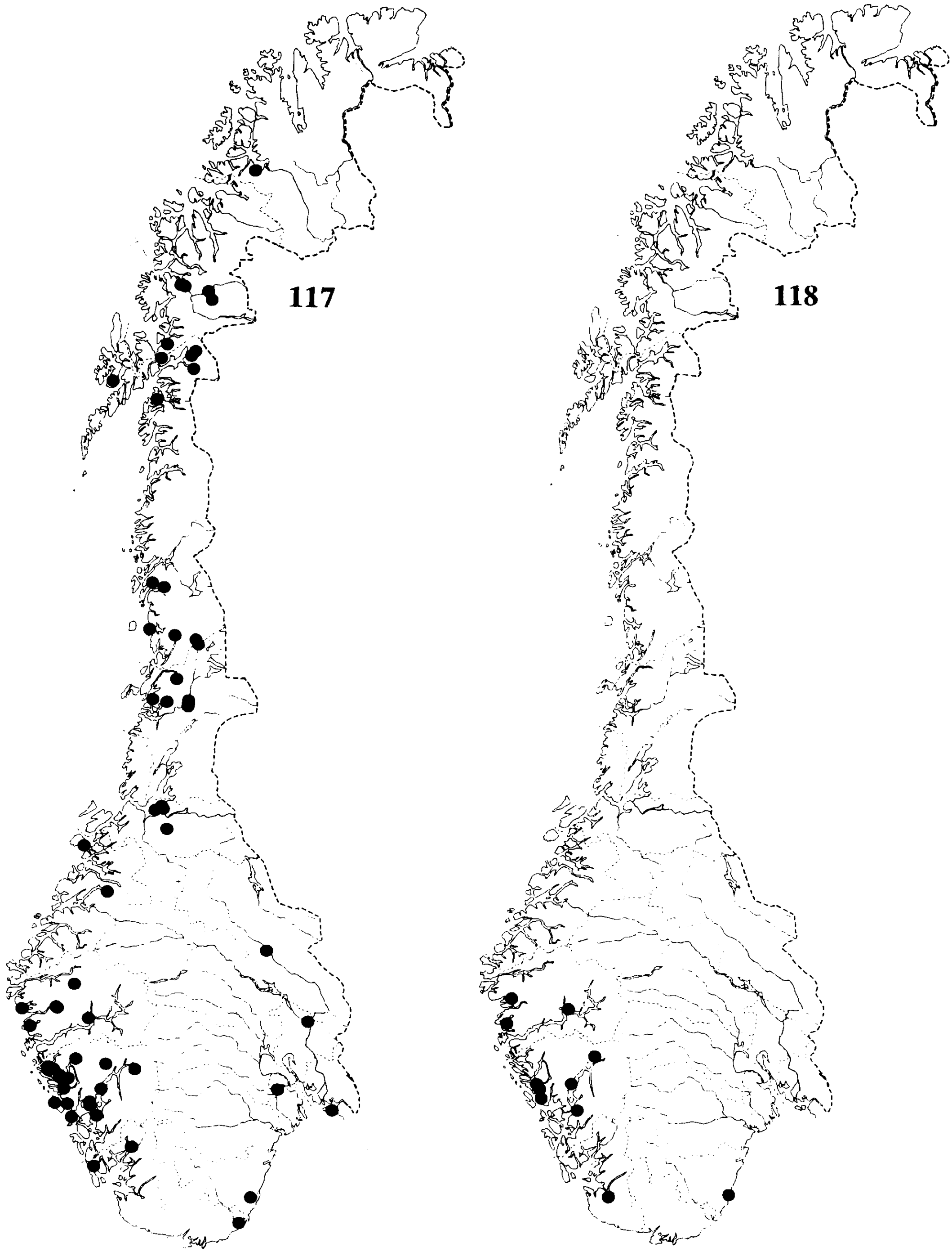
Specimens seen (selected): **Norway:** ST: Åfjord 1988, Holien 3196 (TRH); Åfjord 1983, Tønsberg 8232. - NT: Flatanger 1981, Tønsberg 5534. Flatanger 1983, Tønsberg 8394, 8395, 8458. Fosnes 1980-1985, Tønsberg 4919, 4922, 9196. Leksvik 1981, Tønsberg 5651. Namdalseid 1981-1984, Tønsberg 8448, 8245, 8247, 8250, 8253, 8445, 8940. Namsos 1981-1985, Tønsberg 5568, 9195. Nærøy 1980-1984, Tønsberg 4948, 4949, 6675, 6679, 6680, 6689, 6692, 6693, 6697, 6715b, 8962, 8964. - No: Bindal 1982, Tønsberg 6782, 6793, 6820b, 6826, 6827, 6837. Brønnøy 1987, Tønsberg 10571, 10584, 10589. Hemnes 1984, Øvstedal (BG). A total of 41 Norwegian specimens seen. **Canada:** *British Columbia*: Gulf Islands, Saltspring Island, 1989, Tønsberg 12072. Vancouver Island, W of Shirley, 1989, Tønsberg 12539; Jordan River 12550. West Vancouver, Lynn Canyon Park, 1978, W.J. Noble 6586 (UBC). **U.S.A.:** *California*, Del Norte Co, along U.S. Route 199 just S of the Oregon - California border, 1991, Tønsberg 14690; Humboldt Co, along State Route 299, just W of Lord-Ellis Summit, alt. 570 m, 1991, Tønsberg 14769. *Oregon*, Tillamook Co, S of Netarts, bank of Netarts Bay, 1991, Tønsberg 15032. *Washington*, Pierce County, Nisqually River, Alder Lake, 1989, Tønsberg 12954 (WTU), 12955 (BG). *Montana*, Ravalli County, Bitterroot Range, 1980, B. McCune 10753 (herb. McCune). *Alaska*, Borough of Juneau, W of Auke Bay, between Pt. Lousiana and Indian Pt., 1991, Tønsberg 16298; bank of Cowee Cr., 1991, Tønsberg 16271, 16272.

Rinodina efflorescens Malme

Svensk bot. Tidskr. 21: 251 (1927). Type: Sweden: Västergötland; Habo, St.Kärr, on old *Fagus sylvatica* in a shaded place, 1923, G.O. Malme (S! - holotype). TLC: Pannarin, efflorescens unknown.

Figs 18, 117.

Thallus crustose to subsquamulose, episubstratal, indeterminate; usually forming small irregular patches, occasionally reaching one dm or more in diameter, areolate, sorediate. Prothallus usually indistinct, occasionally visible as a more or less brown stain between the areolae. Areolae grey-brown to green-brown or, rarely, grey-green or yellowish, matt, usually



Figs 117-118. Distribution maps. Fig. 117. *Rinodina efflorescens*. Fig. 118. *Rinodina flavosoralifera*. Known distribution.

scattered, irregularly rounded, often somewhat divided, flat to distinctly convex, often free from the substratum towards the margin and then more or less subsquamiform, up to 0.3(-0.9) mm in diameter. **Soralia** bursting from the upper surface of the areolae or rarely directly through the uppermost cell layers of the substratum, brown, greyish brown, pale green, dull greenish yellow or, rarely, distinctly yellow, minute and punctiform, with more or less flat upper surface, up to 0.15 mm in diameter. Soredia fine, 12-30 µm in diameter, sometimes a few in rounded consoredia; soredial wall distinct, of more or less globose cells; external soredia sometimes distinctly brown due to pigmentation of the cell walls of the external hyphae; brown pigment K+ fuscous brown, N-. Medulla absent. Photobiont green, coccoid, up to 15 µm in diameter.

Apothecia rare, sparsely present in 3 (4%) of the specimens, lecanorine, 0.3-0.5 mm in diameter; thalline margin persistent, esorediate, concolorous with the areolae; disc dark reddish brown to black-brown, flat. Pycnidia not seen.

Chemistry: Pannarin, efflorescens unknown (pigment), ± zeorin (rarely observed). One specimen (Tønsberg 11998) contained an additional pigment in R_F-classes A 5, B 3, C 5. TLC: Fig. 18.

Substratum. *Rinodina efflorescens* has most frequently been collected on *Alnus incana* (37 specimens). Other phorophytes included *Acer pseudoplatanus*, *Alnus glutinosa*, *Betula pubescens/pendula*, *Corylus avellana*, *Fagus sylvatica*, *Fraxinus excelsior*, *Populus tremula*, *Prunus padus*, *Quercus*, *Rhododendron catawbiense*, *Salix caprea*, *Sorbus aucuparia*, and *Tilia*. No specimens were from conifers. It grew on naked bark and on other corticolous lichens, especially *Parmelia sulcata*, but also *P. saxatilis* and *P.* (*Melanelia*) *glabratula*, and on corticolous mosses. It was commonly associated with *Buellia griseovirens*, *Fuscidea arboricola*, and *F. pusilla*.

Distribution. *Rinodina efflorescens* occurred in moist habitats in coastal areas (Fig. 117). Inland (Hedmark) it occurred on a shaded river bank forested with *Picea*. Its vertical distribution ranged from about sea-level to 400 m (Sør-Trøndelag: Trondheim). **Counties:** Østfold, Akershus, Hedmark, Vestfold, Aust-Agder - Finnmark.

Discussion. *Rinodina efflorescens* varies somewhat in the colour of the areolae and soralia, even on the same specimen. Both areolae and soralia are usually more or less tinged with brown. *Rinodina efflorescens* is readily recognized on account of the small, brownish, often subsquamiform areolae, the minute soralia often tinged with brown, and the content of pannarin.

Rinodina efflorescens is a coastal species of acidic to eutrophic bark.

Specimens seen (selected): Øf: Hvaler 1983, Tønsberg 7866. - Akershus, Nes 1990, Tønsberg 13267. - He: Åmot 1982, Tønsberg 7588. - Vf: Hof 1990, Tønsberg 13069. - AA: Grimstad 1977, Tønsberg 1721. - VA: Kristiansand 1988, Tønsberg 10638. - Ro: Suldal 1988, Tønsberg 10830. - Ho: Bergen 1988, Tønsberg 11394. Lindås 1974, Øvstedal (fertile). - SF: Balestrand 1979, Tønsberg 4013. - MR: Nesset 1979, Tønsberg 3786. - ST: Melhus 1982, Tønsberg 6641a (fertile). - NT: Grong 1979, Tønsberg 4458b. - No: Narvik 1982, Tønsberg 7412. - Tr: Skånland 1986, Tønsberg 9813. - Fi: Alta 1982, Tønsberg 7243a. A total of 81 specimens seen.

Rinodina flavosoralifera Tønsb. sp. nov.

Thallus areolatus, sorediatus. Areolae flavidae vel griseo- brunneo- flavidae, minutae, planae vel hemisphaericae, ad 0.3 mm in diameter. Soralia concolora, virido-flava vel brunnea. Apothecia rarissima, hemisphaerica vel subglobosa, disco poriformi brunneo. Sporae immaturae, hyalinae vel brunneae, 1-septatae, 14x6-10 µm. Pycnidia apotheciis similis; conidia bacilliformia. Arthothelicum et acidum thiophanicum continens.

Type: Norway, Hordaland, Bergen, Store Milde, Fana Folkehøgskole, UTM grid ref.: 32V KN 9385 (map

1115 I), alt. 20-40 m, on mossy trunk of *Prunus avium* in an old garden, 14 October 1988, T. Tønsberg 11375 (BG - holotype; E, GZU, O, UPS, herb. Sheard - isotypes).

Fig. 118.

Thallus crustose, episubstratal, indeterminate, forming extensive patches up to several dm in diameter, areolate, sorediate. Prothallus not evident. Areolae sparse, scattered, yellow, greenish yellow, or yellow with a brownish tinge, at first rounded and convex, later becoming more or less flattened, when well-developed usually elongate, more or less irregular in outline, sometimes somewhat incised, up to 0.3 mm long, usually soon becoming completely dissolved into soredia. **Soralia** punctiform or, more rarely, marginal on the areolae; usually discrete; yellow, yellowish green or yellow with a brown tinge, irregular in outline, upper surface flat to slightly convex; up to 0.3 mm wide. Soredia loosely arranged, fine, 20-30(-40) µm in diameter; external hyphae sometimes with reddish brown to brown walls, pigment K-, N-; sorediał wall distinct. Medulla indistinct or absent. Photobiont green, coccoid, up to 12(-15) µm in diameter.

Apothecia sparsely present in two (11%) of the collections, on the areolae or directly on the substratum, hemispherical to subglobose, with a pore-like opening; margin concolorous with the thallus, but brownish in a ring around the hymenium; disc brown, exposed part up to 75 µm in diameter. In sections: Thalline exciple up to 70 µm wide at the mid-point; proper exciple colourless, but brown in upper part, 20-25 µm wide at the mid-point, widening to 40-75 µm in upper part, cells elongate; brown pigment K-. Hymenium brown in uppermost part (epihymenium), otherwise colourless, 85-125 µm deep; hymenial gelatine K/I+ deep blue. Paraphyses sparingly branched in upper part, becoming somewhat lax in K, 2-3 µm wide (in K), apices slightly incrassate, up to 3.5 µm wide (in K), with a sharply delimited pigment in the apex apparently confined to the cell wall. Asci immature, clavate, up to 80 x 15 µm (in K), with a well developed K/I+ deep blue tholus and a K/I- wall, surrounded by K/I+ deep blue hymenial gelatine; usually without spores, occasionally with up to 8 spores. Spores apparently always immature, colourless or, rarely, brown, 1-septate, 14-15 × 6-10m (in K). Subhymenium colourless, up to 60 µm deep, K/I+ blue. Pycnidia (only one seen) similar to the apothecia in form and size; conidia rod-shaped, 4-5 × c. 1 µm.

Chemistry: Arthothelin, thiophanic acid. Thallus including soralia K-, C and KC + persistent orange, PD-; UV+ orange-red.

Substratum. *Rinodina flavosoralifera* has been found on mature boles of *Aesculus hippocastanum*, *Laburnum* sp., *Malus domestica*, *Prunus avium*, *Quercus*, and *Tilia*. It occurred in medium-shaded to sun-exposed situations on naked bark as well as on corticolous mosses (*Hypnum cupressiforme*) and, rarely other corticolous lichens, e.g., *Parmelia* (*Melanelia*) *glabratula*. Associated species included *Bacidia circumspecta*, *Buellia punctata*, *Hypogymnia physodes*, *H. tubulosa*, *Lecanora expallens*, *Lepraria* sp., *Lobaria pulmonaria*, *L. scrobiculata*, *Ochrolechia microstictoides*, *O. subviridis*, *Parmelia* (*Melanelia*) *glabratula*, *P. saxatilis*, *P. sulcata*, *Parmeliella jamesii*, *Pertusaria pupillaris*, *Platismatia glauca*, *Pertusaria albescens*, *P. coronata* and *Rinodina griseosoralifera*.

Distribution. *Rinodina flavosoralifera* occurred in the coastal lowlands of southwestern Norway (Fig. 118). *R. flavosoralifera* often occurred in well-lit sites; however, at the southernmost known site (Aust-Agder: Grimstad), it occurred on the shaded northern side of the phorophyte. Its vertical distribution ranged from 20 - 120 m. **Counties:** Aust-Agder, Rogaland - Sogn og Fjordane.

Discussion. Within *Rinodina*, *R. flavosoralifera*, is characterized by the yellow, sorediate, incised areolae, its chemical constituents, and the corticolous habit.

Rinodina flavosoralifera seems to have a preference for habitats influenced by man as it occurs in old gardens, in churchyards, on road-side trees and on a bole of a *Quercus* adjacent to a farm. Apparently it prefers the well-lit conditions and/or the higher contents of nutrients at such sites. It is often abundantly present forming extensive patches.

Rinodina flavosoralifera is a coastal species on naked bark, corticolous bryophytes, and other corticolous lichens.

Specimens seen (selected): AA: Grimstad 1990, Tønsberg 13537. - Ro: Gjesdal 1976, Jørgensen & Rose (BG, UPS). - Ho: Bergen 1988 -1990, Tønsberg 11382, 11395 (topotypes), 11381, 11401, 12999. Kvam 1987, Tønsberg 10043. Kvinnherad 1990, Tønsberg 13361. Ulvik 1990, Tønsberg 13320. - SF: Fjaler 1989, Tønsberg 11774. Flora 1989, Tønsberg 11814. A total of 19 specimens seen.

Rinodina griseosoralifera Coppins

Lichenologist 21: 169 (1989).

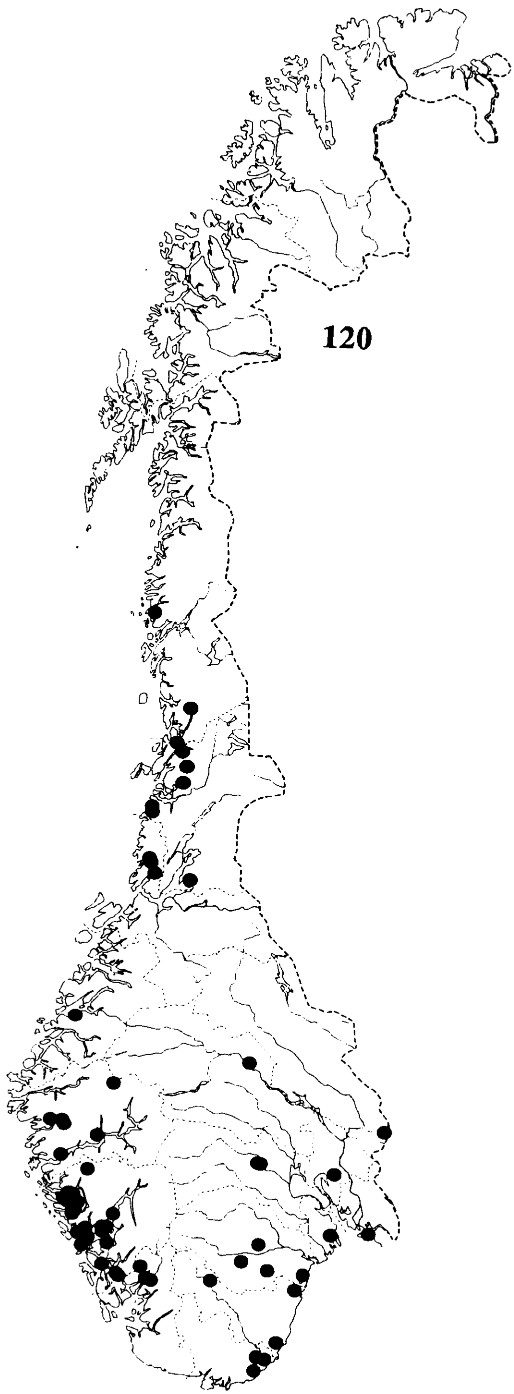
Fig. 119.

Thallus crustose, episubstratal, indeterminate, forming patches up to a dm or more in diameter, areolate, sorediate. Prothallus brown, visible around the areolae. Areolae dull greenish white, pale grey or greyish brown, up to 0.2 mm wide, rounded, flat to ± convex, usually becoming entirely dissolved into soredia. **Soralia** numerous, blue-grey, erupting from the upper surface of the areolae, discrete or, sometimes, a few confluent, more rarely forming a more or less continuous sorediate crust, ± convex, efflorescent, up to 0.2 mm in diameter. Soredia fine, 12-25(-30) µm in diameter; exposed part of pigmented soredia blue-grey, K+ brown; soredial wall distinct. Photobiont green, coccoid, up to 12(-18) µm in diameter.

Apothecia present in two (11%) of the specimens, 0.3-0.4 mm in diameter, sessile; thalline margin distinct, raised, 0.08-0.12 mm thick, white-grey; proper margin brown, forming a narrow ring around the disc, flush with the level of the thalline margin, sometimes not evident; disc usually poriform, sometimes expanding to 0.14 mm, brown. In sections: Thalline margin up to 90 µm wide, more or less brown along the outer rim; proper margin brownish in uppermost part, otherwise colourless, up to 12 µm at the mid-point, widening to 50 µm in uppermost part. Hymenium up to 125 µm deep, brown in uppermost part, otherwise colourless. Hymenial gelatine K/I+ blue. Paraphyses simple to sparingly branched in uppermost part, otherwise simple to sparingly interconnected, 1.5-2(-3) µm wide, widening to 3.5-4.5 µm apically (K), apical cell with a brown pigment in the cell wall. Asci clavate, 62-75 x 16-25 µm, 8-spored, tholus well-developed, K/I+ blue, with a non-amyloid apical cushion. Spores brown, with torus, 18-25(-34)x10-12 µm. Subhymenium colourless, 40 µm deep. Crystals or granules present in the thalline margin and in the upper part of the proper exciple. Pycnidia not observed.

Chemistry: Atranorin, zeorin, unidentified terpenoid (possible trace).

Substratum. *Rinodina griseosoralifera* has been collected on the smooth bark of *Acer platanoides*, *A. pseudoplatanus*, *Aesculus hippocastanum*, *Crataegus* sp., *Malus domestica*, *Tilia* and *Ulmus glabra* in species-rich communities. Noteworthy associated lichen species included *Bacidia incompta*, *Caloplaca obscurella*, *Candelariella* sp., *Leptogium saturninum*, *L. teretiusculum*, *Lobaria pulmonaria*, *Nephroma parile*, *Parmelia* (*Melanelia*) *glabratula*, *P.* (*Parmelina*) *tiliacea*, *Rinodina flavosoralifera* and species of *Phaeophyscia*, *Physcia* and *Physconia*.



Figs 119-120. Distribution maps. Fig. 119. *Rinodina griseosoralifera*. Fig. 120. *Ropalospora viridis*.

Distribution. *Rinodina griseosoralifera* occurred in the southwestern lowlands at altitudes up to 50 m (Fig. 119). **Counties:** Vest-Agder, Hordaland, Sogn og Fjordane.

Discussion. *Rinodina griseosoralifera* resembles *Rinodina* sp. A morphologically (for details, see that species). The much more common species *Buellia griseovirens* also often has bluish soralia; that species contains atranorin and norstictic acid. Specimens with confluent soralia may be confused with a leprose sorediate form of *Caloplaca chlorina*, but can be distinguished from that species by the presence of lichen substances. The lack of chloroatranorin makes *Rinodina griseosoralifera* chemically distinct from the otherwise chemically concordant (but morphologically distinct) *R. degeliana*. Atranorin and zeorin are common constituents of *Rinodina* (see Hecklau et al. 1981, Leuckert & Mayrhofer 1984, Mayrhofer & Leuckert 1985).

Rinodina griseosoralifera is a species of eutrophic bark in coastal habitats.

Specimens seen (selected): VA: Kristiansand 1988 Tønsberg 10641. - Ho: Bergen 1990, Tønsberg 13338. Kvam 1990, Tønsberg 13335. Kvinnherad 1987, Jørgensen (BG, Coppins det. 1987). Os 1989, Tønsberg 11486. Ulvik 1990, Tønsberg 13323. - SF: Førde 1983 - 1989, Tønsberg 7801, 11943, 11944 (fertile). Vik 1990, Tønsberg 13347. A total of 18 specimens seen.

***Rinodina* sp. A**

Fig. 18.

Thallus crustose to subsquamulose, episubstratal, indeterminate, forming extensive patches, areolate, sorediate; prothallus not evident. Esorediate areolae discrete, few and inconspicuous, varying from crustose, rounded and convex and up to 0.08 mm in diameter to flattened, subsquamulose, somewhat incised, rounded to elongate, and up to 0.4(-0.8) mm, dull greyish green, soon bursting apically or laminally to form soralia. **Soralia** numerous, discrete or, often, a few becoming confluent, but never forming a continuous sorediate crust, grey with a brownish tinge due to a greyish to brownish, K-, N- pigment in the cell walls of external soredia or, where the external soredia have been shed, greenish grey; rounded, convex, up to 0.5 mm in diameter. Soredia fine, simple or in rounded consoredia up to 50 µm in diameter; enveloping hyphae of distinctly globose cells giving the soredia a more or less papillate appearance (LM); external soredia sometimes with a brown, K-, N- pigment in the cell walls of the external hyphae. Photobiont green, unicellular, thin-walled, up to 10-15 µm in diameter.

Apothecia and pycnidia not seen.

Chemistry: Zeorin, rinodina sp. A unknown, additional unidentified pigment (trace). Soralia UV+ deeply orange; C + orange. TLC: Fig. 18.

Substratum. *Rinodina* sp. A has been found on naked and mossy (*Hypnum cupressiforme*) bark of a mature, semi-shaded trunk of *Tilia* in an old garden. *Rinodina* sp. A grew on naked bark or on corticolous mosses or other lichens. Associated lichens included *Buellia punctata*, *B. griseovirens*, *Candelariella reflexa*, *Cladonia* sp. (basal squamules), *Dimerella pineti* (sterile form with pycnidia), *Phlyctis argena*, and *Rinodina degeliana*.

Distribution. *Rinodina* sp. A was found at 20-40 m altitude in a single site on the southernmost coast. **County:** Vest-Agder.

Discussion. *Rinodina* sp. A resembles *R. griseosoralifera*, but is distinguished by the brownish grey soralia, the more efflorescent and slightly coarser soredia, and the presence of the unknown xanthone rinodina sp. A. From *R. flavosoralifera* it is distinct by the greyish colour, and its chemistry. Based on the present material, *Rinodina* sp. A seems to have smaller areolae than *R. flavosoralifera* and *R. griseosoralifera*.

Rinodina sp. A is probably a species of eutrophic bark.

Specimens seen: VA: Kristiansand 1988, Tønsberg 10634, 10884.

Ropalospora Massal.

The genus *Ropalospora* is in need of monographic treatment. Hafellner (1984) described a new family, Ropalosporaceae, for *Ropalospora* (see, however, Eriksson & Hawksworth 1985: 73).

Ropalospora viridis (Tønsb.) Tønsb. comb. nov.

Fuscidea viridis Tønsb., in Mycologia 76: 156 (1984). Type: Norway, Buskerud, Krødsherad, NE of Ringneselva River, UTM grid ref.: 32 V, NM 3381 (1715 I), alt. 330 m, on shaded *Sorbus aucuparia* in a *Picea abies* forest, Tønsberg 6924 (BG - holotype; DUKE, E, O, TRH, UPS - isotypes). Chemistry (holotype): Perlatolic, hyperlatolic, isohyperlatolic, and superlatolic acids, and a trace of a substance tentatively identified as anziaic acid.

Figs 19, 120.

Thallus crustose, episubstratal, indeterminate to delimited; forming rosettes up to 3 cm in diameter or, especially when larger, irregular patches, occasionally becoming confluent with other specimens covering areas up to several dm in diameter, areolate, sorediate. Prothallus indistinct to distinct, of brown ramifying hyphae bordering the thallus and individual areolae. Areolae greyish green, matt, discrete or more or less contiguous, rounded, convex, up to 0.2 mm in diameter. **Soralia** bursting from the apices of the areolae, green, yellow-green or straw-coloured, irregularly rounded, errumpent, diffuse, often becoming confluent, especially towards the thallus centre, forming a more or less continuous leprose crust. Soredia fine, 20-30 µm in diameter, simple or loosely packed in consoredia; wall indistinct to distinct. Medulla indistinct or absent. Photobiont green, coccoid, up to 12(-15) µm in diameter.

Apothecia sparsely present in 4 (3%) of the specimens, lecideine, black, 0.2-0.4 mm in diameter; margin persistent; disc flat. In sections: Proper exciple brown in outer part, pale brown in inner part. Epihymenium brown; hymenium colourless, 50-75 µm deep; non-amyloid except for asci, with oil drops. Paraphyses weakly conglutinated, easily becoming free and lax in K, and in aqueous squash preparations; mostly simple, 1.5-2.0 µm wide, not or slightly thickened towards the apices. Asci of *Fuscidea*-type, see Hafellner (1984: 278-279, 334-335), clavate to broadly clavate; polysporous (12-16?); (32-)45-68 × 12-20(-25) µm; wall non-amyloid, tholus thin and weakly developed in mature asci, K/I+ deep blue. Spores colourless; 5-6-septate; clavate, attenuate towards base, straight to somewhat curved; 22-31(-44) × (1.7-)2-2.5(-3.7) µm. Subhymenium dilute brown, 50 µm deep. Brown pigment in excipulum and epihymenium K- or K+ fuscous brown. Crystals absent. Pycnidia not seen.

Chemistry: Perlatolic-, hyperlatolic-, isohyperlatolic- and superlatolic acids. TLC: Fig. 19. TLC/HPLC of several specimens including holotype: perlatolic acid (major), hyperlatolic acid (moderate), isohyperlatolic and superlatolic acids (trace amounts). The identification of isohyperlatolic acid was demonstrated in only one specimen, but the substance was suggested to be more or less constant. In the holotype the molar proportions of the 4 substances were calculated to be 70% perlatolic acid, 24% hyperlatolic acid, 6% isohyperlatolic acid, and 0.3%

superlatolic acid.

The holotype which was also analyzed by the standardized two-dimensional TLC method (Culberson & Johnson 1976) contained traces of additional substances.

Substratum. *Ropalospora viridis* has been collected most frequently on *Betula pubescens/pendula* (26 specimens), *Alnus incana* (27), *A. glutinosa* (20), *Sorbus aucuparia* (19) and less often on *Acer pseudoplatanus, Fagus sylvatica, Fraxinus excelsior, Ilex aquifolium, Juniperus communis, Picea abies, Pinus sylvestris, Populus tremula, Prunus padus, Quercus, Salix aurita, S. caprea*, and *Salix* sp(p).

Distribution. *Ropalospora viridis* has been most frequently been found in the coastal lowlands (Fig. 120). Inland localities included a damp river gorge in Oppland (Øyer: Gudbrandsdalen) and moist *Picea*-forests in Hedmark (Kongsvinger) and Buskerud (Krødsherad). Its vertical distribution ranged from about sea-level to 560 m (Buskerud: Krødsherad). *Ropalospora viridis* occurred in open, as well as in shaded situations. **Counties:** Østfold - Nordland.

Discussion. *Ropalospora viridis* is not a very variable species. In a fertile specimen from U.K.: Scotland the apothecia were up to 0.5 mm in diameter.

Ropalospora viridis was recently described (see Culberson et al. 1984), based on sterile material and assigned to *Fuscidea* on account of its superficial resemblance to, e.g., *Fuscidea lightfootii* and *F. arboricola*. The detection of mature apothecia with asci of *Fuscidea*-type, but with spores of *Bacidia*-type, suggests a transfer to *Ropalospora*. Hence, the previously monotypic genus *Ropalospora* with the saxicolous, non-sorediate, octosporous species *R. lugubris*, is accommodated to include a corticolous, sorediate, and polysporous species.

Ropalospora viridis resembles morphologically *Fuscidea arboricola* and *F. pusilla*, which have been described above. *Fuscidea arboricola* has soralia which never become confluent and contains fumarprotocetraric acid (PD+, UV-). The consistently sterile *F. pusilla* usually has a much smaller thallus and contains divaricatic acid.

Outside Norway *Ropalospora viridis* has been reported from Sweden, Denmark, Finland, Latvia, Germany, Luxembourg and Belgium (Serusiaux et al. 1985, Muhr 1987, Wirth 1987, Alstrup & Søchting 1989, Diederich 1989, Sundin & Thor 1990, Vitikainen 1991) and U.K.: Scotland. *Ropalospora viridis* is mainly a species of acidic bark in coastal situations.

Specimens seen (selected): **Norway:** Øf: Hvaler 1983, Tønsberg 7868b. - Oslo 1982, Tønsberg 6540b. - He: Kongsvinger 1985, Tønsberg 9424. - Op: Øyer 1984, Tønsberg 9005. - Bu: Krødsherad 1982, Tønsberg 6924 (type collection: BG - holotype, E, UPS - isotypes). - Vf: Stokke 1922, Høeg (TRH). - Te: Drangedal 1987, Tønsberg 10256. - AA: Risør 1983, Tønsberg 7970a. - VA: Kristiansand 1986, Tønsberg 9546. - Ro: Sauda 1988, Tønsberg 10807. - Ho: Bergen 1984, Tønsberg 8570; Bergen 1986, Tønsberg 9491, 9487 (fertile). Modalen 1989, Tønsberg 11515 (fertile). Stord 1980, Tønsberg 5016 (fertile). - SF: Førde 1984, Tønsberg 8693. - MR: Vestnes 1979, Tønsberg 3861. - ST: Åfjord 1983, Tønsberg 8216. - NT: Namsos 1981, Tønsberg 5559. - No: Bindal Tønsberg 6783. A total of 123 Norwegian specimens seen. **U.K.**: Scotland, Argyll Main (V.C. 98), Lorn, Glen Nant National Nature Reserve, 1985, Coppins 11186 dupl. (BG). West Ross, 1984, James (BM, fertile).

Exsiccata: Vězda, Lich. Sel. Exs. 2015.

Schaereria Th. Fr.

Schaereria corticola Muhr & Tønsb. sp. nov.

Schaereria fuscocinereae similis, sed apotheciis sessilibus; sporis globosis cum episporio crasso-gelatinoso. Thallus corticolus, sorediatus, acidum 5-O-methylhiascicum et gyrophoricum continens.

Type: Norway, Nord-Trøndelag, Grong, W of river Gartlandselva, 0.5 km N of Hansmoen, alt. 80 m, UTM grid. ref.: 33W UM 7459 (1824 III), on *Alnus incana*, 9 August 1984, T. Tønsberg 8979 (BG - holotype).

Figs 19, 121-122.

Thallus (Fig. 121) crustose, endo- to episubstratal in non-sorediate parts, indeterminate or, where a distinct prothallus was developed, delimited, usually forming small patches up to a few cm across among other crustose lichens or, rarely, becoming fused with adjacent thalli forming extensive patches up to several dm across, areolate, sorediate. Prothallus indistinct, or visible as a greyish black, bluish black or brownish stain on light bark. Areolae often indistinct or absent, mostly discrete, greyish or pale greyish brown; more or less rounded, strongly convex; up to 0.2 mm in diameter. **Soralia** medium to dark brown due to pigmentation of the external soredia or, greenish where the external soredia have been shed, usually persistently discrete, rarely becoming grouped and more or less contiguous with the upper parts still discernible, punctiform, usually distinctly convex, up to 0.2 mm in diameter. Soredia fine, with a distinct cortex, 20-25 µm in diameter; pigment K+ fuscous brown, N+ reddish brown. Medulla indistinct or absent. Photobiont green, coccoid, up to 12 µm in diameter.

Apothecia present in 37 (66%) of the Norwegian specimens, sparse to numerous, discrete, irregularly dispersed, lecideine, black, circular in outline, sessile, 0.15-0.3 mm in diameter when mature; margin up to 0.05 mm wide, becoming more or less obscured in convex apothecia; disc plane or, more rarely, convex, epruinose. In sections: Proper exciple brown, but rim green in upper part, greenish brown in lower part; containing crystals of gyrophoric acid (C+ red); green pigment K-, N+ violet. Epihymenium green, rarely partly with a violet tinge; violet pigment K+ deep (aeruginose) green, N-, but N+ violet after pretreatment with K; green pigment K-, N+ violet. Hymenium colourless, 80-110 µm deep, I-, except for asci. Paraphyses lax, sparingly branched and interconnected in upper part, 1.5-2.5 µm wide;

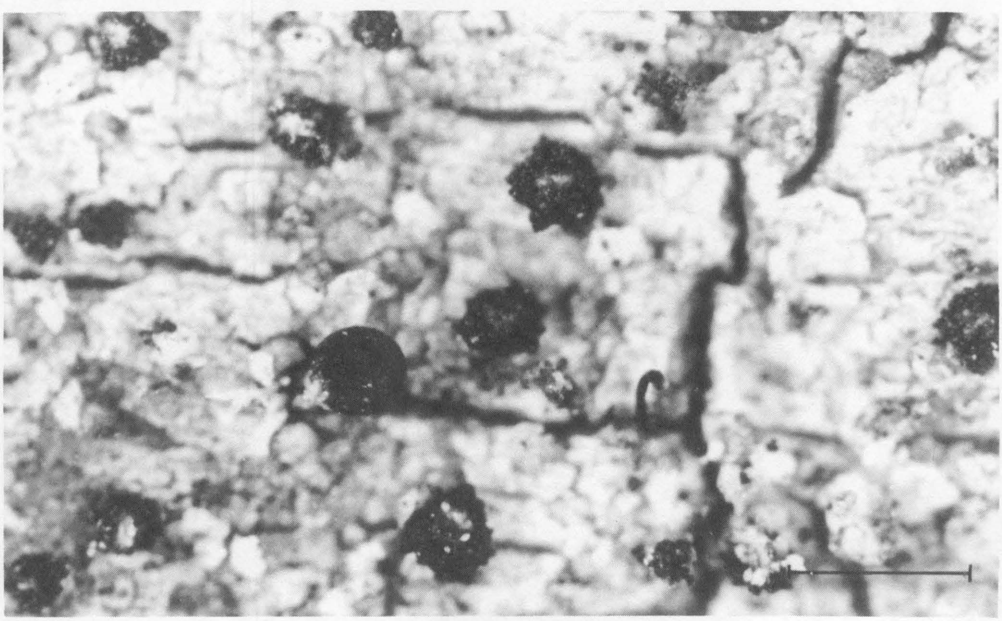
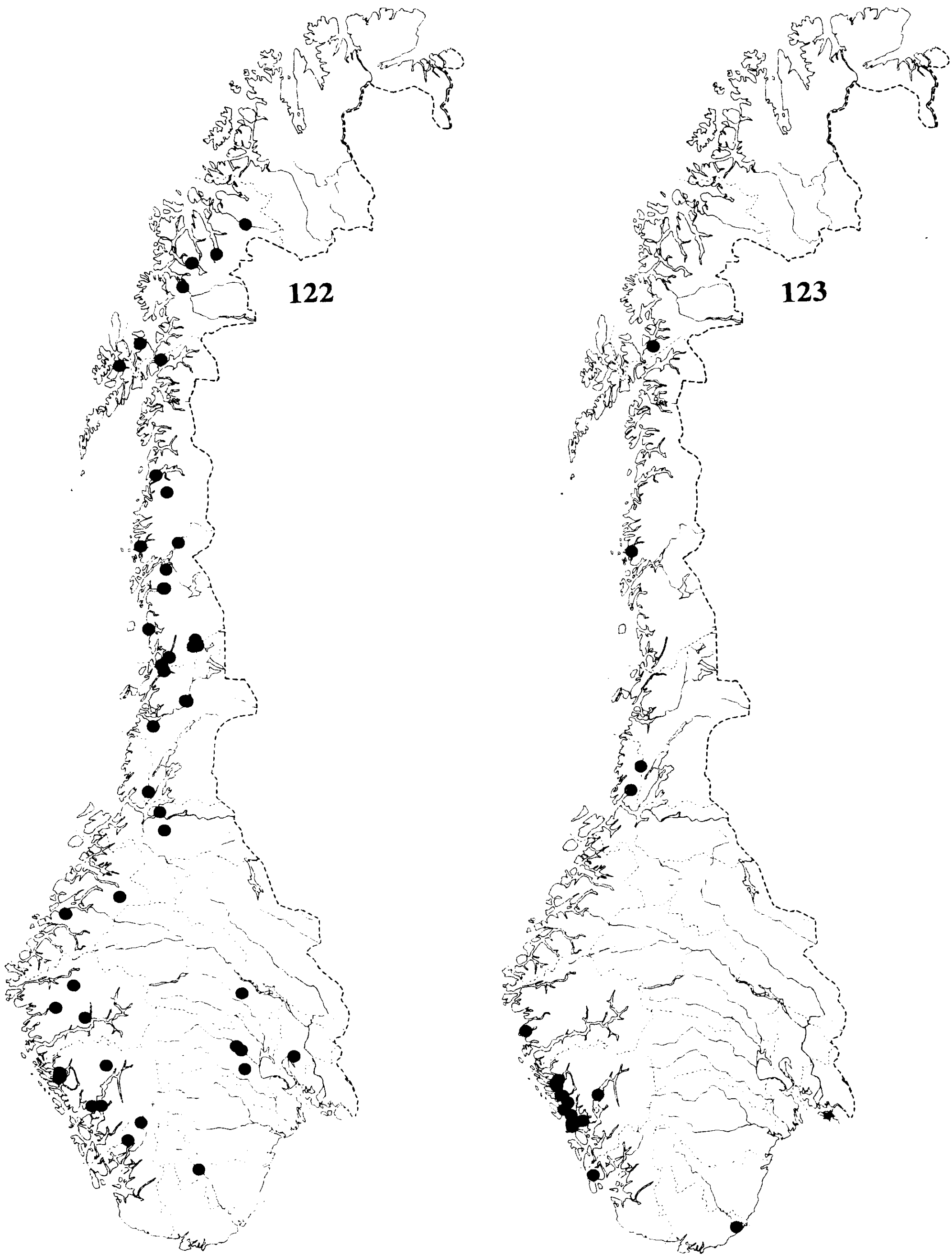


Fig. 121. *Schaereria corticola*. Tønsberg 8972. Apothecium and punctiform soralia with pigmented external soredia. Scale 0.5 mm.



Figs 122-123. Distribution maps. Fig. 122. *Schaereria corticola.* Fig. 123. *Trapelia corticola.*

upper cell slightly thickened, up to 3 µm wide, surrounded by a pigment cap. Asci cylindrical to cylindrical-clavate; I+ blue with or without pretreatment with K, without tholus or, very rarely, with an indistinct, poorly developed tholus, 8-spored, 80-110 × 10-13 µm. Spores uniseriate, colourless, broadly ellipsoid to subglobose, (10-)13-16(-20) × (8-)9-12(-14.5) µm; wall 1-2 µm thick in H_2O, in K the outer gelatinous part (epispore) swelled, and became more or less disrupted and easily detached. Subhymenium largely brown, but colourless in upper part, composed of anticlinal hyphae, 60-30 µm deep. Pycnidia not observed.

Chemistry: Gyrophoric acid, ±lecanoric acid (trace), 5-O-methylhiascic acid (often in amounts more or less equal to that of gyrophoric acid, sometimes in trace amounts only). Heavily pigmented soralia UV-. TLC: Fig. 19.

Substratum. *Schaereria corticola* has mainly been found on *Alnus incana* (43 specimens); other phorophytes included *Betula pubescens/pendula*, *Juniperus communis*, *Picea abies*, *Salix caprea*, and *Sorbus aucuparia*. In U.K.: Scotland is has been found on *Ulmus glabra*.

Distribution. *Schaereria corticola* occurred in humid sites in the lowlands in a broad belt along the coast (Fig. 122). Inland it has been collected once (in Oppland) on the bank of a stream. Its vertical distribution ranged from about sea-level to 700 m (Oppland: Gjøvik). **Counties:** Akershus, Oppland, Buskerud, Aust-Agder, Rogaland - Troms.

Discussion. *Schaereria corticola* seems to be intermediate between *S. cinereorufa* and *S. fuscocinerea* (Nyl.) Clauzade & Roux (syn. *S. tenebrosa* (Flotow) Hertel & Poelt). It is similar to the latter in having a violet pigment in the epihymenium, and gyrophoric acid in the proper excipulum and in the thallus, but approaches the first by its often subglobular spores. *Schaereria corticola* is a distinctive species on account of the spores, which have a distinct, gelatinous epispore, the sorediate thallus, and the corticolous habit. *Schaereria corticola* appears to be the only known predominately corticolous species in the genus. However, *Schaereria cinereorufa* may occasionally grow on bark in Norway (leg. Tønsberg 9328 (BG)).

Schaereria corticola may strongly resemble *Rimularia fuscosora* in thalline characters. Both species have punctiform, brown soralia. However, the soralia of the latter species are consistently dark brown and are often minutely papillate, and further, contain norstictic acid. The two species should therefore not be confused on closer examination.

Outside Norway, *Schaereria corticola* is known from Sweden and U.K.: Scotland. *Schaereria corticola* is a species of acidic bark in coastal habitats.

Specimens seen (selected): Norway: Oslo 1984, Tønsberg 8845. - Op: Gjøvik 1988, v.d. Boom (herb. v. d. Boom). - Bu: Flesberg 1987, Tønsberg 10366. - Krødsherad 1980, Tønsberg 6926a. - AA: Bygland 1987, Tønsberg 10194. - Ro: Sauda 1988, Tønsberg 10809b. - Ho: Fusa 1987, Tønsberg 10025; Kvinnherad 1988, Tønsberg 10784. Lindås 1984, Tønsberg 8884. - SF: Balestrand 1979, Tønsberg 4016b. Gloppen 1983, Tønsberg 7892a. - MR: Sunndal 1979, Tønsberg 3926. Vestnes 1979, Tønsberg 3862b. - ST: Melhus 1982, Tønsberg 7069. Trondheim 1991, Holien 4138 (TRH). - NT: Grong 1984, Tønsberg 8972, 8974, 8979 (type collection). Leksvik 1981, Tønsberg 5863. Namsskogan 1982, Tønsberg 6589b. Nærøy 1982, Tønsberg 6681, 6687, 6699, 6701b, 6705. - No: Beiarn 1986, Tønsberg 9626. Bindal 1982, Tønsberg 6843. Bodø 1986, Tønsberg 9610. Grane 1983 - 1987, Tønsberg 8108, 10560. Rana 1984, Øvstedal. Rødøy 1986, Tønsberg 9646. Sortland 1987, Tønsberg 10444, 10445. Vefsn 1982, Tønsberg 7616c. - Tr: Balsfjord 1982, Tønsberg 7337. Harstad 1987, Tønsberg 10408. Målselv 1982, Tønsberg 7324a. Nordreisa 1988, Tønsberg 11133. Storfjord 1982, Tønsberg 7300a,b. A total of 56 Norwegian specimens seen. **Sweden:** Värmland 1983, Muhr 5764 (BG, UPS), 6241 (UPS). - Jämtland 1986, Muhr 9381 (UPS). - Västerbotten 1982, Muhr 5062 (UPS). - Lule Lappmark 1977, Coppins 6250 & Tibell (E, UPS). **U.K.:** Scotland, E. Sutherland, V.C. 107, Helmsdale, Torrish, alt. 50-80 m, 1990, Coppins 13612 (E).

Schismatomma Flotow & Körber ex Massal.

The genus *Schismatomma* is in need of monographic treatment. Species occurring in parts of the Mediterranean area were treated by Torrente & Egea (1989).

Schismatomma umbrinum (Coppins & P. James) P.M. Jørg. & Tønsb.

Nord. J. Bot. 8: 301 (1988). *Lecanactis umbrinum* Coppins & P. James, in Lichenologist 11: 144 (1979).

Thallus crustose, green or yellowish brown to light chocolate brown, episubstratal, forming discrete, delimited rosettes or forming a mosaic with other thalli, up to 1.5 cm in diameter, mostly continuous, sorediate or esorediate. Prothallus distinct, brownish, forming a 0.5-3 mm wide marginal border. Upper surface smooth towards the margin, distinctly tuberculate, often rugose-plicate and more or less fissured towards the centre. Tuberculae usually bursting apically to form soralia. **Soralia** concolorous with esorediate parts of the thallus, irregular, becoming confluent. Soredia fine, 20-30 µm in diameter, often in consoredia up to 50 µm; wall indistinct to distinct. Medulla indistinct. Photobiont *Trentepohlia.*

Apothecia not observed in corticolous material (rarely present in saxicolous material), lecanorine, up to 1.5 mm in diameter. Margin concolorous with the thallus, 0.1 mm wide, flexuose, sometimes eroded, but hardly sorediate. Disc blackish brown, convex at maturity. Pycnidia rare, observed in one corticolous collection, on minute (0.1-0.5 cm in diameter), esorediate thalli, of *Roccella*-type (of Vobis 1980), immersed, brownish black, 0.1-0.2 mm wide; pigment K+ dark green-brown. Conidia colourless, filiform, curved, 10-30 µm long.

Chemistry: Schizopeltic acid and a range of unidentified substances.

Substratum. *Schismatomma umbrinum* was collected on bark of *Betula pubescens/pendula, Salix caprea,* and *Sorbus aucuparia* close to overhanging rock. Associated lichens included *Arthopyrenia ranunculospora, Enterographa zonata, Lecanactis abietina, Lecania baeomma, Opegrapha gyrocarpa,* and *Thelotrema lepadinum.*

Distribution. Corticolous specimens of *Schismatomma umbrinum* occurred in two sites in Hordaland at about 60 m altitude. **Counties:** Corticolous specimens: Hordaland. All specimens: Telemark - Nordland.

Discussion. *Schismatomma umbrinum* is a distinct species. Corticolous specimens showed some similarities with corticolous material of *Opegrapha gyrocarpa.* It is distinct from that species in the colour of the soralia, and in being devoid of gyrophoric acid.

Saxicolous specimens differed from the present corticolous material in being larger (up to a dm or more in diameter) and sorediate throughout except for only a few mm at the outermost edge; the colour was usually more distinctly brown (in fresh material, turning yellow in the herbarium).

The occurrence of pycnidia in *Schismatomma umbrinum* has so far been observed only on the minute, esorediate, corticolous thalli described above. As fertile specimens occurred on rock in the vicinity of the site where the pycnidiate specimens were found, the conidia of this species possibly act as spermatia. The fertile specimens were sorediate and of normal size. The presence of pycnidia and apothecia on separate, morphologically dissimilar thalli may prove to represent a case parallel to that discussed by Poelt (1980b) for *Lecidea verruca* Poelt. In that species, which was characterized as dioecious, pycnidia occurred on separate ("male") thalli which were much smaller than the ("female") thalli on which apothecia were formed. The generic affinity of *S. umbrinum* was discussed by Jørgensen & Tønsberg (1988).

Schismatomma umbrinum is usually saxicolous, only very rarely is it corticolous. James et al. (1977) assigned it to the saxicolous community *Opegraphae horistico-gyrocarpae* Wirth, an association of the underside of acid, shaded and sheltered overhangs. The known vertical distribution of saxicolous specimens ranged from about sea-level to 200 m. *Schismatomma umbrinum* is a coastal lowland species (Jørgensen & Tønsberg 1988) in Norway, probably of the northern type (see Degelius 1935: 191- 192) as it seems to be much more frequent in Norway than in U.K.: Scotland.

Specimens seen: Ho: Askøy 1984, Tønsberg 8831, 8835a (with pycnidia). Os 1984, Tønsberg 8718a.

Scoliciosporum Massal.

The genus *Scoliciosporum* is in urgent need of monographic treatment. A key to the European species was provided by Poelt & Vězda (1981). The present records of gyrophoric acid in *Scoliciosporum gallurae* and *S. sarothamni* are the first report of lichen substances in the genus.

Scoliciosporum gallurae Vězda & Poelt

In Nimis & Poelt, in Stud. Geobot. 7, Suppl. 1: 221 (1987). Type: Sardinia, Prov. Cagliari. Arcu Neriddu, M. Sette Fratelli, leg. Wittmann & Pilsl (GZU! - holotype). Chemistry: squash of a thallus fragment including soredia, contained crystals (possibly of gyrophoric acid).

Thallus crustose, green to yellowish green, episubstratal, indeterminate, usually forming more or less continuous, rounded patches a few mm in diameter between other lichens, rarely covering more extensive covers, composed of regularly rounded typical **soredia** up to 25 µm, with a distinct wall, and of irregularly rounded to elongate consoredia up to 100 µm in diameter, as well as clusters of more or less free algal cells with no evident hyphal envelope. Soralia not evident. Medulla absent. Prothallus not evident. Photobiont green, globose, simple or with 2-4 cells, up to 16 µm in diameter.

Apothecia present in all collections (but not observed on all thalli), discrete to contiguous, pale to dark brown, sessile, almost flat to slightly convex, up to 0.2(-0.3) mm in diameter; in one collection some apothecia with tiny, erect colourless hairs along the rim. Spores fusiform, straight to slightly curved, simple to 3-septate, (12-)15-22 × 2.5-3.5(-4) µm.

Chemistry: Gyrophoric acid (trace). No positive spot test reaction to C was observed, but in squash preparations the thallus usually reacted C+ fugitive faintly red.

Substratum. *Scoliciosporum gallurae* was collected on stems of *Celastrus orbiculatus* growing adjacent to a south- facing church-wall, on twigs of *Salix aurita* in an open situation and on a trunk of *Alnus incana* in a maritime situation.

Distribution. *Scoliciosporum gallurae* occurred in a few coastal sites on the outskirts of Bergen (westernmost Norway) and Trondheim (central Norway). The vertical distribution ranged from about sea-level to 200 m (Hordaland: Bergen). **Counties:** Hordaland, Sør-Trøndelag.

Discussion. Based on the present, rather sparse Norwegian material of *Scoliciosporum gallurae* and *S. sarothamni*, the latter may prove to have more or less discrete, punctiform soralia, whereas the former is more or less leprose (and without discernable soralia). However, more material is necessary before this can be conclusively settled. Fertile specimens of these species are easily separated by spore characters. The thallus of *S. gallurae* may superficially be similar to that of *Micarea prasina,* but is distinct on closer examination, e.g., due to the presence of a non-micareoid photobiont and a different chemistry.

Scoliciosporum gallurae may prove to be the sorediate counterpart of *S. chlorococcum*. The spores (see Nimis & Poelt 1987), may be regarded as poorly developed *S. chlorococcum* spores. When more material is found, care should be taken to establish whether *S. gallurae* actually is only a sporadically- occurring sorediate offspring from *S. chlorococcum*.

Specimens seen: Ho: Bergen 1987-1990, Tønsberg 11380, 11399, 13093. - ST: Trondheim 1982, Tønsberg 6628.

Scoliciosporum sarothamni (Vainio) Vězda

Folia Geobot. Phytotax. 13: 411 (1978). Type: Germany: Gemeinde Essen in Oldenburg, 9 July 1898, leg. Sandstede, distributed in Arnold, Lich. exs. 328b (UPS! - isotype). Chemistry: Squash preparation of soredia: C+ fugitive red, indicative of gyrophoric acid. (Material too scanty for TLC).

Thallus crustose, greyish yellow, episubstratal, forming rounded to elongate patches up to 1(-2) cm in diameter, indeterminate, leprose sorediate. Prothallus not evident. **Soralia** partly more or less discrete and punctiform and up to 0.2 mm in diameter, partly more or less contiguous or fused, convex. Soredia loosely arranged and more or less efflorescent, more or less rounded, sometimes a few aggregated in consoredia, up to 20 (-25) µm in diameter, often with only one algal cell and then up to 12 µm; wall distinct. Medulla absent. Photobiont green, coccoid, or with 2-3(-4) cells surrounded by a common wall.

Apothecia sparsely present in all collections, brown to dark brown, sessile, convex at first, later, when becoming larger, more or less flat, up to 0.2(-0.3) mm in diameter. Spores up to 7-septate, 20-30 x 2(-2.5) µm, mostly S-shaped. Pycnidia not observed.

Chemistry: Gyrophoric acid (trace). No positive spot test reaction to C was observed, but microscope preparations of the soredia reacted C+ fugitive faintly red.

Substratum. *Scoliciosporum sarothamni* was collected on smooth bark on the trunk of a young *Populus tremula* and on *Syringa vulgaris*. On the latter phorophyte it formed extensive patches on the stems.

Distribution. *Scoliciosporum sarothamni* occurred in some sites in the outskirts of Oslo, southeastern Norway, and Bergen, westernmost Norway. The vertical distribution ranged from 50 to 140 - 160 m. **Counties:** Akershus, Hordaland.

Discussion. When sterile, *Scoliciosporum sarothamni* seems to be distinct from *S. gallurae* in the presence of discrete soralia.

Sorediate specimens of *Scoliciosporum sarothamni* (e.g., Tønsberg 13735 and 13749), sometimes formed a mosaic with darker green, esorediate specimens of *Scoliciosporum* devoid of lichen substances. As the spores of these esorediate specimens were similar to those of the adjacent *S. sarothamni,* it was believed that these esorediate specimens represented an esorediate form of *S. sarothamni*. In fact the isotype-collection of *S. sarothamni* examined, comprised a similar mosaic of sorediate and esorediate forms.

Specimens seen: Oslo, 1984, Tønsberg 8856. - Ho: Bergen 1990, Tønsberg 13735, 13749.

Trapelia Choisy

The genus *Trapelia* was treated for the British Isles by Coppins & James (1984).

Trapelia corticola Coppins & P. James

Lichenologist 16: 254 (1984).

Fig. 123.

Thallus crustose, episubstratal, indeterminate, irregularly spreading, up to one dm or more in diameter, areolate, sorediate. Prothallus not evident. Areolae greyish green to brownish, pale green in shaded niches, discrete or sometimes becoming more or less contiguous, 0.1(-0.2) mm in diameter, rounded in outline, slightly convex or almost flat. **Soralia** bursting from the areolae, pale buff to pale greenish buff, discrete and delimited, regular, mostly distinctly convex, sometimes constricted below, up to 0.2(-0.3) mm in diameter. Soredia fine, 12-25 µm in diameter; wall distinct. Medulla absent. Photobiont green, unicellular, globose to broadly ellipsoid, 5-7.5(-12) µm in diameter.

Apothecia present in one (4%) of the collections, scattered or in small groups, sessile, up to 0.25 mm in diameter; disc brown, ± flat; margin very thin, pale brown.

Chemistry: (I) Gyrophoric acid, lecanoric acid (trace), 5-O-methylhiascic acid (trace).

Substratum. *Trapelia corticola* has been collected on *Quercus* (10 specimens), *Alnus glutinosa* (6), and, more rarely, on *Betula pubescens/pendula, Calluna vulgaris, Juniperus communis, Picea abies, Pinus sylvestris*, and *Salix caprea*. It grew on naked bark, usually on rough surfaces, and on corticolous mosses. Associated lichens included *Dimerella pineti, Graphis scripta, Hypogymnia physodes, Micarea prasina, Normandina pulchella, Platismatia glauca*, and *Trapeliopsis pseudogranulosa.*

Distribution. Corticolous specimens of *Trapelia corticola* were collected on the west coast from Vest-Agder to Nordland (Fig. 123). It occurred both in shaded and more open habitats. Its vertical distribution ranged from about sea-level to 300 m (Sør-Trøndelag: Åfjord). **Counties:** Vest-Agder - Sogn og Fjordane, Sør-Trøndelag, Nordland. All specimens: Østfold, Vest-Agder - Sogn og Fjordane, Sør-Trøndelag, Nordland, Troms.

Discussion. *Trapelia corticola* is the only known corticolous species in the genus (Coppins & James 1984). It resembles *Rinodina efflorescens* which also has minute, regular soralia, but that species differs in its coarser, sometimes divided and subsquamiform, often brownish areolae and the content of pannarin. Juvenile forms with small soralia of the corticolous or muscicolous species *Bacidia epixanthoides* and *Lecidea gyrophorica* may also resemble *Trapelia corticola.* However, these species are distinguished by their irregular, yellowish green soralia. Furthermore, *Bacidia epixanthoides* lacks any medullary constituents and *Lecidea gyrophorica* often has subsquamiform areolae. Specimens of *Trapelia corticola* from shaded habitats have green soralia without a brown tinge. Such specimens may morphologically be similar to pigment-deficient forms of *Trapeliopsis pseudogranulosa*, but can be chemically distinguished by the presence of 5-O-methylhiascic acid.

A sterile specimen from Nordland: Sørfold (leg. Tønsberg 9729) was similar to *Trapelia corticola* in having minute soralia, fine soredia, the small photobiont cells typical of the species, and a muscicolous habit. However, it differed in having pure green soredia, slightly larger (mostly 0.3-0.4 mm in diameter) and less markedly convex soralia, and in producing zeorin as the only constituent. That specimen might represent a distinct, apparently undescribed taxon; it was left out of *Trapelia corticola.*

Trapelia corticola is a coastal species. It is mainly corticolous on acidic to intermediate bark, but occurs also on decayed wood of *Betula pubescens/pendula* and *Salix caprea*, on plant remnants on the ground and on shaded, mossy rock walls.

Specimens seen (selected): VA: Kristiansand 1988, Tønsberg 10646. - Ro: Karmøy 1986, Øvstedal. - Ho: Fusa 1987, Tønsberg 10030 (fertile). Tysnes 1986, Tønsberg 9513. - SF: Askvoll 1989, Tønsberg 11796. - ST: Åfjord 1985, Tønsberg 9141. - No: Rødøy 1986, Tønsberg 9660. A total of 23 specimens seen.

Trapeliopsis Hertel & G. Schneider

The genus *Trapeliopsis* was treated for the British Isles by Coppins & James (1984). Wirth (1987) included *Trapeliopsis* in *Trapelia*.

Trapeliopsis flexuosa (Fr.) Coppins & P. James

Lichenologist 16: 258 (1984).

Thallus crustose, episubstratal, indeterminate, thin to thick, usually irregularly spreading, up to one dm or more across, areolate at least at the edge, often more or less continuous towards the centre, sorediate. Prothallus not apparent. Areolae greyish green to green, usually convex, at the edge of the thallus sometimes constricted at base and more or less incised, up to 0.6 mm in diameter, persistently discrete and scattered throughout, or contiguous or fused towards the centre, forming a more or less continuous crust which may crack into angular portions. **Soralia** aeruginose to dark bluish green, sometimes yellowish green where the external soredia have been shed, more rarely, grey-green, diffuse, 1(-3) per areola, usually apical, rarely marginal, persistently discrete or becoming fused, sometimes, towards the centre of the thallus, forming a more or less leprose crust. Soredia fine, 15-30 µm in diameter, mostly simple; aeruginose pigment K+ brown, N-; soredial wall distinct. Medulla indistinct to distinct, white. Photobiont green, globose, unicellular or divided into two, 6-10 µm in diameter.

Apothecia present in 6 (13%) of the corticolous specimens, lecideine, up to 0.3(-0.7) mm in diameter; proper margin mostly pale greyish beige flecked with dark grey or black, sometimes more or less concolorous with the disc, persistent; disc greyish black to green-black, rarely brownish grey, more or less plane. Spores simple or, occasionally, 1-septate, 6.5-11 × 2.5-5 µm.

Chemistry: Gyrophoric acid, lecanoric acid (trace). Thallus UV+ greyish blue or, in heavily pigmented specimens, UV-.

Substratum. *Trapeliopsis flexuosa* has been collected most frequently on *Betula pubescens/pendula* (16 specimens), *Pinus sylvestris* (12), and *Picea abies* (5), but it has also been found on *Alnus incana*, *A. glutinosa*, *Malus domestica*, *Juniperus communis*, *Populus tremula*, *Prunus padus*, *Prunus* sp., and *Tilia*. It was found on smooth and rough bark, often at the base of the phorophytes. It occurred in town centres, e.g., in Bergen, Tromsø, and Trondheim.

Distribution. *Trapeliopsis flexuosa* occurred mainly in the coastal lowlands, but it has also been found inland. The known vertical distribution of corticolous specimens ranged from about sea-level to 970 m (Sør-Trøndelag: Oppdal). **Counties:** Corticolous specimens: Østfold - Troms. All specimens: Østfold - Finnmark.

Discussion. *Trapeliopsis flexuosa* is a variable species with respect to colour, form, size and degree of fusion of the areolae. One common form had persistently discrete, minute areolae each of which had a more or less flat, punctiform, central soralium. Another form had discrete areolae on the edge and a more or less continuous thallus of fused areolae in the centre. Most specimens were intermediate between these extremes. The colour varied usually in shades of aeruginous green. *Trapeliopsis flexuosa* resembles the chemically concordant *T. granulosa*, which, however, is rarely corticolous. That species has mostly whitish grey, grey or bluish grey areolae, and pale yellow, yellow-green to green or pink, rarely aeruginous soralia, and the soredia are often aggregated in consoredia. However, in the material studied here several intermediate specimens could not with certainty be assigned to one species or the other. Forms morphologically intermediate between *T. flexuosa* and *Trapelia corticola* have also been encountered. However, *Trapeliopsis flexuosa* is chemically distinct from *Trapelia corticola* in lacking 5-O-methylhiascic acid.

Trapeliopsis flexuosa is a widespread species commonly occurring on wood, especially of *Pinus sylvestris*, and on acidic bark.

Specimens seen (selected): Øf: Hvaler 1983, Tønsberg 7778. Oslo 1981, Tønsberg 6491. - He: Os 1988, Tønsberg 11043. - Op: Gjøvik 1990, Tønsberg 11674. - Bu: Krødsherad 1982, Tønsberg 6943b. - Vf: Hof 1990, Tønsberg 13088. - Te: Bamble 1983, Tønsberg 7952. - AA: Risør 1983, Tønsberg 7964. - VA: Kristiansand 1953, Santesson (UPS). - Ro: Suldal 1988, Tønsberg 10855b. - Ho: Bergen 1984, Tønsberg 9088. - SF: Gloppen 1979, Tønsberg 3990b. - MR: Norddal 1947, Magnusson 20661 (UPS). - ST: Melhus 1982, Tønsberg 6664. - NT: Fosnes 1980, Tønsberg 4936a. - No: Saltdal 1986, Tønsberg 9717. - Tr: Målselv 1983, Øvstedal. Exsiccata examined: Havaas, Lich. Norv. 219 (BG, O, UPS). A total of 45 specimens seen.

Trapeliopsis granulosa (Hoffm.) Lumbsch

In Hertel, Lecid. exs., Fasc. 5, No. 99 (1983).

Thallus crustose, episubstratal, indeterminate, becoming thick, forming irregular patches up to one dm or more in diameter, persistently areolate or becoming more or less continuous towards the centre, sorediate. Prothallus indistinct or absent. Areolae whitish grey, pale bluish grey or pale greenish grey, regularly to irregularly rounded, almost plane to subglobular, up to 0.5 mm in diameter, partly discrete and scattered, partly, especially towards the thallus centre, becoming contiguous or, rarely, locally fused. **Soralia** greenish, sometimes some with a brownish or yellowish tinge, rarely pink, diffuse and mostly very irregular, becoming locally fused. Soredia fine, usually in consoredia up to 80 µm in diameter and apparently coarse; wall distinct. Medulla more or less distinct, white. Photobiont green, unicellular, more or less globose, 6-10 µm in diameter.

Apothecia present in 4 (50%) of the specimens, lecideine, up to 1.1 mm in diameter, proper margin whitish brown to black, persistent, esorediate; disc brown to black, more or less plane.

Chemistry: Gyrophoric acid, lecanoric acid (trace).

Substratum. *Trapeliopsis granulosa* has been found on bark of *Pinus sylvestris* (6 specimens), and on *Betula pubescens/pendula* and *Juniperus communis*. All specimens were from the base of the phorophyte, and grew on rough, decaying bark, apparently more decayed than that favoured by *T. flexuosa*.

Distribution. The corticolous specimens were all from southern Norway. The known vertical distribution of corticolous specimens ranged from about sea-level to 1020 m (Buskerud: Gol). **Counties:** Corticolous specimens: Akershus, Hedmark, Buskerud, Telemark, Vest-Agder, Sogn og Fjordane, Sør-Trøndelag. All specimens: Østfold - Vest-Agder, Hordaland - Sogn og Fjordane, Sør-Trøndelag, Troms - Finnmark.

Discussion. The colour of *Trapeliopsis granulosa* is variable. Even within a single specimen, the colour of the soredia may vary between yellow, yellowish brown, pink, and greyish green. The species may be morphologically similar to the chemically concordant *T. flexuosa* (for details, see under that species).

Trapeliopsis granulosa is a widespread and common terrestric lichen on plant debris; it is only occasionally corticolous. Terricolous specimens have been found up to 1470 m (Op: Sel).

Specimens seen: Oslo, Blytt (O); 1868, Moe (O). - He: Elverum 1984, Tønsberg s.n. - Bu: Gol 1987, Tønsberg 9932. - Te: Vinje 1987, Tønsberg 10317. - VA: Songdalen 1991, Tønsberg 17410. - SF: Sogndal 1991, Tønsberg 17244. - ST: Rennebu 1982, Tønsberg 7032.

Trapeliopsis pseudogranulosa Coppins & P. James

Lichenologist 16: 259 (1984).

Figs 18, 124.

Thallus crustose, episubstratal, indeterminate, usually thin, forming rosettes or irregular patches, up to 8 cm in diameter, areolate at the edge, more or less continuous towards centre, sorediate. Prothallus indistinct or absent. Areolae grey to green, at the edge of the thallus discrete, convex and sometimes constricted at base, rounded, up to 0.2 mm in diameter; towards the centre often becoming contiguous or fused forming a more or less continuous, often rimose crust. Thallus here and there with an irregular, patchy orange pigmentation (K+ purple) due to the presence of an anthraquinone. **Soralia** diffuse at first, discrete, orbicular, convex and up to 1.5 mm in diameter, later tending to fuse forming irregular sorediate patches up to several mm across. Soredia fine, up to 20 µm in diameter, sometimes a few forming consoredia; wall distinct. Medulla often distinct, white. Photobiont green, globose, unicellular, or divided into two, 7-12 µm in diameter.

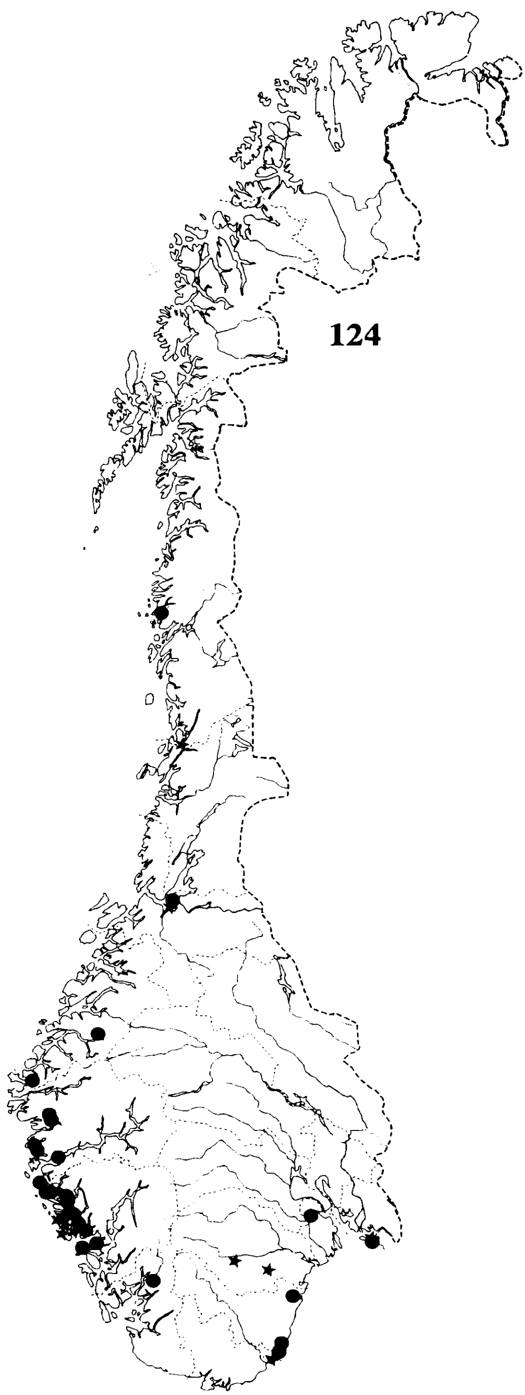
Apothecia unknown in Norwegian corticolous material (but present in one terricolous specimen), lecideine, up to 0.4 mm in diameter; margin bluish grey; disc greyish black.

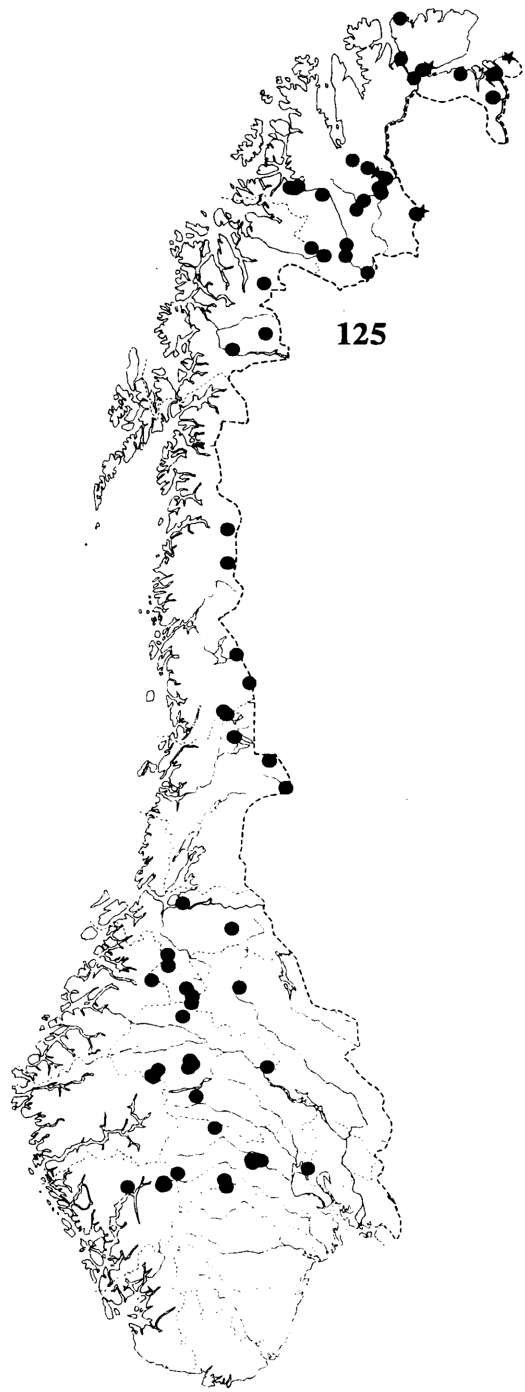
Chemistry: Gyrophoric acid, lecanoric acid (trace), pseudogranulosa unknown (anthraquinone) (absent in a few specimens), ± an additional anthraquinone (trace; in R_F-classes A 7-8 (overlapping with the major pigment), B: 6 (above the major pigment), C 8. Soralia UV+ bluish grey (gyrophoric acid). Orange parts UV+ orange-red. TLC: Fig. 18.

Substratum. *Trapeliopsis pseudogranulosa* has been collected on *Alnus glutinosa*, *Betula pubescens/pendula*, *Calluna vulgaris*, *Juniperus communis*, *Pinus sylvestris*, *Picea abies* (exposed root branches), *Quercus*, and *Sorbus aucuparia*. It occurred on naked bark as well as on corticolous mosses. It usually grew low down on the trunks, but sometimes extended up trunks to a height of more than 2 m.

Distribution. Corticolous specimens have been found in coastal regions (Fig. 124) at altitudes between about sea-level and 460 m. Although it occasionally occurred in open situations, most specimens were from rather shaded and sheltered sites. **Counties:** Corticolous specimens: Østfold, Vestfold, Aust-Agder, Rogaland - Møre og Romsdal, Nordland (Rødøy). All specimens: Østfold, Vestfold - Sør-Trøndelag, Nordland.

Discussion. *Trapeliopsis pseudogranulosa* is usually easily recognized by its patchy orange, K+ purple pigmentation. However, this pigmentation may be very sparse or even fail to occur. Such specimens might be difficult to distinguish from *Trapeliopsis flexuosa* and *T.*





Figs 124-125. Distribution maps. Fig. 124. *Trapeliopsis pseudogranulosa*. Fig. 125. *Varicellaria rhodocarpa*.

granulosa with which it is chemically concordant, and from *Trapelia corticola*. From *Trapeliopsis flexuosa* and *T. granulosa* it differs in having finer soredia, from *Trapelia corticola* in lacking 5-O-methylhiascic acid.

The corticolous specimen from Møre og Romsdal, Norddal (Magnusson 20463 (UPS)) cited by Magnusson (1948) as *Lecidea granulosa* f. *aporetica* Ach. is *Trapeliopsis pseudogranulosa*.

Trapeliopsis pseudogranulosa is mainly a terrestrial species growing over decaying mosses and plant debris.

Specimens seen (selected): Øf: Hvaler 1989, Tønsberg 11715. - Vf: Hof 1990, Tønsberg 13087. - AA: Risør 1983, Tønsberg 7991. - Ro: Suldal 1988, Tønsberg 10855a. - Ho: Austevoll 1990, Tønsberg 13622. Bergen 1984, Tønsberg 8539. - SF: Flora 1983, Tønsberg 7897a. - MR: Norddal 1947, Magnusson 20463 (UPS). - No: Rødøy 1986, Tønsberg 9668. A total of 31 specimens seen.

Varicellaria Nyl.

The genus *Varicellaria* has been treated by Erichsen (1936), see also Oshio (1968).

Varicellaria rhodocarpa (Körber) Th. Fr.

Fig. 125.

Thallus crustose, endo- to episubstratal in non-sorediate parts, delimited, irregularly spreading or forming rosettes, often indistinctly areolate in young parts, later becoming more or less continuous, up to about one dm in diameter, sorediate or not, without isidia. Prothallus mostly indistinct, more or less endosubstratal. Non-sorediate parts grey to white-grey, more or less even to distinctly tuberculate. **Soralia** white, pale grey, or cream-yellow; diffuse, irregular, discrete or becoming confluent forming a more or less leprose crust, especially towards the centre of the thallus; sometimes absent in well-fruiting specimens. Soredia in consoredia up to 125 µm; wall distinct. Medulla distinct, white. Photobiont green, unicellular, globose to broadly ellipsoid, up to 20 µm in diameter. Fertile tuberculae almost always present, with 1-3 apothecia, often more or less concealed by soredia.

Apothecia present in 164 (99%) of the specimens, lecanorine; margin often sorediate and becoming excluded, disc reddish, heavily white-pruinose (lecanoric acid), up to 0.6 mm in diameter, with the apices of the asci visible (DM) as rounded warts.

Chemistry: Lecanoric acid, ± lichexanthone (rarely absent). Thallus UV+ yellowish (lichexanthone), especially in sun-exposed parts; rarely UV+ bluish white throughout (lecanoric acid).

Substratum. *Varicellaria rhodocarpa* has been collected on *Juniperus communis* (74 specimens), *Betula pubescens/pendula* (55), *Picea abies*, *Betula nana* and, rarely, *Pinus sylvestris*, *Prunus padus*, *Salix* sp(p)., and *Sorbus aucuparia*. In sites with both *Betula nana* and *Salix*-shrubs, it was evident that the former phorophyte was preferred.

Distribution. The species occurred commonly in low-alpine areas throughout most of the country, especially in northernmost Norway (Fig. 125). Its known vertical distribution ranged from about sea-level (Finnmark) to 1380 m (Oppland: Lom). In southern Norway it has not been found below 280 m altitude and most specimens were from altitudes above 900 m. **Counties:** Hedmark - Buskerud, Telemark, Hordaland, Møre og Romsdal - Finnmark.

Discussion. *Varicellaria rhodocarpa* is almost always fertile and therefore readily distinguished by apothecial characters. *Varicellaria rhodocarpa* is a rather variable species. In its most reduced state the thallus is largely composed of endosubstratal areolae and is esorediate. Well-developed specimens may have a thick, more or less continuous, distinctly sorediate, episubstratal thallus. Most specimens were intermediate between these two extremes.

Varicellaria rhodocarpa is a common species on acidic bark, but it also occurs on wood (*Juniperus communis* and *Pinus sylvestris*) and on the ground, and, rarely, on stone. A rough map showing the European distribution was published by Erichsen (1940).

Specimens seen (selected): He: Tynset 1910, Lynge (O). - Op: Vang 1985, Tønsberg 9210. - Bu: Hole 1981, Tønsberg 6468. - Te: Tinn 1982, Timdal 3366 (O). - Ho: Eidfjord 1899, Havaas. - MR: Sunndal 1902, Havaas. - ST: Oppdal 1982, Tønsberg 7039. - NT: Røyrvik 1983, Tønsberg 8088. - No: Grane 1983, Tønsberg 8060. - Tr: Storfjord 1988, Tønsberg 11109. - Fi: Sør-Varanger 1864, Fries (UPS). Exsiccata examined: Havaas, Lich. Norv. 354 (BG, O, UPS); 659 (BG, O, UPS). - Fries, Lich. Scand. 73 (O, S, UPS). - Rabenhorst, Lich. Eur. 877 (S, UPS). A total of 166 specimens seen.

SPECIES INCORRECTLY REPORTED FROM NORWAY

Fuscidea lightfootii (Sm.) Coppins & P. James

Øvstedal (1979, as *Catillaria lightfootii*): The material proved to be: *Buellia griseovirens*, *Catillaria pulverea*, *Lecanora expallens*, and *Rinodina efflorescens*.

Lecanora jamesii Laundon

Jørgensen & Øvstedal (1975): The material proved to be: *Buellia griseovirens* and *Ochrolechia androgyna* C.

Øvstedal (1979): The material belonged to *Buellia griseovirens*, *Mycoblastus fucatus*, and *Rinodina efflorescens*.

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