NORDIC LICHEN FLORA

Volume 1

Introductory parts

Calicioid lichens and fungi

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Editorial Board

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Logotype: Erik Acharius' drawing in Westring, Svenska lafvarnas färghistoria p. 205, 1805.

Introduction

The concept of the Nordic Lichen Flora has been worked out by the Nordic Lichen Flora Executive Committee, which included the following persons: Teuvo Ahti (University of Helsinki, Finland), Per Magnus Jørgensen, (University of Bergen, Norway), Hördur Kristinsson (Icelandic Institute of Natural History, Akureyri, Iceland), Roland Moberg (Uppsala University, Sweden), Ulrik Søchting (University of Copenhagen, Denmark), Göran Thor, Secretary (Uppsala University, Sweden). Advisors of the Committee were Gunnar Carlin (Uppsala, Sweden; chemistry), Rolf Santesson (Uppsala, Sweden), Tor Tønsberg (University of Bergen, Norway), and Brian Coppins (Royal Botanic Garden, Edinburgh, Scotland).

Scope of the flora

The only previous attempt to write a flora for the Nordic countries is the unfinished work by Th. M. Fries: Licheno-graphia scandinavica (1871–74). With the increasing use of lichens in matters of nature conservation and biodiversity studies additional to the needs of lichenologists, the demand for a modern flora appears obvious and urgent. We have, like Fries, attempted to make a scientific flora covering the rich lichen flora of the region which has been regarded as one of the lichenologically best known in the world. We usually only include fungi which form independent thalli with the photobiont (except for this volume), and thus no truly lichenicolous fungi, though we have for practical reasons included some borderline-cases, then often as comments in the text, and not as individual entries. However, in some groups such as Calicioid fungi and lichens, non-lichenized species are also treated.

The area covered is the following (see also map p. 19):

Denmark (Danmark) with
  Faeroe Islands (Føroyar; Færøerne)
  Greenland (Kalaallit Nunaat; Grønland)
Finland (Suomi) with Åland (Ahvenanmaa)
Iceland (Island)
Norway (Norge) with Arctic Islands including
  Svalbard, Bjørnøya (Bear Island) and Jan Mayen
Sweden (Sverige)

The lichen flora of the Arctic islands, including Greenland, is treated rather cursorily since it is not well-known and contains many taxa which are in need of a modern revision outside the scope of this flora. No full description is given on the taxa that are only known from Greenland, but they are mentioned in the keys.

In a number of details our flora follows the presentation in The lichen flora of Great Britain and Ireland (Purvis et al. 1992), but includes a considerably different species composition and is essentially based on material from the Nordic countries.

The flora will for practical reasons be published in separate volumes, though preferably so that each volume covers taxonomically related or similar taxa. Because of this it is impossible to present a general key or a glossary before the last volume, and we recommend the readers to consult the British lichen flora (Purvis et al. 1992), though we cover a different range of species. The treatment of our flora is entirely based on original studies made on material collected in our region.

Acknowledgements

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Lichen habitats

Teuvo Ahti

Lichens are a conspicuous element in many communities of vegetation in the Nordic countries.

Terricolous (epigeic) lichens may be the dominant in pine or birch woodlands on sand over extensive areas, especially in Lapland. They also serve as the primary winter range for domesticated or wild reindeer, which feed on lichens, primarily species of *Cladonia*, subg. *Cladina*. Only some crustose lichens, e.g. *Placynthiella oligotropha*, and small *Cladonia* species can benefit from reindeer grazing. Especially in Norway, Iceland and the Faeroes the ground lichens suffer from grazing by sheep and cattle, also above timberline. Ungrazed, old-growth stands may carry solid, 15-cm-tall carpets of *Cladonia stellaris* (see also chapter Red-listed lichens). Terricolous lichens are also abundant in arctic and alpine situations. Further south they are found on thin veneer of soil over rock outcrops, in sand fields and dunes, and in many successional communities, such as road banks and gravel pits. Most of the terricolous lichens are fruticose, but especially in the arctic there are numerous crustose species, many of which may also by called

muscicolous (bryicolous, epibryic). Most of the terricolous lichen species, especially in the arctic, require prolonged snow cover in wintertime; they are called **chionophilous**, e.g. *Solorina crocea*. Muscicolous species are common on saxicolous bryophytes, such as *Andreaea*. There are also species, such as *Ochrolechia frigida* and *Ophioparma ventosa*, which are **chionophobous** (achionophilous), highly resistant to removal of snow even in windswept habitats.

More than a thousand species of Nordic lichens are strictly **saxicolous** (epilithic), growing directly on rocky substrates, which are very abundant in many regions because of long exposition of the bedrock during the latest Ice Age. The glacial deposits also include large amounts of rocks, ranging from small pebbles to huge ice-carried erratic blocks and extensive block fields, which all serve as excellent habitats for lichens, especially crustose and foliose species. Much of the area belongs to the Precambrian Fennoscandian (Baltic) Shield characterized by siliceous rocks such as granites and gneisses. The Scandinavian mountains also contains sedimentary rocks, including highly calcareous regions. The Baltic islands Gotland and Öland are characterized by **alvars**, i.e. flat lowland limestone rocks, which harbour a lichen flora very unusual elsewhere in the Nordic countries (e.g., Fröberg 1989). The siliceous and basic rocks carry very different lichen floras. Certain other minerals can also be recognized by means of their lichen flora. For instance, *Acarospora sinopica*, *Lecidea silacea* and *Miriquidica atrofulva* – all rust-coloured (due to hydrated iron oxides) species – are characteristic on iron-rich minerals, while *Lecidea inops* is restricted to copper-rich substrates. The primarily terricolous lichens which grow on a thin cover of soil over the rocks could also be called **chomophytic**, and they include species specialized on this kind of habitat. A special group of truly saxicolous lichens consists of species on concrete and other basic, man-made structures (buildings, walls, tombstones, monuments, etc.); this flora includes aggressive, weedy, fast colonizers, such as *Lecanora albescens*, *Candelariella aurella* and *Caloplaca citrina*. Other very distinct saxicolous floras and characteristic lichen zonations are found on saline, coastal cliffs (see Degelius 1939) and on freshwater shore rocks (see Santesson 1939).

Rocks in the upper geolittoral zone, as well as further inland (particularly in the mountains) have got special communities of **ornithocoprophilous** lichens, like *Aspicilia leprosescens*, *Buellia coniops*, *Lecanora helicopis*, *Physcia caesia*, *Xanthoria parietina* etc. These species are **nitrophilous** and favoured by bird droppings. Similar communities are found on eutrophicated wayside trees. Tholurna dissimilis is restricted to tops of solitary, dwarf spruce trees which are birds' look-out places.

Perhaps the largest number of lichens in the world belong to the **corticolous** (epiphytic, epidendric) species. They grow on bark of trees and shrubs, even arctic dwarf shrubs. Most of them are crustose but many foliose, relatively few fruticose. Unlike parasitic or many saprobic non-lichenized fungi they are rarely highly specialized to certain plant genera, but there are a few such lichens, e.g. *Lecanora populicola*, which is confined to *Populus*. However, most of the lichen epiphytes do prefer certain phorophytes (substrate trees or shrubs) and are scarce or absent on others mainly because of differences in the property of this bark. Since coniferous forests dominate much of the Nordic countries, there are numerous species which are specialized to grow on conifer bark, some more to *Picea*, other to *Pinus* and *Juniperus*. The temperate deciduous trees, such as *Acer* and *Fraxinus* house many lichens (so-called "rikbark" of Du Rietz 1945) which are never found on conifers. One major reason is that the conifer bark is normally highly acidic, while the deciduous trees have weakly acid to basic bark, which is an important difference to lichen growth. This difference is often accentuated by secondary eutrophication of trees in villages and towns (usually deciduous) caused by dust from agriculture, traffic, etc. Some common boreal deciduous trees, such as *Prunus*, *Salix caprea*, and *Sorbus*, are somewhat intermediate as to bark pH, while *Betula* and (native) *Quercus* are almost equal to conifers as lichen phorophytes. *Populus tremula* is a widespread boreal tree with often subneutral bark, thus differing sharply from surrounding trees. Its flora is especially rich on eutrophicated situations such as field margins. In old-growth forests it can have rather a different but unique corticolous flora.

Lignicolous (epixylic) lichens grow on lignum, i.e. decorticated wood, such as stumps, stubs and logs, which are often (especially in the timberline regions) a long-persistent habitat. Worked timber, such as fence rails, poles and unpainted buildings is likewise a common, but disappearing lichen habitat with e.g. *Letharia vulpina*, *Thelomma ocellatum* etc. The lignicolous flora consists of many specialized crustose species e.g. *Calicium* spp., *Hypocenomyce xanthococca*, *Lecanora mughicola* and *Xylographa* spp.

Lichenicolous lichens are a smaller group of species, and often difficult to distinguish from a few hundred species of lichenicolous non-lichenized fungi. A lichenicolous lichen may start as a non-lichenized parasite but later develop an independent lichen thallus, or it may be lichenicolous only at its early phase of development ("jugend-parasit"). Some lichenicolous non-lichenized fungi are also regarded as "delichenized fungi", having close, congeneric relatives among the true lichens. They are with few exceptions all crustose.

Biogeography

Teuvo Ahti

The ranges of the lichen species are generally better known than those of any other group of fungi. However, this is really true only for the macrolichens and a limited number of crustose species. Most of the Nordic lichens are actually badly known as to their detailed distribution. Numerous distribution maps have been published but no intensive mapping schemes like in Britain or Austria have been developed. On the other hand, there is a sufficient number of well-studied species which can be used as representative examples showing characteristic distribution patterns of lichens in the area.

Traditional interest has been shown to the oceanic elements in the Nordic lichen flora. Degelius (1935) published a major treatise of such species, and Jørgensen (1996) has made many additions to these elements. He showed that the oceanic element is not uniform, consisting of different entities. A southern group of species is concentrated in Sunnhordaland south of Bergen in western Norway, many of which have affinities to tropical/subtropical regions, e.g. *Gomphillus calycioides*, *Leptogium burgessii*, *L. cochleatum*, *L. hibernicum* and *Megalospora tuberculosa*. There is also a northern group, mainly found in the moist boreal spruce forests of Trøndelag (and Värmland), often with disjunct occurrences in similar forests in W or E North America, e.g. *Bryoria glabra*, *Cavernularia hultenii*, *Cladonia umbricola*, *Erioderma pedicellatum*, *Fuscopannaria ahlneri* and *Lobaria hallii*. More rarely a disjunctive pattern with occurrences in southern South America has been found, as in *Leptogium britannicum*, *Pseudocyphellaria norvegica* and *Toninia thiospora*.

On the other hand, there are also continental elements, which mainly occur in Siberia in Eurasia, and reach Finland (usually in the northern and middle boreal zones) and less frequently Sweden and Norway. Such species include *Evernia mesomorpha*, *Hypogymnia bitteri*, *Miriquidica ventosa*, *Phaeophyscia kairamoi*, and *Tuckermannopsis ciliaris*. A number of conifer epiphytes can be assigned to this group (Ahlner 1948). Other continental elements, especially species of more southern, xerothermic regions, are found disjunctively on Öland and Gotland, e.g. *Aspicilia coronata*, *Catapyrenium lacinulatum*, *Fulgensia fulgens*, or in Gudbrandsdalen and adjacent valleys in south-central Norway, e.g. *Fulgensia desertorum*, *Solorinella asteriscus*, *Toninia philippea*, and *T. sculpturata*.

Besides these elements, largely controlled by air humidity and precipitation, the south-north gradient, i.e. the zonation caused by the amount of heat, has a very distinct effect on lichen distributions (Ahti 1977). Many essentially temperate species, such as *Caloplaca flavescens*, *Diploicia canescens*, *Flavoparmelia caperata*, and *Melanelia laciniatula* extend to Denmark and southern Sweden or Norway but not to the boreal zone proper. Common boreal species include *Bryoria fremontii* (in the north), *Bryoria furcellata*, *Cladonia stellaris*, and *Tuckermannopsis sepincola*. Further north essentially arctic species invade into the boreal zone, such as *Cladonia bellidiflora*, *Flavocetraria cucullata*, *F. nivalis*, *Ochrolechia frigida*, *Pertusaria geminipara*, *Stereocaulon alpinum*, and *S. grande*.

Above the timberline in Fennoscandia and Iceland, and in the real Arctic in Greenland and the other islands there are numerous species, which are confined to these inhospitable regions. A very high proportion of their total biodiversity consists of lichens and lichenicolous fungi. A representative example is *Usnea sphacelata* in Greenland, Iceland and Svalbard; it is also known from the Antarctic. *Caloplaca alcarum* and *Leprocaulon subalbicans* are widespread arctic species which are very rare in Scandinavia.

In Greenland there are some "American" species, such as *Cladonia alaskana*, but most of the Greenland lichens are "European".

In many cases in this book the limits and frequencies of each species are described in terms of bioclimatic zones. As to the temperate and boreal main zones the terms used are usually those proposed by Ahti et al. (1968) but the delimitations of the zones, especially in the Norwegian coast, may be slightly deviating. A compromise is made in case of the arctic zones so that low-arctic is used instead of southern arctic, and low-alpine instead of lower oroarctic in accordance with the perhaps most frequent usages. As to their circumpolar delimitation and counterparts in the southern Hemisphere, see e.g. Hämet-Ahti (1981), Dahl (1986), Tuhkanen (1984, 1992). The used (sub)zones are as follows:

Northern temperate
Hemiboreal (or boreomeridional)
Southern boreal
Middle boreal
Northern boreal
Hemiarctic
Low-arctic or (in mountains) low-alpine
Mid-arctic or mid-alpine
High-arctic or high-alpine

In this flora the Nordic distribution of each taxon is given according to the biogeographical provinces of each country (see maps on p.). However, no detailed distribution is given for Greenland. The information is derived from a

Nordic Lichen Flora Database in Uppsala, maintained by R. Moberg and collected in collaboration with the national editors of the Nordic lichen flora from herbaria and literature.

References

Ahlner, S. 1948. Utbredningtyper bland nordiska barrträdslavar. – Acta Phytogeogr. Suec. 22: 1–257.

Ahti, T. 1977. Lichens of the boreal coniferous zone. In: Lichen ecology (ed. M.R.D. Seaward): 145–181. Academic Press, London.

Ahti, T., Hämet-Ahti, L. & Jalas, J. 1968. Vegetation zones and their sections in northwestern Europe. – Ann. Bot. Fenn. 5: 169–211.

Ahti, T. & Oksanen, J. 1990. Epigeic lichen communities of taiga and tundra regions. – Vegetation 86: 39–70.

Alstrup, V., Christensen, S.W., Hansen, E.S. & Svane, S. 1994. The lichens of the Faeroes. – Fróðskaparrit 40: 61–121.

Dahl, E. 1986. Zonation in arctic and alpine tundra and fellfield ecobiomes. In: Ecosystem theory and application (ed. N. Polunin): 35–62. Wiley & Sons, New York.

Degelius, G. 1935. Das ozeanische Element der Strauch- und Laubflechtenflora von Skandinavien. – Acta Phytogeogr. Suec. 7: 1–411.

Degelius, G. 1939. Die Flechten von Norra Skaftön. – Uppsala Univ. Årsskr 1939(1).

Du Rietz, G.E. 1945. Om fattigbark- och rikbarkssamhällen. – Svensk Bot. Tidskr. 1939: 147–150.

Foucard, T. 1990. Svensk skorplavsflora. – Interpublishing, Stockholm.

Fries, E. 1831. Lichenographia Europaea. Lundae

Fröberg, L. 1989. The calcicolous lichens on the Great Alvar of Öland, Sweden. – Inst. Systematisk Botanik, Lund.

Hämet-Ahti, L. 1981. The boreal zone and its biotic subdivision. – Fennia 159: 69–75.

Holtan-Hartwig, J. 1993. The lichen genus Peltigera, exclusive of the P. canina group, in Norway. – Sommerfeltia 15: 1–77.

Jørgensen, P.M. 1996. The oceanic element in the Scandinavian lichen flora revisited. – Symb. Bot. Ups. 31(3): 297–317.

Krog, H., Østhagen, H. & Tønsberg, T. 1994. Lavflora. Norske busk- og bladlav. Ed. 2. – Universitetsforlaget, Oslo.

Moberg, R. & Holmåsen, I. 1990. Lavar. En fälthandbok. Ed. 3. – Interpublishing, Stockholm.

Purvis, O.W., Coppins, B.J., Hawksworth, D.L., James, P.W. & Moore, D.M. 1992. The lichen flora of Great Britain and Ireland. – Natural History Museum Publications, London.

Santesson, R. 1939. Über Zonationsverhältnisse der lakustrinen Flechten einiger Seen im Anebodagebiet. – Medd. Lunds Univ. Limnolog. Inst. 1.

Santesson, R. 1993. The lichens and lichenicolous fungi of Sweden and Norway. – SBT-förlaget, Lund.

Tuhkanen, S. 1984. A circumboreal system of climatic- phytogeographic regions. – Acta Bot. Fenn. 127: 1–50.

Vitikainen, O., Ahti, T., Kuusinen, M., Lommi, S. & Ulvinen, T. 1997. Preliminary checklist of lichens and allied fungi of Finland. – Norrlinia 6 1–123.

Wirth, V. 1995. Die Flechten Baden-Württembergs. Ed. 2. 1, 2. – Ulmer, Stuttgart.

Lichens as bioindicators of air pollution

Ulrik Søchting

Lichens, generally absorbing necessary water and mineral nutrients from precipitation, ambient air and dust particles are physiologically adapted to taking up minerals and other chemicals, with which they get into contact. This ability being a ecological necessity in natural environments, becomes a severe problem when the precipitation and the air is polluted with toxic compounds.

Many studies during the last hundred years show that industrialization has led to reduced vitality of particularly epiphytic lichens. This is due mainly to toxic concentrations of sulphur dioxide derived from combustion of fossil fuel for heating and industry, but high doses of fluorides, heavy metals and ammonia may also injure the lichens. Most of the Nordic countries receive an annual deposit less than 1 gS/m^2, while Denmark and the southernmost parts of Sweden, Norway and Finland have a deposit 1–2 gS/m^2. This is still less than through most of central Europe and much of Britain and therefore the Nordic lichen flora has also survived better. In the extreme north and the islands the deposits are generally negligible. However, locally there are severely polluted areas, e.g. around aluminum factories in Iceland and Norway, a copper smelter in Finland, and pulp mills in many towns. The highly polluted mining areas in the Murmansk Region, Russia, extend some influence to the lichens of Norwegian and Finnish Lapland. Much of the other long distance pollution is coming from abroad, from Britain, Germany, Poland, Estonia and Russia, in particular. Atmospheric nitrate and ammonia deposition levels are high (above 0.4 $gN/m^2/a$) in Denmark and Scania but low in Lapland, for instance. On the other hand, the earlier high nitrogene levels in farmyards and roadsides due to extensive cattle raising and horses have become much reduced in northern regions, apparently leading to local disappearance of many Physciaceae, for instance.

In larger cities such as Copenhagen, Helsinki, Oslo and Stockholm, zones without lichens (”lichen deserts”) were formed in the town centres, surrounded by zones of increasing species diversity with increasing distance from the city centres. This development culminated in the early seventies. Some lichen species are extremely sensitive to

sulphur dioxide, e.g. *Bryoria* species in boreal regions and *Anaptycia ciliaris* and some *Physconia's* in temperate areas, whereas other species are extremely tolerant to or even thriving on air pollution. Such species are *Lecanora conizaeoides* and *Scoliciosporum chlorococcum*, both of which have become dominant on bark of broad-leaved trees in urban areas. Scales have been established for estimation of concentrations of sulphur dioxide based on the specific sensitivity of different lichen species (e.g. Søchting & Ramkær 1982, Arvidsson & Skoog 1984).

In recent years sulphur dioxide pollution has decreased significantly in urban centres, and the lichens are rapidly colonizing tree trunks in the cities, this being a fine biological indication of the improving purity of the air.

One of the cures for urban air pollution has been the construction of higher chimneys leading to increased pollution in rural areas. This has resulted in a general decline in the health and diversity of lichen vegetations particularly in the southern part of the Nordic countries. The epiphytic vegetation is heavily influenced, and a particularly drastic decline has taken place in the flora of canopy twigs, which was formerly rich and well-documented in Scandinavia (Degelius 1964). Trivial lichen species, such as *Lecanora conizaeoides* and *Scoliciosporum chlorococcum* are now abundant on bark.

Sulphur dioxide together with nitrogen oxides from car exhaust lead to acidifying compounds in the air and the precipitation. Acid rain and dry deposition of acid compounds have acidified the originally more neutral bark of Ulmus, Tilia and Fagus in southern Scandinavia thus allowing colonization of species such as *Hypocenomyce scalaris* and *Parmeliopsis ambigua*, that are characteristic of the acid bark of conifers and *Betula*. Acidification of bark and soil can even be demonstrated very far from the pollution sources, e.g. in coastal sites with high precipitation, where it can be detrimental to *Lobaria* and *Peltigera* (Hallingbäck & Thor 1988).

The exhaust from cars mainly consisting of nitrogen oxides seems to have little direct effect on lichens. They also seem to tolerate a considerable uptake of heavy metals such as copper, nickel, chromium, cadmium and zinc, and the content of those metals in e.g. *Hypogymnia physodes* have even been used as an indicator of heavy metal deposition (Kubin 1990). Extreme exposition to metal pollution, as seen around smelters may, however, be detrimental to the lichens.

Ammonia emitted from animal farms and from pulp mills is readily deposited on lichen thalli and is almost instantly taken up by the lichens. In the thalli it leads to increased algal growth and elevated chlorophyll content, at higher levels the lichen may die. The nitrogen content of *Hypogymnia physodes* has been used as an indicator of nitrogen deposition (Bruteig 1993, Søchting 1995).

Lichens have been shown to be extremely efficient absorbers of radioactive fall-out. Carpets of reindeer lichens (*Cladonia* subgen. *Cladina*) hold back any amount of ^{137}Cs or ^{90}Sr precipitated upon them, and their radioactivity can be traced back to the nuclear testings in the 60's, and particularly to the Chernobyl accident in 1986.

References

Arvidsson, L. & Skoog, L. 1984. Svaveldioxidens inverkan på lavfloran i Göteborgsområdet. – Svensk Bot. Tidskr. 78: 137–144.

Bruteig, I. 1993. The epiphytic lichen Hypogymnia physodes as a biomonitor of atmospheric nitrogen and sulphur deposition in Norway. – Envir. Monit. and Assessment 26: 27–47.

Degelius, G. 1964. Biological studies of the epiphytic vegetation and twigs of Fraxinus excelsior. – Acta Horti Gothoburgensis 27:1–55.

Hallingbäck, T. & Thor, G. 1988. Jättelav, Lobaria amplissima, i Sverige. – Svensk Bot. Tidskr. 82: 125–151.

Kubin, E. 1990. A survey of element concentrations in the epiphytic lichen Hypogymnia physodes in Finland in 1985–86. In: Kauppi, P. Anttila, P. & Kenttämies, K. (Eds.), Acidification in Finland: 421–446. Springer-Verlag, Berlin & Heidelberg.

Søchting, U. 1995. Lichens as monitors of nitrogen deposition. – Crypt. Bot. 5: 264–269.

Søchting, U. & Ramkær, K. 1982. The epiphytic lichen zones in rural Denmark and Schleswig-Holstein. – Nord. J. Bot. 2: 171–181.

Red-listed lichens

Göran Thor

Almost all vegetation in the Nordic countries has been affected by man even though the scale and type have differed in different periods in different areas and habitats. Lichen-rich habitats have been continuously destroyed or negatively affected, and lichens have become rarer or lost from each country. In addition to destruction of lichen habitats, many lichens have apparently arrived at the Nordic countries or increased there due to benefit through nutrient dispersal from agriculture and especially animal husbandry, enriching the flora. There are published Red Lists from all the Nordic countries. The latest versions of Red Lists were published from Denmark in 1997 (Stoltze & Pihl 1998, 574 species), Finland 1995 (Kuusinen et al. 1995, 138 species), Iceland 1996 (Náttúrufræðistofnum

Íslands 1996, 67 species), Norway 1996 (Tønsberg et al., 69 species), and Sweden 1995 (Aronsson et al. 1995, 238 species). Somewhat different criteria to select the species have been used, and the number of evaluated species differ. Even though the old IUCN categories (Threatened Plants Committee Secretariat 1980) have mainly been used, their definitions have sometimes been slightly changed, and additional Red List categories have been added, which complicates the comparison. The percentage and number of red-listed species distinctly differ between different countries. Denmark has the highest number with 60 %, while only 9 % are regarded as red-listed in Finland, and 12 % in Sweden. In Norway only macrolichens have been included while also crustose species have been included in Denmark, Finland, Iceland and Sweden. The percentage of evaluated crustose species are low due to insufficient knowledge, except in Denmark where almost all species were evaluated. Almost all foliose and fruticose species have been evaluated being more intensely studied than crustose species, and accordingly the Red Lists include proportionally more such species. The increasing interest for lichens has highlightened the importance of that collecting of red-listed species should be kept to a minimum and only to obtain a reliable identification or for scientific reasons.

Most widespread lichens are rare in parts of their range, especially at the periphery. Such species are included in the Red Lists (e.g. *Nephroma arcticum* in Denmark, *Pseudevernia furfuracea* in Iceland, *Arthonia cinnabarina* in Sweden), but it is striking that within each vegetation zone the same species are commonly red-listed in all the Nordic countries. Examples of such species are *Collema curtisporum*, *Evernia divaricata*, *Lobaria hallii*, *Fuscopannaria ahlneri* and *Usnea longissima* in the boreal zone as well as *Bactrospora brodoi*, *B. corticola*, *Chaenotheca cinerea* and *Opegrapha illecebrosa* within the temperate zone. Several lichens which are still more or less common in the northern part of the Nordic countries are red-listed or rare in Southern and Central Europe, e.g. *Lobaria pulmonaria*, *Nephroma bellum*, *Peltigera venosa* and *Tuckermannopsis sepincola*.

Threats

The major threats can be divided into three categories; forestry, air pollution (see above) and structural changes in the agricultural landscape, which can more or less interact with each other. The overwhelming number of the Red List species inhabit forests while some are found in agricultural landscape or on cliffs and outcrops, but only a few in the alpine zone. The red-listed species from the alpine zone are all rather large and conspicuous. This might reflect the fact that the knowledge about the taxonomy, biology and distribution of the crustose lichen species, in particular in the alpine zone is still insufficient, but it also might reflect the fact that the threats are less obvious here. However, it is evident that reindeer grazing has drastically altered the species composition and the abundance in the northern boreal and alpine zone, also in nature reserves and national parks where grazing is normally allowed. Large areas are heavily trampled and largely overgrazed so that most terricolous and some arboreal lichens are badly developed. Above all species of *Cladonia* subg. *Cladina* have suffered severely. However, some crustose pioneer lichens, e.g. *Placynthiella oligotropha*, and small *Cladonia* species can benefit from reindeer grazing. Carpets of *Cladonia stellaris* are locally used for commercial collecting and export from Finland, Norway and Sweden and *Cetraria islandica* from Iceland, but such an activity is usually not truly destructive, if only part of the colonies are selectively harvested every 10th year or so, allowing sufficient regeneration to maintain continuous productivity. Especially in Norway, Iceland and the Faeroes the terricolous lichens suffer from grazing by sheep and cattle, also above the timberline. In other areas, as the Alvar in Öland, undergrazing has resulted in increased shrub vegetation, being a threat to many terricolous lichens.

(1) Forestry. Almost all of the forests in the Nordic countries below the true timberline woodlands are managed and cut for commercial purposes, which has had a drastic impact on the structure and species composition of lichens in the forests. Only small fractions of forests with a long tree continuity (old-growth forests) remain and most of these are located in the northern boreal areas. The rapid decrease and fragmentation of forests with a tree continuity is a threat to many lichens and have resulted in e.g. longer dispersal distances between the fragments. Forestry practices have created monospecific, even-aged tree stands with short rotation periods, and clear-cutting regimes have dominated forest management during recent decades in the Nordic countries (except in Iceland). Many red-listed lichens are good indicators of forests with a continuity in the tree layer as well as earlier influences of forestry. Dead wood is also an important substrate which is scarce today in the forest. Most red-listed lichens are mainly found in productive forests with a continuity in the tree layer. However, most protected forests are impediment or low productive forests.

(2) Structural changes in the agricultural landscape. Main threats are that the modern agricultural landscape is at large-scale where many minor and marginal habitats (e.g. single old trees, stone walls, alleys, old barns) are disappearing. Many red-listed species confined to the agricul-

tural landscape are today mainly restricted to churchyards, alleys and parks surrounding castles and old manors. A substrate which has become rare in the agricultural landscape is old wood which is not creosote-impregnated, e.g. in fences, fence posts, old barns and windmills.

Habitats

Most forests with red-listed lichens are not necessarily also rich in other red-listed organisms such as vascular plants or bryophytes. Especially in the boreal zone, coniferous forests with a long tree continuity on siliceous bedrock dominated by *Picea abies* or *Pinus sylvestris* can harbour many red-listed lichens, but few or no red-listed vascular plants (e.g. Thor 1998, Olsson & Gransberg 1993). Two forest cover types which now are rare but have many red-listed lichens are the broad-leaved deciduous old-growth forests (in Denmark, southern and central Sweden and to some extent also southern Norway and SW Finland), and the shady old-growth forests dominated by *Picea abies* (sometimes intermixed with e.g. *Pinus sylvestris* and *Populus tremula*) with high air humidity in the boreal zone. Many red-listed species are found in open broad-leaved deciduous forests still or earlier used for grazing (wooded pastures) or haymaking (wooded meadows), and many of these species probably depend on or are favoured by the traditional management practices (e.g. pollarding). However, such areas have rapidly been decreasing and now only cover small areas. Red-listed species found here include *Pertusaria multipuncta*, *Lecanora impudens*, *Buellia violaceofusca*, *Chaenotheca hispidula*, *Opegrapha illecebrosa* and *Phaeophyscia endophoenicea*. Wood in the agricultural landscape provides habitats for Red List species such as *Acarospora anomala*, *Calicium abietinum*, *Cyphelium notarisii*, *C. trachylioides* and *Sphinctrina anglica*. Spruce forests with a suitable microclimate for red-listed lichens are often located on north slopes of mountains, in ravines, close to streams and rivers and in marshes and on peatlands (cf. Karström 1993). Most of these forests have not been badly affected by forest fires, which otherwise earlier were frequent in most of the forests in the boreal zone. The red-listed species found in spruce forests are dependent on high air humidity, and are negatively affected by drainage (cf. Esseen & Eriksson 1982), and other environmental impacts. Red List species found in old-growth spruce forests are e.g. *Chaenotheca gracillima*, *C. laevigata*, *Cybebe gracilenta*, *Cyphelium karelicum*, *Evernia divaricata*, *E. mesomorpha*, *Ramalina thrausta* and *Sclerophora coniophaea*. Remarkable spruce forests are the humid lowland forests of central Norway, and a small group of lichens have their main or only European occurrences in these forests (e.g. *Erioderma pedicellatum*, *Lecidea subcinnabarina*, *Rinodina disjuncta*) (e.g. Tønsberg 1992, Holien & Tønsberg 1996).

References

Aronsson, M., Hallingbäck, T. & Mattsson, J.-E. (eds). 1995. Rödlistade växter i Sverige 1995: (Swedish Red Data Book of Plants 1995). – ArtDatabanken, Uppsala.

Berg, Å., Ehnström, B, Gustafsson, L., Hallingbäck, T., Jonsell, M. & Weslien, J. 1994. Threatened plant, animal, and fungus species in Swedish forests: distribution and habitat associations. – Conservation Biology 8: 718–731.

Esseen, P.A. & Eriksson, L. 1982. Granskogar med långskäggslav i Sverige. – Swedish Environmental Protection Agency Report 1513.

Holien, H. & Tønsberg, T. 1996. Boreal regnskog i Norge – habitatet for trøndelagselementets lavarter. – Blyttia 54: 157–177.

Karström, M. 1993. Indikatorarter som biologisk inventeringsmetod. In: Olsson, G.A. & Gransberg, M. (eds), Indikatorarter för identifiering av naturskogar i Norrbotten. – Swedish Environmental Protection Agency Report 4276.

Kuusinen, M., Kaipiainen, H., Puolasmaa, A. & Ahti, T. 1995. Threatened lichens in Finland. – Crypt. Bot. 5: 247–251.

Náttúrufrædistofnum Íslands 1996. Válisti 1, Plöntur. – Reykjavik.

Olsson, G.A. & Gransberg, M. (eds) 1993. Indikatorarter för identifiering av naturskogar i Norrbotten. – Swedish Environmental Protection Agency Report 4276.

Rassi, P., Kaipiainen, H., Mannerkoski, I. & Ståhls, G. 1992. Uhanalaisten eläinten ja kasvien seurantatoimikunnan mietintö (English summary: Report on the monitoring of threatened animals and plants in Finland). – Ministry of the Environment, Committee Report 1991: 30. Government Printing Centre, Helsinki.

Stoltze, M. & Pihl, S. (eds). 1998. Rødliste 1997 over planter og dyr i Danmark. – Miljø og Energiministeriet, Danmarks Miljöundersøgelser og Skov- og Naturstyrelsen, Hørsholm.

Thor, G. 1998. Red-listed lichens in Sweden: habitats, threats, protection, and indicator value in boreal coniferous forests. – Biodiv. Conserv. 7: 59–72.

Threatened Plants Committee Secreteriat 1980. How to use the IUCN Red Data Book categories. – IUCN.

Tønsberg, T. 1992. The sorediate and isidiate, corticolous, crustose lichens in Norway. – Sommerfeltia 14: 1–331.

Tønsberg, T., Gauslaa, Y., Haugan, R., Holien, H. & Timdal, E. 1996. – The threatened macrolichens of Norway – 1995. – Sommerfeltia 23: 1–258.

Chemistry

Gunnar Carlin

The extracellular products of lichens – lichen compounds or secondary metabolites – are a large and unique group of compounds which has attracted much taxonomic interest and debate, and no description of lichen taxa is considered complete without chemical data.

The lichen compounds are traditionally classified in three major groups acording to their biosynthetic pathways: the shikimic acid group, the mevalonic acid group, and the acetate-polymalonate group (see review by Mosbach 1973, and the key references of lichen chemistry by C.F. Culberson 1969, 1970 and Culberson et al. 1977).

Compounds of shikimic acid origin are few in lichens. This small group include tetronic acid (pulvic acid) derivatives such as the yellow pigments vulpinic, pinastric and rhizocarpic acids. Compounds of mevalonic acid origin (triterpenoids) are also few. The widespread compound zeorin and other hopane derivatives, for example found in rich variation in *Peltigera*, belong here. Compounds of acetate-polymalonate origin constitute the largest group of secondary compounds characteristic for lichens. The group includes several hundred aliphatic fatty acids and aromatic compounds such as depsidones, depsides, depsones and dibenzofurans.

Identification

The standard method for identification of lichen compounds is the convenient thin-layer chromatography (TLC, HPTLC) technique (Culberson 1972, Arup et al. 1993), although lichenologists are becoming increasingly comfortable with the reversed phase high performance liquid chromatography (HPLC) technique, which is theoretically similar but far more sensitive, and which allows accurate identification and quantification of the compounds, but requires expensive laboratory equipment (see Huovinen 1987).

The use of colour tests is sometimes convenient and may aid in the identification of a lichen specimen. However, only few compounds can be identified by colour reagents only, one example is the red needle-like crystals of norstictic acid formed in K, and many compounds do not give a colour reaction.

The standard reagents are:

K = A solution of 10 % potassium hydroxide (KOH) in water.

C = Bleaching agent, sodium or calcium hypochlorite ($Ca(OCl)_2$), the solution must be replaced as soon as it does not smell strongly of chlorine.

KC = K immediately followed by C.

PD = Paraphenylenediamine ($(H_2N)_2C_6H_4$), freshly prepared solution of a few crystals in 96 % ethanol. (Do not use "stable" solutions, such as Steiner's solution, which will give less reliable results.)

The possible carcinogenic effects of p-phenylenediamine and its oxidation products have been studied extensively, and as a result p-phenylenediamine is currently not considered as carcinogenic, see e.g. Bracher et al. (1990). On the other hand p-phenylenediamine is a major cause of occupational allergic contact dermatitis, see e.g. Guerra et al. (1992), and should thus be treated with care, not only because it discolours skin, clothes, herbarium packets and books.

In addition, the following reagents and tests are sometimes useful:

I = A solution of 0.1–1 % iodine and 0.1–1% potassium iodide in 70 % ethanol or water; now often in the form of "lugol", a light non-resistant reagent which must be renewed frequently to get a good and reliable result.

HNO_3 = 50 % nitric acid.

S = 10 % sulphuric acid

UV = fluorescence under long-wave (about 366 nm) or, rarely, short-wave (254 nm) ultraviolet light.

Apply a small drop of the reagent to a young part of the thallus. Alternatively (in case of dark-coloured specimens), a larger drop may be applied and then taken up on filter paper. The cortex and the medulla should be tested separately, since different tissues may contain different lichen compounds. Remove a small part of the cortex before testing the medulla. Observe the reactions under the dissecting microscope for up to a minute, keeping in mind that some reactions are slow, while e.g. a pink reaction with C may disappear almost immediately. The colour reaction is dependent on the amount of lichen compound present and a false negative result may occur in parts of the thallus containing low concentrations of lichen compounds. If possible, remove and discard the tested portion of the thallus, but leave a record of the test with the material. The correct interpretation of colour tests requires some experience, for example the moistening with K on dry *Cladonia* thalli lacking atranorin may cause a dull yellowish spot, which can be mistaken for the pure and intensely yellow spot given by atranorin. Table 1 lists the colour reactions of some

lichen compounds. Consult White and James (1985) for further information on identification of lichen compounds.

Use of lichen compounds in taxonomy

Lichen compounds are with few exceptions produced by fungi in symbiosis with algae only, not by isolated fungi, a fact often given the interpretation that the fungus synthesizes the lichen compounds from carbohydrates supplied by the alga. The remarkable dependence of both the symbiotic partners to produce these compounds indicates that the compounds reflect something fundamental about the lichen organism, and makes the compounds attractive in the taxonomic work.

However, the use of chemistry in lichen taxonomy has not been uncontroversial. Interpretation of the chemical variations ranges from accepting virtually all chemical variants as species, over accepting some compounds as characteristic for a taxon while treating others as accessory, to ignoring the compounds at the species level.

The problem with acceptance of chemical characters in lichen taxonomy is multi-facetted. First, taxonomic species are traditionally separated on account of morphological differences. Second, it is not obvious how the expression of secondary products is linked to the genome. The metabolic path between the genes and the final lichen compound is long, and it involves first the transcription of the DNA into RNA, subsequently translation of the RNA into an enzyme – and a large number of enzymes are probably needed to produce the final product. All of these steps are under hereditary *and environmental control*. An example of the latter was given by Timdal (1989), who reported that the production of rhodocladonic acid in some *Cladonia* species was restricted to areas of the thallus infested by mites. Consequently, differences in the expression of secondary products do not necessarily reflect genetic differences (Carlin 1987, Timdal 1989), and there is certainly no justification for the common assumption that biogene-tically distant lichen compounds are produced by genetically distant lichens. For a review of the influence of environmental factors on the expression of lichen compounds, see Rogers (1989), who also discusses the value of chemical characters in lichen taxonomy. Genetic differences, although elusive, must, of course, form the basis of all taxonomy irrespective of species concepts.

However, the problem may largely be theoretical rather than practical. Since most morphologically defined species seem to have a constant chemistry, the usefulness of secondary metabolites in lichen taxonomy and identification work is unquestioned. In other words, "... most chemotypes (disregarding accessory chemical compounds) appear to have subtle morphological, ecological or distributional differences and consequently should be afforded some taxonomic recognition at the species level" (Elix 1992). This is a practically useful approach, it does not grant any *independent* taxonomical value to the secondary compound and it avoids the theoretical obstacles connected with ascribing taxonomical significance to the compounds. One such obstacle is that many lichen compounds, for example usnic acid, gyrophoric acid or the "compound-pair" squamatic and thamnolic acids, are often not unique for a certain species or a group of closely related species, but occur in several apparently unrelated species. This fact,which indicates different genetic backgrounds for one and the same lichen compound, is theoretically hard to reconcile with the idea of secondary compounds as being of taxonomic importance, and distinguish these compounds from DNA and proteins, for which each species have unique and genetically determined sequences.

An interesting possible mechanism for the regulation of phenotypic changes was recently suggested by DePriest (1993). The genes coding for the enzymes, which produce a certain lichen compound may contain introns, therefore these genes or their corresponding RNA transcripts need splicing before the enzymes are expressed. Compound-deficient chemotypes could result from suppression of intron splicing rather than from genetic variation. The splicing of introns is enzyme controlled and thus controlled by other genes.

Culberson and Culberson (1976) coined the expression chemosyndromic variation to describe the chemical variation found in *Cetrelia*. They found that the 15 species of *Cetrelia* (including 9 "chemical" species – chemical species differ in the content of their lichen compounds only) produced together 16 different lichen compounds. Each species produced a chemosyndrome of one major constituent and, in lower quantities, several of the other 15, which differed mainly in the side-chain length and oxidation state of the phenolic precursors of the lichen compounds. The authors suggested that the chemosyn-drome had its origin in the partial substrate specificity of the enzymes, unique for each species, which produced the major constituents from their preferred precursors, and the minor constituents from the less specific – but available – precursors with suboptimal side-chain lenghts. If this view is true, the same lichen compound is produced by several genetically and *functionally* different enzymes, which emphasizes the theoretical obstacle for accepting lichen compounds as of fundamental taxonomic importance.

Table I. Chemical and UV reactions of some lichen compounds.

Lichen compound	**PD**	**K**	**C**	**KC**	**UV**
Alectorialic acid	yellow	yellow	red	red	+
Alectoronic acid	–	–	–	red	+
Atranorin	yellow	yellow	–	–	–
Baeomycesic acid	yellow	yellow	–	–	+
Barbatic acid	–	–	–	–	+
Barbatolic acid	yellow	yellow	–	–	–
Bourgeanic acid	–	–	–	–	–
Calycin	–	–	–	–	–
Caperatic acid	–	–	–	–	–
a-Collatolic acid	–	–	–	red	+
Constictic acid	orange	yellow	–	–	–
Cryptochlorophaeic acid	–	red	red	red	+
Didymic acid	–	–	–	–	+
Diffractaic acid	–	–	–	–	+
Divaricatic acid	–	–	–	–	+
Eriodermin	orange	–	–	–	–
Evernic acid	–	–	–	–	–
Fumarprotocetraric acid	red	brownish	–	–	–
Glomelliferic acid	–	–	–	red	–
Grayanic acid	–	–	–	–	+
Gyrophoric acid	–	–	red	red	–
Hiascic acid	–	yellow–red	red	red	+
Homosekikaic acid	–	–	–	–	+
Hypoprotocetraric acid	–	–	–	–	+
Lecanoric acid	–	–	red	red	–
Lichesterininc acid	–	–	–	–	–
Lichexanthon	–	–	–	–	+
Lobaric acid	–	–	–	violet	+
Merochlorophaeic acid	–	–	red	red	+
Methyl gyrophorate	–	yellow	red	red	–
Miriquidic acid	–	–	–	–	–
Norstictic acid	yellow	red	–	–	–
Olivetoric acid	–	–	red	red	+
Pannarin	orange	–	–	–	–
Parietin	–	red	–	–	–
Perlatolic acid	–	–	–	–	+
Physodalic acid	red	yellow–red	–	–	–
Physodic acid	–	–	–	red	+
Pinastric acid	–	–	–	–	+
Porphyrilic acid	–	–	green	–	–
Protocetraric acid	red	brownish	–	–	–
Protolichesterinic acid	–	–	–	–	–
Psoromic acid	yellow	–	–	–	–
Pulvinic acid	–	–	–	–	+
Rangiformic acid	–	–	–	–	–
Salazinic acid	red	yellow	–	–	–
Scrobiculin	–	yellow–red	red	red	+
Sekikaic acid	–	–	–	–	+
Siphulin	–	–	yellow	yellow	+
Skyrin	–	red	–	–	–
Sphaerophorin	–	–	–	–	+
Squamatic acid	–	–	–	–	+
Stenosporic acid	–	–	–	–	+
Stictic acid	orange	yellow	–	–	–
Strepsilin	–	–	–	green	–
Thamnolic acid	orange	yellow	–	–	–
Usnic acid	–	–	–	yellow	–
Variolaric acid	–	–	yellow	–	–
Vulpinic acid	–	–	–	–	–
Zeorin	–	–	–	–	–

Biological role

Secondary compounds are deposited as crystals on the hyphae. They may constitute up to 20 % of the dry weight of a lichen specimen, and their production is evidently a main metabolic activity of the lichens which produce them (not all species or specimens do). As a rule, different compounds are produced in the medulla and in the cortex. The question of the control of secondary metabolite synthetis is obviously closely linked to the question of the biological role of these compounds. If we knew why these compounds are produced in such great diversity, the interpretation of their taxonomic value would be highly facilitated.

Lawrey (1986) summarized the knowledge a decade ago, and concluded that the available evidence pointed towards defense against microorganisms, defense against herbivores and defense against vascular and other plants competing for the biotope. Further evidence have accumulated since then, for example Vitikainen (1994) found that *Peltigera* species producing secondary metabolites were less infected by fungi than the other species. Many other hypotheses have been put forward, including effects as light-screens by compounds in the cortex.

It is not uncommon that different chemical strains of otherwise apparently similar lichens grow intermixed. The chemical defense theory is not very attractive in such cases, since the need for defence should be the same for both strains, and should not contribute to the evolutionary force leading to the chemical diversity, which furthermore may be very small.

Biosynthesis

Studies of biosynthesis pathways will give invaluable insight into the relations between different lichen compounds, and will assist the taxonomical interpretation of chemical variation. As already discussed, the acceptance of lichen compounds as taxonomically important entities is met with considerable conceptual difficulties, while differences in biosynthetic pathways may be easier to accept (Rogers 1989). "Considerations of biogenetic pathways instead of final products only, might yield more interesting information for phylogeny" (C.F. Culberson 1986). Unfortunately, remarkably few studies of secondary product biosynthesis have been published (Mosbach 1973). The first was by Mosbach (1964), who followed the synthesis of gyrophoric acid from radiolabelled malonate and carbon dioxide precursors. This is in sharp contrast to the, often excellent, efforts made towards molecular structure determinations. Also, this is a rare field of lichenology well suited for experimental work since it requires culture for short times only (minutes to hours!). Note that published biogenetic or biosynthetic schemes are, at least in large parts, hypothetical to speculative, or founded on conclusions from analogies with metabolic studies of free-living fungi.

Studies of biochemical macromolecules

Lichen proteins have been studied to some extent, although these studies have contributed very little to the solutions of taxonomical problems, see review by Mattsson (1994). That review, mainly covering electrophoretic patterns, did not include studies of secondary product-forming enzymes, although such studies have indeed been performed, e.g. by Mosbach (1973).

Recently, the first studies of the molecular biology of lichens were presented. DePriest (1993, 1994) described variable intron patterns in ribosomal DNA (rDNA) and correlated rDNA restriction-fragment patterns with chemotypes in different populations of the *Cladonia chlorophaea* complex. She found a remarkable diversity in rDNA genotypes, but no simple correlation with chemo-types, and thus no support for the recognition of "chemo-species" within this complex. On the contrary, indirect evidence of gene flow between different chemotypes was found. More experience and data on *intra-* and *inter*-specific variation may be needed before the rDNA restriction-fragment patterns can be fully interpreted from a taxonomic viewpoint. Studies like this must be considered as representing a uniquely "straight-to-the-point" way of studying genetic characters.

References

Arup, U., Ekman, S., Lindblom, L. & Mattsson, J.-E. 1993. High performance thin layer chromatography (HPTLC), an improved technique for screening lichen substances. – Lichenologist 61–71.

Bracher, M., Faller, C., Grotsch, W., Marshall, R. & Spengler, J. 1990. Studies on the potential mutagenicity of p-phenylenediamine in oxidative hair dye mixtures. – Mutation Research 241: 313–323.

Carlin, G. 1987. On the use of chemical characters in lichen taxonomy. – Graphis Scripta 1: 72–76.

Culberson, C. F. 1969. Chemical and botanical guide to lichen products. – University of North Carolina Press, Chapel Hill.

Culberson, C.F. 1970. Supplement to "Chemical and botanical guide to lichen products". – Bryologist 73: 177–377

Culberson, C. F. 1972. Improved conditions and new data for the identification of lichen products by a standardized thin-layer chromatographic metod. – J. Chromatogr. 72: 113–115.

Culberson, C. F. 1986. Biogenetic relationships of the lichen substances in the framework of systematics. – Bryologist 89: 91–98.

Culberson, C. F. & Culberson, W.L. 1976. Chemosyndromic variation in lichens. Systematic Botany 1: 325–339.
Culberson, C. F., Culberson, W.L. & Johnson, A. 1977. Second supplement to "Chemical and botanical guide to lichen products". – American Bryological and Lichenological Society, St. Louis.
DePriest, P. T. 1993. Molecular innovations in lichen systematics: The use of ribosomal and intron nucleotide sequences in the Cladonia chlorophaea complex. – Bryologist 96: 314–325.
DePriest, P. T. 1994. Variation in the Cladonia chlorophaea complex II: Ribosomal DNA variation in a Southern Appalacian population. – Bryologist 97: 117–126.
Elix, J. A. 1992. Lichen chemistry. – Flora of Australia 54: 23–29.
Guerra, L. Tosti, A., Bardazzi, F., et al. 1992. Contact dermatitis in hairdressers. – Contact Dermatitis 26: 101–107.
Huovinen, K. 1987. A standard HPLC method for the analysis of aromatic lichen compounds. – Bibliotheca Lichenol. 25: 457–466.
Lawrey, J. D. 1986. Biological role of lichen substances. – Bryologist 89: 111–112.
Mattsson, J.-E. 1994. Lichen proteins, secondary products and morphology: A review of protein studies in lichens with special emphasis on taxonomy. – J. Hattori Bot. Lab. 76: 235–248.
Mosbach, K. 1964. On the biosynthesis of lichen substances. Part I. The depside gyrophoric acid. – Acta Chem. Scand. 18: 329–334.
Mosbach, K. 1973. Biosynthesis of lichen substances. In: Ahmadijan V., Hale M. E. (eds) The Lichens: 523–546. Academic Press, New York.
Rogers, R. W. 1989. Chemical variation and the species concept in lichenized ascomycetes. – Bot. J. Linn. Soc. 101: 229–239.
Timdal, E. 1989. The production of rhodocladonic acid in Cladonia bacilliformis and C. norvegica triggered by the presence of a lichenicolous mite. – Graphis Scripta 2: 125–127.
Vitikainen, O. 1994. Taxonomic revision of Peltigera (lichenized Ascomycotina) in Europe. – Acta Bot. Fennica 152: 1–96.
White, F. J., James, P.W. 1985. A new guide to microchemical techniques for the identification of lichen substances. – Bull. Br. Lichen Soc. 57 (suppl.): 1–41.

Names

Scientific names

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The primary source of the nomenclature adopted here is the checklist entitled *The lichens of Sweden and Norway* by Santesson (1993), with several additions, alterations and corrections. There are a number of species which are absent from the cited list simply because they are only known from Nordic countries other than Sweden and Norway. All accepted names of lichen-forming fungi in that work are considered in this flora.

As to synonyms we refer to the cited checklist. However, some recently much used synonyms, especially those for recent generic segregates not adopted in this flora, are cited. Also, some synonyms absent from Santesson's list but adopted in the Nordic national standard lichen floras (and hence in ecological papers, etc.) or other important papers are listed.

Taxa which are considered to have been erroneously reported from the Nordic countries or those which are of dubious taxonomic validity are mentioned below allied taxa or at the ends of appropriate generic accounts.

Types are cited when known, particularly when the names are described from the Nordic countries.

The abbreviations of the authors follow Brummitt & Powell (1992), with some corrections and additions.

The lichen nomenclature is generally controlled by the *International Code of Botanical Nomenclature* (9th ed., Greuter et al. 1994). Some of the names adopted here have officially been proposed for conservation (nom. cons. prop.) but the proposals have not yet been acted upon by the international organs which make the decision. While up to recent times name changes were automatically made when an older name for a taxon was detected, there is now a trend to maintain as many species names as posssible in use by means of a conservation procedure described in the Code.

We have followed this trend as clearly illustrated in the recent revision and typification of the Linnaean lichens (Jørgensen et al. 1994).

Nomenclatural novelties necessary for this work are collected in each volume in an appendix to secure that they are published properly and easily available.

Vernacular names

Roland Moberg

Vernacular names for lichens have been used in the Nordic countries since long before Linnaeus' time as lichens have played an important role in national economy, as for instance as dyes and food. However, this is not the reason why one today has taken up old vernacular names and also created new ones. The main reason is that lichens frequently are cited in popular articles, and vernacular names are preferable when presenting red-listed lichens to the general public. The existing names in Danish, Finnish, Icelandic, Norwegian and Swedish have been indicated for each species under the entries D: (Denmark) F: (Finland) I: (Iceland) N: (Norway) S: (Sweden).

Unfortunately many lichens in the old days were inclu-ded in mosses and the names often had the ending "-mossa", "-mose", "-mos", and still we have difficulties to convince traders that "vitmossa" or "adventsmossa" (*Cladonia stellaris*) is a lichen rather than a moss.

There are considerable differences in the use and naming of lichens in the different Nordic countries. In Denmark fairly few lichens have old vernacular names, but recently Danish lichenologists have established vernacular names for the most common or otherwise significant species. In Finland vernacular names have recently been compiled by a committee of the Finnish Mycological Society (Vitikainen et al. 1997). For many lichens vernacular names were created in the 1940's and 1950's, but some few lichens have old, traditional names. Some of the oldest vernacular names in the region of the flora are found in Iceland and the Faroes on species traditionally used as fodder and for dying since the viking times, but in these countries there has apparently been little interest for making new names. Other old vernacular names are found in Lapponian, naturally since their culture are dependant on them as a basis for their reindeeer husbandry. As they do not occur in any national list, they are not included here, but they are listed in Krog et al. 1994: 326–328. In Norway all foliose and fruticose species have been given vernacular names (Hovda et al. 1975, 1979 with supplement in Holien et al. 1994), but these lists contain only a few crustose lichens. In Sweden the tradition of using vernacular names dates back to Erik Acharius who in his Prodromus 1799 included several vernacular names. This tradition has been followed by later authors of various floras. In 1984 the national botanical society Svenska Botaniska Fören-ingen elected a committee that in 1985 published a list of vernacular names (Moberg 1985) and in 1995 the second edition appeared (Moberg et al. 1995). With the increasing number of red-listed lichens, vernacular names will be given to additional lichens in various ways in different countries. No nwe names are made in this flora as this is best done by local committees in the individual countries.

References

Acharius, E. 1799. Lichenographiae Svecicae Prodromus. – Linkopiae.

Brummitt, R. K. & Powell, C. E. (eds) 1992. Authors of plant names. – Royal Botanic Gardens, Kew.

Greuter, W., Barrie, F. R., Burdet, H. M., Challoner, W. G., Demoulin, V., Hawksworth, D. L., Jørgensen, P. M., Nicolson, D. H., Silva, P. C., Trehane, P. & McNeill, J. 1994. International code of Botanical Nomenclature (Tokyo Code). – Regnum Vegetabile 131.

Holien, H., Jørgensen, P. M., Timdal, E. & Tønsberg, T. 1994. Norske lavnamn – supplement. – Blyttia 52: 25–28.

Hovda, J.T., Jørgensen, P.M., Krog, H. & Østhagen, H. 1975. Norske lavnamn. – Blyttia 33: 41–52.

Hovda, J. T., Krog, H., Jørgensen, P. M. & Østhagen, H. 1979. Norske lavnamn (ny utgave). – Blyttia 37: 155–165.

Jørgensen, P. M., Jarvis, C. & James, P. W. 1994. Linnaean lichen names and their typification. – Bot. J. Linn. Soc. 115: 261–405.

Krog, H., Østhagen, H. & Tønsberg, T. 1994. Lavflora. Norske busk- og bladlav. Ed. 2. – Universitetsforlaget, Oslo.

Moberg, R., 1985. Lavar med svenska namn. – Svensk Bot. Tidskr. 79: 221–236.

Moberg, R., Thor, G. & Hermansson, J. 1995. Lavar med svenska namn – andra upplagan. – Svensk Bot. Tidskr. 89: 129–149.

Santesson, R. 1993. Lichens and lichenicolous fungi of Sweden and Norway. – Lund.

Vitikainen, O., Ahti, T., Kuusinen, M., Lommi, S. & Ulvinen, T. 1997. Preliminary checklist of lichens and allied fungi of Finland. – Norrlinia 6 1–123.

Provinces and maps

Roland Moberg

We have not followed the present administartive divisions of the countries, but have adopted a modified version of the provinces to be used by the "Flora Nordica". The abbreviations are explained below (see also map p. 19). The division of larger provinces has caused some practical problems, and sometimes we have had to adopt the old terminology when it proved to be cumbersome or unnecessary to differentiate between the parts.

The maps are meant to give an overview of the distribution and the dots indicate only the center of the provinces. As Greenland and the Arctic Islands are not subdivided they have not been included in the maps, but could be found under the headline Distribution only. A map with all dots included is presented below.

The dots are places centrally in each of the accepted provinces.

Denmark (D)

NJy Nordjylland
ØJy Østjylland
VJy Vestjylland
SJy Sydjylland
Fyn Fyn & surrounding islands
Sjæ Sjælland, Lolland, Falster & surr. islands
Brn Bornholm

Greenland (Gr)

Faeroe Islands (Fæ)

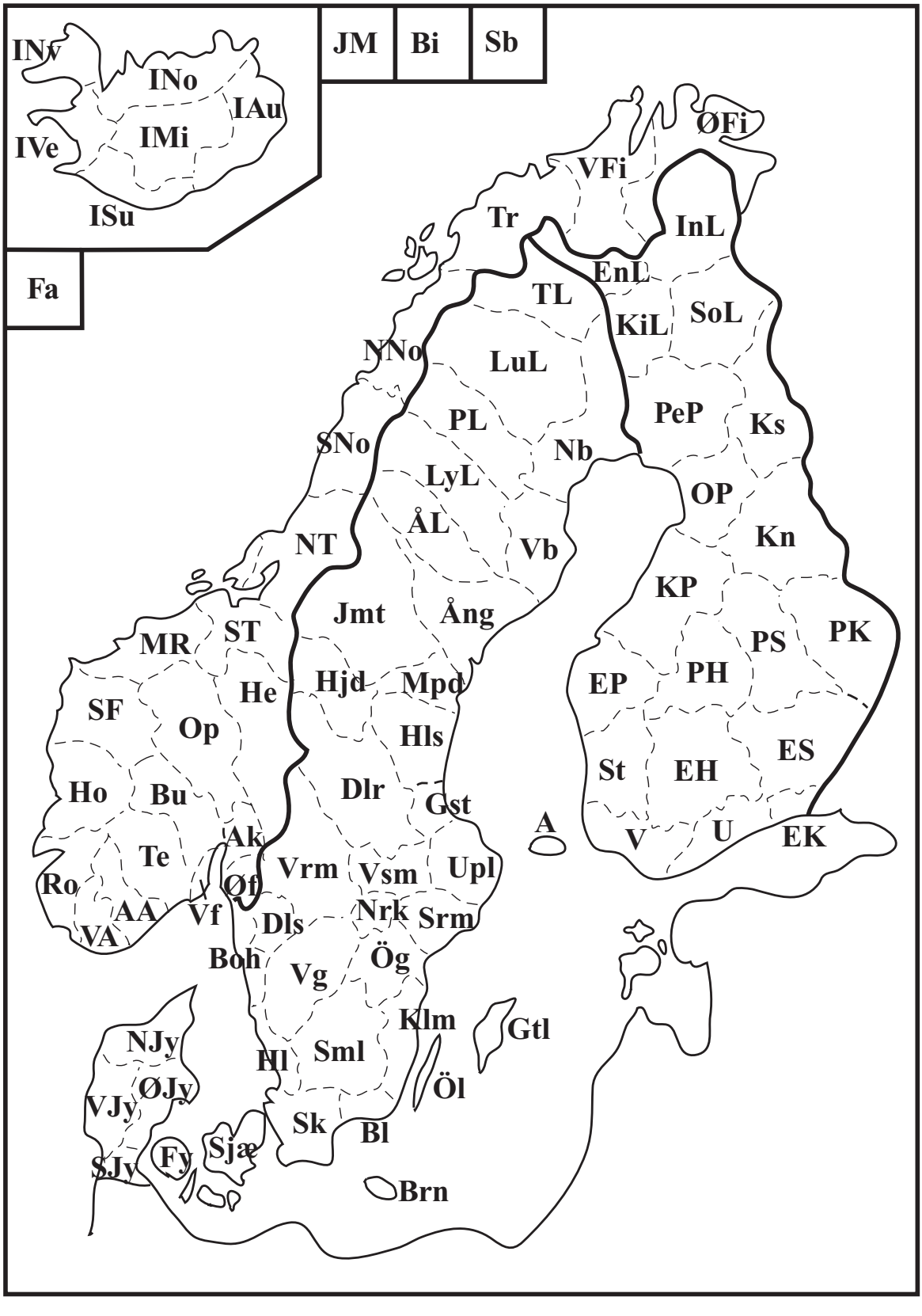
Finland (F)
A Åland, (Ahvenanmaa) Alandia (Al)
V Varsinais-Suomi; Regio aboensis (Ab)
U Uusimaa; Nylandia (N)
EK Etalä-Karjala; Karelia australis (Ka)
St Satakunta
EH Etelä-Häme; Tavastia australis (Ta)
ES Etelä-Savo; Savonia australis (Sa)
EP Etelä-Pohjanmaa; Ostrobottnia australis (Oa)
PH Pohjois-Häme; Tavastia borealis (Tb)
PS Pohjois-Savo; Savonia borealis (Sb)
PK Pohjois-Karjala; Karelia borealis (Kb)
KP Keski-Pohjanmaa; Ostrobottnia media(Om)
Kn Kainuu; Ostrobottnia kajanensis (Ok)
OP Oulun Pohjanmaa; Ostrobottnia ouluensis (Obo)
PeP Perä-Pohjanmaa; Ostrobottnia ultima (Obu)
(PP Pohjois-Pohjanmaa; Ostrobottnia borealis (Ob))
Ks Koillismaa; Regio kuusamoensis (Ks)
KiL Kittilän Lappi; Lapponia kittilensis (Lkk)
SoL Sompion Lappi; Lapponia sompiensis (Lks)
(KemL Kemin Lappi; Lapponia kemensis (Lk))
EnL Enontekiön Lappi; Lapponia enontekiensis (Le)
InL Inarin Lappi; Lapponia inarensis (Li)

Iceland (I)
ISu Sudur-Island
IVe Vestur-Island
IMi Mid-Island
IAu Austur-Island
INv Nordvestur-Island
INo Nordur-Island

Norway (N)
Øf Østfold
Ak Akershus
He Hedmark
Op Oppland
Bu Buskerud
Vf Vestfold
Te Telemark
AA Aust-Agder
VA Vest-Agder
Ro Rogaland
Ho Hordaland
SF Sogn og Fjordane
MR Møre og Romsdal
ST Sør-Trøndelag
NT Nord-Trøndelag
(No Nordland)
SNo Sør-Nordland
NNo Nord-Nordland
Tr Troms
(Fi Finnmark)
VFi Vest-Finnmark
ØFi Øst-Finnmark

Arctic Islands (AI)
JM Jan Mayen
BI Bjørnøya
Sb Svalbard

Sweden (S)
Sk Skåne
Bl Blekinge
Öl Öland
Gtl Gotland
(Sm Småland)
Klm Kalmar (East Småland)
SmI Småland (Inner Småland)
Hl Halland
Bh Göteborg + Bohuslän
Dls Dalsland
Vg Västergötland
Ög Östergötland
Nrk Närke
Srm Södermanland
Vrm Värmland
Vsm Västmanland
Upl Uppland
Dlr Dalarna
Gst Gästrikland
Hls Hälsingland
Mpd Medelpad
Ång Ångermanland
Hrj Härjedalen
Jmt Jämtland
Vb Västerbotten
ÅsL Åsele Lappmark
LyL Lycksele lappmark
PL Pite lappmark
LuL Lule Lappmark
TL Torne lappmark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Calicioid lichens and fungi

Leif Tibell

Caliciales for a long time was regarded as a model case of a monophyletic group, characterized by a mazaedium, where the mature spores accumulate in large numbers, and the often stalked apothecia. The spores are dispersed passively in mazaediate lichens. Fifteen years ago, however, a different view was presented (Tibell 1984). It was then well known that some of the genera included in Caliciales are not lichenized. Moreover, some of the genera only contain non-lichenized species. From detailed morphological, ultrastructural and chemical investigations Tibell concluded that the development of a mazaedium, and the passive spore dispersal is a convergent feature of some lichenized and non-lichenized fungi. These organisms often occur in similar ecological niches. Subsequent investigations of the anamorphs (asexual stages) of these fungi have supported the view of calicioid lichens and fungi as a phylogenetically diverse, ecological grouping (Tibell 1998). Studies of parts of the mitochondrial genome have shown that lichenized and mazaediate genera such as *Calicium*, *Cyphelium*, *Thelomma* and *Tholurna* are closely related. They belong to Caliciaceae, and like *Bunodophoron* and *Sphaerophorus* in Sphaerophoraceae, they are part of a large order of mainly lichenized species, Lecanorales. The non-lichenized species have no mazaedium. They belong to Mycocaliciaceae, which includes *Chaenothecopsis*, *Mycocalicium*, *Phaeocalicium* and *Stenocybe*. Mycocaliciaceae in Mycocaliciales is more closely related to other non-lichenized fungi such as Eurotiales, and rather far from Lecanorales. *Sphinctrina*, in Sphinctrinaceae, has a mazaedium and occurs as commensals on lichens. It is closely related to Mycocaliciaceae. The phylogenetic relationships of other genera, like *Chaenotheca*, *Cybebe*, *Microcalicium* and *Sclerophora*, have still not been clarified. Lichens and non-lichenized fungi which earlier have been referred to Caliciales are here called 'calicioid'.

Characteristics

Lichenized or non-lichenized saprobes or parasites on lichens or algae. In lichenized species the thallus is immersed to crustaceous to foliose to fruticose. Ascomata often stalked, sometimes sessile and rarely with a thalline border. Asci in many species disintegrating early, cylindrical to clavate. In some genera with persisting asci the apex is thickened. Spores non-septate, spherical to ellipsoid, or 1–8-septate or muriform. Spore wall often strongly pigmented and the spores in species with passive spore dispersal are accumulated on the surface of the ascomata to form a mazaedium. Mazaedium black to pale brown or greenish. Conidiomata common, coelomycetous or hyphomycetous.

Key to genera

1 Thallus dactyliform, fruticose or foliose 2
– Thallus crustose 4
2 Thallus dactyliform, forming colonies 2–3 cm diam., with apically situated, sessile ascomata..... *Tholurna*
– Thallus fruticose 3
3 Thallus flattened, young spores hyaline, mature spores grey to brownish ..... *Bunodophoron*
– Thallus terete, young spores violet-bluish, mature spores black..... *Sphaerophorus*
4 Spores non-septate 5
– Spore with 1–several transversal septa or sub-muriform 12
5 Spores spherical to subglobose 6
– Spores ellipsoidal 9
6 Spore wall hyaline; mazaedium pale 7
– Spore wall distinctly pigmented, brown to blackish, mazaedium brown to black 8
7 Asci formed singly, photobiont *Trentepohlia* ...*Sclerophora*
– Asci catenulate, photobiont *Stichococcus* ..... *Cybebe*
8 Ascomata with long and slender stalks, mazaedium medium brown ..... *Chaenotheca*
– Ascomata short-stalked or sessile, mazaedium black..... .....*Sphinctrina*
9 Asci not persisting, spores maturing outside the ascus, mazaedium present, slightly aeruginose, spores with an ornamentation of spirally arranged ridges .....*Microcalicium*
– Ascus apex persisting, spores maturing within the asci, mazaedium not present 10
10 Asci unevenly thickened, apex in semi-mature asci penetrated by a thin canal, asci usually less than 55 µm long..... .....*Chaenothecopsis*
– Ascus apex strongly and uniformly thickened 11
11 Spores fusiform, flattened, asci less than 45 µm long ....*Mycocalicium*
– Spores ellipsoidal, not flattened, asci more than *65* µm long ..... *Phaeocalicium*
12 Asci disintegrating early, mazaedium present 13
– Asci persisting, no mazaedium present 19

13 Mazaedium brown ..... *Chaenotheca*
– Mazaedium black or with an aeruginose tinge. 14
14 Ascomata sessile or immersed..... 15
– Ascomata distinctly stalked 18
15 Ascomata immersed 16
– Ascomata sessile..... 17
16 Excipulum strongly thickened at the base, fertile verrucae 1.5–2.0 mm diam., thallus with areas of black, granular isidia, medulla I+ blue ..... *Thelomma*
– Excipulum thin throughout, fertile verrucae up to 1 mm diam., thallus without isidia, medulla I– ..... *Cyphelium*
17 Spores cylindrical, 1–3(–7)-septate, with an ornamentation of spirally arranged ridges, mazaedium with an aeruginose tinge..... *Microcalicium*
– Spores ellipsoidal to broadly ellipsoidal, smooth or with an ornamentation of spirally arranged ridges or irregular cracks, mazaedium black..... *Cyphelium*
18 Ascomata with distinctly constricted capitulum margin, semi-mature spores with thick gelatinous coat..*Sphinctrina*
– Ascomata without distinctly constricted capitulum margin, semi-mature spores without thick gelatinous coat..... ..... *Calicium*
19 Asci unevenly thickened, apex in semi-mature spores penetrated by a thin canal, asci usually less than 55 µm long... ..... *Chaenothecopsis*
– Asci strongly and uniformly thickened, asci more than 65 µm long..... 20
20 Spores ellipsoidal, 1-septate, 11–13 µm long..... ..... *Phaeocalicium*
– Spores broadly to narrowly fusiform, (1–)3-septate, 9–35 µm long..... *Stenocybe*

Bunodophoron A. Massal.

Mem. Imp. Reale Ist. Veneto Sci. 10: 76 (1861).

Literature: Wedin, Pl. Syst. Evol. 187: 231–232 (1993), Symb. Bot. Ups. 31(1) (1995).

Thallus fruticose, dorsiventrally flattened to terete, grey to yellowish, often with a differentiation between larger fertile branches and densely tufted sterile, much shorter branches. Branching anisotomic. Medulla I–. Ascomata formed from the lower side of the terminal branches or rarely laminal, enclosed in the branches with only the mazaedium protruding. Asci cylindrical, with uniseriately arranged spores, disintegrating before the spores are mature. Spores globose to subglobose, 4–21 µm diam., pale to greyish or brownish. Spore surface obtaining an ornamentation of adhering amorphous material and hyphal fragments after they have left the asci. Conidiomata formed in the tips and along the edges of the terminal branches, pycnidial, black to pale brownish. Conidiophores branched with both terminal and intercalary conidiogenous cells. Conidia simple, hyaline, bacilliform to oblong, 3.0–8 × 1.5–2.5 µm. Photobiont trebouxioid.

Chemistry. Sphaerophorin and related substances and ß-orcinol depsidones occur in most species. Usnic acid and related substances and dibenzofurans occur in some species.

Note. Mainly a Southern Hemisphere genus with most species growing as epiphytes in temperate rainforests and some occurring on the ground or on rocks. It also occurs in high-altitude rainforests of tropical and subtropical areas.

1. Bunodophoron melanocarpum (Sw.) Wedin

Mycotaxon 55: 383 (1995). – Lichen melanocarpus Sw., Nova Genera et Species Plantarum: 147 (1788). – Sphaerophorus melanocarpus (Sw.) DC. – Type: Jamaica, Swartz (SBT, lectotype, Wedin, Mycotaxon 55: 383, 1995).

N: kystkorallav.

Redlisted in: **N**.

Thallus greyish green, flattened, often forming extensive colonies. Fertile branches 1.5–4 cm high, erect, flattened with subterete terminal branches, 1.2–1.7 mm wide. Sterile branches abundant, often forming a loose tuft at the base. Upper surface of the branches smooth, but in old branches transversely annulate to cracked. Lower surface irregularly wrinkled or pitted. Ascomata terminal, about as wide as the branch, 2.2–3.5 mm diam. Thalline receptacle poorly developed, smooth or sometimes wrinkled, without branchlets along the margin. Mazaedia subapical, on the lower side of the branches. Spores 7–8 µm diam., greyish. Conidia bacilliform.

Chemistry. Thallus K– or K+ pale yellow, C–, KC–, PD– or PD+ orange red; containing sphaerophorin only or sphaerophorin, stictic acid and constictic acid.

Habitat. On siliceous rocks in oceanic areas, rarely on turf.

Distribution. Rare in western Norway. **N:** VA, Ro, Ho, SF. Widely distributed in the Northern Hemisphere, occurring in the British Isles, oceanic areas of Continental Europe and the West Indies. The material in our region differ somewhat from that in West Indies. – Map 1.

Note. The taxonomy of *Bunodophoron* in the Northern Hemisphere is in need of further study.

Calicium Pers.

Ann. Bot. (Usteri) 7: 20 (1794).

Literature: Middelborg & Mattsson, Sommerfeltia 5: 30–40 (1987); Tibell, Svensk Bot. Tidskr. 71: 239–259 (1977); Tibell, Nova Hedwigia Beih. 79: 656–658 (1984).

THALLUS crustose, superficial or immersed in the substrate. When developed over the surface the thallus is verrucose to granular, grey to greenish grey, pale yellowish to beige or deep green. ASCOMATA well stalked or, rarely, sessile. Stalk consisting of sclerotized blackish, brownish black or greenish black, intertwined hyphae. Mazaedium well developed, black. Capitulum lenticular to obconical. Excipulum well developed, cup-shaped, formed by intertwined hyphae or almost isodiametric cells, sclerotized but sometimes hyaline in the outer part. Hypothecium dark brown or black, with convex or flat upper surface. Asci cylindrical to clavate, formed singly from ascogenous hyphae with croziers, dissolving before the spores have reached maturity. Spores 1-septate, dark brown, 7–15 × 4–8 µm. Spore wall thick and often with a distinctive ornamentation. CONIDIOMATA pycnidial, sessile or slightly immersed, simple, spherical and with punctiform ostiolum. Conidiophores branched and anastomosing. Conidia broadly ellipsoidal to short cylindrical, hyaline, non-septate. PHOTOBIONT trebouxioid.

Chemistry. Orcinol- and ß-orcinol depsides and depsidones, xanthones, anthraquinones, usnic acid, placodiolic acid and vulpinic acid derivatives present.

Note. A cosmopolitan genus. The majority of the species inhabit cool to temperate areas and only a small number of species are confined to the tropics. Predominantly on bark and wood. Only one species is confined to siliceous rocks. Most species occur in sheltered situations with low light intensities and a high humidity.

1 Ascomata with long stalks, stalks at least twice as long as the diameter of the capitulum 2
– Ascomata short-stalked or nearly sessile 14
2 Stalk and excipulum in section or squash preparation I–, or only a hyaline surface layer of the stalk slightly I+ reddish blue 3
– Stalk and excipulum in section or squash preparation I+ dark blue to blackish 13
3 Ascomata with a yellow pruina 4
– Ascomata without yellow pruina 5
4 Thallus immersed, PD–. Asci cylindrical ..... 12 *C. trabinellum*
– Thallus verrucose, PD+ yellow-red. Asci clavate ..... 3 *C. adspersum*
5 Lower side of capitulum brown 6
– Lower side of capitulum with or without a white pruina, not brown 7
6 Thallus well developed, greenish, asci clavate, spores 13–14 × 6–7 µm ..... 13 *C. viride*
– Thallus immersed or seen as a grey stain of the substrate, asci cylindrical, spores 8–11 × 4–5 µm ..... 11 *C. salicinum*
7 Mature asci clavate 8
– Mature asci cylindrical 9
8 Spores 8–11 × 3.5–5 µm, thallus thin, areolate, slightly glossy ..... 8 *C. parvum*
– Spores 13–14 × 6–7 µm, thallus usually thick, dull, green ..... 13 *C. viride*
9 Ascomata usually with a pruina, at least along the edge of the excipulum 10
– Ascomata without pruina 11
10 Thallus immersed, K– ..... 6 *C. glaucellum*
– Thallus rather thick, grey, with granular surface, K+ yellow-red ..... 10 *C. quercinum*
11 Stalk often with brownish tinge, mature spores with an ornamentation of minute dots, ascomata 6–11 times as high as the diameter of the stalk ..... 1 *C. abietinum*
– Stalk shining black, mature spores with a coarsely areolate ornamentation, ascomata 2–4 or 10–14 times as high as the diameter of the stalk 12
12 Ascomata 0.3–0.4 mm high, 2–4 times as high as the diameter of the stalk, spores 9.5–13.5 × 5–6.5 µm ... 9 *C. pinastri*
– Ascomata 0.7–1.3 mm high, 9–17 times as high as the diameter of the stalk, spores 11–14 × 6–8 µm ..... 5 *C. denigratum*
13 Stalk pale olivaceous to grey, spores with distinctiv ornamentation of spirally arranged ridges ..... 2 *C. adaequatum*
– Stalk black or very dark reddish brown, spores with a minute, irregular ornamentation ..... 7 *C. lenticulare*
14 Ascomata without pruina or with a faint greyish pruina on the lower side, thallus greenish ..... 4 *C. corynellum*
– Ascomata with a yellow pruina, thallus immersed or grey 15
15 A thick pruina present on both the capitulum and on the mazaedium ..... 3 *C. adspersum*
– Ascomata with a faint yellow pruina at the edge of the excipulum only ..... 12 *C. trabinellum*

1. **Calicium abietinum** Pers.

Tent. disp. meth. fung. Suppl. 59 (1797). – TYPE: Without locality (L-Pers., lectotype, Tibell, Symb. Bot. Ups. 21(2): 24, 1975).

D: nøgen nålelav. **F:** sysinuppijäkälä. **N:** skjörnål. **S:** vedspik.

Redlisted in: **D**, **F**, **S**.

Literature: Tibell, Symb. Bot. Ups. 21(2): 63–68 (1975); Bot. Notiser 129: 134–135 (1976).

Thallus immersed. Ascomata without pruina, black or stalk sometimes with a brownish tinge, 0.6–0.9 mm high. All parts of the ascomata I– (watermount of sections or squash preparations). Capitulum lenticular to slightly bell-shaped, 0.2–0.3 mm diam. Excipulum formed as a continuation of the stalk tissue, consisting of isodiametric to slightly elongated and anticlinally arranged, heavily sclerotized cells. Hypothecium with flat to slightly convex surface. Stalk 0.08–0.13 mm diam., consisting of densely interwoven, sclerotized hyphae. Outermost part of stalk hyaline, consisting of non-sclerotized hyphae covered by a thin, I– sheath of gelatinous material. Asci cylindrical, 49–60 × 4–5 µm with uniseriately arranged spores. Spores 13–15 × 5–7 µm, provided with an ornamentation of minute warts or areolae, when old with some irregular cracks.

Chemistry. Thallus K–, C–, KC–, PD–; no secondary substances found.

Habitat. On wooden fence-posts in fields or on stumps adjacent to fields or pasture.

Distribution. Rather rare with few recent collections in Denmark, southern Finland, southern Norway and southern and central Sweden. **D:** Sjæ. **F:** A, V, U, EH, PH. **N:** Ak, MR, Tr. **S:** Sk, Bl, Sm, Hl, Bh, Dls, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr. Otherwise known from Continental Europe, Asia, North and South America and Australasia. – Map 2.

Note. Characterized by its non-pruinose ascomata, the frequently brownish to olivaceous stalks, and the large, minutely warty spores. *Calicium glaucellum* differs from *C. abietinum* in having smaller ascomata and spores, which have an ornamentation of minute irregular ridges and cracks. Most of the old records of *C. abietinum* are mis-identified *C. glaucellum*.

2. Calicium adaequatum Nyl.

Flora 27: 409 (1869). – Type: Finland, Turtola, 1867 Norrlin 851 (H-NYL 40739, lectotype, Tibell, Symb. Bot. Ups. 21(2): 26, 1975).

F: lepännuppijäkälä. **N:** orenål. **S:** mörkhövdad spiklav.

Redlisted in: **S**.

Literature: Tibell, Symb. Bot. Ups. 21(2): 68–71 (1975).

Thallus immersed. Ascomata without pruina, with dark capitulum and olive brown stalk, 0.6–0.8 mm high. Stalk and excipulum I+ dark blue (watermount of sections or squash preparations). Capitulum cylindrical to distinctly bell-shaped, 0.1–0.2 mm diam. Excipulum 20–35 µm thick, with a distinct thickening in the upper part. Outermost part of excipulum brown, consisting of isodiametric, medium brown cells, 3–5 µm diam. Inner part of excipulum 10–17 µm thick, consisting of intertwined hyphae with swollen walls. Hypothecium medium brown, up to 40 µm high, consisting of intertwined, brown, thin-walled hyphae. Stalk rather short to long, 0.07–0.09 mm diam., in the inner part consisting of largely periclinally arranged but intertwined hyphae with strongly thickened walls. The outermost layer of the stalk is 5–10 µm thick, medium brown and consists of periclinally arranged, brown hyphae. Ascomata 8–10 times as high as the diam of the stalk. Asci cylindrical, 31–39 × 3–4 µm with uniseriately or sometimes biseriately arranged spores. Spores 9.0–11.0 × 4.5–5.5 µm, provided with a distinctive ornamentation of spirally arranged ridges.

Chemistry. Thallus K–, C–, KC–, PD–; no secondary substances found.

Habitat. On thin branches of *Alnus incana*, *Populus* and *Salix* along streams and in fairly well-lit situations in swampy areas with high humidity in the north. In the southern parts of its distribution area in Scandinavia also on branches of Populus tremula.

Distribution. Rare in Norway and central Sweden, more frequent in Finland and the northern parts of Sweden. **F:** St, EH, ES, PH, Kn, OP, PeP, Ks. **N:** He, Op. **S:** Vrm, Dlr, Gst, Hls, Mpd, Ång, Jmt, Nb, ÅsL, LyL, PL, LuL. A widely distributed species also known from Continental Europe, Asia, and North and South America. – Map 3.

Note. Characterized by its non-pruinose ascomata with dark capitulum and paler, olivaceous stalks, the I+ reaction of the stalk and excipulum and the large spores with their distinctive spiral ornamentation.

3. Calicium adspersum Pers.

Icon. descr. fung. Fasc. 2: 59 (1800). – Type: Germany (L-Pers., lectotype, Tibell, Symb. Bot. Ups. 21(2): 27, 1975).

D: tyk nålelav. **F:** kelonuppijäkälä. **N:** breinål. **S:** gulpulvrad spiklav.

Redlisted in: **D**, **F**.

Literature: Tibell, Symb. Bot. Ups. 21(2): 71–77 (1975).

Thallus verrucose to irregular, grey. Ascomata with a yellow pruina on the surface of the mazaedium and lower side of the upper part of the excipulum particularly in young ascomata. Ascomata 0.8–1.4 mm high, usually with a short stalk, but sometimes with a moderately long stalk. Capitulum broadly lenticular, 0.6–0.8 mm diam. Excipulum dark brown, formed by strongly sclerotized and interwoven hyphae forming an homogeneous tissue. Hypothecium dark brown, with flat to convex upper surface, consisting of largely periclinally arranged, somewhat interwoven hyphae. Stalk 0.2–0.3 mm diam., consisting of weakly sclerotized, thick-walled, intertwined pale greenish hyphae to brown hyphae. The outermost part of the stalk slightly paler, consisting of strongly sclerotized hyphae. The outermost, thin layer of the stalk is translucent and gelatinous and reacts faintly I+ blue. Asci clavate with 2–3-seriately arranged spores, 24–33 × 6–8 µm. Spores 13–17 × 6–8 µm, with a distinctive ornamentation of spirally arranged ridges. Conidiomata semi-immersed in the thallus, spherical to slightly flattened, 0.13–0.20 mm in diameter, black and first with a small, round ostiolum. Old pycnidia turn irregular in shape and the ostiolum opens by irregular slits. Pycnidium wall 8–13 µm thick, in the upper part consisting of sclerotized, dark brown cells. Lower part of pycnidium wall not sclerotized. Ostiolum first punctiform, later irregularly widened. The ontogeny is of the Umbilicaria-Type. Conidiophores branched, consisting of 3.0–4.0 × 1.5–2.0 µm large cells forming conidia laterally. Acrogenous conidiogenous cells elongated, 6.0–9.0 × 1.5 µm. The conidiophores belong to Vobis' Type VI. Conidia non-septate, hyaline, of variable shape, broadly to narrowly ellipsoidal, 2.0–3.0 × 1.0–1.5 µm, often slightly constricted at the centre or with one end thicker or slightly curved.

Chemistry. Thallus K+ red, PD+ yellow to orange. The yellow pruina of the ascomata is formed by vulpinic acid and the thallus contains norstictic acid.

Habitat. Mainly on trunks of old oaks in semi-shaded situation. In southern and eastern Finland it also occurs on bark of *Picea* and on lignum in coniferous forests.

Distribution. Uncommon in southern Sweden and Finland, very rare in Norway and Denmark. **D:** SJy, Sjæ. **F:** EH, PK, Kn. **N:** Øf, Vf, Te, AA. **S:** Sk, Bl, Öl, Gtl, Sm, Hl, Bh, Dls, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Gst. A wide-ranging species otherwise also known from Continental Europe, North America and the. Southern Hemisphere (ssp. australe in Australia, New Zealand and southernmost South America). – Map 4.

Note. A very variable species, *Calicium adspersum* is recognized by the yellow pruina on the mazaedium, the usually short-stalked ascomata, the K+ red thallus and the distinctive ornamentation of the spores. The specimens growing on spruce bark from Finland are similar to specimens from conifers from Central Europe and differ in having much longer, slender stalks and a thin, smooth thallus.

4. Calicium corynellum (Ach.) Ach.

Methodus: 94 (1803). – Lichen corynellus Ach., Lichenogr. suec. prodr.: 85 (1799). – Type: Without locality (H-ACH 461, lecto-type, Tibell, Ann. Bot. Fenn. 24: 264, 1987).

F: kallionuppijäkälä. **N:** klippenål. **S:** klippspik.

Thallus fairly thick, granular to leprose, green to yellowish green. Ascomata with a faint, greyish white pruina, black, 0.5–0.6 mm high. All parts of the ascomata I– (watermount of sections or squash preparations). Capitulum dull, lenticular 0.3–0.4 mm diam. Excipulum dark brown, 40–75 µm thick, consisting of largely anticlinally arranged, strongly sclerotized, intertwined cells. Hypo-thecium medium brown, with flat upper surface, consisting of clearly discernible, intertwined hyphae 2.0–2.5 µm diam. Stalk dull, 0.07–0.13 mm diam., consisting of dark brown, moderately sclerotized, thick-walled, intricately interwoven hyphae 2–3 µm diam. Asci clavate, 21–27 × 4.5–5.5 µm with 2–3-seriately arranged spores. Spores 12–14 × 4.5–6.0 µm, provided with a coarsely cracked surface and a constriction at the septum.

Chemistry. Thallus K–, C–, KC–, PD–; rhizocarpic and usnic acids.

Habitat. On steep siliceous rocks in shaded and humid situations.

Distribution. Very rare in Norway, rather rare in southern Sweden with scattered localities in central Sweden and southern Finland. **F:** A, V, U, St, EH, ES, PH, PS, Ks. **N:** Ak, Bu. **S:** Sk, Bl, Gtl, Sm, Hl, Bh, Dls, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Hls, Mpd. A Northern Hemisphere species also known from temperate to cool temperate parts of Continental Europe and North America. – Map 5.

Note. Characterized by its rather short-stalked and slightly pruinose ascomata, the greenish to yellowish thallus, the clavate asci and rather large, coarsely ornamented spores. *Calicium corynellum* differs from *C. viride* in having much shorter ascomata, a leprose rather than verrucose thallus and a greyish white pruina.

5. Calicium denigratum (Vain.) Tibell

Bot. Notiser 129: 132 (1976). – *Calicium curtum* var. *denigratum* Vain., Medd. Soc. Fauna Fl. Fenn. 6: 95 (1881). – Type: Finland, Ostrobottnia kajanensis, Kuhmo, 1877 Vainio (TUR-V 29378, holotype).

F: männynnuppijäkälä. **N:** blanknål. **S:** blanksvart spiklav.

Literature: Tibell, Bot. Notiser 129: 131–136 (1976).

Thallus immersed. Ascomata without pruina, shining black, 0.7–1.3 mm high. All parts of the ascomata I– (watermount of sections or squash preparations). Capitulum slightly bell-shaped, 0.2–0.3 mm diam. Excipulum 15–25 µm thick, consisting of dark brown, isodiametric, sclerotized cells, 3–5 µm diam. Hypothecium dark brown, with flat to slightly convex upper surface, 55–70 µm high, consisting of dark brown, sclerotized, intertwined hyphae. Stalk 0.06–0.09 mm diam., consisting of dark brown, sclerotized hyphae. Outermost part of stalk hyaline, 4–17 µm thick, consisting of non-sclerotized prosoplecten-chymateous hyphae. The central part of the stalk dark brown, consisting of dark brown, irregularly intertwined, sclerotized hyphae with thickened walls, 3–4 µm diam. Between the central part of the stalk and the hyaline coat there is a pale brown, 8–13 µm wide transition zone. Asci cylindrical, 38–48 × 4–5 µm with uniseriately arranged spores. Spores 11–14 × 6–8 µm, provided with an ornamentation of irregular areolae.

Chemistry. Thallus K–, C–, KC–, PD–; no secondary substances found.

Habitat. On the hard and dry wood of decorticated stumps and trunks of still standing, but decorticated *Pinus sylvestris* in open situations. Often together with *Chaenothecopsis fennica*.

Distribution. Rather rare in Finland and in the central and northern parts of Norway and Sweden, very rare in southern Sweden. **F:** U, EH, PS, PK, Kn, PeP, Ks, KiL, SoL. **N:** Ak, He, Op, Bu, Te, ST, NT, Tr, Fi. **S:** Sm, Vg, Vrm, Upl, Dlr, Gst, Hls, Ång, Hrj, Jmt, Vb, Nb, ÅsL, LyL, PL, LuL. Also known from Continental Europe and Siberia. – Map 6.

Note. Characterized by its non-pruinose, shining black ascomata with slender stalks, the bell-shaped capitulum, and the large, coarsely areolate spores.

6. Calicium glaucellum Ach.

Methodus: 97 (1803). – Type: Without locality (H-ACH 472, lectotype, Tibell, Symb. Bot. Ups. 21(2): 28, 1975).

D: grågrøn nålelav. **F:** härmänuppijäkälä. **N:** hvitringnål. **S:** svart spiklav.

Redlisted in: **D**.

Literature: Tibell, Symb. Bot. Ups. 21(2): 78–84 (1975); Tibell, Bot. Notiser 129: 134–135 (1976).

Thallus immersed or rarely superficial and then thin, verrucose and dark greyish green. Ascomata 0.5–0.9 mm high, with a faint white pruina along the edge of the excipulum or sometimes epruinose. All parts of the ascoma I– (watermount of sections or squash preparations). Capitulum obovoid to lenticular, 0.2–0.3 mm diam. Excipulum formed by dark brown to aeruginose, elongated to almost isodiametric, anticlinally arranged, sclerotized hyphae which are paler close to the surface of the excipulum. Hypothecium dark brown, with a flat or slightly convex upper surface. Stalk shining black, 0.1–0.2 mm diam., consisting of dark brown to dark aeruginose, irregularly interwoven, and strongly sclerotized hyphae. Surface layer of the stalk paler and forming a more or less distinct, hyaline, I– coat. Asci when mature cylindrical, with uniseriately arranged spores, 35–41 × 3.5–4.5 µm. Spores ellipsoidal, 9–13 × 5–7 µm. Young spores have an ornamentation of mainly longitudinally arranged ridges, which is disrupted by irregular cracks during the maturation in the mazaedium to form an ornamentation of irregular cracks and short ridge fragments in mature spores.

Chemistry. Thallus K–, C–, KC–, PD–. Sekikaic acid (major), 2-O-methylsekikaic acid (minor) and 4-O-methylhypoprotocetraric (minor) were identified by J. A. Elix (personal communication).

Habitat. On decorticated stumps of both conifers and deciduous trees, sometimes in rather exposed situations. Also collected on bark of *Picea abies* and *Pinus sylvestris*, rarely on other trees.

Distribution. Common, particularly in the central and northern parts of Norway and Sweden, throughout Finland, not uncommon in Denmark. **D:** NJy, ØJy, SJy, Fyn, Sjæ, Brn. **F:** A, V, U, EK, St, EH, EP, PH, PS, PK, Kn, OP, PeP, Ks, KiL. **N:** Øf, Ak, He, Op, Bu, Vf, Te, AA, VA, Ro, Ho, SF, MR, ST, NT, No, Tr. **S:** Sk, Bl, Öl, Gtl, Sm, Hl, Bh, Dls, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Gst, Hls, Mpd, Ång, Hrj, Jmt, Vb, Nb, ÅsL, LyL, PL, LuL. Widely distributed in cool temperate and temperate areas of both the Northern (North America, Asia, Europe) and the Southern Hemisphere (Australasia, Central and South America). – Map 7.

Note. Characterized by its rather short-stalked, black ascomata which have a thin white rim of pruina on the excipulum around the mazaedium, the immersed thallus, and the medium-sized spores which have an ornamentation of irregular cracks and short ridge fragments. The pruina might sometimes be lacking and then *C. glaucellum* is quite similar to *C. abietinum*, but that species differs in having brownish stalks and larger spores with an ornamentation of minute warts. Calicium glaucellum is very similar to C. trabinellum, which mainly differs in having a yellow pruina.

7. Calicium lenticulare Ach.

K. Vetensk.-Acad. Handl. 1816: 262 (1816). – Type: Without locality (H-ACH 495, lectotype, Tibell, Ann. Bot. Fenn. 24: 269, 1987).

Syn. *Calicium subquercinum* Asahina

F: sumunuppijäkälä. **N:** fossenål. **S:** skuggspiklav.

Redlisted in: **F**, **S**.

Literature: Tibell, Symb. Bot. Ups. 21(2): 93–103 (1975).

Thallus granular to verrucose or almost immersed, greenish to yellowish grey or with a bluish tinge. Ascomata 0.5–1.2 mm high, epruinose or with a white pruina on the lower side of the capitulum. Stalk and excipulum I+ deep blue to black (watermount of sections or squash preparations). Capitulum narrowly obconical to lenticular, 0.2–0.4 mm diam. Excipulum consisting of densely intertwined, sclerotized hyphae. Hypothecium blackish brown, with convex upper surface. Stalk black or with a slight reddish tinge, epruinose, 0.1–0.2 mm diam., in section distinctly reddish brown, consisting of densely intertwined sclero-tized hyphae and sometimes with strands of granular crystals. Outermost part of stalk paler and covered by a very thin I– gelatinous coat. Asci narrowly clavate, 24–32 × 4.5–5.5 µm. Spores in the asci partly biseriately arranged and remaining non-septate until they are released. Mature spores 1-septate, broadly ellipsoidal to ellipsoidal, 11–12 × 6–7 µm, with a minutely verrucose to areolate ornamentation.

Chemistry. Thallus K–, C–, KC–, PD–. Placodiolic acid found in Nordic material 4-O-methylhypoprotocetraric acid occurs along with placodiolic acid or alone in material from other areas.

Habitat. In Scandinavia *C. lenticulare* grows on lignum of decorticated stumps and trunks of *Picea* in dark and humid situations in coniferous forests.

Distribution. Possibly extinct in Sweden, rare in central Norway and Finland. **F:** PS. **N:** He, Op, Ho. **S:** LuL. Very widely distributed from cold temperate to subtropical areas. It occurs in Eurasia, North America, Africa, the Pacific, Australasia, and Central and South America. – Map 8.

Note. A very variable species with respect to thallus thickness, ascoma size, pruinosity and spore size but easily recognized by its obconical ascomata, the strong I+ deep blue reaction of the stalk (watermount of sections or squash preparation), the narrowly clavate asci, and by the spores which remain unseptated for a long time in the asci.

8. Calicium parvum Tibell

Symb. Bot. Ups. 21(2): 84 (1975). – Type: Canada, Ontario, Renfrew Co., 1972 Tibell 4638 (UPS, holotype).

F: pikkunuppijäkälä. **N:** svartprikknål. **S:** liten spiklav.

Literature: Tibell, Symb. Bot. Ups. 21(2): 84–89 (1975).

Thallus thin, grey to greenish grey, verrucose, somewhat glossy. Verrucae later confluent. Ascomata small, sometimes with a faint whitish pruina on the lower side of the capitulum, 0.7–1.1 mm high. All parts of the ascomata I– (watermount of sections or squash preparations). Capitulum lenticular, 0.3–0.4 mm diam. Excipulum formed as a continuation of the stalk tissue, consisting of sclerotized, in the outer part anticlinally arranged cells. Hypothecium obconical, with convex surface. Stalk 0.1–0.14 mm diam., consisting of irregularly interwoven, sclerotized hyphae. Outermost part of stalk pale brown to hyaline, 22–28 µm thick, consisting of non-sclerotized hyphae. Asci clavate, 22–29 × 4.5–6.0 µm with 2–3-seriately arranged spores. The asci persist until the spores are nearly mature. Spores 8–10 × 4.0–4.5 µm, provided with a slight, irregular ornamentation. Conidiomata pycnidial, frequent, 0.08–0.10 mm diam. Conidia ellipsoidal, 2.0–3.0 × 1.0–1.5 µm.

Chemistry. Thallus K+ dull yellow, C–, KC–, PD+ faintly yellow, UV+, contains as major substance diffractaic acid (Middelborg & Mattsson, 1987; confirmed by J. A. Elix, personal communication) with 4-O-demethylbarbatic acid occurring as a minor substance (Elix, personal communication).

Habitat. On bark of old *Pinus sylvestris* in rather open but fairly humid situations, rarely on *Picea abies*.

Distribution. Rare in Norway, uncommon in central Sweden and southern and central Finland. **F:** V, U, St, EH, ES, EP, PH, PS, PK, KP, Kn, OP Ks. **N:** He, Op, Te, AA, Ro, MR. **S:** Gtl, Sm, Dls, Vg, Ög, Nrk, Srm, Vrm, Vsm,

Upl, Dlr, Gst, Hls, LuL. A Northern Hemisphere species also known from Continental Europe and North America. – Map 9.

Note. Characterized by its slightly glossy, verrucose thallus, the clavate asci and the frequent occurrence of pycnidia. *C. glaucellum* differs from *C. parvum* in having an immersed thallus, and cylindrical asci. C. pinastri differs from *C. parvum* by having cylindrical asci and only having small amounts of unidentified substances in the thallus rather than diffractaic acid.

9. Calicium pinastri Tibell

Literature: Tibell, Mycotaxon 70: 436 (1999). – Type: Finland, Ostrobottnia media, Lappajärvi, Isaks park, 6.IV. 1907 Backman (H, holotype).

Thallus very thin, grey or with a greenish tinge, or immersed. Ascomata small, 0.3–0.4 mm high, epruinose. All parts of the ascoma I– (watermount of sections or squash preparations). Capitulum obconical to lenticular, 0.1–0.2 mm diam. Excipulum formed by dark brown, elongated to almost isodiametric strongly sclerotized cells, which are paler and anticlinally arranged close to the outer surface of the excipulum. In the innermost part of the excipulum the cells are elongated and periclinally arranged. Hypothecium dark brown, with a flat or slightly convex upper surface. Stalk often rather short, shining black, epruinose, 0.09–0.15 mm diam., consisting of dark brown, irregularly interwoven, and strongly sclerotized hyphae. Surface layer of the stalk paler and forming a more or less distinct, hyaline, I– coat. Asci when mature cylindrical, with uniseriately arranged spores, 30–35 × 4–5 µm. Spores when young smooth, when mature with an ornamentation of irregular cracks, broadly ellipsoidal, 9.5–13.5 × 5–6.5 µm.

Chemistry. Thallus K–, C–, KC–, PD–; containing minute amounts of several unidentified compounds.

Habitat. On loose, flaking bark of trunks of *Pinus sylvestris*.

Distribution. Rather widely distributed in Finland, probably overlooked. **F:** U, EH, PH, PS, KP, OP. – Map 10.

Note. Characterized by its thin thallus, the minute and often rather short-stalked, epruinose ascomata, the medium-sized spores which are smooth as young and when mature have an ornamentation of irregular cracks. It is quite similar to specimens of *C. glaucellum* with small ascomata, but *C. glaucellum* differs in having a spore ornamentation with minute longitudinal ridges or ridge fragments, in usually having a distict rim of white pruina at the edge of the excipulum and by containing sekikaic acid as major secondary substance. *C. parvum*, which also usually occurs on bark of P. sylvestris, differs by having clavate rather than cylindrical asci, and containing diffractaic acid as major secondary substance. *C. abietinum* differs in usually having brownish stalks and larger spores with an ornamentation of minute warts.

10. Calicium quercinum Pers.

Tent. disp. meth. fung. Suppl.: 59 (1797). – Type: Without locality (L-Pers., lectotype; designated on p. 72).

D: ege-nålelav. **F:** tammennuppijäkälä. **N:** eikenål. **S:** ekspik.

Redlisted in: **F**, **S**.

Thallus episubstratic, grey, dull, with minutely granular surface. Ascomata black, but with a white pruina on the lower side of the capitulum, 0.8–1.3 mm high. All parts of the ascomata I– (watermount of sections or squash preparations). Capitulum lenticular, 0.4–0.6 mm diam. Exci-pulum 30–50 µm thick, dark brown, consisting of spherical to slightly elongated and anticlinally arranged cells, up to 7–10 × 5–6 µm diam. Hypothecium medium brown, with slightly convex upper surface, consisting of interwoven, sclerotized hyphae. Stalk in section medium brown, 0.1–0.2 mm diam., consisting of densely irregularly arranged, intertwined, sclerotized hyphae, 2–3 µm diam., forming a denser tissue towards the surface. Asci cylindrical, 24–39 × 4–5 µm with uniseriately or sometimes biseriately arranged spores. Spores 10–13 × 5.5–6.0 µm, provided with an ornamentation of minute spirally arranged ridges and irregular cracks.

Chemistry. Thallus K+ yellow-red, C–, PD+ yellow, containing norstictic acid.

Habitat. On bark of old *Quercus*, *Acer*, *Ulmus* and *Fraxinus*, rarely on lignum, in semi-shaded situations at glades in old deciduous woodlands.

Distribution. Rare in southern and central Sweden, southern Norway, Denmark and southwesternmost Finland. **D:** ØJy, Sjæ. **F:** A, V. **N:** Ak. **S:** Sk, Bl, Öl, Sm, Hl, Bh, Dls, Vg, Ög, Nrk, Srm, Vrm, Upl, Dlr, Mpd. Otherwise known from Central Europe, the British Isles, Spain and North America. – Map 11.

Note. Characterized by its pruinose ascomata, the rather thick, grey, granular, K+ thallus and the spore ornamentation of spirally irregular ridges and cracks.

11. Calicium salicinum Pers.

Ann. Bot. (Usteri) 7: 20 (1794). – Type: "Calycium salicinum Pers. In Salica cava No 28." (L-Pers., lectotype; designated on p. 72).

Syn. *Calicium lichenoides* (L.) Schumach.:, nom. rejic. prop.

D: Persoons nålelav. **F:** pajunnuppijäkälä. **N:** rødhodenål. **S:** kopparspik.

Literature: Tibell, Symb. Bot. Ups. 21(2): 90–92 (1975).

Thallus immersed, often staining the substrate grey or superficial, thin, minutely granular, greyish green. Ascomata with a brown pruina on the lower side of the capitulum, 0.9–1.1 mm high. All parts of the ascomata I– (watermount of sections or squash preparations). Capitulum lenticular, 0.3–0.4 mm diam. Excipulum dark brown, consisting of isodiametric to slightly elongated, heavily sclerotized cells. Outer surface of excipulum covered by a smooth to strongly irregular layer of brownish, amorphous crystals. Hypothecium blackish brown with convex upper surface. Stalk black or covered by a thin brown pruina in the uppermost part, 0.08–0.13 mm diam. The central part of the stalk consists of densely intertwined and irregularly arranged 2–3 µm thick hyphae. Outermost part of stalk slightly paler and with an I– gelatinous coat. Asci cylindrical, 35–38 × 3–4 µm, with uniseriately arranged spores. Spores ellipsoidal, 8–10 × 3.5–4.5 µm, provided with an ornamentation of spirally arranged ridges and occasional irregular cracks, particularly in old spores. Conidiomata spherical, semi-immersed, 0.06–0.12 mm in diameter, with apical ostiolum. Pycnidium wall 6–9 µm thick, dark brown, pale at the base, but close to the ostiolum it has a very thick dark brown pigment layer covering the outer wall. Conidiophores 1.5–2.5 µm thick, branched and anastomosing, with 3–6 µm long cells. Conidia acrogenous or pleurogenous. Conidiogenous cells 2.0–3.0 × 1.0–1.5 µm. Conidiophores of Vobis' Type V or VI. Conidia non-septate, hyaline, 2.0–2.5 × 1.5 µm, broadly ellipsoidal to ellipsoidal, often slightly curved or of irregular shape or very narrow and curved, 5–8 × <1 µm. When released the long conidia are curved to vermiform. The pycnidia producing different types of conidia occur mixed on the same thallus.

Chemistry. Thallus K+ dull yellow, C–, KC+ dull yellow turning orange, PD+ pale yellow or PD–. Thallus containing norstictic acid in Nordic collections. Norstictic acid and/or placodiolic acid occur in other areas. The brown pruina of the stalk and capitulum gives a red reaction with K. The pruina first dissolves forming violet red, feather-, plate- or needlelike to irregular crystals.

Habitat. On lignum (wooden fence-posts, decorticated stumps) in moderately shaded situations in coniferous forests, on bark particularly of *Quercus* in parks and open deciduous forests, and on decorticated stumps of *Alnus* in swamps.

Distribution. Not uncommon in most parts of Finland, Norway and Sweden, somewhat more rare in Denmark. **D:** NJy, ØJy, SJy, Fyn, Sjæ, Brn. **F:** A, V, U, EK, St, EH, ES, EP, PH, PS, PK, KP, Kn, OP, PeP, Ks, KiL, EnL. **N:** Øf, Ak, He, Op, Bu, Vf, Te, AA, Ro, Ho, SF, ST, NT, No, Tr, Fi. **S:** Sk, Bl, Öl, Gtl, Sm, Hl, Bh, Dls, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Gst, Hls, Ång, Hrj, Jmt, Vb, Nb, ÅsL, LyL, LuL, TL. Widely distributed in cool to temperate areas of Europe, Asia, Africa, North America, Australasia and South America. – Map 12.

Note. Characterized by the immersed or thin K+ yellow thallus, the brown pruina of the lower side of the excipulum which forms a red, crystalline precipitate with K, and the spiral ornamentation of the spores.

12. Calicium trabinellum (Ach.) Ach.

Methodus Suppl.: 14 (1803). – *Calicium xylonellum* ß *trabinellum* Ach., Methodus: 93 (1803). – Type: Sweden (H-ACH 488, lectotype, Tibell, Ann. Bot. Fenn. 24: 277, 1987).

F: kantonuppijäkälä. **N:** rødhodenål. **S:** gulkantad spiklav.

Redlisted in: **D**.

Literature: Tibell, Symb. Bot. Ups. 21(2): 103–107 (1975).

Thallus immersed or rarely superficial, dark greyish green, thin, verrucose. Ascomata black, with a yellow pruina on the lower side of the excipulum, 0.6–0.9 mm high. All parts of the ascomata I– (watermount of sections or squash preparations). Capitulum lenticular to obovoid, 0.2–0.3 mm diam. Excipulum consisting of isodiametric to slightly elongated cells. In the outer part of the excipulum the cells are pale, but in the inner they are sclerotized and dark brown or greenish. Outer surface of excipulum with a granular, yellow pruina. Hypothecium blackish brown, with a convex upper surface. Stalk black, epruinose, 0.09–0.13 mm diam. Central part of stalk dark brown or with an aeruginose tinge, consisting of intricately interwoven and heavily sclerotized hyphae. Outer part of stalk hyaline to pale brown, 22–27 µm thick, consisting of strongly gelatinized, interwoven hyphae. The stalk is enclosed by a thin, I– gelatinous coat. Asci cylindrical, 32–34 × 3.5–4 µm. Spores uniseriately arranged in the asci. Spores ellipsoidal, 10–11 × 5–6 µm. Young spores have an ornamentation of mainly longitudinally arranged

ridges, which is disrupted by irregular cracks during the maturation in the mazaedium to form an ornamentation of irregular cracks and short ridge fragments in mature spores.

Chemistry. Thallus K–, C–, KC–, PD–. The pruina of the ascomata consists of vulpinic acid.

Habitat. On decorticated stumps in open to moderately shaded, not too dry situations, particularly on stumps of conifers, but also recorded from lignum of *Betula*, *Picea*, *Quercus* and *Salix caprea*.

Distribution. Common in the central and northern parts of the area. **F:** A, V, U, EK, St, EH, ES, EP, PH, PS, PK, KP, Kn, OP, PeP, Ks, KiL, SoL, EnL, InL. **N:** Ak, He, Op, Bu, Vf, Te, AA, Ho, SF, MR, ST, NT, No, Tr, Fi. **S:** Sm, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Gst, Hls, Mpd, Ång, Hrj, Jmt, Vb, Nb, ÅsL, LyL, PL, LuL, TL. Widely distributed in cold to cool temperate areas of the Northern Hemisphere (North America, Asia, Europe), Africa, Australasia and South America. – Map 13.

Note. Characterized by its immersed thallus, rather short ascomata, the yellow pruina on the lower side of the capitulum, and the spore ornamentation. It is very similar to *C. glaucellum*, which, however, has a whitish pruina.

13. Calicium viride Pers.

Ann. Bot. (Usteri) 7: 20 (1794). – Type: Sweden, Västmanland, Ängsö, 1969 Moberg 1146a (UPS, neotype; designated on p. 72).

D: gulgrøn nålelav. **F:** vihernuppijäkälä. **N:** grønnsotnål. **S:** grön spiklav.

Literature: Tibell, Symb. Bot. Ups. 21(2): 108–110 (1975).

Thallus superficial, granular to minutely verrucose, intensely green, rarely immersed. Ascomata with a brown pruina on the lower side of the capitulum or epruinose, 1.1–2.2 mm high. All parts of the ascomata I– (watermount of sections or squash preparations). Capitulum lenticular, 0.4–0.7 mm diam. Excipulum dark brown, consisting of isodiametric to slightly elongated, heavily sclerotized, anticlinally arranged cells. Outer surface of excipulum often covered by a smooth to strongly irregular layer of brownish, amorphous crystals. Hypothecium blackish brown with convex upper surface. Stalk black, 0.1–0.2 mm diam., sometimes with a brown pruina in the upper part and a greyish pruina in the lower part. The central part of the stalk consists of densely intertwined and mainly periclinally to irregularly arranged 2–3 µm thick hyphae. Outermost part of stalk slightly paler and often with an I– gelatinous coat. Asci clavate, 20–25 × 4–5 µm, with biseriately arranged spores. Spores ellipsoidal, 12–14 × 6–7 µm. Semi-mature spores provided with an ornamentation of spirally arranged ridges. Mature spores constricted at the septum and the ornamentation is irregularly cracked-areolate.

Chemistry. Thallus K–, C–, KC–, PD–. The thallus contains rhizocarpic acid and epanorin. The brown pruina of the stalk and capitulum gives a red reaction with K. The pruina first dissolves forming violet red, feather-, plate- or needlelike to irregular crystals.

Habitat. On bark and wood of *Picea* in old coniferous forests, on lignum of *Pinus sylvestris*, on *Betula*, *Quercus* and *Alnus*.

Distribution. Common in most parts of Finland, Norway and Sweden; less frequent in Denmark. **D:** NJy, ØJy, SJy, Fyn, Sjæ, Brn. **F:** A, V, U, EK, St, EH, ES, EP, PH, PS, PK, KP, Kn, OP, PeP, Ks, KiL, SoL, EnL. **N:** Øf, Ak, He, Op, Bu, Vf, Te, AA, Ho, SF, MR, ST, NT, No, Tr, Fi. **S:** Sk, Bl, Öl, Gtl, Sm, Hl, Bh, Dls, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Gst, Hls, Mpd, Ång, Hrj, Jmt, Vb, Nb, ÅsL, LyL, PL, LuL, TL. Widely distributed in cool to temperate areas of the Northern Hemisphere (North America, Eurasia) and southernmost South America. – Map 14.

Note. A very variable species, particularly with respect to ascoma size and shape, the occurrence of the brown pruina and thallus thickness. Characterized by the green, superficial thallus, the brown pruina of the lower side on the capitulum forming a red, crystalline precipitate with K, and the very irregular ornamentation of the mature spores. Specimens with immersed thalli are quite similar to *C. salicinum*, but differ in spore size, spore ornamentation and in having clavate asci.

No original material has been located, neither in L nor in other herbaria. A neotype is thus designated.

Chaenotheca Th.Fr.

Acta Reg. Sci. Ups. 3(3): 250 (1860).

Literature: Middelborg & Mattsson, Sommerfeltia 5: 40–53 (1987), Tibell, Svensk Bot. Tidskr. 72: 171–188 (1978); Symb. Bot. Ups. 23(1): 1–65 (1980); Nova Hedwigia Beih. 79: 662–664 (1984).

Thallus crustose, superficial or immersed in the substrate. When superficial the thallus is farinaceous, granular, verrucose or minutely squamulose. Thalline colour grey to greenish grey, golden yellow or brownish. Ascomata stalked. Stalk fairly short to very long and slender, consisting of periclinally arranged, medium brown hyphae.

Mazaedium well developed, medium to pale brown. Capitulum spherical to obconical. Excipulum more or less well developed, formed by periclinally arranged, more or less intertwined hyphae and continuous with the stalk tissue. Hypothecium medium brown, with convex to flat upper surface. Asci cylindrical, ellipsoidal or of irregular shape, dissolving at early stages. Asci formed from ascogenous hyphae with croziers, either singly or in chains. Spores spherical to ellipsoidal, non-septate or ellipsoidal to cylindrical, rarely with 1–5 septa. Spore wall medium thick to thick, brown to pale brown, smooth or with an ornamentation of irregular cracks. Different types of conidiomata occur, both coelomycetous (pycnidial), spherical with apical ostiolum or hyphomycetous, simple, Phialophora-like. Pycnidium wall thin and consisting of one or a few layers of radially arranged cells. Wall-forming cells with a thick pigment layer at their distal surface. Conidiogenous cells simple, ellipsoidal to cylindrical. Conidia hyaline, one-celled, non-pigmented, 2–3 x 1 µm. PHOTOBIONT Dictyochloropsis, Stichococcus, Trentepohlia or trebouxioid.

Chemistry. The tetronic acid derivative vulpinic acid, pulvinic acid, and pulvinic dilactone occur as a pruina of the ascomata, and more rarely in the thallus, of some Chaenotheca species. The ß-orcinol depsides atranorin, baeomycesic, and squamatic acid occur in the thallus of some species. The usnic acid related compound pseudoplacodiolic acid occurs in one species.

Note. Anamorphs are so far only known from cultures of the mycobiont (Tibell 1991, 1993a). The genus is cosmopolitan. The majority of the species inhabit cool to temperate areas and only a small number of species are confined to the tropics. *Chaenotheca* occurs predominantly on bark and wood, although a few species also inhabit soil and siliceous rocks. Most species prefer sheltered situations with low light intensities and a high humidity.

1 Ascomata with a greenish yellow, yellow to reddish yellow or brown pruina on the lower side of the excipulum and/or upper part of the stalk 2
– Ascomata with a white pruina on the lower side of the excipulum or epruinose 10
2 Pruina reddish brown to brown ..... 8 *C. gracillima*
– Pruina yellowish green, yellow or reddish yellow 3
3 Photobiont trebouxioid, with spherical cells, or *Trentpohlia* 4
– Photobiont with small cylindrical cells sometimes forming chains (*Stichococcus*) 8
4 Thallus intensely yellow, containing vulpinic acid..... ..... 4 *C. chrysocephala*
– Thallus greenish grey or inconspicuous, immersed in the substrate 5
5 Photobiont Trentepohlia, thallus immersed ... 9 *C. hispidula*
– Photobiont trebouxioid, thallus immersed 6
6 Spore ellipsoidal, ascomata tall and slender, 1.3–1.9 mm high, thallus immersed..... 10 *C. laevigata*
– Spores spherical, ascomata shorter, thallus episubstratic ... 7
7 Thallus very thin, minutely granular, ascomata 0.8–1.5 mm high ..... 14 *C. subroscida*
– Thallus verrucose to squamulose, usually thick, greenish to greyish brown, ascomata 0.5–1.2 mm high .... 11 *C. phaeocephala*
8 Spores partly ellipsoidal, thallus usually well developed, verrucose to granular, greyish green to green..... ..... 3 *C. chlorella*
– All spores spherical, thallus immersed or farinaceous, when well developed intensely yellowish green 9
9 Thallus superficial, farinose. Ascomata 1.6–2.6 mm high, mazaedium usually pale brown, spores with a minute verrucose ornamentation..... 7 *C. furfuracea*
– Thallus immersed. Ascomata 0.4–1.4 mm high, mazaedium dark brown, spores with an ornamentation of irregular cracks, cuboid ..... 1 *C. brachypoda*
10 Photobiont with small cylindrical cells sometimes forming chains (*Stichococcus*) 11
– Photobiont with large or medium sized, sphaerical cells (photobiont trebouxioid or *Dictyochloropsis*) 14
11 Thallus thin, farinose, light greenish-bluish green, PD+ yellow-reddish ..... 13 *C. stemonea*
– Thallus not farinose, immersed or well developed and PD– 12
12 Stalk pale, particularly in the lower part, exciplum with irregularly dissected edge, strongly pruinose..... 5 *C. cinerea*
– Stalk black, excipulum with even edge 13
13 Thallus thin or rather thick, verrucose to squamulose, greenish grey, outer part of the excipulum at the base consisting of periclinally arranged or intertwined hyphae .... 15 *C. trichialis*
– Thallus immersed, outer part of the excipulum a the base consisting of anticlinally arranged, swollen hyphae..... ..... 16 *C. xyloxena*
14 Thallus superficial, white to greyish, often with K+ yellow to red patches. Spores 6–7 µm diam..... 6 *C. ferruginea*
– Thallus immersed or superficial, without yellow or red patches. Spores 3.5–4.5 µm diam 15
15 Thallus immersed, stalk shining black, associated with Dictyochloropsis ..... 2 *C. brunneola*
– Thallus minutely granular, stalk often faintly grey pruinose, photobiont trebouxioid 16

16 Asci irregular in shape, formed in chains ..... 12 *C. sphaerocephala*

– Asci cylindrical, well-stalked, formed singly ..... 10 *C. hygrophila*

1. Chaenotheca brachypoda (Ach.) Tibell

Symb. Bot. Ups. 27(1): 71 (1987). – Coniocybe brachypoda Ach., K. Vetensk.-Acad Handl. 1816: 287 (1816). – Type: Without locality (H-ACH 535, lectotype, Tibell, Symb. Bot. Ups. 27(1): 71, 1987).

Syn. *Coniocybe sulphurea* (Retz.) Nyl.

D: gulgrøn knappenålslav. **F:** lahoneulajäkälä. **N:** dverg-gulnål. **S:** gulnål.

Redlisted in: **D**.

Thallus immersed. Ascomata 0.4–1.4 mm high. Stalk 0.04–0.08 mm diam., covered by a dense yellowish green pruina. Outermost part of stalk with dark brown, sclerotized hyphae, 5–10 µm thick. Lower part of stalk sometimes epruinose, black. Capitulum 0.1–0.2 mm diam., spherical, like the mazaedium covered by a dense yellowish green pruina, with a poorly developed excipulum. Excipulum lacking or forming a very small collar at the base of the hypothecium. Hypothecium hemispherical, dark brown and sclerotized throughout or with brown, radiating, sclerotized hyphae only in the periphery and hyaline, spherical to elongated cells, 5–8 µm, in the central part. Mazaedium dark brown, but often covered by a thick yellowish green pruina. Asci catenulate, formed from ascogenous hyphae with hooks, cylindrical or irregular, often with expanded end, 10–14 × 1.5–3.0 µm. Spores medium brown, globose to cuboid, 3–4 µm, provided with a few irregular cracks and irregularly thickened walls. Photobiont *Stichococcus*.

Chemistry. Thallus K–, C–, KC–, PD–. The thallus contains pulvinic and vulpinic acid, which also form the pruina of the ascomata.

Habitat. In dark and humid situations, particularly on rotting stumps of *Salix* and *Alnus*. More rarely on bark of *Populus tremula* and *Ulmus*, lignum of *Betula*, *Fagus* and *Quercus* and old polypores.

Distribution. Scattered in southern Norway, Sweden and Finland but more common in northern Sweden. Rare in Denmark. **D:** NJy, Fyn, Sjæ. **F:** V, U, St, EH, ES EP, PS, KP, Kn, OP, PeP, Ks, KiL. **N:** Ak, He, Op, Bu, Vf, Ro, MR, ST, NT, No, Tr. **S:** Sk, Öl, Sm, Hl, Dls, Vg, Ög, Vrm, Upl, Dlr, Hls, Jmt, Vb, Nb, ÅsL, LyL, PL, LuL, TL. Widely distributed in cool temperate to temperate areas of the Northern Hemisphere (Eurasia, North America). – Map 15.

Note. Characterized by having a dark brown mazaedium, which, however, often is covered by a bright yellowish green pruina, spherical capitula, the immersed thallus and the spore shape and ornamentation. Often very similar to Chaenotheca furfuracea, which, however has an episub-stratic, yellowish green thallus, a paler mazaedium, and paler and smaller spores with an ornamentation of minute warts.

2. Chaenotheca brunneola (Ach.) Müll.Arg.

Mém. Soc. Phys. Hist. Nat. Genève 16(2): 360 (1862). – Calicium brunneolum Ach., K. Vetensk.-Acad. Handl. 1816: 279 (1816). – Type: Without locality (H-ACH 494, lectotype, Tibell, Symb. Bot. Ups. 23(1): 22, 1980).

D: skov-knappenålslav. **F:** keloneulajäkälä. **N:** fausknål. **S:** vednål.

Redlisted in: **D**.

Thallus immersed or sometimes superficial, granular to farinaceous, ecorticate, consisting of photobiont cells enclosed by mycobiont hyphae. Ascomata short to tall, 0.5–1.5 mm high, 9–23 times as high as the width of the stalk. Stalk 0.05–0.10 mm diam., shining black, without pruina, sometimes branched and carrying 2–5 capitula. Capitulum spherical. Excipulum more or less well developed, formed as a continuation of the stalk tissue. The excipulum edge is short and turned outwards or better developed and consisting of several layers of parallel or slightly intertwined hyphae. Hypothecium broadly obconical, with a strongly convex upper surface. Capitulum without pruina, but the lower side of the capitulum sometimes appears pruinose due to the presence of pale hyphae projecting from the surface of the excipulum. Asci of variable shape, estipitate, with uni- to biseriately arranged spores, 11–13 × 2.0–3.5 µm, produced in chains with hooks or cylindrical, well stalked with uniseriately arranged spores, 15–19 × 2.0–3.0 µm. Spores globose, 3.5–4.5 µm diam., smooth or with irregular fissures. Photobiont Dictyochloropsis.

Chemistry. Thallus K–, C–, KC–, PD+ yellowish red or PD–. *Chaenotheca brunneola* contains baeomycesic and squamatic acid according to Middelborg & Mattsson (1987).

Habitat. Mainly occurring on lignum of decorticated stumps of *Picea abies* and *Pinus sylvestris* in rather dark and humid situations in coniferous forests. Also on *Alnus glutinosa*, *Quercus* and occasionally old polypores and bark of *Juniperus*.

Distribution. Common in Finland, Norway and Sweden. Very rare in Denmark. **D:** NJy. **F:** A, V, U, St, EH, ES, EP, PH, PS, PK, Kn, PeP, Ks, EnL, InL. **N:** Øf, Ak, He, Op, Vf, Te, VA, Ro, Ho, SF, MR, ST, NT, No, Tr. **S:** Sk, Öl, Gtl, Sm, Hl, Dls, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Gst, Hls, Ång, Hrj, Jmt, Vb, Nb, ÅsL, LyL, PL, LuL. Widely distributed both in tropical, temperate and cool temperate areas of both hemispheres (Eurasia, North America, Africa, Australasia and Central and South America. – Map 16.

Note. A very variable species characterized by its small spores, the medium-sized ascomata, the association with Dictyochloropsis and the usually PD+ yellowish to yellowish red thallus. The thallus may be immersed or superficial and granular to farinaceous. *Chaenotheca ferruginea* differs in having a grey thallus which frequently is provided with yellow to red spots and by having larger spores. *Chaenotheca trichialis* differs in having a PD– thallus and *Stichococcus* as photobiont.

3. **Chaenotheca chlorella** (Ach.) Müll.Arg.

Mém. Soc. Phys. Hist. Nat. Genève 16(2): 360 (1862). – *Calicium chlorellum* Ach., Methodus: 89 (1803). – Type: Without locality, Wahlenberg (S-Swartz, lectotype, Tibell, Ann. Bot. Fenn. 24: 262, 1987).

Syn. *Chaenotheca carthusiae* (Harm.) Lettau

D: grønlig knappenålslav. **F:** viherneulajäkälä. **N:** vortenål. **S:** kornig nållav.

Redlisted in: **D**, **S**.

Literature: Tibell, Svensk Bot. Tidskr. 67: 446–448 (1973).

Thallus superficial, usually well developed, verrucose to minutely granular, greyish green to green. Ascomata short to rather short, 0.7–0.9 mm high. Stalk 0.05–0.08 mm in diam., shining black but with a prominent, intensely yellow pruina. Capitulum broadly obovoid to lenticular. Excipulum 0.16–0.23 mm diam., well developed and obconical or reduced to a short collar around the base of the mazaedium. Excipulum consisting of periclinally arranged, more or less branched and intertwined hyphae. Hypothecium broadly obconical to semiglobose, with convex upper surface. Capitulum with a dense yellow pruina on the lower side of the excipulum. Asci formed singly, cylindrical, with well developed stalks, 16–20 × 2.0–3.0 µm and with uniseriately arranged spores. Spores globose to broadly ellipsoidal, 4.5–9 × 3.0–4.0 µm, with a rough ornamentation formed by irregular cracks. Photobiont *Stichococcus* or trebouxioid.

Chemistry. Thallus K–, C–, KC–, PD–. The pruina of the ascomata consists of vulpinic acid Middelborg & Mattsson (1987) reported two further unidentified substances.

Habitat. On decorticated stumps of conifers and deciduous trees. In southern areas on bark of *Quercus*, more rarely on *Tilia*, *Fraxinus*, in the north on stumps of *Salix* and *Picea*. Occasionally on bark of *Populus*, *Betula*, on wood of *Betula*, *Populus*, *Fagus* and *Alnus* and on the walls of old wooden barns. Occurring in humid and moderately shaded situations.

Distribution. Scattered in southern and eastern Norway, south and central Finland and almost all of Sweden. Rare in Denmark. **D:** NJy, Fyn, Sjæ. **F:** A, V, U, EK, St, EH, PH, PS. **N:** He, Op, Bu, AA, VA, Ro, SF, MR, ST, NT, No, Tr. **S:** Sk, Gtl, Sm, Bh, Dls, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Gst, Hls, Mpd, Ång, Jmt, Vb, ÅsL, LyL, LuL. Widely distributed in cool temperate and temperate areas of both the Northern (Eurasia, North America) and the Southern Hemisphere (Australasia, Central and South America). – Map 17.

Note. Characterized by its yellow pruinose ascomata, the partly ellipsoidal spores which have a coarse and irregular ornamentation and the association with Stichococcus as a photobiont. It is very variable with respect to thallus development (from almost completely immersed to coarsely granular) and height of ascomata, which vary from having stalks of medium length to being very long and slender in some Southern Hemisphere populations. *Chaenotheca chrysocephala* differs in having a yellow thallus.

4. **Chaenotheca chrysocephala** (Ach.) Th.Fr.

Acta Reg. Soc. Sci. Ups. 3(3): 250 1860. – *Calicium chrysocephalum* Ach., Methodus Suppl.: 15 (1803). – Type: England (H-ACH 486, lectotype, Tibell, Symb. Bot. Ups. 23(1): 27, 1980).

D: citrongul knappenålslav. **F:** keltaneulajäkälä. **N:** gulgrynnål. **S:** grynig nållav.

Redlisted in: **D**.

Thallus usually superficial and well developed, granular to verrucose, when well developed continuous, intensely greenish yellow. Sometimes the thallus is almost completely immersed. Ascomata short to middle sized, 0.6–1.3 mm high, 9–22 times as high as the width of the stalk. Stalk 0.04–0.08 mm diam., with a dense yellow pruina in the upper part. Lower part of stalk black to pale brown. Capitulum obovoid to broadly obconical with a well developed excipulum. Excipulum 0.2–0.3 mm diam., consisting of

more or less branched and intertwined hyphae. In the inner part the hyphae of the excipulum are periclin-ally arranged, while in the outer part they are turned outwards and almost anticlinally arranged. Hypothecium broadly obconical with flat or slightly concave upper surface. Capitulum with a dense yellow pruina on the lower side of the excipulum. Asci formed singly, cylindrical, with well developed stalks, 14–19 × 2.0–3.5 µm and with uniseriately arranged spores. Spores short ellipsoidal to globose, 6–9 × 4–5 µm, with a rough and irregular ornamentation formed by irregular cracks. Photobiont trebouxioid.

Chemistry. Thallus K–, C–, KC–, PD–. The thallus contains vulpinic acid, which also forms the pruina of the ascomata.

Habitat. In moderately shaded situations, mainly on trunks of Picea and decorticated stumps in spruce forests, sometimes also on bark of *Quercus*, *Betula*, *Juniperus*, *Larix* and *Alnus*, walls of timbered barns, lignum of *Betula*, *Quercus*, *Alnus* and dry twigs of *Pinus* and *Picea*.

Distribution. Common over large parts of Finland, Norway and Sweden. Rare in Denmark. **D:** Fyn, Sjæ, Brn. **F:** A, V, U, EK, St, EH, ES, EP, PH, PS, PK, KP, Kn, OP, PeP, Ks, KiL, SoL, EnL, InL. **N:** Øf, Ak, He, Op, Bu, Vf, Te, AA, VA, Ho, SF, MR, ST, NT, No, Tr, Fi. **S:** Sk, Bl, Öl, Gtl, Sm, Hl, Bh, Dls, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Gst, Hls, Mpd, Ång, Hrj, Jmt, Vb, Nb, ÅsL, LyL, PL, LuL, TL. This species has a very wide distribution in cool temperate to temperate areas of both hemispheres (Eurasia, North America, Africa, Australasia, and Central and South America). – Map 18.

Note. Although variable in ascoma size and thallus development, *C. chrysocephala* is characterized by having a bright yellow thallus, a yellow pruina on the ascomata, middle-sized ascomata, and non-catenulate asci. The spores are rather small, globose to ellipsoidal, and have a coarse ornamentation

5. Chaenotheca cinerea (Pers.) Tibell

Symb. Bot. Ups. 23(1): 30 (1980). – Calicium cinereum Pers., Icon. descr. fung. 2: 58 (1800). – Type: Without locality (L-Pers., lectotype, Tibell, Symb. Bot. Ups. 23(1): 30, 1980).

Syn. *Chaenotheca schaereri* (De Not.) Zahlbr.

D: hvidlig knappenålslav. **F:** harmaaneulajäkälä. **N:** huldrenål. **S:** blekskaftad nållav.

Redlisted in: **D**, **F**, **S**.

Literature: Tibell, Svensk Bot. Tidskr. 67: 448 (1973).

Thallus episubstratic, greyish white, granular to verrucose to almost immersed. Ascomata short, 0.6–1.0 mm high, 6–10 times as high as the width of the stalk. Stalk 0.07–0.12 mm diam., dark in the upper part and covered by a very thick white pruina, but pale brown to almost white in the lower part. Outermost part of stalk hyaline, 10–15 µm thick, consisting of strongly gelatinized, periclinally arranged hyphae. Capitulum obovoid to obconical with a well developed excipulum, covered by a dense white pruina on the lower side. Excipulum 0.2–0.4 mm diam., in the inner part consisting of periclinally arranged, medium brown hyphae. In the outer part of the excipulum the hyphae are irregularly intertwined, strongly swollen and have sclero-tized walls. The excipular edge is often very irregular from deep, vertical splits. Hypothecium obconical with concave upper surface, pale brown or hyaline. Asci estipitate, ellipsoidal or of variable shape, 13–18 × 2.0–3.0 µm, formed in chains from ascogenous hyphae with hooks. Spores uniseriately or irregularly arranged in the asci. Spores globose, 4.5–5.5 µm diam., smooth or with irregular cracks. Photobiont *Stichococcus*.

Chemistry. Thallus K–, C–, KC–, PD–. According to Middelborg & Mattsson (1987) the thallus contains atra-norin and one further unidentified substance.

Habitat. On bark of *Quercus* and also *Acer*, *Fraxinus*, *Ulmus* and *Populus* in old woodlands. In Central Norway, Iceland and Finland it also occurs on decaying *Dryas* and mosses, a remarkable "switch" in habitat.

Distribution. A rare species with few recent records occurring in central southern Norway, Denmark, Finland, southern Sweden and at an outlying locality in Jämtland. **D:** Fyn. **F:** V, Ks **I**: INo. **N:** Op, ST. **S:** Ög, Vrm, Upl, Jmt. It has now probably disappeared from most of Continental Europe. It also occurs in Asia and North America. – Map 19.

Note. This species is usually easy to recognize by its short-stalked ascomata, the very light lower part of the stalk and the often very irregularly split excipular edge. The specimens collected on ground and mosses in Finland, Norway and Iceland are rather similar to *C. trichialis*. They are, however, tentatively placed in *C. cinerea*.

6. Chaenotheca ferruginea (Turner ex Sm.) Mig.

Krypt.-Fl., Flecht. 2: 479 (1931). – *Calicium ferrugineum* Turner ex Sm., Engl. Bot. 35: 2473 (1812). – Type: England, Framingham near Norwich, Turner (BM, holotype).

Syn. *Chaenotheca melanophaea* (Ach.) Zwackh

D: rustbrun knappenålslav. **F:** ruosteneulajäkälä. **N:** rustflekknål. **S:** rostfläckig nållav.

Thallus superficial or more rarely immersed, granular to verrucose, pale grey to whitish, often with K+ deep red yellow to reddish spots. Ascomata without pruina, short to long, 1–2 mm high, 7–19 times as high as the width of the stalk. Stalk 0.07–015 mm diam., shining black. Capitulum broadly to narrowly obconical, 0.2–0.5 mm diam. Excipulum well developed, consisting of numerous layers of interwoven but largely periclinally arranged hyphae. Hypothecium obconical, medium brown, with convex upper surface. Asci cylindrical to narrowly clavate, 14–18 × 2.5–3.5 µm, well stalked. Spores uni- to biseriately arranged in the asci. Asci usually formed singly but sometimes two asci join to form a short chain. Spores globose, 6–8 µm diam., when mature provided with an ornamentation of coarse and irregular fissures. Photobiont trebouxioid.

Chemistry. Thallus K–, C–, KC–, PD–, but the yellow to red pigment patches are K+ deep red. A yellowish, K+ red pigment also occurs in the mazaedium, which often has a yellowish rather than brown tinge.

Habitat. Mainly occurring on acidic bark and on lignum, mainly on bark and lignum of *Pinus* and *Picea*, and decorticated stumps of conifers. It also occurs on charred wood and on worked wood of old buildings, rarely on lignum of *Betula* and *Quercus* and occasionally on bark of *Larix* and *Juniperus*. It tolerates rather high pollution levels and is probably increasing in frequency in areas affected by air pollution, particularly in southern Scandinavia.

Distribution. Not uncommon in southern Norway and Sweden and southern and central Finland. More rare in Denmark. **D:** VJy, Fyn, Sjæ, Brn. **F:** A, V, U, EK, St, EH, ES, EP, PH, PS, PK, KP, Kn, OP, PeP, Ks. **N:** Øf, Ak, He, Op, Bu, Vf, Te, AA, VA, Ro, Ho, SF, MR, ST, NT, No, Tr. **S:** Bl, Öl, Gtl, Sm, Hl, Bh, Dls, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Gst, Hls, Hrj, Jmt, Vb, Nb, LyL, LuL. A very widespread species in temperate to cool temperate areas of both hemispheres (Europe, North America, Asia, Australasia and South America). – Map 20.

Note. Characterized by the grey verrucose thallus which often is provided with yellow to deep red, K+ red spots. Sometimes, however, the thallus is completely immersed in the substrate. It is further characterized by the epruinose ascomata, conical capitulum and rather large, globose spores.

7. Chaenotheca furfuracea (L.) Tibell

Nova Hedwigia Beih. 79: 664 (1984). – *Mucor furfuraceus* L., Sp. Pl.: 1185 (1753). – Type: Sweden, Uppland, Vänge par., Fiby urskog, R. Santesson 14432 (UPS, neotype, Jørgensen et al., Bot. J. Linn. Soc. 115: 383, 1994).

Syn. *Coniocybe furfuracea* (L.) Ach.

D: tørve-knappenålslav. **F:** varjoneulajäkälä. **N:** gulnål. **S:** ärgnål.

Redlisted in: **D**.

Thallus superficial, farinaceous, intensely yellowish green. Occasionally the thallus is almost completely immersed. Ascomata tall, 1.6–2.6 mm high. Stalk 0.06–0.10 mm diam., covered by a dense yellowish green pruina. Stalk hyphae towards the surface dark brown, sclerotized. Stalk in the upper part with often branched, laterally projecting hyphae, 5–20 µm long, densely covered by yellow crystals. Lower part of stalk sometimes epruinose, black. Capitulum spherical with a poorly developed excipulum, 0.1–0.2 mm in diam., with a dense yellow pruina also covering the mazaedium. Excipulum lacking. Hypothecium pale brown, strongly convex, knob-like, consisting of intricately interwoven hyphae which are slightly sclerotized towards the surface of the hypothecium. Asci formed in chains, often irregular, 12–15 × 2.0–3.0 µm. Spores spherical, 2.3–3.0 µm, with a very minute ornamentation of tiny warts very difficult to discern in the light microscope. Photobiont *Stichococcus*.

Chemistry. Thallus K–, C–, KC–, PD–. The thallus contains vulpinic acid, pulvinic acid and pulvinic dilactone, substances which also form the pruina of the ascomata.

Habitat. In dark and humid situations, particularly on rootlets and soil of uprooted trees in coniferous forests. Also on decorticated stumps of conifers, *Betula* and *Alnus*, on bark of *Picea*, *Populus*, *Salix*, *Quercus*, *Ulmus*, Acer and on soil, on mosses and on rocks.

Distribution. Common both in Finland, Norway and Sweden. Less common in Denmark. Known also from Iceland, Spitzbergen and Greenland. **D:** ØJy, SJy, Fyn, Sjæ, Brn. **Gr. F:** A, V, U, EK, St, EH, ES, EP, PH, PS, PK, KP, Kn, OP, PeP, Ks, KiL, SoL, EnL, InL. **I:** IAu, INo. **N:** Øf, Ak, He, Op, Bu, Vf, Te, AA, VA, Ro, Ho, SF, MR, ST, NT, No, Tr, Fi. **AI:** Sb. **S:** Sk, Bl, Öl, Gtl, Sm, Hl, Bh, Dls, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Gst, Hls, Mpd, Ång, Hrj, Jmt, Vb, Nb, ÅsL, LyL, PL, LuL, TL. Chaenotheca furfuracea has a very wide distribution in cool temperate to temperate areas of the Northern Hemisphere (Eurasia, North America). – Map 21.

Note. Characterized by having a bright yellowish green, farinaceous thallus, the yellow pruina of the ascomata, the long and slender ascomata, the spherical capitula and small spores. When having a poorly developed thallus and short ascomata it is very similar to C. brachypoda, but differs in having a lighter mazaedium and a different ornamentation of the spores.

8. Chaenotheca gracillima (Vain.) Tibell

Nova Hedwigia Beih. 79: 664 (1984). – *Coniocybe gracillima* Vain., Medd. Soc. Fl. Fauna Fenn. 6: 97 (1881). – Type: Finland, Karelia borealis, Kalliovaara, 1875 Vainio (TUR–V 29919, holotype).

F: hentoneulajäkälä. **N:** langnål. **S:** brunpudrad nållav.

Redlisted in: **S**.

Literature: Tibell, Svensk Bot. Tidskr. 67: 452 (1973).

Thallus immersed in the substrate or covering the surface, minutely granular, pale greyish green. Ascomata 1.5–2.5 mm high, 24–40 times as high as the width of the stalk. Stalk flexuous, 0.05–0.08 mm diam., black in the lower part and with a reddish brown pruina in the upper part. Capitulum lenticular to subspherical or spherical, 0.1–0.2 mm diam., with a dense reddish brown pruina on the lower side. Outer surface of the excipulum frequently wrinkled. Excipulum 40–80 µm thick, consisting of sparingly branched, periclinally arranged medium brown hyphae. Hypothecium pale brown, strongly convex, 50–95 µm high. Asci formed singly, well stalked, or catenulate, cylindrical or irregular, 9–13 × 2.0–2.5 µm, and with the spores uniseriately or more rarely biseriately arranged. Spores globose to subglobose, medium brown, 2.5–3.5 µm diam., smooth or with a few irregular cracks. Photobiont Stichococcus.

Chemistry. Thallus K–, C–, KC–, PD–. Pruina of excipulum and upper part of the stalk dissolving in K and a precipitate of violet red plate- to featherlike crystals is formed.

Habitat. On decorticated stumps of *Picea* and *Betula* in advanced stages of decay, particularly in hollows of the stumps, occasionally on lignum of *Pinus*, *Salix*, *Alnus*, *Sorbus*, bark of *Picea*, and dead *Populus* in shaded and humid situations.

Distribution. Rather rare in eastern Norway and central and northern Sweden and Finland, with occasional occurrences in southern Sweden. **F:** A, V, U, St, EH, EP, PS, PK, Kn, OP, PeP, Ks, KiL. **N:** Ak, He, Op, Bu, Vf, MR, ST, NT, No, Tr. **S:** Sm, Hl, Dls, Vg, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Gst, Hls, Mpd, Ång, Hrj, Jmt, Vb, Nb, ÅsL, LyL, LuL, TL. Widespread in cool temperate and temperate areas of both hemispheres (Europe, North America, Asia, Australasia, Central and South America). Also known from high altitudes in tropical Africa. – Map 22.

Note. Characterized by its long and slender, flexuous stalks, the small capitula, the reddish brown pruina on the upper part of the stalk, and the lower side of the excipulum. The pruina is K+ and a precipitate of violet red crystals is formed after a while (microscopic investigation needed).

9. Chaenotheca hispidula (Ach.) Zahlbr.

Cat. lich. univ. 1: 567 (1922). – *Calicium trachelinum* g *C. hispidulum* Ach., Lich. univ.: 237 (1810). – Type: England (H-ACH 493, lectotype, Tibell, Symb. Bot. Ups. 23(1): 34, 1980).

D: park-knappenålslav. **F:** nuijaneulajäkälä. **S:** parknål.

Redlisted in: **D**, **F**, **S**.

Thallus immersed in the substrate. Ascomata short, 0.5–1.0 mm high, 8–16 times as high as the width of the stalk. Stalk 0.05–0.08 mm diam. Stalk surface black in the lower part and with a thick yellow pruina in the upper part. Capitulum obconical to obovoid, with a dense yellow or sometimes reddish brown pruina on the lower side. Excipulum well developed, 0.1–0.3 mm diam. Excipulum formed by periclinally arranged, medium brown hyphae 3–4 µm diam. Hypothecium medium brown, obconical with flat upper surface. Asci cylindrical, either formed singly and provided with a stalk or formed in chains and cylindrical to irregular in shape. Asci produced singly measure 15–20 x 2.0–2.5 µm, whereas asci formed in chains measure 13–17 × 1.5–2.5 µm. Spores uniseriate in single asci, sometimes biseriate in catenulate asci, globose, 5–8 µm diam., with an ornamentation of irregular, reticulate fissures surrounding polygonal areas. Photobiont *Trentepohlia*.

Chemistry. Thallus K–, C–, KC–, PD–. The yellow pruina consists of vulpinic acid.

Habitat. On bark of old oak trees in parklands and forest edges in rather shaded situations, occasionally on *Alnus* and *Salix*.

Distribution. A rare species in southern and central Sweden also occurring in Finland and Denmark. **D:** Brn. **F:** EH. **S:** Sk, SmI, Bh, Vg, Ög, Srm, Vsm, Vrm, Upl, Dlr, Hrj. Widely distributed in temperate areas of the Northern Hemisphere (Europe, Asia, North America) and also occurring in Australasia and southernmost South America. – Map 23.

Note. Characterized by the rather short yellow-pruinose ascomata, the large globose spores and by having *Trentepohlia* as a photobiont.

10. Chaenotheca hygrophila Tibell

Symb. Bot. Ups. 23(1): 37 (1980). – Type: Japan, Musashi, Agano, 1929 Yamamoto (TNS, holotype).

Thallus superficial, minutely granular (granules 0.02–0.04 mm diam.), ecorticate, consisting of photobiont cells enclosed by mycobiont hyphae, or sometimes immersed. Ascomata medium-sized, 0.9–1.3 mm high, 9–14 times as high as the width of the stalk. Stalk 0.06–0.10 mm in diam., sometimes with a thin, grayish pruina. The pruina is formed by a layer of ruptured surface hyphae. Capitulum lenticular to almost spherical, 0.2–0.3 mm diam. Excipulum usually well developed, up to 50 µm thick, but occasionally poorly developed. Excipulum formed as a continuation of the stalk tissue, consisting of several layers (12–26) of interwoven but largely periclinally arranged hyphae. Hypo-thecium broadly obconical, with a flat or convex upper surface. Capitulum sometimes appearing white pruinose on the lower side due to the presence of pale hyphae projecting from the surface of the excipulum. Asci cylindrical, produced singly, well stalked with uniseriately arranged spores, 12–16 × 2–2.5 µm. Spores spherical, 3.0–4.5 µm in diam., smooth or irregularly cracked-areolate. Photobiont trebouxioid.

Chemistry. Thallus K–, C–, KC–, PD+ yellowish-orange. Contains barbatic and obtusatic acid.

Habitat. On lignum of *Pinus sylvestris* and *Picea abies* in spruce forests at moderate altitudes.

Distribution. Only known from a few localitites in Western Norway, most probably overlooked. **N:** ST. Widely distributed in humid, temperate areas, occurring both in the Northern Hemisphere (Europe, Asia, North America), and Southern Hemisphere (Austalasia) – Map 24.

Note. Characterized by its minutely granular thallus, small spores, the usually well developed excipulum, the non-catenulate asci, the association with a trebouxioid photobiont, and the PD+ yellowish to yellowish red thallus containing barbatic and obtusatic acid. *C. sphaerocephala* is similar, but differs in having a poorly developed excipulum and catenulate asci. *C. brunneola*, which also has a PD+ thallus, differs in mostly having an immersed thallus, shining black stalks of the apothecia, in being associated with *Dictyochloropsis*, having catenulate asci, and containing baeomycesic and squamatic acid. *C. trichialis* differs in having a PD– thallus and *Stichococcus* as photobiont. Not previously reported from Europe.

11. Chaenotheca laevigata Nádv.

Repert. Spec. Nov. Regni Veg. 36: 309 (1934). – Type: Ukraine, Uzhorod, 1933 Nádvorník (BRA-Nádv., lectotype, Tibell, Symb. Bot. Ups. 23(1): 39, 1980).

F: siloneulajäkälä. **N:** taiganål. **S:** nordlig nållav.

Redlisted in: **S**.

Thallus immersed. Ascomata middle-sized to long, 1.3–1.9 mm high. Stalk 0.06–0.09 mm diam., covered by a dense yellow pruina. Capitulum obovoid to broadly obconical with a well developed excipulum. Excipulum 0.2–0.4 mm diam., consisting of largely periclinally arranged, slightly branched, brown hyphae. Hypothecium obconical with flat or slightly concave upper surface, consisting of irregularly intertwined, dark brown, sclerotized hyphae. Capitulum with a dense yellow pruina on the lower side of the excipulum. Asci formed singly, cylindrical, with well developed stalks, 16–18 × 2.0–2.5 µm and with uni- to biseriately arranged spores. Spores ellipsoidal to short cylindrical, non-septate, 6–7 × 3.0–3.5 µm, with a rough and irregular ornamentation formed by irregular cracks. Photobiont trebouxioid.

Chemistry. Thallus K–, C–, KC–, PD–. Vulpinic acid forms the pruina of the ascomata.

Habitat. Occurring in moderately shaded situations, mainly on decorticated stumps in coniferous forests, occasionally on bark of *Picea*, *Juniperus* and *Salix*.

Distribution. A rare species occurring in eastern Norway and northern Sweden, rather wide-spread in Finland. **F:** V, EK, St, EH, PS, PK, Kn, PeP, Ks. **N:** He, Op, Fi. **S:** Dls, Vrm, Dlr, Gst, Hls, Mpd, Ång, Jmt, Vb, ÅsL, LyL, LuL, TL. Also known from Continental Europe and North America. – Map 25.

Note. Characterized by having a yellow pruina, long and slender ascomata, short cylindrical spores and a trebouxioid photobiont. The populations in Central Europe differ by having short-stalked ascomata, whereas the North American material looks very similar to the North European. The spores of the North American population are larger and provided with 1–5 septa.

12. Chaenotheca phaeocephala (Turner) Th.Fr.

Acta Reg. Soc. Sci. Ups. 3(3): 251 (1860). – *Lichen phaeocephalus* Turner, Trans. Linn. Soc. Lond. 8: 281 (1807). – Type: England, Lakenham, Turner (BM, lectotype, Tibell, Symb. Bot. Ups. 23(1): 41, 1980).

D: brunhovedet knappenålslav. **F:** ruskoneulajäkälä. **N:** stautnål. **S:** brun nållav.

Redlisted in: **D**, **F**, **S**.

Thallus superficial, usually well developed, with thick, large squamules, convex verrucae or verrucose-granular, dull olivaceous brown to greenish. Ascomata short to middle-sized, 0.5–1.2 mm high, 6–15 times as high as the width of the stalk. Stalk 0.06–0.10 mm diam., pale to dark brown or with a faint yellowish pruina in the uppermost part. Outermost part of stalk hyaline, 7–16 µm thick, consisting of strongly gelatinized, periclinally arranged hyphae. Capitulum broadly obconical to lenticular, 0.1–0.3 mm diam. Excipulum consisting of largely periclinally arranged, slightly branched, brown hyphae, with a more or less prominent yellow pruina on the lower side. Hypothecium broadly obconical with flat to slightly convex upper surface. Asci formed singly, cylindrical, with well developed stalks, 17–24 × 3–4 µm, with uniseriately arranged spores. Spores globose 6–7 µm diam., with an ornamentation of irregular, polygonal areas delineated by irregular cracks. Photobiont trebouxioid.

Chemistry. Thallus K–, C–, KC–, PD–. No secondary substances detected in the thallus. The pruina of the ascomata consists of vulpinic acid.

Habitat. On lignum of conifers and deciduous trees, particularly of old, unpainted wooden buildings, and on bark particularly of old *Quercus* in moderately shaded situations, rarely on *Alnus* and *Ulmus*.

Distribution. Not uncommon in southeastern Norway and most of Sweden and Finland except for the northern parts. Rare in Denmark. **D:** NJy, SJy. **F:** A, V, U, EK, St, EH, ES, EP, PH, PS, PeP, Ks. **N:** Ak, He, Bu, Te. **S:** Sk, Bl, Öl, Sm, Bh, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Gst, Hls, Hrj, Jmt, Vb, LuL. Widely distributed in cool temperate and temperate areas of the Northern Hemisphere (Europe, Asia and North America). – Map 26.

Note. Characterized by its rather short and robust ascomata, the yellow pruinose ascomata, the globose, rather large spores and the association with a trebouxioid photobiont. It is quite variable with respect to thallus development and thallus colour.

13. Chaenotheca sphaerocephala Nádv.

Ann. Mycol. 40: 134 (1942). – Type: Chile, "Corral Stockert" (W, holotype).

Thallus superficial, minutely granular (granules 0.4–0.6 mm diam.) or sometimes with slightly larger, verrucose granules (0.12–0.15 mm diam.), ecorticate, consisting of photobiont cells enclosed by mycobiont hyphae. Ascomata medium-sized to tall, 1.1–1.5 mm high, 10–38 times as high as the width of the stalk. Stalk 0.04–0.11 mm in diam., often covered by a thin, grayish pruina. The pruina is formed by a layer of ruptured surface hyphae. Capitulum spherical, 0.3–0.4 mm diam. Excipulum poorly developed, up to 30 µm thick and only surrounding the base of the capitulum as a collar or missing. Hypothecium broadly obconical, with a strongly convex to hemispherical upper surface. Capitulum without crystalline pruina, but the lower side of the capitulum sometimes appears white pruinose due to the presence of pale hyphae projecting from the surface of the excipulum. Asci of variable shape, estipitate, with uni- to biseriately arranged spores, produced in chains with hooks or sometimes cylindrical, well stalked with uniseriately arranged spores, 14–19 × 2–3 µm. Spores spherical, 3.0–4.5 µm in diam., smooth or with irregular fissures. Photobiont trebouxioid.

Chemistry. Thallus K–, C–, KC–, PD+ yellowish-orange. Contains barbatic and obtusatic acid. In some specimens squamatic acid occurs. In one of the Swedish specimens, however, Dr J. A. Elix (personal communication) detected atranorin, obtusatic acid, methylplacodiolic acid and eumitrin C.

Habitat. Growing in very shaded localitites at bases of old trunks of *Picea abies* in northern spruce forests.

Distribution. Only known from a few localities in Northern Sweden, possibly rare but also most probably overlooked. **S:** LyL. Widely distributed in temperate and cool temperate areas of the Southern hemisphere, also occurring in the Northern Hemisphere (Asia, North America), although its distribution there is poorly known. – Map 27.

Note. Characterized by its minutely granular thallus, the small spores, the poorly developed excipulum, the often pruinose stalks of the apothecia, the association with a trebouxioid photobiont, and the PD+ yellowish to yellowish red thallus. *C. brunneola*, which also often has a PD+ thallus, differs in mostly having an immersed thallus, shining black stalks of the apothecia, in being associated with *Dictyochloropsis*, and containing baeomycesic and squamatic acid. *C. hygrophila* also has a minutely granular

thallus containing a trebouxioid photobiont, but differs in having a well-developed, cup-like excipulum and non-catenulate asci. *C. trichialis* differs in having a PD– thallus and *Stichococcus* as photobiont. Not previously reported from Europe.

14. Chaenotheca stemonea (Ach.) Müll.Arg.

Mém. Soc. Phys. Hist. Nat. Genève 16(2): 360 (1862). – *Calicium stemoneum* Ach., K. Vetensk.-Acad. Handl. 1816: 278 (1816). – Type: Without locality (H-ACH 498, lectotype, Tibell, Symb. Bot. Ups. 23(1): 47, 1980).

D: melet knappenålslav. **F:** jauheneulajäkälä. **N:** skyggenål. **S:** luddnål.

Redlisted in: **D**.

Thallus thin, farinaceous, glaucous green. Ascomata short to middle-sized, 0.7–1.6 mm high. Stalk 0.05–0.09 mm diam., in the upper part whitish to dull brownish, in the lower part brown to black. Capitulum spherical, with poorly developed excipulum, 0.2–0.3 mm diam. The excipulum forms a small collar at the base of the capitulum and is not visible from above. The brown colour of the lower side of the excipulum is caused by the brown spores caught in the hyphal web which covers the surface of the excipulum. This hyphal web is well developed and renders the outer surface of the excipulum a pale colour in a zone closest to the mazaedium. Hypothecium with strongly convex upper surface. Asci formed in chains, short cylindrical or of irregular shape, 9–14 × 1.5–2.5 µm. Spores uniseriately or irregularly arranged in the asci. Spores globose, 3.5–4.0 µm diam., smooth or with irregular, narrow cracks. Photobiont *Stichococcus*.

Chemistry. Thallus K–, C–, KC–, PD+ yellow to reddish. Contains barbatic and obtusatic acids.

Habitat. On decorticated stumps particularly of *Picea*, *Pinus*, *Betula* and *Alnus* and bark of *Picea* in humid an very shaded situations, often under overhanging parts. Also known from bark of *Quercus* and *Salix caprea*, very rarely on soil.

Distribution. Widely distributed but not common in Finland, Norway and Sweden. Rare in Denmark. **D:** Sjæ. **F:** V, U, EK, St, EH, EP, PH, PS, KP, Kn, PeP, Ks. **N:** Ak, He, Op, Vf, Te, VA, Ho, MR, ST, NT, No, Tr. **S:** Bl, Öl, Gtl, Sm, Dls, Vg, Ög, Nrk, Srm, Vrm, Upl, Dlr, Gst, Hls, Ång, Hrj, Jmt, Vb, ÅsL, LyL, PL, LuL. A very widely distributed species occurring in cool temperate to temperate areas of the Northern Hemisphere (Europe, Asia, North America) and corresponding areas in Australasia and South America. – Map 28.

Note. Characterized by the thin, farinose, PD+ yellow-red thallus, the almost spherical capitula, the hyphal web on the lower side of the excipulum, the catenulate asci, the small, globose spores and the association with *Stichococcus* as photobiont.

15. Chaenotheca subroscida (Eitner) Zahlbr.

Cat. lich. univ. I: 578 (1922). – *Cyphelium subroscidum* Eitner, Jahrb. Schles. Ges. vaterl. Cult. 88: 53 (1911). – Type: Poland, Untere Zackelklamm, 1902 Eitner (W, holotype).

F: kuusenneulajäkälä. **N:** sukkernål. **S:** vitgrynig nållav.

Literature: Tibell, Svensk Bot. Tidskr. 67: 448–450 (1973).

Thallus superficial, pale grey, patchy, diffuse, usually 0.5–1 cm large, consisting of a thin layer of minute granules 0.05–0.1 mm diam., rendering the thallus a sorediate appearance. In older parts of the thallus larger, flat verrucae occur. They are smooth, brownish or olivaceous and covered by scattered minute, pale grey granules. Ascomata middle-sized, 0.8–1.5 mm high. Stalk 0.06–0.08 mm diam., black, with a dense greenish yellow pruina in the upper part. Capitulum lenticular, 0.2–0.3 mm diam., with well developed excipulum. Excipulum consisting of largely periclinally arranged, intricately interwoven, sclerotized brown hyphae, with a prominent yellow pruina on the lower side. Hypothecium lenticular, medium brown, with a convex upper surface. Asci formed singly, cylindrical, with well developed stalks, 19–22 × 3.5–4.0 µm, with uni-seriately arranged spores. Spores globose 6–7 µm diam., with an ornamentation of irregular, polygonal areas delineated by irregular cracks. Photobiont trebouxioid.

Chemistry. Thallus K–, C–, KC–, PD–. An unidentified substance, 'subroscida unknown' was reported by Middelborg & Mattsson (1987). A major substance occurring in the thallus was identified as pseudoplacodiolic acid by Elix (personal communication). The pruina of the ascomata consists of vulpinic acid.

Habitat. Almost exclusively on bark of *Picea* in moderately shaded situations in old, undisturbed forests. Occasionally found on bark of *Betula* and lignum.

Distribution. Occurring in eastern Norway, northern and central Sweden and Finland. **F:** U, EK, EH, ES, EP, PH, PS, PK, Kn, OP, PeP, Ks, SoL. **N:** He, Op, Bu, Te, ST, NT, No. **S:** Sm, Dls, Vg, Ög, Nrk, Vrm, Vsm, Upl, Dlr, Gst, Hls, Mpd, Ång, Hrj, Jmt, Vb, Nb, ÅsL, LyL, PL, LuL. Widely distributed in cool temperate and temperate areas of the Northern Hemisphere (Europe and North America). – Map 29.

Note. Characterized by its rather slender, yellow pruinose ascomata, the pale thallus consisting of minute, pale grey granules, the globose, rather large spores and the association with a trebouxioid photobiont.

16. Chaenotheca trichialis (Ach.) Th.Fr.

Acta Reg. Soc. Sci. Ups. 3(3): 251 (1860). – *Calicium trichiale* Ach., K. Vetensk.-Acad. Nya Handl. 1808: 283 (1808). – Type: Switzerland (H-ACH 492, lectotype, Tibell, Ann. Bot. Fenn. 24: 278, 1987).

D: grå knappenålslav. **F:** suomuneulajäkälä. **N:** skjellnål. **S:** grå nållav.

Redlisted in: **D**.

Thallus covering the substrate in extended colonies or patchy in small colonies, granular to minutely squamulose, greenish grey to slightly brownish, with matt surface or, particularly when squamulose, glossy. Ascomata middle-sized to long, 1.0–1.9 mm high, 12–38 times as high as the width of the stalk. Stalk 0.05–0.10 mm diam., with a faint white pruina in the upper part or epruinose, shining black. Capitulum obconical to lenticular, 0.2–0.3 mm diam. Excipulum well developed, continuous with the stalk, consisting of periclinally arranged, slightly intertwined hyphae only somewhat thicker than the stalk hyphae. Hypothecium pale brown, obconical with convex upper surface. Lower side of excipulum usually with a faint whitish pruina, but sometimes epruinose. Asci formed in chains, short cylindrical or of irregular shape, 11–14 × 2.0–3.0 µm. Spores uniseriately or irregularly arranged in the asci. Spores globose, 3–4 µm diam., smooth or with irregular, narrow cracks. Photobiont *Stichococcus*.

Chemistry. Thallus K–, C–, KC–, PD–. Two unidentified substances were recorded by Middelborg & Mattsson (1987).

Habitat. On a wide range of substrata including both bark and wood of conifers and deciduous trees. It occurs in moderately shaded and rather humid situations.

Distribution. Rather common over most of Finland, Norway, Sweden, Finland and Denmark. **D:** ØJy, Fyn, Sjæ. **F:** A, V, U, EK, St, EH, ES, EP, PH, PS, PK, KP, Kn, OP, PeP, Ks, KiL, SoL, EnL. **N:** Øf, Ak, He, Op, Bu, Vf, Te, AA, VA, Ro, Ho, SF, MR, ST, NT, No, Tr, Fi. **S:** Sk, Bl, Öl, Gtl, Sm, Hl, Bh, Dls, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Gst, Hls, Ång, Hrj, Jmt, Vb, Nb, ÅsL, LyL, PL, LuL, TL. A very widely distributed species in cool temperate to temperate areas of the Northern Hemisphere (Europe, Asia, North America) also occurring in Australasia and Central and South America. Also recorded from high altitudes in Africa. – Map 30.

Note. Characterized by the usually well developed, PD–, granular to squamulose thallus, the faint white pruina on the excipulum and by having *Stichococcus* as a photobiont.

17. Chaenotheca xyloxena Nádv.

Repert. Spec. Nov. Regni Veg. 36: 308 (1934). – Type: Ukraine, Perečin, 1933 Nádvorník (BRA-Nádv., lectotype, Tibell, Symb. Bot. Ups. 23(1): 55, 1980).

D: ved-knappenålslav. **N:** puslenål. **S:** slank vednål.

Redlisted in: **D**.

Thallus immersed, sometimes revealed as a greenish or greyish tinge of the surface of the substrate. Ascomata medium-sized to long, 0.9–1.6 mm high. Stalk 0.04–0.08 mm diam., usually with a thick white pruina in the upper part. Lower part of stalk shining black. Capitulum 0.2–0.3 mm diam., obconical, with a well developed excipulum. The innermost, narrow part of the excipulum continuous with the stalk, consisting of periclinally arranged hyphae continuing into the outer part of the stalk. The thick outer part of the excipulum consists of swollen, anticlinally arranged hyphae. Hypothecium obconical, pale brown, with convex upper surface. Lower side of excipulum usually with a thick whitish pruina. Asci formed in chains, short cylindrical or of irregular shape, 8–13 × 2.0–3.0 µm. Spores uniseriately or irregularly arranged in the asci. Spores globose, 3–4 µm diam., smooth or with irregular, narrow cracks. Photobiont Stichococcus.

Chemistry. Thallus K–, C–, KC–, PD–. No secondary substances detected.

Habitat. On dry lignum of *Pinus*, *Picea*, *Betula* and *Quercus* in moderately shaded localities. More rarely on lignum of *Alnus*, *Sorbus*, *Ulmus*, *Populus*, and *Salix*.

Distribution. Having a slightly eastern distribution in Norway, occurring in most parts of Finland and Sweden. Rare in Denmark. **D:** Sjæ. **F:** A, V, U, EK, EH, PS, KiL, EnL, InL. **N:** Øf, Ak, He, Op, Bu, Vf, Ho, ST, NT, No, Tr. **S:** Sk, Bl, Sm, Vg, Ög, Srm, Vrm, Vsm, Upl, Dlr, Gst, Hls, Ång, Hrj, Jmt, Vb, Nb, LyL, LuL, TL. A widely distributed species in cool to temperate areas of the Northern (Europe, North America) and the Southern Hemisphere (New Zealand, South America. – Map 31.

Note. Characterized by the immersed thallus, the slender ascomata, the obconical capitula, the thick white pruina of

the excipulum and upper part of stalk, the thickened outer part of the excipulum consisting of anticlinally arranged, swollen hyphae and the association with *Stichococcus*.

Chaenothecopsis Vain.

Acta Soc. Fauna Fl. Fenn. 57(1): 70 (1927).

Literature: Schmidt, Mitt. Staatsinst. Allg. Bot. Hamburg 13: 111–166 (1970); Tibell, Nova Hedwigia Beih. 79: 664–666 (1984); Symb. Bot. Ups. 27(1): 117–165 (1987); Can. J. Bot. 69: 2427–2433 (1991); Nord. J. Bot. 13: 331–335 (1993); Tibell & Constantinescu, Mycol. Rev. 95: 556–560; Titov & Tibell, Nord. J. Bot. 13: 313–329 (1993); Tibell & Ryman, Nova Hedwigia 60: 199–218 (1995).

Saprobic or parasitic species without a lichenized thallus. Ascomata well stalked or sessile, black to brownish black or with a paler stalk. Capitulum obovoid to lenticular. Mazaedium not developed. Excipulum more or less well developed, consisting of dark brown, periclinally arranged hyphae. Hymenium covered by a thin, dark epithecium. Stalk formed by pale, intricately interwoven or by pericli-nally arranged, dark brown hyphae. Outer part of stalk formed by periclinally arranged dark brown, reddish or aeruginose hyphae. Asci formed singly from ascogenous hyphae with croziers, cylindrical to subclavate, 25–55 µm long, persisting until the spores are mature. Ascus apex strongly thickened and penetrated by a very thin canal or in some species with a short and wide canal or uniformly thickened, without canal. Spores non-septate or 1-septate, dark brown to pale brown or with an aeruginose tinge, ellipsoidal to fusiform. Spore wall medium thick, dark brown, smooth or with a minute verrucose ornamentation, but without irregular cracks. Conidiomata. Several types of anamorphs occur. Some species have small coelomycetous anamorphs (pycnidia) of simple structure, the anamorph in one instance belonging to Asterophoma. Stalked coelo-mycetous anamorphs also occur. Hyphomycetous ana-morphs occur in some species, both of a simple, Phialophora-like type and a rather complex, catenulate anamorph with rather large conidia belonging to Catenomycopsis. Conidiogenous cells of coelomycetous anamorphs simple, ellipsoidal to ovoid, with a thick pigment cap in the distal end, 5–7 × 3–4 µm. Conidia hyaline, ellipsoidal, 2.0–3.5 × 1.0 µm. Some of the anamorphs mentioned above have only been obtained in culture (Tibell & Constantinescu 1991, Tibell 1991, 1993a, 1995).

Chemistry. No secondary substances have been identified. Some species contain pigments which may or may not change colour with a change of pH yielding reactions with K and HNO_3 observable under the microscope. Some of the pigments dissolve into an aqueous medium. Sometimes pigment crystals occur in the ascomata. Some of the pigments yield coloured precipitates when 10% aqueous K or HNO_3 are added. The colour reactions range from reddish brown to yellowish or deep red to aeruginose or intensely green.

Note. The genus is cosmopolitan with many species occurring in cool temperate to temperate areas, while other species are restricted to the tropics. The species occur as saprobes, parasymbionts or parasites on a variety of lichens on bark and lignum. A few species inhabit siliceous rocks in shaded situations. Many occur on other calicioid species, particularly on Calicium and Chaenotheca. Other species occur as parasites on free-living algae or are saprobic on wood or on exudates of vascular plants. The taxonomy of Chaenothecopsis is still poorly understood and in need of further study.

1 Spores non-septate 2
– Spores 1-septate 7
2 Ascomata K+ green (squash preparations under the microscope) 3
– Ascomata K+ red or K– 4
3 Stalk covered by pruina-like, whitish hyphae, spores 7–9 × 3–4 µm, with a minute ornamentation ..... 15 *C. viridialba*
– Stalk not pruinose, sometimes dark red, spores 3.5–6.0 × 2.0–3.5 µm, smooth ..... 5 *C. haematopus*
4 Ascomata K+ red, sometimes fading fast 5
– Ascomata K– 6
5 Ascomata 0.4–0.7 mm high, well stalked, associated with Trentepohlia ..... 11 *C. rubescens*
– Ascomata 0.1–0.3 mm high, very short-stalked or sessile, parasitic or parasymbiotic on Lecanora and *Haematomma* ..... 6 *C. hospitans*
6 Ascomata minute, 0.4–0.6 mm high, spores fusiform, dark brown, 6.0–7.0 × 3.0–3.5 µm ..... 7 *C. nana*
– Ascomata 0.5–1.3 mm high, spores ellipsoidal with rounded ends, pale brown, 4.5–7.0 × 2.0–3.0 µm ..... 12 *C. savonica*
7 Ascomata K+ red or green in a fast fading reaction 8
– Ascomata K–, or only slightly intensified 10
8 Ascomata K+ red ..... 10 *C. pusiola*
– Ascomata K+ green 9
9 On the thallus of Chaenotheca chrysocephala, spores 7.0–9.0 × 2.5–3.0 µm1 ..... 1 *C. consociata*
– On free-living colonies of algae or as a parasite on lichens, but not on *Chaenotheca chrysocephala*, spores 6.0–7.0 × 2.5–3.5 µm ..... 16 *C. viridireagens*

10 Ascomata short-stalked or very short-stalked, often in groups and aggregated, 0.2–0.3 mm high, parastic or parasymbiotic on Haematomma ochroleucum ..... 13 *C. subparoica*

– Ascomata well-stalked 11

11 Ascomata including stalks HNO_3+ reddish or intensified 12

– Ascomata and stalks HNO_3– 13

12 Not associated with any alga, hypothecium brownish ....2 *C. debilis*

– Associated with Trentepohlia, hypothecium strongly aeruginose ..... 14 *C. vainioana*

13 Spores 8–10 µm long 14

– Spores 6–8 µm long 15

14 Ascomata 0.9–1.6 mm high, epithecium covered by a faint white pruina, saprobic on lignum .....4 *C. fennica*

– Ascomata 0.4–0.6 mm high, epithecium epruinose, shining black, associated with Trentepohlia or lichen thalli containing Trentepohlia as photobiont ... 14 *C. vainioana*

15 Septum poorly pigmented ..... 9 *C. pusilla*

– Septum distinct, at least as dark as the spore wall 16

16 On the thallus of Chaenotheca trichialis, hypothecium dark green, stalk in squash preparation re dish brown, spores medium brown, 6–8 µm long .....3 *C. epithallina*

– Associated with free-living algal colonies or other lichens, but not Chaenotheca trichialis, hypothecium brownish to greenish brown, stalk in squash preparations dark brown, spores very pale, greyish brown, 5–6 µm long..... .....8 *C. nigra*

1. Chaenothecopsis consociata (Nádv.) A.F.W. Schmidt

Mitt. Staatsinst. Allg. Bot. Hamburg 13: 148 (1970). – *Calicium consociatum* Nádv., Stud. Bot. Cech. 5: 10 (1942). – Type: Slovakia, V. Tatry, Strba-See, 1935 Nádvorník (not seen).

Literature: Tibell, Svensk Bot. Tidskr. 67: 450–451 (1973); Symb. Bot. Ups. 21(2): 111–115 (1975).

Occurring as a parasite or parasymbiont on Chaenotheca chrysocephala. Ascomata 0.7–1.2 mm high, black. Capitulum lenticular, 0.2–0.4 mm diam., often irregular and almost subdivided into smaller capitula, sometimes with a faint white pruina on the surface. Epithecium thin, reddish. Hypothecium 44–60 µm high, brownish to reddish brown. Excipulum 7–16 µm thick, consisting of intertwined and sclerotized reddish brown to brown hyphae. Epithe-cium, excipulum and hypothecium H–, K+ green, the reaction persisting. Hypothecium, excipulum and stalk with varying amounts of droplets or granular crystals containing a red pigment. Stalk 0.05–0.10 mm in diam., with dark reddish brown surface and a pale centre, consisting in the outermost part of a 6–9 µm thick layer of periclinally arranged, dark reddish brown hyphae surrounding a core of hyaline, largely periclinally arranged but somewhat intertwined, strongly gelatinized hyphae. Asci 33–41 × 2.5–3.0 µm, cylindrical, with a thickened apex penetrated by a thin canal and with uniseriate, periclinally arranged spores. Spores 1-septate, ellipsoidal, dark brown, 6–8 × 2.0–2.5 µm, appearing smooth under the light microscope. Septum poorly pigmented, less distinct than the spore wall.

Chemistry. No secondary substances have been identified. The red pigment of the ascomata reacts K+ green.

Habitat. Parasitic or parasymbiotic on the thallus of *Chaenotheca chrysocephala*. *Chaenothecopsis consociata* occurs mainly on trunks of old trees in old and humid conifer forests of the boreal and boreo-nemoral zone. The production of ascomata of *Chaenotheca chrysocephala* is sometimes inhibited in specimens attacked by *C. consociata.*

Distribution. Widely distributed in Sweden and not uncommon in some areas, probably overlooked in Norway and Finland. **F:** V, EH, PK, Kn, OP, Ks. **N:** He, Op, Te. **S:** Bl, Sm, Bh, Dls, Vg, Ög, Srm, Vrm, Vsm, Upl, Dlr, Gst, Hls, Hrj, Jmt, Vb, LuL. Widely distributed in the Northern Hemisphere. It is known also from Continental Europe, the Russian Far East, China and North America. – Map 32.

Note. The red, K+ green pigment of the ascomata, the rather large spores and the parasitic or parasymbiotic occurrence on *Chaenotheca chrysocephala* are characteristic for this species.

2. Chaenothecopsis debilis (Sm.) Tibell

Symb. Bot. Ups. 21(2): 45 (1975) – *Lichen debilis* Sm. in Smith & Sowerby, Engl. Bot. 35: tab. 2462 (1813). – Type: England, Henfield (BM, holotype).

D: ved-chaenothecopsis. **F:** liekoneulakka

Literature: Tibell, Symb. Bot. Ups. 21(2): 115 (1975).

Saprobic on lignum. Ascomata 0.7–1.2 mm high, black, shiny. Capitulum lenticular, 0.2–0.4 mm diam., sometimes with white, cottony hyphae on the lower side. Epithecium brown to reddish brown, 5–7 µm thick. Hypothecium 85–100 µm high, brownish or with a faint greenish tinge, HNO_3– or HNO_3+ slightly intensified reddish brown, K. Excipulum reddish brown, 10–35 µm thick, formed by up to eight layers of periclinally arranged hyphae. Sometimes the excipulum is poorly developed and only consists of

amorphous or sclerotized material. Excipulum and epithecium HNO_3– or HNO_3+ slightly intensified reddish brown, K–. Stalk 0.04–0.10 mm diam., the surface often with a distinct reddish tinge in section and HNO_3+ intensified reddish to violet red in a fast and transient reaction, K+ greyish red or sometimes K–. Central part of stalk consisting of pale, slightly branched but largely periclinally arranged hyphae. Outer part of stalk reddish to reddish brown, consisting of strictly periclinally arranged hyphae. Asci 40–48 × 2.5–3.5 µm, cylindrical, with a thickened apex penetrated by a thin canal. Spores 1-septate, medium brown, ellipsoidal and with a distinct septum, 7.0–9.0 × 2.5–3.0 µm, appearing smooth under the light microscope or having a very minute, areolate ornamentation. Conidio-mata pycnidial, not uncommon, occurring on wood along with the teleomorph. Pycnidia black, subspherical to elongated, flattened and orientated along the fibres of the wood, 0.1–0.2 × 0.1 mm, with a central ostiolum on a small papilla when mature, but later often with a longitudinal split. Conidiogenous cells ellipsoidal, 5–8 × 1–2 µm, with a collarette, producing conidia apically. Conidia hyaline, distinctly curved, 3–6 × 1 µm.

Chemistry. No secondary substances have been identified. The ascomata contain a reddish pigment, which turns more intensely red with HNO_3 and greyish red with K. Sometimes the pigment concentration is very low and the reactions hard to detect or failing.

Habitat. On decorticated trunks in exposed situations, particularly on lignum of *Betula*, *Pinus* and *Picea*, also known from lignum of *Fraxinus*, *Acer*, *Populus*, *Alnus*, *Sorbus*, *Tilia*, *Ulmus* and *Quercus*. Rarely on bark of *Betula*.

Distribution. Widely distributed and not uncommon in Finland, Norway and Sweden. Rare in Denmark. **D:** Sjæ. **F:** A, V, U, EK, St, EH, EP, PH, PS, KP, Kn, KiL, SoL, EnL. **N:** Ak, He, Op, Te, AA, Ho, No, Tr, Fi. **S:** Sk, Bl, Gtl, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Gst, Hls, Ång, Hrj, Jmt, Vb, Nb, ÅsL, LyL, LuL, TL. Widely distributed in cool temperate and temperate areas of both the Northern (Eurasia, North America) and the Southern Hemisphere (Australasia, Central and South America). – Map 33.

Note. Characterized by the one-septate, medium-sized spores with distinct septum, the reddish brown colour of the epithecium, excipulum and outer part of the stalk and the HNO_3+ red reaction of the stalk. *Chaenothecopsis debilis* varies considerably in ascoma size.

3. Chaenothecopsis epithallina Tibell

Symb. Bot. Ups. 21(2): 116 (1975). – Type: Sweden, Dalarna, Hamra par., Hamra National Park, 1973 Tibell 5449 (UPS, holotype).

Occurring as a parasite or parasymbiont on the thallus of Chaenotheca trichialis. Ascomata 0.7–1 mm high, black. Capitulum lenticular, 0.2–0.3 mm diam Epithecium thin, brown. Hypothecium 60–80 µm high, aeruginose, continuous with the upper part of the stalk. Excipulum 6–10 µm thick, consisting of periclinally arranged, slightly intertwined, brown hyphae. Epithecium, excipulum and hypothecium H–, K–. Stalk 0.05–0.07 mm diam., black, consisting of an outer, 6–9 µm thick layer formed by strongly sclerotized, dark brown hyphae, while the inner part is formed by irregularly interwoven, non-pigmented and swollen hyphae. In the upper part of the stalk, however, the hyphae of the central part of the stalk tend to be periclinally arranged. Asci 31–38 × 2.0–3.0 µm, cylindrical, with a thickened apex penetrated by a thin canal. Spores 1-septate, ellipsoidal, medium brown, 6.0–8.0 × 2.0–2.5 µm, appearing smooth under the light microscope, periclinally or slightly obliquely arranged, uniseriate or slightly overlapping. Spore septum of about the same contrast as the outer spore wall.

Chemistry. No secondary substances have been identified. The aeruginose pigment of the ascomata is K–.

Habitat. Parasitic or parasymbiotic on thallus of *Chaenotheca trichialis* on trunks of old trees, mainly *Picea abies*, in old and humid conifer forests. It also occurs on lignum of *Picea*, *Pinus*, *Quercus* and *Populus*, on bark of *Betula*, *Quercus* and *Salix caprea*.

Distribution. Not rare in central and northern Sweden. Also known from southern central Norway and Finland. **F:** V, Ks. **N:** He, Op. **S:** Sm, Ög, Vrm, Upl, Dlr, Hls, Hrj, Jmt, Vb, Nb, ÅsL, LyL, PL, LuL. Widely distributed in the Northern Hemisphere. It is also known from Continental Europe, the British Isles and North America. – Map 34.

Note. Characterized by the 1-septate spores, the aeruginose hypothecium and by being parasitic or parasymbiotic on *Chaenotheca trichialis*.

4. Chaenothecopsis fennica (Laurila) Tibell

Publs Herb. Univ. Uppsala 1: 6 (1978). – *Embolidium fennicum* Laurila, Ann. Bot. Soc. Zool.-Bot. Fenn. Vanamo 15: 10 (1940). – Type: Russia, Murmansk Region, Salla, Tuntsa River, Mt Hassersokka, 1938 Laurila (H, holotype).

S: blågrå svartspik.

Literature: Tibell, Lichenologist 10: 172–174 (1978).

Saprobic on lignum. Ascomata 1.4–1.7 mm high, black, except for the surface of the capitulum which is covered by a faint bluish white pruina. Capitulum lenticular, 0.3–0.4 mm diam. Epithecium dark brown, 4–7 µm thick, H+ reddish brown. Hypothecium 100–125 µm high, medium brown, consisting of radiating, slightly intertwined hyphae, H+ reddish brown, K–. Excipulum dark brown, 20–50 µm thick, thickest at the base. The excipulum is in the innermost part formed by periclinally arranged, narrow hyphae forming a thin layer. Then outer part of the excipulum consists of 2–5 layers of irregular, more or less isodiametric cells, 3–6 µm diam., with thickened and sclerotized walls. Between these layers there is a layer of periclinally arranged to intertwined hyphae with thickened walls which is particularly prominent towards the base of the exci-pulum. Excipulum H+ intensified reddish brown, K. Stalk 0.08–0.10 mm diam., the surface dark reddish brown, 6–12 µm thick, H+ brownish red. Central part of stalk consisting of pale, slightly branched but largely periclinally arranged hyphae. Asci 46–54 × 2.5–3.0 µm, cylindrical, when mature with the apex being strongly thickened. The canal penetrating the apex is narrow in young asci only and later becomes strongly widened. Spores 1-septate, medium brown, ellipsoidal and with septum of similar contrast as the outer wall, septum, 7.5–9.0 × 2.5–3.0 µm, appearing smooth under the light microscope.

Chemistry. No secondary substances have been identified. The ascomata contain a pigment, which turns reddish brown with HNO_3.

Habitat. On decorticated, still standing trunks of old *Pinus sylvestris* in exposed situations, particularly along the edge of bogs. Occasionally on lignum of *Picea abies*. Often growing together with *Calicium denigratum*.

Distribution. Widely distributed but only locally abundant in continental areas of Norway and northern and central Sweden. **N:** *Ak*, *He*, *Op*, *Fi*. **S:** *Vrm*, *Dlr*, *Hls*, *Ång*, *Jmt*, *Vb*, *Nb*, *LyL*, *PL, LuL*. It also occurs in Russia, close to the Finnish border, but seems to be endemic to Northern Europe. – Map 35.

Note. Characterized by the large ascomata with a bluish pruina on the surface of the capitula, the one-septate, large spores with distinct septum and the large asci with strongly widened canal.

5. Chaenothecopsis haematopus Tibell

Symb. Bot. Ups. 27(1): 126 (1987). – Type: New Zealand, South Island, Otago, 26 km W of Owaka, 1981 Tibell 10328 (UPS, holotype).

S: rödskaftad svartspik.

Literature: Tibell & Constantinescu, Mycol. Res. 95: 556–560 (1991).

Saprobic on lignum of conifers, algae not present in the substrate. Ascomata large, 0.8–3.2 mm high. Capitulum subspherical to hemispherical, 0.1–0.3 mm diam., black. Epithecium greenish brown, hypothecium ca 0.1–0.2 mm high, containing red pigment crystals. Excipulum poorly developed. Stalk 0.03–0.10 mm thick, strongly red to greyish brown, containing numerous red crystals. Stalk consisting mainly of periclinally arranged hyphae, brown in outer part and pale in the central part. All red pigmented parts of the ascoma K+ aeruginose, H–. Asci 29–35 x 3–4 µm with thickened apex penetrated by a thin canal. Spores uniseriately arranged in the asci, obliquely orientated in semi-mature asci and more periclinally in mature asci. Spores non-septate, ellipsoidal with rounded ends, pale, 3.5–6.0 × 2.0–3.5 µm, smooth. The hyphomycetous anamorph Catenomycopsis rosea has been obtained from cultures of C. haematopus. Conidiophores up to 0.5 mm high, mononematous, simple, consisting of a few to numerous, hyaline, cylindrical cells with thick walls and constrictions at the septa. Conidia holoblastic, non-septate, hyaline, ellipsoidal, thick-walled, 4–11 × 2–3 µm arranged in acropetal simple or branched chains.

Chemistry. No secondary substances have been identified. The ascomata contain a red, K+ green pigment.

Habitat. On lignum of *Picea abies* and *Betula* in shaded situations in old, humid Picea forests.

Distribution. Rare in Scandinavia and only known from two localities in northern Sweden, but probably overlooked. **F:** U. **S:** Vb, LyL. The species was originally described from Australasia but has later also been reported from the Far East of Russia and from South America. – Map 36.

Note. A very variable species. In the Southern Hemisphere often characterized by its large ascomata and the flexuous, often dark red stalks. In Sweden, however, the specimens have had rather small capitula and blackish to grey, straight stalks. The non-septate, pale and smooth spores with rounded apices and the K+ aeruginose reaction of its red pigment are characteristic as is its unique anamorph, Catenomycopsis, which has also been obtained in cultures from Swedish collections.

6. Chaenothecopsis hospitans (Th.Fr.) Tibell

Nova Hedwigia 60: 202 (1995). – *Calicium hospitans* Th.Fr., Bot. Notiser 1865: 40 (1865). – TYPE: Sweden, Uppland, Tibble, 1864 Almquist (UPS, lectotype, Tibell & Ryman, Nova Hedwigia 60: 202, 1995).

Syn. *Chaenothecopsis exserta* (Nyl.) Tibell

Literature: Tibell 6 Ryman, Nova Hedwigia 60: 202–206 (1995).

Usually parasitic or parasymbiotic on lichens. ASCOMATA often agglomerated in groups of 3–8. When growing on Lecanora the ascomata mainly occur on the ascomata of the host, but sometimes also on the thallus. They usually develop on the thalline margin of the host ascomata, but soon more or less cover the entire host ascoma. Ascomata very short-stalked or almost sessile, 0.2–0.3 mm high, black. Capitulum black, hemispherical to lenticular, 0.16–0.24 mm diam. Epithecium hyaline. Hypothecium hyaline, mainly consisting of radiating hyphae with thin-walled, elongated cells. Excipulum in the lowermost and outer part greyish green, 10–14 µm thick, consisting of 3–4 layers of periclinally arranged, 2–3 µm wide hyphae. Stalk sometimes very short, but sometimes more well-developed, 0.06–0.10 mm wide and 0.1–0.2 mm high, dull, black or pale at the base. In section hyaline or with a slight greenish grey pigmentation in the uppermost and outer part, consisting of thin-walled, isodiametric cells, 3.5–6.0 µm diam intermingled with large and elongated cells up to 11 x 4 µm large. All parts of the ascomata HNO_3–. Excipulum and stalk with varying amounts of a yellowish to red pigment which gives a strong, transient K+ red reaction. Asci 43–54 × 4–5 µm, cylindrical, with a thickened apex penetrated by a short, soon widened and in longitudinal section broadly triangular canal. Spores uniseriately arranged in the asci, periclinally to obliquely and irregularly orientated, dark brown, slightly fusiform to broadly ellipsoidal, 8–10 × 4–5 µm, non-septate and with a minute ornamentation under the light microscope.

Chemistry. No secondary substances have been identified. The ascomata contain a yellowish to red pigment which turns intensely red with K in a fast fading reaction.

Habitat. Grows as a parasite or parasymbiont on the thallus of Lecanora carpinea on bark of deciduous trees. It has been recorded from bark of *Fraxinus excelsior* and *Sorbus aucuparia*. It also grows on *Haematomma ochroleucum* var. ochroleucum and *H. ochroleucum* var. *porphyrium* on siliceous rocks in shaded situations.

Distribution. Rather rare in southern Finland and southern Sweden. **F:** A, V, St, EH. **S:** Bl, Bh, Ög, Nrk, Vrm, Upl. Also known from Central Europe. – Map 37.

Note. Characterized by having non-septate, slightly fusiform to broadly ellipsoidal spores and the occurrence of a yellowish to red, K+ red pigment in the ascomata.

7. Chaenothecopsis nana Tibell

Publs Herb. Univ. Uppsala 4: 4 (1979). – TYPE: Sweden, Norrbotten, Tärendö par., Rissa Nature Reserve, 1977 Tibell 6850 (UPS, holotype).

F: pikkuneulakka. **S:** liten svartspik.

Literature: Tibell, Lichenologist 13: 54–57 (1981).

Saprobic on bark. ASCOMATA small, 0.4–0.6 mm high, black. Capitulum broadly obovate to lenticular, 0.15–0.23 mm diam. Epithecium reddish brown. Hypothecium pale aeruginose to brownish. Excipulum poorly developed in mature ascomata. In young ascoma it is 11–14 µm thick and consists of 5–6 layers of periclinally arranged, medium brown hyphae formed as a continuation of the outermost stalk tissue. Stalk 0.04–0.05 mm diam., consisting of largely periclinally arranged hyphae. Outermost part of stalk brownish to greenish brown, central part of stalk pale. In the lower part of the stalk the hyphae are more irregularly arranged. All parts of the ascomata HNO_3–, K–. Asci 26–33 × 3–4 µm, cylindrical, with an apical thickening penetrated by a narrow canal. The spores are usually very densely and obliquely orientated in the semi-mature asci, whereas in mature asci they assume a periclinal arrangement. Spores non-septate, fusiform, medium to dark brown, 6.0–7.0 × 2.5–3.5 µm, in the light microscope with a distinctive, areolate ornamentation.

Chemistry. No secondary substances have been identified and no pigments found.

Habitat. Almost exclusively of spruce bark in boreal, humid forests. It has also been recorded from *Pinus sylvestris*, *Quercus robur* and lignum.

Distribution. Not uncommon in the northern parts of Sweden, more rare in the central and southern parts. Also known from Finland and Norway, but probably overlooked. **F:** Ks. **N:** Op, ST, NT, No. **S:** Vrm, Upl, Dlr, Gst, Hls, Hrj, Jmt, Vb, Nb, ÅsL, LyL, PL, LuL. Widely distributed and occurring in both hemispheres (Eurasia, North America, Australasia, South America). – Map 38.

Note. Characterized by having small, black ascomata, by the negative K reaction and the non-septate, dark, fusiform spores which are obliquely arranged in the semi-mature asci.

8. Chaenothecopsis nigra Tibell

Symb. Bot. Ups. 27(1): 132 (1987). – Type: New Zealand, Canterbury, 1980 Tibell 10085 (UPS, holotype).

Literature: Tibell, Symb. Bot. Ups. 27,1: 132–135 (1987).

Parasitic on colonies of algae or parasitic/parasymbiotic on the thallus of Chaenotheca species. Ascomata black, intermediate, 0.7–1.1 mm high. Capitulum lenticular to hemispherical, 0.18–0.30 mm in diam. Epithecium reddish brown to brown. Hypothecium greenish brown to dark brown, 90–110 µm high. Excipulum poorly developed, slightly yellowish to greenish brown, 8–10 µm thick, consisting of 3–4 layers of periclinally arranged hyphae. Stalk black, 0.04–0.08 mm in diam., consisting of periclinally arranged hyphae measuring c 1–2 µm in diam. The outermost part of the stalk is dark brown, while the inner part is greenish brown to pale Epithecium K+ slightly intensified reddish brown. Stalk, excipulum and hypothecium K+ slightly yellowish brown. All parts of the ascoma HNO_3– or slightly intensified in colour. Asci cylindrical, 31–37 × 1.5–2.0 µm, with a thickened apex penetrated by a fine canal. Spores uniseriately and periclinally arranged in the asci. Spores very pale greyish brown, ellipsoidal, 1-septate 5.0–6.0 × 1.5–2.0 µm, smooth. The septum is strongly pigmented and conspicuously darker than the outer spore wall. Conidiomata unknown.

Chemistry. No secondary substances known No strong pigment reactions.

Habitat. Growing with *Chaenotheca* species or poorly lichenized, possibly decaying algal colonies on lignum of *Betula* and *Pinus*, and on bark and lignum of *Picea* in old forests with high humidity.

Distribution. Probably overlooked. Only known from rather few localities. **F:** EH. **S:** Bh, Srm, Jmt, Vb, LyL. Also occurring in cool temperate areas of the British Isles, Central Europe and Australasia. – Map 39.

Note. Characterized by its pale spores, the dark septum of the spores and the periclinally arranged, thin and dark stalk hyphae. Erroneously reported as Chaenothecopsis tas-manica by Tibell,. Nord. J. Bot. 12: 434 (1992).

9. Chaenothecopsis pusilla (Ach.) A.F.W. Schmidt

Mitt. Staatsinst. Allg. Bot. Hamb. 13: 151 (1970). – *Calicium claviculare* **pusillum* Ach., K. Vetensk.-Acad. Nya Handl. 1808: 279 (1808). – Type: Sweden, Västerbotten, Vindeln par., Kulbäcksliden Nature Reserve, 1989 Tibell 18565 (UPS, neotype, Tibell, Flora Neotropica 69: 46, 1996).

Syn. *Chaenothecopsis subpusilla* (Vain.) Tibell, *Chaenothecopsis parasitaster* (Bagl. & Carestia) D.Hawksw.

D: liden chaenothecopsis.

Redlisted in: **D**.

Saprobic or parasitic on free living algae, lichens, lignum or bark. Ascomata 0.5–0.9 mm high, epruinose, or occasionally with a faint white pruina on the surface of the ascoma. Stalk black or sometimes pale greenish, brownish or grey in the lower part becoming darker in the upper part. Capitulum lenticular, 0.2–0.3 mm diam. Epithecium thin, greenish to brown in section. Hypothecium 85–110 µm high, pale or greenish to brownish. Excipulum 8–14 µm thick, consisting of 3–4 layers of largely periclinally arranged, greenish to brown hyphae. Stalk 0.04–0.08 mm diam. The outer part of the stalk brown to greenish, consisting of periclinally arranged, sclerotized hyphae. Inner part of the stalk hyaline, in the upper part consisting of largely periclinally arranged hyphae, whereas in the lower part the hyphae are irregularly intertwined. The stalk swells strongly in K. All parts of the ascoma HNO_3– and K– or with slightly intensified colouration. Asci 36–45 × 2.0–3.0 µm, cylindrical, with the apex strongly thickened and penetrated by a thin canal. Spores 1-septate, ellipsoidal, medium brown, 6.0–7.0 × 2.0–2.5 µm, smooth. Septum thin and with less contrast than the wall.

Chemistry. No secondary substances have been identified. The ascomata contain varying amounts of greenish and brown pigments, which neither react with HNO_3 nor with K.

Habitat. On lignum of conifers and deciduous trees (*Alnus*, *Betula*, *Fagus*, *Quercus*, occasionally on bark of *Picea*, and *Populus*. Sometimes on squamules of *Cladonia species*, on *Hypocenomyce* and soil in rather shaded situations. Often occurring in mosaics with several other calicioid species and then possibly parasitic on *Calicium* species.

Distribution. Known from rather few localities only in Denmark, Finland and Norway, but probably overlooked. Not uncommon in Sweden. **D:** Sjæ. **F:** U, EK, EH, PH, PS, PK, PeP, Ks, InL. **N:** Øf, Ak, He, Op, Te, Ho, No, Tr. **S:** Bl, Öl, Gtl, Sm, Dls, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Hls, Mpd, Ång, Hrj, Jmt, Vb, Nb, ÅsL, LyL, PL, LuL, TL. Widely distributed in the Northern Hemisphere (Eurasia, North America), also occurring in Australasia and Central and South America. – Map 40.

Note. Characterized by its 1-septate, smooth spores, the thin and poorly pigmented septum, the frequently pale colour

of the lower part of the stalk, and the negative reactions with K and HNO_3. This is probably a complex of species which has as yet not been resolved.

10. Chaenothecopsis pusiola (Ach.) Vain.

Acta Soc. Fauna Fl. Fenn. 57(1): 70 (1927). – Calicium pusiolum Ach., K. Vetensk.-Acad. Handl. 1817: 231 (1817). – TYPE: Without locality (H-ACH 476, holotype).

Syn. Chaenothecopsis lignicola (Nádv.) A.F.W. Schmidt

On thalli of Chaenotheca species or on free-living colonies of algae. ASCOMATA 0.3–0.5 mm high. Capitulum lenticular to hemispherical, black, 0.15–0.22 mm diam. Epithecium thin, medium brown. Hypothecium 55–65 µm high, hyaline to yellowish brown. Excipulum well developed, consisting of periclinally arranged, interwoven hyphae, 5–9 µm thick. Stalk 0.03–0.05 mm diam. Outermost layer of stalk medium brown, 3–6 µm thick, consisting of irregularly intertwined hyphae. Inner part of stalk hyaline, consisting of largely periclinally arranged, somewhat intertwined hyphae. Inner part of stalk with varying amounts of a yellowish to reddish pigment. All brown or yellowish/reddish pigmented parts of the ascoma K+ red, but the reaction fades fast and the tissue turns greenish brown. Asci 34–45 × 2.0–3.0 µm. Spores 1-septate, ellipsoidal, pale brown, 6.0–7.0 × 2.0–2.5 µm, smooth with poorly pig-mented septum.

Chemistry. No secondary substances have been identified. The ascomata contain varying amounts of a yellowish to red pigment which yields a strong K+ red, fast fading reaction.

Habitat. Occurs on lignum of *Picea* and *Pinus* in coniferous forests or less often on lignum of deciduous trees (*Alnus*, *Betula*, *Populus*, *Quercus*, *Salix*, *Sorbus*). It is often found associated with *Chaenotheca gracillima*, *C. trichialis* and *C. xyloxena* and appears to be a parasite or parasymbiont on these species. In Kuusamo it occasionally occurs on mosses.

Distribution. Not uncommon in Finland, Norway and Sweden. **F:** U, St, EH, ES, PH, PS, PK, Kn, PeP, Ks, KiL, SoL, InL. **N:** He, Op, SF, ST, NT, No. **S:** Gtl, Sm, Vg, Vrm, Vsm, Upl, Dlr, Gst, Hls, Ång, Hrj, Jmt, Vb, Nb, ÅsL, LyL, PL, LuL. Widely distributed in the boreal zone of the Northern Hemisphere (Continental Europe, the British Isles, Asia, North America) and also known from New Zealand. – Map 41.

Note. Recognized by the presence of a yellow pigment in the ascomata which yields a red, rapidly fading reaction with K and the small 1-septate smooth spores with a poorly pigmented septum.

11. Chaenothecopsis rubescens Vain.

Acta Soc. Fauna Fl. Fenn. 57(1): 71 (1927). – TYPE: Finland, Tavastia australis, Hollola, Tiirismaa, 1873 Vainio (TUR-V 29621, holotype).

Associated with *Trentepohlia*. ASCOMATA 0.4–0.7 mm high. Capitulum lenticular, black, 0.1–0.3 mm diam. Epithecium thin, medium brown. Hypothecium 70–95 µm high, hyaline to yellowish brown, particularly towards the base. Excipulum 6–10 µm thick, consisting of 3–4 layers of periclinally arranged, more or less interwoven hyphae, dark yellowish brown. Stalk 0.04–0.07 mm diam., shiny, consisting of periclinally arranged hyphae, medium brown. Inner part of stalk with pale hyphae, which in the central part contain varying amounts of yellowish to reddish pigment. Outermost part of stalk dark yellowish brown. Towards the base the stalk consists of irregularly arranged hyphae. All brown or yellowish/reddish pigmented parts of the ascoma K+ persistently red. Asci 31–37 × 3.0–3.5 µm. Spores non-septate, allantoid to ellipsoidal, medium brown, 7.0–9.0 × 3.0–3.5 µm, with a distinctive, minute ornamentation visible at high magnifications in the light microscope.

Chemistry. No secondary substances have been identified. The ascomata contain varying amounts of a yellowish to red pigment which yields a K+ red, persisting reaction.

Habitat. In Northern Europe only recorded from bark of *Alnus*, but in Asia also known from the bark of other deciduous and rarely coniferous trees in cool temperate and temperate forests.

Distribution. In Northern Europe only known from a small area in southern Finland where it was collected in the latter part of the 19th century. **F:** EH. Also known from Central Europe, Asia and North America. – Map 42.

Note. Characterized by its non-septate spores, the ornamented spores, the occurrence of a yellowish pigment which reacts K+ persistently red and the association with Trentepohlia.

12. Chaenothecopsis savonica (Räsänen) Tibell

Nova Hedwigia Beih. 79: 666 (1984). – *Mycocalicium savonicum* Räsänen, Lichenotheca Fenn. no 296, Schedae ad fasc. VII–IX: 26, 1947. – TYPE: Finland, Savonia borealis, Pielavesi, 1947 Huuskonen (Räsänen, Lichenoth Fenn. no 296, H, lectotype; designated on p. 72).

Literature: Tibell, Can. J. Bot. 69: 2427–2433 (1991).

Parasitic or parasymbiotic on lichen thalli or parasitic on free-living algal colonies on lignum. Ascomata 0.4–0.8 mm high, black or with a slight greenish hue, epruinose. Capitulum spherical to lenticular, 0.1–0.3 mm diam. Epithecium thin, aeruginose to brownish. Hypothecium aeruginose to slightly brownish. Excipulum poorly developed, consisting of a few layers of hyphae and formed as a continuation of the outermost part of the stalk, normally restricted to the base of the capitulum only. Stalk slender, 0.03–0.05 mm diam., consisting of periclinally arranged, somewhat intertwined and flexuous, greenish to brown hyphae. Central part of stalk with pale hyphae. Outer part of stalk, epithecium, and excipulum with a greenish or brownish green pigment, and these parts turn yellowish brown with K and intensified greenish with HNO_3. When the brownish colour dominates there is no reaction with K and HNO_3. Asci small, 28–37 × 2.0–3.0 µm, cylindrical and with the apex strongly thickened and penetrated by a narrow canal. Spores non-septate, ellipsoidal with rounded ends, pale greenish brown, 5.0–7.0 × 2.0–2.5 µm, smooth under the light microscope. Anamorphs. Two anamorphs occur. The coelomycetous anamorph is known from the field. Conidiomata black, solitary, 0.03–0.04 mm diam., with a slimy droplet of exuded conidia at the ostiolum, occurring on the wood or occasionally on decaying ascomata. Conidioma wall consisting of one layer of radially arranged conidiogenous cells. Conidiogenous cells with a thickened, strongly pigmented wall. Conidia hyaline, 2.0–3.5 × 1.0 µm, slightly truncate at the proximal end. A hyphomycetous anamorph is known from cultures, where conidia are formed singly or in groups of lateral branches or at the end of undifferentiated hyphae. These conidia are hyaline, ellipsoidal to dacryoid, 3.0–3.5 × 1.0–2.0 µm.

Chemistry. No secondary substances have been identified. The ascomata contain a greenish pigment that turns brownish with K and becomes intensified upon the addition of HNO_3.

Habitat. Occurring on thalli of *Chaenotheca* or free-living colonies of algae on lignum of both conifers (Picea, Pinus) and deciduous trees (*Alnus*, *Betula*, *Corylus*, *Quercus*, *Sorbus*, *Tilia*), more rarely on decaying bark.

Distribution. Widely distributed and not uncommon in Finland, Norway and Sweden. **F:** V, U, EH, PS, InL. **N:** Op, Vf, VA, No, Tr. **S:** Öl, Sm, Bh, Vg, Ög, Vrm, Vsm, Upl, Dlr, Jmt, ÅsL, LyL, LuL. Widespread in cool temperate and temperate areas of the Northern Hemisphere (Continental Europe, Asia, North America) and also in Australasia and South America. – Map 43.

Note. Characterized by its pale, non-septate spores, which have rounded ends, the frequently aeruginose tinge of the stalk and hypothecium, the small asci and the periclinal arrangement of hyphae in the stalk. It is similar to *C. pusilla*, which differs in having darker brown, 1-septate spores.

13. **Chaenothecopsis subparoica** (Nyl.) Tibell

Nova Hedwigia 60: 215 (1995). – *Calicium subparoicum* Nyl., Herbarium Musei Fennici: 78 (1859). – Type: Russia, Hogland, 1851 Nylander (H, holotype).

Literature: Tibell, Svensk Bot. Tidskr. 67: 446 (1973); Tibell & Ryman, Nova Hedwigia 60: 215–216.

Parasitic on thallus of Haematomma. Ascomata solitary or in groups of up to 7–8, sometimes densely aggregated, 0.2–0.3 mm high, short-stalked to very short-stalked, black. Capitulum black, hemispherical to lenticular, 0.2–0.3 mm diam. Epithecium dark brown. Hypothecium consisting of light yellowish brown, thin-walled cells of irregular shape. Excipulum aeruginose, 6–10 µm thick, consisting of 2–3 layers of dark cells, ca 2 µm diam. Stalk black, dull, short, 0.06–0.08 mm wide, consisting of light yellowish-brownish largely periclinally arranged, intertwined hyphae. The outermost part of the stalk with strongly sclerotized and intertwined hyphae. All parts of the ascomata HNO_3–, K. Asci 40–52 × 3.5–5 µm, cylindrical, with the apex penetrated by a short and soon widened canal. Spores uniseriately arranged in the asci, often somewhat overlapping and periclinally or slightly irregularly orientated. Spores brown, 7.0–8.0 × 2.5–4.0 µm, 1-septate, ellipsoidal, with a minute, irregular ornamentation under the light microscope. Septum distinct and of similar contrast as the outer wall.

Chemistry. No secondary substances have been identified. The ascoma contain no pigments reacting with K or HNO_3.

Habitat. On *Haematomma ochroleucum* var. *porphyrium* growing on steep rocks in shaded and humid situations.

Distribution. Rare in Finland and Sweden. **F:** V, St, EH, PK. **S:** Sm, Bh, Vg, Upl, Dlr, Gst, ÅsL. Also known from Russia, France and Italy. – Map 44.

Note. Characterized by having very short stalked ascomata, the 1-septate spores and an aeruginose, K– epithecium, excipulum and stalk.

14. Chaenothecopsis vainioana (Nádv.) Tibell

Publs Herb. Univ. Uppsala 4: 5 (1979). – *Calicium vainioanum* Nádv., Preslia 18–19: 128 (1940). – Type: Czech Republic, Hrádek, 1922 Suza (not seen).

D: Vainios chaenothecopsis.

Redlisted in: **D**.

Literature: Tibell, Lichenologist 13: 57–59 (1981).

Parasitic or parasymbiotic on colonies of algae or lichen thalli containing Trentepohlia. Ascomata 0.4–0.6 mm high, black, stalk sometimes with a slightly brown tinge. Capitulum broadly obovate, 0.2–0.3 mm diam Epithecium reddish brown. Hypothecium obconical, dark aeruginose, 40 –65 µm high. Excipulum reddish brown, 8–14 µm thick, formed as a continuation of the cortex of the upper part of the stalk, consisting of 5–8 layers of largely periclinally arranged but intertwined hyphae. All parts of the ascomata K+ yellowish brown. Excipulum, epithecium and outermost part of the stalk HNO_3+ slowly intensified reddish brown. Stalk 0.04–0.07 mm diam. Outer part of stalk dark reddish brown, 5–8 µm thick, consisting of irregularly intertwined hyphae. Central part of stalk consisting of pale, largely periclinally arranged hyphae. Asci cylindrical, 40–52 × 3–4 µm, with a thickened apex penetrated by a thin canal. Spores 1-septate, medium brown, ellipsoidal and with a distinct septum, 8.0–10.0 × 2.5–3.5 µm, appearing smooth under the light microscope.

Chemistry. No secondary substances have been identified. The ascomata contain a reddish pigment, which turns more intensely red with HNO_3 and yellowish brown with K.

Habitat. On bark of Quercus and occasionally *Alnus*, *Fraxinus*, *Juniperus*, in southern Scandinavia, rarely on lignum. In northern Sweden on lignum of *Betula*, *Picea* and then often together with *Arthonia vinosa* and possibly parasitic or parasymbiotic on this species. Sometimes ascomata of *C. vainioana* are developed on the ascomata of *A. vinosa*.

Distribution. Recorded only from a few localities in Denmark and Norway, not uncommon on *Quercus* in southern Sweden. Rare on lignum in northern Sweden. **D:** NJy. **F:** A, V, U, St, EH. **N:** Op, Vf, SF, NT. **S:** Bl, Öl, Gtl, Sm, Hl, Vg, Ög, Nrk, Srm, Vrm, Upl, Dlr, Gst, Ång, Jmt, ÅsL, LyL, LuL. Known only from temperate parts of northern Europe. – Map 45.

Note. Characterized by the one-septate, rather large spores with distinct septum, the usually aeruginose hypothecium, the reddish brown colour of the epithecium, excipulum and outer part of the stalk and the HNO_3+ slowly intensified red brown reaction of these tissues. It is similar to *C. debilis* but differs in being associated with *Trentepohlia*, the strongly aeruginose hypothecium, in the slow, HNO_3+ intensified red brown reaction of the stalk rather than the rapid, violet reaction of *C. debilis*, and the irregular arrangement of the outermost stalk hyphae.

15. Chaenothecopsis viridialba (Kremp.) A.F.W. Schmidt

Mitt. Staatsinst. Allg. Bot. Hamburg 13: 143 (1970). – *Calicium viridialbum* Kremp. in Arnold, Flora 53: 482 (1870). – Type: Germany, Bavaria, Ramsau, 1864 Krempelhuber (not seen).

F: kuusenneulakka. **S:** vitskaftad svartspik.

Redlisted in: **S**.

Literature: Tibell, Svensk Bot. Tidskr. 67: 451 (1973).

Ascomata 1.1–1.8 mm high, with black capitula and greyish white stalks. Capitulum lenticular in young ascomata, but soon hemispherical and often irregular, black, 0.2–0.3 mm diam. Epithecium thin, brownish. Hypothecium consisting of branched and intertwined hyphae, pale, but with varying amounts of yellowish red pigment in the lower part, 80–110 µm high. Excipulum poorly developed, forming a short collar at the base of the capitulum, 8–14 µm thick, consisting of 4–6 layers of periclinally arranged and ± interwoven hyphae, reddish brown from abundant occurrence of a yellowish red pigment. Stalk 0.06–0.09 mm diam., pale in the central part, consisting of periclinally arranged hyphae. Outer part of stalk with irregular surface, aeruginose. The outermost layers of hyphae die and turn whitish and thus an irregular layer of senescent tissue is formed that renders the stalk an uneven, pruina-like surface and pale colour. All parts of the ascoma which contain the red pigment turn K+ aeruginose. In some ascomata, however, there is very little pigment or none. Asci 40–49 × 3–4 µm, cylindrical. Spores uniseriately arranged in the asci, periclinally or slightly obliquely orientated. Spores non-septate, ellipsoidal, medium to dark brown, 7.0–9.0 × 3.0–4.0 µm, with a distinctive minute ornamentation visible at high magnification under the light microscope.

Chemistry. No secondary substances have been identified. Parts of the ascomata containing a red K+ aeruginose pigment.

Habitat. Occurs in shaded and humid situations on bark and lignum of *Picea abies* and rarely on bark of *Alnus*, *Betula* and *Salix caprea* in cool temperate forests with long continuity. Often found on decaying, dry twigs of P. abies. Sometimes overgrowing *Chaenotheca chrysocephala*.

Distribution. Rather rare in eastern Norway, Finland and north and central Sweden. **F:** V, EH, PH, PS, PK, Kn, PeP Ks. **N:** He, Op, Bu, Te, NT. **S:** Vrm, Upl, Dlr, Ång, Jmt, Vb, Nb, ÅsL, LyL, LuL. Widely distributed in the boreal zone of the Northern Hemisphere and also known from Continental Europe, Scotland, Asia and North America. – Map 46.

Note. Characterized by its long and slender, pale stalks which look pruinose, the non-septate medium brown spores and by the K+ green reaction of the red-pigmented parts of the ascomata.

16. Chaenothecopsis viridireagens (Nádv.) A.F.W. Schmidt

Mitt. Staatsinst. Allg. Bot. Hamb 13: 153 (1970). – *Calicium viridireagens* Nádv., Preslia 18–19: 129 (1940). – Type: Not seen.

Literature: Tibell, Nord. J. Bot. 13: 331–335 (1993).

Saprobic or parasitic on free living algae or on lichens on lignum. Ascomata 0.6–1.4 mm high, black, sometimes with a reddish tinge on the uppermost part of stalk and lower part of the excipulum. Capitulum hemispherical to sub-spherical, 0.1–0.3 mm diam Epithecium thin, brownish. Hypothecium reddish to yellowish brown, 40–80 µm thick, with dark red pigment granules and numerous colourless oil droplets. Excipulum 10–14 µm thick, consisting of periclinally arranged or interwoven hyphae, with varying amounts of red pigment. Stalk 0.04–0.07 mm diam., often containing red pigment droplets. All parts of the ascoma which contain the red pigment react K+ persistently green. Outermost part of stalk reddish brown, 6–9 µm thick, consisting of intricately interwoven hyphae Inner part of stalk consisting of largely periclinally arranged, swollen and intertwined, hyaline hyphae. Asci 32–36 × 2.0–3 µm, cylindrical. Spore periclinally or slightly obliquely arranged. Spores 1-septate, ellipsoidal, pale brown, 5.0–7.0 × 1.5–2.5 µm, smooth under the light microscope, with poorly pigmented septum. Anamorphs. A pycnidial anamorph is rather often found in association with the teleomorph, often occuring on stalks of decaying Chaenotheca specimens. Pycnidia stalked, often in small groups or growing on a joint stalk to form tree-like structures containing up to 30 conidiomata Individual pycnidia obovate, 65–95 µm long and 25–35 µm wide, ostiolate and with a pale droplet of exuded conidia at the apex. Pycnidia with a reddish pigment yielding a transient K+ green reaction. Pycnidium wall consisting of one layer of radially arranged cells. The distal part of the wall cells strongly thickened and protruding, with several layers of an electron-dense pigment. Conidiogenous cells among the wall cells, ca 5 × 1.5 µm, with distinct collarettes. Conidia hyaline, non-septate, 2.0–2.5 × 1.0 µm, with a slightly truncate proximal end with an abscission scar. In cultures a hyphomycetous anamorph has been obtained.

Chemistry. No secondary substances have been identified. A pigment which reacts K+ green occurs in the ascomata and pycnidia.

Habitat. On lignum of conifers (*Picea*, *Pinus*) and deciduous trees (*Alnus*, *Betula*) in shaded and humid localities in coniferous forests. It is associated with colonies of free living algae or occurs as a parasite or parasymbiont on lichen thalli, usually species of *Calicium* and *Chaenotheca*.

Distribution. Probably overlooked in Finland. Widely distributed in Norway and northern and central Sweden. **F:** St, PeP. **N:** Ak, He, Op, Ho, ST, NT. **S:** Vg, Srm, Vrm, Vsm, Upl, Dlr, Gst, Hls, Mpd, Ång, Jmt, Vb, LyL, PL, LuL. Occurs in both hemispheres and also known from Continental Europe, Asia, North America, Australasia and South America. – Map 47.

Note. Characterized by the presence of a red, K+ green pigment, the 1-septate spores with pale septum and the strongly swollen pale hyphae in the central part of the stalk.

Cybebe Tibell

Nova Hedwigia Beih. 79: 666 (1984).

Note. Only one species known.

1. Cybebe gracilenta (Ach.) Tibell

Nova Hedwigia Beih. 79: 666 (1984). – *Calicium gracilentum* Ach., Lich. univ.: 243 (1810). – Type: Without locality (H-ACH 532, lectotype, Tibell, Ann. Bot. Fenn. 24: 267, 1987).

Syn. Coniocybe gracilenta (Ach.) Ach.

F: varjojäkälä. **N:** hvithodenål. **S:** smalskaftslav.

Redlisted in: **F**, **S**.

Literature: Middelborg & Mattsson, Sommerfeltia 5: 45–48 (1987); Tibell, Svensk Bot. Tidskr. 72: 185 (1978); Nova Hedwigia Beih. 79: 666–667 (1984).

Thallus forming a thin, farinaceous crust over the substrate, greyish green. Ascomata tall, with long, slender and often flexuous stalks, 2.0–3.5 mm high. Stalk black, covered by a thin, greyish, granular pruina, consisting of strictly periclinally arranged, medium brown, somewhat sclerotized hyphae, 0.06–0.09 mm diam. Outermost layer of stalk hyphae disrupted and remain as a granular, pruina-like layer on the surface of the stalk. Capitulum

spherical, 0.2–0.4 mm diam. Excipulum poorly developed, formed from the continuation of stalk hyphae. Hypothecium medium brown, formed as a continuation of the stalk, ca 120–150 µm wide and 65–90 µm high. Mazaedium well developed, pale grey. Asci ellipsoidal, formed in chains from ascogenous hyphae without hooks, 7.0–10.0 × 2.5–3.5 µm. Spores globose, 2.5–3.0 µm diam., very pale brown to hyaline, smooth. PHOTOBIONT Stichococcus.

Chemistry. No secondary substances have been identified, but an unidentified triterpenoid and two further unidentified substances were mentioned by Middelborg & Mattsson (1987). Tönsberg (1992) reported several unidentified substances.

Habitat. On lignum, particularly of *Picea*, but also of *Betula*, *Populus*, *Salix*, *Ulmus*. Preferably in hollows of old stumps in very shaded and humid situations. Also on mosses on steep rock-faces and rarely on rocks. Very shade-tolerant and requiring a high microclimatic humidity.

Distribution. **F:** EK, St, EH, PK, Kn, OP, PeP, Ks. **N:** Ak, He, Op, Bu, Te, Ho, SF, ST, NT, No, Tr, Fi. **S:** Sm, Hl, Vg, Ög, Srm, Vrm, Upl, Dlr, Hls, Mpd, Ång, Jmt, ÅsL, LyL, LuL. Widely distributed in the Northern Hemisphere and also known from Continental Europe, the British Isles, Asia and North America. – Map 48.

Cyphelium Ach.

K. Vetensk.-Acad. Handl. 1815: 261 (1815).

Literature: Middelborg & Mattsson, Sommerfeltia 5: 55–58 (1987); Tibell, Svensk Bot. Tidskr. 63: 465–485 (1969); Svensk Bot. Tidskr. 65: 138–164 (1971); Svensk Bot. Tidskr. 74: 55–60 (1980); Nova Hedwigia Beih. 79: 667–669 (1984).

THALLUS crustose, covering the substrate, verrucose to subareolate, grey, greenish grey, golden yellow, greenish yellow or brownish, or immersed. ASCOMATA sessile or im-mersed. Excipulum variable, uniform and thin or strongly thickened at the base, blackish brown, consisting of sclerotized hyphae. Mazaedium well developed, black. Asci obovate to cylindrical, formed singly from ascogenous hyphae with hooks. Spores 1-septate, rarely submuriform, 9–32 × 5–19 µm. Spore wall thick, dark brown, smooth or with distinctive ornamentations of irregular cracks or spirally arranged ridges. CONIDIOMATA spherical to slightly flattened or confluent to form irregular aggregates, 55–190 × 55–125 µm, at first semi-immersed in the thallus. Ostiolum first punctiform, later with irregularly split. Pycnidium wall 7–20 µm thick, in the lower part thinner, consisting of isodiametric or slightly elongated, hyaline cells ca 2–3 µm diam. In the uppermost part the wall cells are spherical, 4–5 µm diam., and heavily sclerotized, blackish brown. The ontogeny is of the. Umbilicaria-Type. Conidiophores branched. Conidiogenous cells ellipsoidal to short cylindrical, 2.0–4.0 × 1.5–3.0 µm, conidia produced acrogenously and pleurogenously. Conidiophores of Vobis' Type V. Conidia non-septate, hyaline, cylindrical, 3.0–4.0 × 1.0 µm, narrower towards one end or ellipsoidal, 3.0–4.0 × 1.5 µm. Both types of conidia often produced in the same thallus. PHOTOBIONT trebouxioid.

Chemistry. ß-Orcinol depsides, ß-orcinol depsidones, usnic acid, placodiolic acid and pulvinic acid derivatives present.

Note. Mainly a Northern Hemisphere genus occurring on bark and lignum in cool to temperate areas. A few species occur on rocks and some are parasymbiotic or parasitic on lichens. Ecologically wide-ranging, with some species occurring in very dry and exposed and others in wet and humid habitats.

1 Thallus intensely yellowish green 2
– Thallus grey or greyish brown 4
2 Ascomata sessile, with thick and at the base strongly thickened excipulum ..... 4 *C. pinicola*
– Ascomata immersed in the thallus, excipulum very thin 3
3 Spores 1-septate ..... 6 *C. tigillare*
– Spores submuriform ..... 3 *C. notarisii*
4 Ascomata immersed in the thallus, excipulum very thin ..... 7 *C. trachylioides*
– Ascomata sessile 5
5 Occurring as a parasite or parasymbiont on Pertusaria species, spores with a coarse, irregular spiral ornamentation, 6–8 µm wide ..... 5 *C. sessile*
– With autonomous thallus, not a parasite or parasymbiont, spores minutely striated or coarsely and irregularly cracked, 8–11 µm wide 6
6 Ascomata 1.5–2.5 mm diam., with a distinct white pruina at the edge, thallus grey, verrucose, spores with minutely striated surface ..... 1 *C. inquinans*
– Ascomata 0.4–0.7 mm diam., with very faint pruina, thallus greenish grey to brownish, subareolate to verrucose, spores with coarsly areolate surface ..... 2 *C. karelicum*

1. Cyphelium inquinans (Sm.) Trevis.

Flora 45: 3 (1862). – *Lichen inquinans* Sm. in Smith & Sowerby, Engl. Bot. XII: 810 (1801). – TYPE: England, Turner (BM, lectotype, Tibell, Svensk Bot. Tidskr. 65: 146, 1971).

D: siddende sodlav. **F:** harmaanokijäkälä. **N:** gråsotbeger. **S:** sotlav.

Redlisted in: **D**.

THALLUS granular to verrucose, light to dark grey, usually well developed but sometimes almost immersed. ASCOMATA sessile, 0.9–1.3 mm diam., 0.4–0.7 mm high, short cylindrical to lenticular, with a faint white pruina on the outer surface of the edge of the excipulum. Excipulum 80–170 µm thick laterally, consisting of strongly sclerotized, interwoven hyphae and with a 6–9 µm thick, gelatinous layer at the surface. Excipulum strongly thickened at the base and often forming a short stalk sometimes immersed in the thallus, up to 450 µm high, medium-dark brown, consisting of intricately interwoven, sclerotized hyphae. Hypothecium up to 170 µm high, dark brown, consisting of periclinally arranged, sclerotized hyphae. Asci cylindrical, persisting until the spores are nearly mature, 42–55 × 4.5–6 µm. Spores uniseriately arranged in the asci, broadly ellipsoidal, 15–18 × 9–10 µm. Young spores have an ornamentation of mainly longitudinally arranged, very minute ridges, which is disrupted by a few irregular cracks during the maturation of the spore. CONIDIOMATA at first spherical to slightly flattened, 80–140 × 55–70 µm, semi-immersed, first with punctiform ostiolum, later with irregularly split ostiolar area. Pycnidium wall 17–20 µm thick, in the lower part thinner, consisting of isodiametric or slightly elongated, hyaline cells ca 2–3 µm diam. In the uppermost part the wall cells are spherical, 4–5 µm diam., and heavily sclerotized, blackish brown. Conidiogenous cells short cylindrical, 3.0–4.0 × 2.5–3.0 µm. Conidia non-septate, hyaline, cylindrical, 3–4.0 × 1.0 µm, narrower towards one end.

Chemistry. Thallus K+ yellow to reddish brown, C–, PD, PD+ pale yellow or PD+ yellowish red; contains placo-diolic acid and sometimes a yellow, unidentified pigment. Three unidentified substances were reported by Middelborg & Mattsson (1987).

Habitat. On wooden fences, fence-posts, walls of old barns and on dead and decorticated, dry twigs of *Picea* in moderately shaded to rather open situations. It also occurs on rough bark near the base of old trunks of *Betula*, *Picea*, *Pinus*, *Quercus* and *Alnus* and very rarely on rocks.

Distribution. Widely distributed in Finland, Norway and Sweden, nowadays rare in Denmark. **D:** VJy, SJy, Fyn, Sjæ, Brn. **F:** A, V, U, EK, St, EH, ES, EP, PH, PS, PK, KP, Kn, OP, PeP, Ks, KiL, SoL, EnL, InL. **N:** Ak, He, Op, Bu, Ho, MR, ST, NT, No, Tr, Fi. **S:** Sk, Bl, Öl, Gtl, Sm, Hl, Bh, Dls, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Gst, Hls, Mpd, Ång, Hrj, Jmt, Vb, Nb, ÅsL, LyL, PL, LuL, TL. Widely distributed in cool temperate and temperate areas of the Northern Hemisphere (Continental Europe, the British Isles, North America). It also occurs in cool temperate parts of Australasia and South America. – Map 49.

Note. Characterized by its rather large ascomata, the distinctive white pruina rim on the excipulum around the mazaedium, the well-developed, grey, K+ thallus and the spore ornamentation. It is sometimes similar to C. karelicum, which differs in having smaller ascomata, an often brownish, thin, subareolate, K– thallus and the spores which are constricted at the septum and have a very coarse, areolate ornamentation.

2. **Cyphelium karelicum** (Vain.) Räsänen

Ann. Bot. Soc. Zool.-Bot. Fenn. Vanamo 12(1): 188 (1939). – *Cyphelium lucidum* var. *karelicum* Vain., Acta Soc. Fauna Fl. Fenn. 57(1): 20 (1927). – TYPE: Russia, Karelia onegensis, Klimski, 1863 Kullhem (H-NYL 40470, holotype).

F: aarninokijäkälä. **N:** trollsotbeger. **S:** liten sotlav.

Redlisted in: **S**.

Literature: Tibell, Svensk Bot. Tidskr. 67: 453 (1973).

THALLUS verrucose or subareolate, greenish grey, upon storage more or less brownish, thin and smooth. ASCOMATA sessile, 0.5–0.8 mm diam., 0.3–0.4 mm high, with a faint white pruina on the outer surface of the edge of the excipulum, short cylindrical to lenticular. Excipulum 39–140 µm thick laterally, thickened at the base and up to 380 µm high, formed by dark brown, sclerotized, interwoven hyphae. Hypothecium 110–140 µm consisting of peri-clinally arranged, sclerotized hyphae. Asci cylindrical, 28–33 × 4–5 µm. Spores uniseriately arranged in the asci, ellipsoidal, distinctly constricted at the septum, 14–17 × 8–10 µm. Young spores smooth, but in older spores a very coarse ornamentation of irregular areolae separated by irregular, deep cracks develops.

Chemistry. Thallus K–, C–, KC– and PD–; contains placodiolic acid. Three unidentified substances reported by Middelborg & Mattsson (1987).

Habitat. At the base of trunks of *Picea* in humid and shaded situations. Sometimes it grows on dry, dead twigs at the base of *Picea* and lignum, very rarely on shaded rocks and bark of *Quercus*. Usually occurring in tiny colonies in a complex mosaic with many other calicioid species and also not rarely with *C. inquinans*.

Distribution. Widely distributed in Finland and Northern and central Sweden, but rare. Also known from eastern Norway. **F:** EH, ES, EP, PS, PK, KP, Kn, PeP, Ks, KiL, InL. **N:** He, Op, Bu, Te, NT. **S:** Vg, Ög, Vrm, Upl, Dlr, Jmt, Vb, Nb, ÅsL, LyL, PL, LuL, TL. Widely distributed in cool temperate and temperate areas of the Northern Hemisphere (Continental Europe, North America). – Map 50.

Note. Characterized by its small ascomata, the greenish grey, subareolate, K–, thin thallus and the spore ornamentation.

3. Cyphelium notarisii (Tul.) Blomb. & Forssell

Lichenes in Enumerantur plantae Scandinaviae, Lund: 95 (1880). – *Acolium notarisii* Tul., Ann. Sci. Nat. sér. 3 (Bot.) 17: 81. – Type: Not seen.

D: gulgrøn sodlav. **F:** etelännokijäkälä. **S:** sydlig sotlav.

Redlisted in: **F**, **S**.

Thallus verrucose, intensely yellowish green, usually well developed but sometimes almost immersed in the substrate. Cortex 22–34 µm thick, in the lower part densely inspersed with yellow crystals; the outermost 6–12 µm forming a hyaline layer. Fertile verrucae 0.5–0.8 mm diam., with constricted or widened base. Ascomata immersed, mazae-dium 0.2–0.5 mm diam., epruinose. Excipulum thin throughout, not thickened at the base, laterally 14–34 µm wide, consisting of intricately interwoven, brown, sclero-tized hyphae. At the base the excipulum is 8–17 µm thick and of a similar structure. Hypothecium very thin, poorly pigmented. Asci ellipsoidal to pyriform, evanescent at a very early stage, 15–24 × 7–10 µm. Spores 2–3 seriately arranged in the asci, broadly ellipsoidal or irregular, of very variable shape and constricted at the septa, 1-septate to submuriform, 17–24 × 13–18 µm, smooth, with 2–14 subspherical or angular cells. Septa length- and crosswise, often oblique. Conidiomata at first spherical to ellipsoidal, 55–100 × 55–70 µm, later irregular, confluent with other pycnidia to leave incomplete walls delimiting aggregates of numerous loci. Pycnidium aggregates irregular, up to 0.26 mm wide, sometimes with one or a few longitudinal slits opening to the loci. Pycnidium wall 7–15 µm thick, in the lower part consisting of isodiametric or slightly elongated, hyaline cells ca 1 µm diam., in the uppermost part the wall cells are spherical, 3–4 µm diam and heavily sclerotized, blackish brown. Conidiogenous cells short cylindrical, 2.0–2.5 × 1.5–2.0 µm. Conidia non-septate, hyaline, cylindrical, 3.0–4.0 × <1 µm or ellipsoidal, 3.0–4.0 × 1.5 µm. The pycnidia producing different types of conidia occur on the same thallus.

Chemistry. Thallus K–, C–, KC–, PD–, containing the intensely yellowish green pigment rhizocarpic acid.

Habitat. On dry, weathered wood, particularly of fence-posts, wooden fences and walls of old barns.

Distribution. A rare and threatened species known from southern Finland and Sweden with only few recent occurrences in Skåne, Gotland, Halland, Småland, Västergötland and Hälsingland in Sweden and in Varsinais-Soumi, Finland. **F:** A, V. **S:** Sk, Bl, Öl, Gtl, Sm, Bh, Ög, Nrk, Srm, Vsm, Upl, Dlr, Gst, Hls. Widely distributed in temperate areas of the Northern Hemisphere (Continental Europe, Khazak-stan, North America), but has probably vanished in many areas. – Map 51.

Note. Characterized by the immersed ascomata, the intensely yellowish green thallus and the submuriform, irregular and large spores. In gross morphology it is indistinguishable from *C. tigillare*, but differs in having submuriform spores. It also has a more southern/low-altitude *Distribution.* The thallus is often almost sterile and provided with irregular groups of conspicuous, irregular, black, multilocular pycnidia. Very similar pycnidia are also present in *C. tigillare*. Completely sterile thalli with abundant pycnidia cannot be identified, since such thalli may also be produced by *C. tigillare*. Two different types of conidia are produced by *C. notarisii*, and both sometimes co-occur on the same thallus.

4. Cyphelium pinicola Tibell

Svensk Bot. Tidskr. 63: 477 (1969). – Type: Norway, Oppland, Lom, Sterringi, 1958 Ahlner (S, holotype).

N: furusotbeger. **S:** fjällsotlav.

Redlisted in: **S**.

Thallus verrucose, intensely yellowish green, well developed, superficial or almost immersed in the substrate. Cortex 11–16 µm thick, consisting of hyaline, gelatinized hyphae and densely inspersed with tiny yellow crystals in the lower part. Ascomata sessile, 0.5–0.7 mm diam., 0.2–0.4 mm high, cylindrical, constricted at the base and without a pruina. Excipulum 45–95 µm thick laterally, consisting of dark brown, sclerotized, intricately interwoven hyphae. Excipulum at the base strongly thickened and extending deep down into the thallus, up to 300 µm thick. Delimitation of the hypothecium diffuse. Excipular margin constricted, shining black. Asci cylindrical to narrowly clavate, persisting until the spores are nearly ripe, 35–42 × 5–7 µm, with uniseriately or sometimes biseriately arranged spores. Spores ellipsoidal, slightly constricted at the septum, 14–16 x 7–9 µm. Young spores smooth. Mature spores with a few irregular cracks.

Chemistry. Thallus K–, C–, KC–, PD–, containing rhizocarpic acid.

Habitat. On dry twigs of living *Pinus sylvestris* in open situations in subalpine areas, mainly at the edge of bogs and

in pine heaths in areas with a continental climate. Rarely on lignum of *Picea* and *Betula*, old stumps or boards of barns and bark of *Betula*.

Distribution. Rare along the Scandinavian Mountain range. **N:** He, Op, MR, ST, Tr. **S:** Hrj, Jmt, LyL, LuL, TL. Widely distributed in cool temperate and temperate areas of the western Northern Hemisphere (Central and South Europe, North America). – Map 52.

Note. Characterized by the intensely yellowish green thallus, the cylindrical asci, the sessile ascomata and the excipulum which is thickened at the base.

5. Cyphelium sessile (Pers.) Trevis.

Flora 45:3 (1862). – *Calicium sessile* Pers., Tent. disp. meth. fung. Suppl.: 59 (1797). – Type: Without locality (L-Pers., holotype).

D: snyltende sodlav. **F:** loisnokijäkälä. **S:** parasitsotlav.

Redlisted in: **D**, **F**, **S**.

Parasymbiotic or parasitic on Pertusaria. Ascomata sessile, 0.3–0.6 mm diam., without a pruina, 0.2–0.3 mm high. Excipulum 50–90 µm thick laterally, consisting of strongly sclerotized, interwoven hyphae and with a 2–3 µm thick, gelatinous layer at the surface. Excipulum strongly thickened at the base and often forming a stalk immersed in the host thallus, up to 230 µm high, medium to dark brown, consisting of intricately interwoven, sclerotized hyphae. Hypothecium 40–55 µm high, dark brown, consisting of periclinally arranged, sclerotized hyphae. Asci narrowly clavate, 25–31 × 5–7 µm. Spores biseriately arranged in the asci, ellipsoidal, 12–15 × 8–9 µm. Young spores have an ornamentation of spirally arranged ridges. In the mature spores a coarse ornamentation of spirally arranged ridges is disrupted by irregular cracks.

Habitat. On trunks of old *Quercus*, rarely on *Fraxinus* and *Tilia* in moderately shaded to rather open situations in parklands and old deciduous forests. It usually occurs on *Pertusaria coccodes*, but has also been recorded from other *Pertusaria* species. The *Pertusaria* thallus is modified when attacked by *C. sessile*, and turns darker and the production of isidia in *P. coccodes* is often suppressed.

Distribution. Rare in Denmark, southern Sweden and Finland. **D:** ØJy. **F:** A, U, Kn. **S:** Sk, Bl, Öl, Gtl, Bh, Dls, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr. Also occurring in the British Isles and Continental Europe. – Map 53.

Note. Characterized by the occurrence on *Pertusaria* thalli, the rather small, epruinose ascomata, the narrowly clavate asci with biseriately arranged spores and the coarse, irregular ornamentation of spirally arranged ridges in the mature spores.

6. Cyphelium tigillare (Ach.) Ach.

K.Vetensk.-Acad. Handl. 1815: 266 (1815). – *Lichen tigillaris* Ach., Lichenogr. suec. prodr.: 67 (1799). – Type: Sweden (H-ACH 520, lectotype, Tibell, Svensk Bot. Tidskr. 65: 158, 1971).

F: keltanokijäkälä. **N:** vanlig sotbeger. **S:** sydlig ladlav.

Redlisted in: **S**.

Thallus intensely yellowish green, verrucose, well developed or sometimes almost immersed in the substrate. Ascomata immersed in verrucae, 0.4–1 mm diam. Verrucae constricted at the base or widened, epruinose. Mazaedium 0.3–0.5 mm diam. Cortex 14–25 µm thick, in the lower part densely inspersed with yellow crystals. Excipulum thin throughout, not thickened at the base, laterally 14–28 µm wide, consisting of intricately interwoven, brown, sclerotized hyphae. At the base the excipulum is 19–31 µm thick and of a similar structure. Hypothecium very thin, poorly pigmented. Asci pyriform, evanescent at a very early stage, 18–22 × 6–7 µm, with 2–3 seriately arranged spores. Spores broadly ellipsoidal, 1-septate, 17–21 × 10–11 µm, smooth. Conidiomata at first spherical to ellipsoidal, 160–190 × 105–125 µm, later irregular and confluent with other pycnidia to leave incomplete walls delimiting aggregates of numerous loci. Pycnidium aggregates irregular, up to 0.40 mm wide, sometimes opening by a few longitudinal slits. Pycnidium wall 9–12 µm thick, consisting of isodiametric or slightly elongated , moderately sclerotized, medium brown cells. In the uppermost part the wall cells are spherical, 4–5 µm diam and heavily sclerotized, blackish brown. Conidiophores short, with few branches. Basal cells of conidiophores more or less iso-diametric, 3–4 µm. Conidiogenous cells 2.5–4.0 × 1.5–2.5 µm, ellipsoidal to short cylindrical, terminal and in branched conidiophores also produced laterally. Conidia non-septate, hyaline, ellipsoidal, 3.0–4.0 × 1.5 µm.

Chemistry. Thallus K–, C–, KC–, PD–, containing rhizocarpic acid, epanorin and two unidentified substances (Middelborg & Mattsson 1987).

Habitat. On dry, weathered wood and dry branches of *Pinus sylvestris*, particularly on worked timber like wooden fences, fence-posts and walls of old barns. It also occurs on lignum of *Picea abies* and has been collected from bark of *Betula*.

Distribution. Not uncommon in the cooler and more continental parts of Norway, Finland and the northern part of Sweden. It also occurs along the Baltic Coast of central Sweden. **F:** A, V, U, EK, St, EH, ES, EP, PH, PS, PK, KP, Kn, OP, PeP, Ks, KiL, SoL, EnL, InL. **N:** Ak, He, Op, Bu, Te, Ro, Ho, ST, NT, No, Tr, Fi. **S:** Sk, Bl, Öl, Gtl, Sm, Dls, Vg, Ög, Nrk, Srm, Vrm, Upl, Dlr, Gst, Hls, Mpd, Ång, Hrj, Jmt, Vb, Nb, ÅsL, LyL, PL, LuL, TL. Widely distributed in temperate areas of the Northern Hemisphere (Continental Europe, Asia and North America). – Map 54.

Note. Very similar to *C. notarisii*, but differs in having 1-septate spores, and has a different *Distribution.* Pycnidia are much more rare in *C. tigillare* than in *C. notarisii*.

7. Cyphelium trachylioides (Nyl. ex Branth & Rostr.) Erichsen

in Keissler, Rabenh. Krypt.-Fl. 9, 1(2): 784 (1938). – *Spilomium trachylioides* Nyl. ex Branth & Rostr., Lichenes Daniae: 141 (1869). – Type: Denmark, Jutland, Viborg, Randrup, Branth & Rostrup (H-NYL 588, lectotype, Tibell, Svensk Bot. Tidskr. 65: 160, 1971).

D: grå sodlav. **S:** grå ladlav.

Redlisted in: **D**, **S**.

Literature: Tibell, Lichenologist 10: 175–177 (1978).

Thallus dark grey, verrucose, well developed or sometimes almost immersed in the substrate. Ascomata immersed in verrucae, 0.5–0.7 mm diam. Verrucae constricted at the base or widened, epruinose. Mazaedium 0.2–0.4 mm diam. Cortex 11–22 µm thick, consisting of intricately interwoven, gelatinized hyphae. Excipulum thin throughout, not or only very slightly thickened at the base, laterally 25–34 µm wide, consisting of intricately interwoven, brown, sclerotized hyphae. Hypothecium very thin, poorly pigmented. Asci obovate to pyriform, cylindrical or irregular, evanescent at a very early stage, 21–27 × 5–7 µm, with 2–3 seriately arranged spores. Spores broadly ellipsoidal, 1-septate, 20–23 × 10–13 µm, smooth.

Chemistry. Thallus K+ reddish brown, C–, KC–, PD–, but no secondary substances have been identified.

Habitat. On dry, weathered wood, particularly of wooden fences in lowland areas.

Distribution. Very rare, but recently reported from one locality in Skåne. **D:** ØJy. **S:** Sk. Also known from Continental Europe, North America and Australasia. – Map 55.

Note. If this is a species distinct from *C. tigillare* is not clear. A different habitat ecology and distribution and a slight difference in spore size support the recognition of it as a species, although the main difference towards *C. tigillare* is that it lacks rhizocarpic acid. The situation is further complicated by the occurrence of what seems to be rhizocarpic acid deficient populations of *C. tigillare* in the Alps.

Microcalicium Vain.

Acta Soc. Fauna Fl. Fenn. 57(1): 77 (1927).

Literature: Hawksworth, Bull. Brit. Mus. (Nat. Hist.) 9(1): 41–44 (1981); Middelborg & Mattsson, Sommerfeltia 5: 59–61 (1987); Tibell, Bot. Notiser 131: 229–246 (1978); Svensk Bot. Tidskr. 74: 60–63 (1980); Nova Hedwigia Beih. 79: 669–671 (1984).

Parasitic on lichen and on free-living algae or saprobic. Ascomata stalked or sessile. Excipulum consisting of isodiametric cells, greenish or brownish. Stalk consisting of irregularly intertwined hyphae. Mazaedium well developed, accumulating large amounts of spores and often protruding far beyond the edge of the excipulum, aeruginose. Asci broadly ellipsoidal, formed in chains from ascogenous hyphae without croziers. Spores 1–7-septate, broadly ellipsoidal to cylindrical. Mature spores with a distinctive ornamentation of spirally arranged ridges. Conidiomata pycnidial, arising singly or in small groups, subspherical, sessile to subimmersed, black to dark brown, with ostiolum and with the conidia emerging in a mucilaginous droplet. Upper part of conidioma wall consisting of several layers of thick-walled, aeruginose or brownish cells. Lower part of wall thinner, hyaline, consisting of thin-walled cells. Conidiogenous cells lining the conidioma wall, enteroblas-tic, acrogenous, cylindrical to subcylindrical, phialidic, with elongated canal, hyaline. Conidia arising singly, broadly ellipsoidal to subglobose, simple, hyaline, thin-walled.

Chemistry. No secondary substances have been identified. The pigments in the ascomata are affected by pH changes and are aeruginose in acidic and brownish in alkaline solutions.

1 Ascomata sessile or with very short stalk, mature spores 1–3(–7)-septate, 11–13 µm long ..... 3 *M. disseminatum*

– Ascomata well stalked, mature spores 1-septate, 5–6 µm long 2

2 Ascomata with long stalks, 0.6–1.8 mm high, mazaedium without sclerotized hyphae ..... 2 *M. arenarium*

– Ascomata with shorter stalks, 0.4–1.1 mm high, mazaedium with sclerotized hyphae ..... 1 *M. ahlneri*

1. Microcalicium ahlneri Tibell

Bot. Notiser 131: 234 (1978). – Type: Sweden, Jämtland, Offerdal par., 44 km NNE of Åre, 1975 Tibell 6299 (UPS, holotype).

F: kantoparaka. **S:** kortskaftad ärgspik.

Redlisted in: **S**.

Growing on colonies of unidentified green algae or not associated with algae. Ascomata variable in size, 0.4–0.7 mm high. Capitulum narrowly conical, 0.1–0.3 mm wide. Mazaedium lower than the width of the capitulum. Exci-pulum in section reddish brown, very poorly developed. Stalk 0.06–0.10 mm diam., dull black, with a coarsely granular surface. Outer surface of stalk covered by irregular groups of sclerotized hyphae. Inner part of stalk consisting of short, strongly curved and intertwined, thick-walled hyphae. Asci broadly ellipsoidal, 7.0–10.0 × 3.0–3.5 µm. Spores broadly ellipsoidal, 1-septate, 5.0–7.0 × 2.0–2.5 µm, with a distinctive ornamentation of spirally arranged ridges. Conidiomata not known.

Chemistry. No secondary substances have been identified. The aeruginose pigment of the ascomata turns yellowish brown with K. Excipulum K+ deep yellowish brown.

Habit On decorticated stumps heavily attacked by brown rot fungi, usually of *Pinus sylvestris*, more rarely on lignum of *Picea abies*, and occasionally on oak wood. Mainly at the margin of mires and in other humid locations.

Distribution. Rather rare in eastern Norway and Sweden. Also known from Finland. **F:** V, U, EH. **N:** He, Op, Bu, Vf, SF, NT. **S:** Öl, Sm, Vg, Srm, Vrm, Vsm, Upl, Dlr, Gst, Hls, Ång, Jmt, Vb, LuL. Widely distributed in the Northern Hemisphere and also known from Continental Europe, Asia and North America. – Map 56.

Note. Characterized by its distinctly but rather short-stalked ascomata, the conical capitula, the coarse surface of the stalk and the persisting sclerotized paraphyses of the mazaedium.

2. Microcalicium arenarium (Hampe ex A. Massal.) Tibell

Bot. Notiser 131: 237 (1978). – *Cyphelium arenarium* Hampe ex A. Massal., Misc. Lich.: 20 (1856). – Type: Germany, Harz, Blankenburg, Hampe (UPS, lectotype, Tibell, Bot. Notiser 131: 237, 1978).

F: varjoparakka. **S:** långskaftad ärgspik.

Growing on non-lichenized *Stichococcus* colonies, mixed colonies of non-lichenized *Stichococcus* and trebouxioid algae or on Psilolechia lucida. Ascomata very variable in size, 0.8–1.6 mm high, with a long stalk. Capitulum spherical, 0.2–0.3 mm diam. Mazaedium protruding less than the diameter of the capitulum Paraphyses not sclerotized, dissolving at early stages. Excipulum in section reddish brown, forming a small collar at the base of the capitulum. Stalk 0.06–0.10 mm thick, dull black or greyish, with a coarsely granular surface or smooth. Outer surface of stalk covered by groups of sclerotized hyphae. Inner part of stalk consisting of pale and periclinally arranged, interwoven hyphae. Asci broadly ellipsoidal, 8.0–10.0 × 3.0–4.5 µm. Spores ellipsoidal, one-septate, 6.0–7.0 × 2.0–2.5 µm, with a distinctive ornamentation of spirally arranged ridges.

Chemistry. No secondary substances have been identified. The aeruginose pigment of the ascomata turns yellowish brown with K. Excipulum K+ deep yellowish brown.

Habitat. On soil, rootlets, decorticated stumps, lignum and siliceous rocks in shaded and humid localities. Often along road-cuts, on rootlets of upturned conifers and under overhanging rocks and often growing together with *Psilolechia lucida*.

Distribution. Scattered and rather rare in Norway and Sweden. Also known from Finland. **F:** V, U, St, EH, PH, PK, Kn, PeP, KiL. **N:** Op, Bu, Ho, SF, No. **S:** Sk, Sm, Bh, Vg, Ög, Srm, Vrm, Upl, Hls, Ång, Hrj, Jmt, Vb, ÅsL, LuL. Widely distributed in the Northern Hemisphere and known from the British Isles, Continental Europe, Asia and North America. Also occurring in Australasia and southernmost South America. – Map 57.

Note. Characterized by its long-stalked ascomata, the spherical capitula and the one-septate spores.

3. Microcalicium disseminatum (Ach.) Vain.

Acta Soc. Fauna Fl. Fenn. 57(1): 77 (1927). – *Calicium disseminatum* Ach., K. Vetensk.-Acad. Handl. 1817: 227 (1817). – Type: Sweden, Småland, E. Fries (UPS-ACH 1276, lectotype, Tibell, Bot. Notiser 131: 240, 1978).

Syn. *Microcalicium subpedicellatum* (Ach.) Tibell

S: ärgspik.

Growing on calicioid lichens, on non-lichenized colonies of green algae or sometimes apparently saprobically on bark or wood, without association with algae. Ascomata sessile or very short-stalked, 0.1–0.2 mm high. Capitulum broadly cylindrical to lenticular, 0.1–0.3 mm diam. Mazae-dium often protruding as a column far beyond the edge of the excipulum. Paraphyses sclerotized, persisting. Excipulum well-developed, in section aeruginose, K+ brown. Asci

broadly ellipsoidal, 11–16 x 4–6 µm. Spores usually 1–3-septate, ellipsoidal to subcylindrical, 11–13 × 3–4 µm. Ageing spores irregular, 4–5-septate and up to 28 µm long. Conidiomata solitary, spherical, black, 0.04–0.10 mm in diameter, colonizing the host lichen and occurring on the thallus and ascomata, sometimes also on free-living algal colonies or apparently occurring as a saprobe on bark or lignum. The thallus of the lichens attacked soon becomes discolored and disintegrates. Ostiolum with a distinctive white, small droplet of exuded conidia. Pycnidium wall 4–12 µm thick, consisting of 3–5 layers of spherical to elongated, sclerotized brown, cells, 2 µm diam. Lower part of wall paler, consisting of intertwined hyphae, sometimes forming a short stalk. Conidiogenous cells simple, 4.0–5.0 × 1.0–1.5 µm, in the lower part of the conidiomata sitting on elongated and sparingly branched conidiophores. Conidiophores of Vobis' Type I or II. The ontogeny of the conidiomata is of Lecanactis-Type. Conidia hyaline, broadly ellipsoidal, 2.0–3.0 × 2.0 µm, slightly truncate at the proximal end.

Chemistry. No secondary substances have been identified. The aeruginose pigment of the ascomata turns brown with K.

Habitat. On lignum and bark of both deciduous trees and conifers in moderately shaded situations. Often parasitic on calicioid lichens, particularly *Chaenotheca* species, with the conidiomata forming much earlier than the ascomata. Also on free-living algal colonies and apparently also occurring saprobically on wood.

Distribution. Widely distributed in Finland, Continental Norway and Sweden, very rare in Denmark. **D:** Sjæ. **F:** A, V, U, St, EH, EP, PH, PS, PK, Kn, OP, PeP, Ks, KiL. **N:** He, Op, Bu, Vf, Te, Ro, SF, MR, ST, NT, No, Fi. **S:** Sk, Bl, Öl, Gtl, Sm, Bh, Dls, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Gst, Hls, Ång, Hrj, Jmt, Vb, Nb, ÅsL, LyL, PL, LuL. Also known from Continental Europe, Asia and North America. – Map 58.

Note. Characterized by its sessile ascomata and the cylindrical, often multiseptate spores. Often easily recognized by the protruding, aeruginose mazaedia. During early stages of colonization of *Chaenotheca* and *Calicium* specimens only the conidiomata of *M. disseminatum* are formed, but later, when the thallus of the attacked lichens disintegrate, ascomata develop both on the ascomata and thallus of the host and on the substrate.

Mycocalicium Vain.

Acta Soc. Fauna Fl. Fenn. 7(2): 182 (1890).

Literature: Schmidt, Mitt. Staatsinst. Allg. Bot. Hamburg 13: 111–166 (1970); Tibell, Nova Hedwigia Beih. 79: 671–672; (1984); Nord. J. Bot. 10: 221–242 (1990).

Saprobic. Ascomata stalked, black to brownish black. Capitulum obovoid to lenticular. Excipulum more or less well developed, consisting of dark brown, periclinally arranged hyphae, almost isodiametric cells, 5–15 µm diam or anticlinally arranged, branched hyphae with swollen walls. Hymenium covered by a dark brown, thin epithecium. Stalk consisting of strictly periclinally arranged, narrow dark brown hyphae or slightly more irregularly arranged and in the central part slightly swollen and paler hyphae. Outermost part of stalk formed by periclinally arranged, dark brown hyphae. Asci formed singly from ascogenous hyphae with croziers, cylindrical, 35–65 µm long., with strongly and evenly thickened apex or with a short and blunt canal penetrating the apex. The asci persist until the spores are mature. No mazaedium, although a thin layer of mature spores sometimes accumulates on the surface of the epithecium. Spores dark brown, non-septate, usually broadly fusiform, 5–11 × 3–5 µm, uniseriately arranged in the asci. Spore wall rather thick, well pigmented, smooth or with a minutely verrucose ornamentation. Surface of the spores without cracks. Conidiomata pycnidial, pyriform to spherical, with a wall consisting of several layers of more or less sclerotized cells, ostiolate. Conidiogenous cells enteroblastic, lining the pycnidial cavity, acrogenous, phialidic, simple, ellipsoidal to more or less swollen at the base, when old brown and with a thickened wall in the upper part. Conidia arising singly, slightly curved, smooth, with an abscission scar in the proximal end, pale brown, conidium exudate dark brown.

Chemistry. The tetronic acid derivatives vulpinic acid and pinastrinic acid occur in the ascomata of a few species, none of them, however, occurring in Europe.

Note. The genus is cosmopolitan and occurs in warm to cool temperate areas of both the Northern and Southern Hemisphere. *Mycocalicium* species occur as saprobes on vascular plants. Some are unspecific with respect to substrate and inhabit a variety of trees, while others have very specific host requirements.

1. Mycocalicium subtile (Pers.) Szatala

Magyar Bot. Lapok 24: 47 (1926). – *Calicium subtile* Pers., Tent. disp. meth. fung. Suppl.: 60 (1797). – Type: Not seen.

Syn. *Mycocalicium parietinum* (Ach.) D.Hawksw., *M. pallescens* (Nyl.) Vain.

D: ved-nålesvamp.

Redlisted in: **D**.

Literature: Tibell, Nord. J. Bot. 10: 221–242 (1990).

Saprobic Ascomata black to dark brown, 0.5–0.8 mm high. Stalk shining black or dull, 0.04–0.06 mm diam. Capitulum obconical to lenticular, with convex upper surface, 0.2–0.3 mm diam. Stalk epruinose, consisting of pericli-nally arranged, sparsely intertwined and branched, dark to dark greenish brown hyphae, ca 3 µm diam. The stalk hyphae tend to be more brownish or reddish brown towards the surface of the stalk. Excipulum poorly to very well developed, 15–50 µm thick. When thin the excipulum consists of a few layers of thin, periclinally arranged, heavily sclerotized hyphae. When better developed it consists of intricately intertwined, pale to slightly brownish hyphae with swollen walls or of rows of pale to pale brown, short cylindrical cells with only moderately thickened walls. Hypothecium dark brown, broadly obconical, 60–90 µm high. Hymenium 50–85 µm high. Stalk K– or K+ slightly reddish brown, HNO_3– or slightly intensified reddish brown. Asci cylindrical, 39–42 × 3.0–3.5 µm, with uniseriately arranged spores. Spores periclinally arranged or slightly oblique. Ascus apex strongly and uniformly thickened and without canal, also in semi-mature asci. Spores dark brown, 7.0–8.0 × 3.5–4.0 µm, broadly ellipsoidal to ellipsoidal, non-septate, slightly fusiform and flattened. Ornamentation of spore surface none or faint and irregular under the light microscope. Conidiomata not very frequent, but when they occur they are often numerous, black, spherical to somewhat ovoid, often with a distinctively extended apical part, when mature 0.15–0.20 mm diam., with a distinct apical pore. The pycnidia sometimes are arranged in groups up to 0.7 × 0.2 mm in the direction of the fibres of the wood. Pycnidium wall laterally 20–25 µm thick, consisting of several layers of dark brown, tangentially arranged and intertwined hyphae with gelatinized walls and small lumina. Conidiogenous cells narrowly cylindrical to lageniform, 9–11 × 1.0 µm. Conidia 4.0–5.0 × 1.0–1.5 µm, more or less curved.

Chemistry. No secondary substances have been identified.

Habitat. On dry, weathered lignum and worked timber, particularly of *Pinus sylvestris*, also common on wood of *Picea abies*, and on lignum of deciduous trees (*Acer*, *Alnus*, *Betula*, *Fraxinus*, *Malus*, *Populus*, *Quercus*, *Salix*, *Sorbus* in open situations. Rarely on bark of *Picea abies*.

Distribution. Widely distributed and common in Finland, Norway and Sweden Uncommon in Denmark. **D:** NJy, ØJy, SJy, Fyn, Brn. **F:** A, V, U, EK, St, EH, ES, EP, PH, PS, PK, KP, Kn, OP, PeP, Ks, KiL, SoL, EnL, InL. **N:** Ak, He, Op, Vf, Ho, ST, NT, No, Tr, Fi. **S:** Sk, Bl, Öl, Gtl, Sm, Hl, Bh, Dls, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Gst, Hls, Mpd, Ång, Hrj, Jmt, Vb, Nb, ÅsL, LyL, PL, LuL, TL. A very wide-ranging species in cool to temperate areas of both hemispheres. Known from Europe, Asia, North America, Australasia and Central and South America. – Map 59.

Note. Characterized by having dark brown, flattened fusiform non-septate spores and an ascus with a thick apex without canal.

Phaeocalicium A.F.W. Schmidt

Mitt. Staatsinst. Allg. Bot. Hamburg 13: 128 (1970).

Literature: Schmidt, Mitt. Staatsinst. Allg. Bot. Hamburg 13: 111–166 (1970); Tibell, Nova Hedwigia Beih. 79: 673–674 (1984); Tibell, Ann. Bot. Fenn. 33: 205–221 (1996); Titov, Bot. Zhurn. 71: 384–389 (1996).

Saprobic or parasitic. Ascomata well stalked, black to blackish brown. Capitulum obovoid to lenticular or strongly compressed. Excipulum well developed, consisting of dark brown, periclinally arranged hyphae. Hymenium covered by a thin layer of dark brown hyphae, the epithecium. Stalk consisting of dark brown to aeruginose or pale, periclinally arranged hyphae. Asci cylindrical, with uniseriately arranged spores, 70–100 µm long, formed singly from asco-genous hyphae with hooks. Asci with strongly and uniformly thickened apex or the apex is penetrated by a short and blunt canal persisting until the spores are ejaculated. No mazaedium. Spores 10–18 × 4–6 µm, non-septate or 1–3-septate, ellipsoidal, with rounded apices or fusiform. Spore wall rather thick, dark brown, smooth or with a verrucose ornamentation, not rupturing at maturity.

Chemistry. No secondary substances have been identified. Some species contain pigments which change colour with a change of pH yielding reactions with K and HNO_3 observable under the microscope.

Note. The genus mainly occurs in cool temperate to temperate areas of the Northern Hemisphere, with one species each occurring in Australasia and South America. The species occur as saprobes or possibly weak parasites on branches of trees and shrubs.

1 Spores non-septate 2
– Spores 1(–3)-septate 5
2 Capitula strongly flattened 3
– Capitula lenticular 4
3 Excipulum consisting with an outer layer of small, isodiametric cells, spores pale brown, smooth ..... 1 *P. betulinum*

– Excipulum consisting of periclinally arranged hyphae, without isodiametric cells, spores dark brown, with a minute ornamentation ..... 3 *P. compressulum*

4 Excipulum edge not thickened, ascomata 0.6–0.9 mm high, K+ green, on Populus ..... 7 *P. praecedens*

– Excipulum edge strongly thickened, ascomata 0.3–0.4 mm high, K–, on Populus and Salix ..... 5 *P. interruptum*

5 Capitula strongly flattened..... 4 *P. flabelliforme*

– Capitula not strongly flattened..... 6

6 Ascomata 0.4–0.7 mm high, excipulum consisting of periclinally arranged hyphae, on *Populus*..... *P. populneum*

– Ascomata 0.3–0.4 mm high, excipulum consisting of isodiametric or irregular cells, on *Alnus*, *Betula*, *Populus* and Salix 7

7 Excipulum edge strongly thickened, spores 9.0–11.0 × 4.0–4.5 µm..... 5 *P. interruptum*

– Excipulum edge not strongly thickened, spores 12–17 × 4.5–6 µm..... 8

8 Excipulum and stalk reddish in section, K+ intensified reddish, stalk finally dark reddish grey..... 2 *P. boreale*

– Excipulum and stalk pale, brownish or greenish brown in section, K– 9

9 Mature spores with heavily pigmented septa, excipulum consisting of a single layer of 5–6 µm wide, isodiametric cells with thick walls ..... 8 *P. tremulicola*

– Mature spores with poorly pigmented septa,excipulum consisting of 2–3 layers of sclerotized, periclinally arranged hyphae..... (*Stenocybe pullatula*)

1. Phaeocalicium betulinum (Nyl.) Tibell

Ann. Bot. Fenn. 28: 118 (1991). – *Calicium pallescens* f. *betulinum* Nyl., Flora 50: 370 (1867). – Type: Finland, Tavastia australis, Asikkala, 1866 Norrlin (H-NYL 40730, lectotype, Tibell, Ann. Bot. Fenn. 28: 118, 1991).

Literature: Tibell, Ann. Bot. Fenn. 28: 118 (1991); Ann. Bot. Fenn. 33: 206–208 (1996).

Saprobic or parasitic on Betula. Ascomata 0.3–0.4 mm high. Capitulum blackish brown, strongly flattened, 0.08–0.13 mm wide, epruinose. Epithecium brown, 6–8 µm thick. Hypothecium ca 75 µm high, hyaline, consisting of mainly periclinally arranged, winding and sparsely branched, thinwalled hyphae, 1.5–2.0 µm diam. Excipulum medium brown, 6–12 µm thick, composed of two layers. The outer layer is formed by isodiametric to irregular, slightly sclerotized cells with strongly thickened walls and lumina only 1–2 µm diam. The inner part of the excipulum consists of 2–4 layers of periclinally arranged hyphae 1.0–1.5 µm diam. Excipulum and epithecium HNO_3– and K–. Stalk pale, olivaceous brown, 0.04–0.05 mm diam., K–, HNO_3, in section very pale olivaceous brown, consisting of periclinally arranged, short-celled, slightly intertwined hyphae, 1.5–2.0 µm diam., surrounded by a 2–5 µm thick hyaline gelatinous coat. Asci narrowly cylindrical, 48–71 × 4.5–5.0 µm. Spores non-septate, pale brown, ellipsoidal, 10–13 × 4.5–5.5 µm, appearing smooth under the light microscope.

Chemistry. No secondary substances have been identified.

Habitat. On bark of *Betula*.

Distribution. Only known from a few 19th century collections from southern Finland Present status unknown. **F:** EH. – Map. 60.

Note. Characterized by the none-septate spores, the strongly flattened capitula, the excipulum anatomy, the smooth spores, the K– reaction of the ascomata and the occurrence on Betula. Similar to *P. flabelliforme*, but has a different excipulum anatomy and non-septate spores. A similar species, *P. compressulum* (Szatala) A. F. W .Schmidt, is known from Greenland. It differs in having a differently organized excipulum (see key) and darker brown spores and the habitat: thin, young branches of *Alnus crispa*. This species may also turn up in our region as it is known also from C. and S. Europe and Russia to the Far East region, as well as across North America.

2. Phaeocalicium boreale Tibell

Ann. Bot. Fenn. 33: 208 (1996). – Type: Sweden, Torne Lappmark, Jukkasjärvi par., 3.5 km SW of Abisko, 1989 Tibell (holotype, UPS).

Literature: Tibell, Ann. Bot. Fenn. 33: 208–210 (1996).

Saprobic or parasitic on branches of Alnus, Betula and Salix. Ascomata 0.35–0.40 mm high, olivaceous to greyish brown or almost black, shiny. Capitulum obconical to narrowly lenticular, 0.12–0.23 mm diam., epruinose. Epithecium reddish brown, 6–10 µm high, amorphous. Hypothecium 55–65 µm high, pale brown, consisting of largely periclinally arranged, intricately interwoven branching and thin-walled hyphae. Excipulum yellowish to reddish brown, 6–14 µm thick, formed by 2–4 layers of irregularly intertwined, sclerotized and thick-walled cells, 2–3 µm diam., forming a puzzle-like mosaic in surface view. Excipulum and epithecium K+ intensified reddish, HNO_3– or turning more yellowish red. Stalk 0.04–0.07 mm diam., in section pale to deep violet red, HNO_3+ intensified, violet red, consisting of largely periclinally arranged, slightly intertwined hyphae, 1–2 µm diam., with swollen walls. Stalk K+ dark reddish grey, strongly swelling. Stalk without or surrounded by a very thin or up to 6 µm thick hyaline gelatinous coat. Asci narrowly cylindrical, 63–75

× 4.5–6.0 µm, with uniseriately or sometimes overlapping and almost biseriately arranged spores. Ascus apex often swollen, subspherical, particularly in semi-mature asci. Spores usually 1-septate, medium brown, ellipsoidal to narrowly ellipsoidal, 12–16 × 4.5–6.0 µm, smooth under the light microscope or with a very minute punctate ornamentation. The septation of the spores is irregular insofar that 2–3-septate spores occur regularly, although in low frequencies. Spore septa formed early in the asci.

Chemistry. No secondary substances have been identified.

Habitat. On twigs of *Alnus incana*, and *Salix caprea* and on trunks of *Betula*, mainly in subalpine situations. Also known from *Ribes spicatum*.

Distribution. Only known from Finland, Norway, Sweden and northwesternmost Russia. **F:** EH. **N:** Fi. **S:** LuL, TL. – Map 61.

Note. Characterized by the 1–3-septate spores, the violet red colour of the stalk (section), the transient K+ aeruginose reaction of the stalk, which then turns purplish, the thin and well defined, reddish brown excipulum consisting of irregularly arranged cells and the swollen ascus apex.

3. Phaeocalicium compressulum (Szatala) A.F.W. Schmidt

See under *Phaeocalicium betulinum*.

4. Phaeocalicium flabelliforme Tibell

Ann. Bot. Fenn. 33: 211 (1996). – Type: Sweden, Norrbotten, Korpilombolo par., 15 km SSE of Kainulaisjärvi, 1977 Tibell 6820 (UPS, holotype).

Literature: Tibell, Ann. Bot. Fenn. 33: 211–213 (1996).

Saprobic or parasitic on Betula. Ascomata 0.25–0.29 mm high, with black capitulum and paler, olivaceous brown stalk, shiny. Capitulum of young ascomata obconical, but in mature ascomata strongly flattened, 0.14–0.24 × 0.05–0.07 mm, epruinose. Epithecium brown, sclerotized, 5–8 µm thick. Hypothecium obconical, ca 55 µm high, hyaline, consisting of more or less isodiametric cells. Exci-pulum medium brown, 11–13 µm thick, consisting of 3–4 layers of periclinally arranged, moderately sclerotized hyphae 2–3 µm diam. Excipulum and epithecium K–. Stalk 0.03–0.04 mm diam., K–, medium brown in the central part, consisting of periclinally arranged, slightly intertwined hyphae, 2–3 µm diam., surrounded by an up to 8 µm thick gelatinous coat. Asci narrowly cylindrical, 76–96 × 4.5–5.5 µm, with uniseriately arranged spores. Ascus apex strongly thickened with the ascus plasma cut off horizontally. Spores consistently septated, 1-septate or rarely with two septa, medium brown, ellipsoidal, 12–14 × 4–5 µm, appearing smooth under the light microscope or with a very minutely dotted surface. Spore septum not pig-mented.

Chemistry. No secondary substances have been identified.

Habitat. On thin, decaying branches of Betula along streams in mixed *Picea abies-Betula* forests.

Distribution. Only known from two collections from northern Sweden. Probably overlooked. **S:** Nb. – Map 62.

Note. Characterized by the one-septate spores, the strongly flattened capitula, the excipulum anatomy, the smooth spores, the K– reaction of the ascomata and the occurrence on *Betula*. Similar to *P. asciiforme*, which occurs in New Zealand, but *P. flabelliforme* differs in having a thinner excipulum, in section a brown rather than aeruginose stalk and darker brown spores. It is also similar to *P. compressulum* (cf above).

5. Phaeocalicium interruptum (Nyl.) Tibell

Ann. Bot. Fenn. 28: 119 (1991). – *Calicium pallescens* var. *interruptum* Nyl. in Norrlin, Not. Sällsk. Fauna Fl. Fennica Förh. 13: 316 (1873). – Type: Finland, Muonio, 1867 Norrlin (H-NYL 40728, lectotype, Tibell, Ann. Bot. Fenn. 28: 119, 1991).

Syn. *Mycocalicium pusiolum* var. *macrosporum* Räsänen

Literature: Tibell, Ann. Bot. Fenn. 33: 213–215 (1996).

Saprobic or parasitic on branches of Populus and Salix. Ascomata 0.3–0.4 mm high. Stalk olivaceous brown, rather pale, glossy. Capitulum campanulate, dark brown to black, 0.1–0.2 mm diam., epruinose, with thickened excipular edge. Epithecium poorly developed. Hypothecium poorly developed, 20–30 µm high, hyaline, consisting of largely periclinally arranged, short-celled hyphae, 2–3 µm diam. Excipulum thin at the base, 7–15 µm thick, consisting of 1–2 layers of isodiametric to irregular, sclerotized cells, 2–5 µm diam., forming a puzzle-like mosaic in surface view. Upper part of excipulum strongly widened, 38–44 µm thick, consisting of an outer layer of the same structure as further down and an inner part which widens strongly towards the top. This inner layer consists of largely periclinally arranged or somewhat curved and intertwined, hyaline hyphae 2–4 µm diam. All parts of the excipulum and epithecium K–. Stalk 0.03–0.05 mm diam., in section pale violet red, consisting of largely periclinally arranged, slightly intertwined hyphae with swollen walls 2–4 µm diam. Stalk K+ intensified violet red, strongly swelling.

Stalk surrounded by a 5–8 µm thick hyaline gelatinous coat. Asci narrowly cylindrical, 43–58 × 3.0–4.5 µm, with uniseriately or sometimes overlapping and almost biseri-ately arranged spores. Ascus apex uniformly and not strongly thickened. Spores usually non-septate, but often 1-septate, medium brown, ellipsoidal to narrowly ellipsoidal, 9.0–11.0 × 4.0–4.5 µm, under the light microscope with a very minute punctate ornamentation. Spore septa not pigmented. Spores growing after they have left the asci, up to 15 x 7 µm, 1–3-septate, obtaining a coarse, areolate ornamentation.

Chemistry. No secondary substances have been identified.

Habitat. On twigs of *Salix* and *Populus tremula*. Has been found on *Salix caprea*, *S. glauca*, *S. myrsinifolia*, *S. pentandra* and *S. nigricans*.

Distribution. Known from a few localities in Finland, Norway and Sweden, but probably overlooked. **F:** PeP, Ks, KiL. **N:** He, Fi. **S:** Vrm, Upl, Gst, Jmt, LuL. – Map 63.

Note. This species is not easily accommodated neither in *Phaeocalicium* nor in *Stenocybe* in a traditional sense, and a revision of the generic delimitation is needed. The thickening of the excipular edge is found in some *Stenocybe* species, but the spore size and spore shape is much more similar to that of *Phaeocalicium*. The spores of *Stenocybe* have 3–9 transverse septa, whereas in *Phaeocalicium* the spores are non- or 1-septate. In *P. interruptum* the spores are either non-septate or 1-septate with an unpigmented septum. In old spores, however, additional septa are formed and 3-septate spores are rather common. In this respect *P. interruptum* is similar to *P. boreale*, which is also rather similar in size and ecology, but *P. interruptum* is, however, easily recognized by the thickened excipulum edge, by having a thin apical ascus wall and smaller spores. It differs from *Stenocybe pullatula* in never having branched stalks, the distal thickening of the excipulum and in having shorter spores.

6. Phaeocalicium populneum (Brond. ex Duby) A.F.W. Schmidt

Mitt. Staatsinst. Allg. Bot. Hamburg 13: 132 (1970). – *Calicium populneum* Brond. ex Duby, Bot. Gall.: 638 (1830). – Type: France, Paris, St. Cloude, 1861 Pelvet (UPS, neotype, Tibell, Ann. Bot. Fenn. 33: 215 (1996).

F: haavansojokka. **S:** kvistspik.

Redlisted in: **F**, **S**.

Literature: Schmidt, Mitt. Staatsinst. Allg. Bot. Hamburg 13: 132–134 (1970); Tibell, Svensk Bot. Tidskr. 67: 454 (1973); Ann. Bot. Fenn. 33: 215–217 (1996).

Saprobic or parasitic on branches of Populus. Ascomata 0.4–0.7 mm high, olivaceous to greyish brown or almost black, shiny. Capitulum lenticular, 0.2–0.3 mm diam., epruinose. Epithecium brown to reddish brown, 5–12 µm thick, consisting of layers of anticlinally arranged, sclerotized hyphae. Hypothecium 30–60 µm high, hyaline, consisting of largely periclinally arranged, thin-walled hyphae with occasional branches at right angles. Excipulum brown to reddish brown, with an aeruginose tinge in the inner part, 6–19 µm thick, formed by 3–6 layers of periclinally arranged, sclerotized hyphae. Excipulum and epithecium HNO_3– and K– or slightly intensified reddish. Stalk 0.04–0.06 mm diam., the surface often with a slight reddish tinge in section, K+ first darker and then strongly swelling and slightly reddish brown, HNO_3+ slightly reddish brown, consisting of largely periclinally arranged, slightly intertwined, sclerotized, dark hyphae, 2 µm diam., with a reddish brown or aeruginose tinge. Stalk surrounded by a 2–5 µm thick hyaline gelatinous coat. Asci narrowly cylindrical, 75–83 × 4–5 µm. Spores 1-septate, medium brown, ellipsoidal and with a poorly pigmented septum which forms rather late, 12–13 × 4–5 µm, appearing smooth under the light microscope.

Chemistry. No secondary substances have been identified.

Habitat. Mostly on thin, decaying branches of *Populus tremula* and occasionally *P. balsamifera*, sometimes also on thick branches and trunks.

Distribution. Widely distributed in Norway and Sweden, rare in Finland. **F:** Ks, KiL. **N:** He, Op, Bu, Ho, MR, ST, No, Tr, Fi. **S:** Gtl, Vg, Srm, Vsm, Upl, Dlr, Gst, Hls, Mpd, Hrj, Vb, ÅsL, LyL, PL, LuL, TL. Also known from cool temperate and temperate areas of the Northern Hemisphere (British Isles, Continental Europe, Asia, North America). – Map 64.

Note. Characterized by the one-septate spores with poorly pigmented septum, the olivaceous or greyish brown colour of the stalks, the smooth spores, the K– or faint K+ reaction of the stalk and the occurrence on twigs of *Populus*.

7. Phaeocalicium praecedens (Nyl.) A.F.W. Schmidt

Mitt. Staatsinst. Allg. Bot. Hamburg 13: 131 (1970). – *Calicium praecedens* Nyl., Flora 50: 370 (1867). – Type: Finland, Evois (=Lammi, Evo), 1866 Norrlin (H-NYL 40719, lectotype, Tibell, Ann. Bot. Fenn. 33: 217, 1996).

S: stor kvistspik.

Redlisted in: **S**.

Literature: Schmidt, Mitt. Staatsinst. Allg. Bot. Hamburg 13: 131–132 (1970); Tibell, Ann. Bot. Fenn. 33: 217–218 (1996).

Saprobic or parasitic on branches of *Populus*. Ascomata 0.6–0.9 mm high, dark greyish to black, shiny. Capitulum lenticular, 0.2–0.3 mm diam., epruinose. Epithecium brown, 7–17 µm thick, consisting of layers of anticlinally arranged, sclerotized hyphae. Hypothecium 75–110 µm high, medium brown or with a yellowish or aeruginose tinge, consisting of largely periclinally arranged, thin-walled hyphae with occasional branches at right angles. Excipulum brown, with an aeruginose tinge in the inner part, 11–31 µm thick, formed by 5–12 layers of periclinally arranged, sclerotized hyphae. Excipulum and epithecium HNO_3+ intensified reddish. Stalk 0.04–0.07 mm diam., reddish in section in the outer part and often in the inner part with hyphae filled by an oily, yellowish red pigment; K–, only turning slightly darker or usually K+ intensely aeruginose, HNO_3+ intensified reddish brown, consisting of largely periclinally arranged, slightly intertwined hyphae with strongly swollen walls, 3–4 µm diam. Stalk usually without but sometimes surrounded by a 4–6 µm thick hyaline gelatinous coat. Asci narrowly cylindrical, 62–75 × 4–5 µm. Spores non-septate, medium brown, ellipsoidal, 11–13 × 4–5 µm, appearing smooth under the light microscope.

Chemistry. No secondary substances have been identified.

Habitat. On thin, decaying branches of *Populus tremula*.

Distribution. Scattered and rather rare or possibly overlooked in Finland, Norway and Sweden. **F:** St, EH, PH. **N:** Øf, Ak. **S:** Sm, Bh, Dls, Vg, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Gst, Hls, Vb, Nb, LuL. Also known from Scotland. – Map 65.

Note. Characterized by the non-septate smooth spores, the K+ aeruginose reaction of the stalk, the brown hypo-thecium, the strongly swollen hyphae of the stalk and the occurrence on twigs of *Populus*.

8. Phaeocalicium tremulicola (Norrl. ex Nyl.) Tibell

Ann. Bot. Fenn. 33: 219 (1996). – *Stenocybe tremulicola* Norrl. ex Nyl., Flora 66: 531 (1883). – Type: Finland, Tavastia australis, Hollola, 1882 Norrlin (H-NYL 40571, lectotype, Tibell, Ann. Bot. Fenn. 33: 219, 1996).

Literature: Tibell, Ann. Bot. Fenn. 33: 219–220 (1996).

Saprobic or parasitic on branches of *Populus*. Ascomata 0.25–0.33 mm high, black, shining, often with olivaceous to greyish brown stalk. Capitulum obovate to narrowly lenticular, 0.04–0.13 mm diam., epruinose. Epithecium medium brown, 7–10 µm high, consisting of small cells with partly melanized walls. Hypothecium 35–45 µm high, hyaline, consisting of largely periclinally arranged, intricately interwoven, branched, thin-walled hyphae. Excipulum medium brown, 9–13 µm thick, formed by an outer layer of large, sclerotized and thick-walled cells, 4–7 µm diam covering a thin layer of periclinally arranged hyphae, 1–3 cells thick. Excipulum and epithecium K–, HNO_3–. Stalk 0.02–0.04 mm diam., in section pale brown, K–, HNO_3–, consisting of largely periclinally arranged, somewhat intertwined hyphae, 1–2 µm diam., with swollen walls. Stalk enclosed in a 5–8 µm thick, hyaline layer. Asci narrowly cylindrical, 75–91 × 4.5–5.5 µm, with uniseriate spores. Ascus apex with uniformly thickened apical wall. Mature spores 3-septate, brown, narrowly ellipsoidal, 14–17 × 5.0–5.5 µm, smooth under the light microscope. The spores often remain unseptated or have one septum only. Spore septa strongly pigmented.

Chemistry. No secondary substances have been identified.

Habitat. On thin and decaying twigs of *Populus tremula*.

Distribution. Only known from a few localities in central and northern Finland and adjacent parts of Russia. **F:** EH, PeP, Ks, KiL. – Map 66.

Note. Characterized by the small size of the ascomata, the 3-septate spores, the anatomy of the excipulum, the often pale stalk and the occurrence on *Populus*.

Sclerophora Chevall.

Fl. env. Paris 1: 315 (1826).

Literature: Middelborg & Mattsson, Sommerfeltia 5: 61–65 (1987); Tibell, Svensk Bot. Tidskr. 72: 171–188 (1978); Nova Hedwigia Beih. 79: 678–679 (1984).

Thallus crustose, immersed. Ascomata stalked. Capitulum spherical to obconical. Mazaedium well-developed, pale. Excipulum well-developed, often forming a distinct collar at the base with the lower part extending to enclose the uppermost part of the stalk, consisting of anticlinally orientated, hyaline more or less intertwined hyphae. Stalk short to very long and slender, yellow, pale or reddish brown, of strictly periclinally arranged hyaline or pale brownish hyphae. Asci cylindrical, formed singly from ascogenous hyphae with croziers, dissolving at early stages. Spores globose, hyaline, with a minute verrucose ornamentation. The spore wall does not rupture at maturity. Conidiomata not known. Photobiont Trentepohlia.

Chemistry. No secondary substances have been identified. The ascomata have a white, yellowish, violet red or brownish pruina which often changes colour during maturation.

Different colour reactions and precipitates are obtained when K reacts with the pruina.

Note. Sclerophora is cosmopolitan and occurs on bark and lignum in warm temperate to temperate areas of both the Northern and Southern Hemisphere.

1 Mazaedium and stalk covered by an dark reddish brown pruina ..... 2 *S. coniophaea*
– Mazaedium and stalk not with reddish brown pruina, sometimes pale carneous 2
2 Spores 3–6 µm 3
– Spores 7–8 µm 4
3 Ascomata 0.5–0.8 mm high, stalk pale, but with a dark reddish brown core when wet, spores 3.0–3.5 µm ..... 5 *S. peronella*
– Ascomata 0.6–1.7 mm high, stalk brown to yellow, spores 5–6 µm ..... 1 *S. amabilis*
4 Ascomata 0.7–1.2 mm high, stalk brown, excipulum with a white pruina on the lower side ..... 3 *S. farinacea*
– Ascomata 0.4–0.7 mm high, stalk pale yellow, excipulum with a pale yellow or white pruina on the lower side ..... 4 *S. nivea*

1. Sclerophora amabilis (Tibell) Tibell

Beih. Nova Hedwigia 79: 679 (1984). – *Coniocybe amabilis* Tibell, Publs Herb. Univ. Uppsala 10: 6 (1982). – Type: New Zealand, Wellington, Tongariro, 1981 Tibell 13605 (Calic. exs. 65, UPS, holotype).

S: sydlig blekspik.

Redlisted in: **S**.

Literature: Tibell, Lichenologist 17: 196–198 (1985); Symb. Bot. Ups. 27(1): 211–213 (1987); Gustavsson, Svensk Bot. Tidskr. 89: 79–80 (1995).

Ascomata 0.6–1.7 mm high. Stalk 0.1–0.2 mm diam., brown to reddish brown, sometimes yellowish. Uppermost part of stalk often with a yellow or white pruina. Stalk consisting of hyaline, strictly periclinally arranged, non-sclerotized hyphae, 1 µm diam. Capitulum spherical, 0.4–0.5 mm diam. Excipulum forming a small collar 40–50 µm thick, at the base of the capitulum. Excipulum collar consisting of hyaline, radiating, apically somewhat branched hyphae 1.5–2 µm diam. Lower side of excipulum covered by a pale lemon yellow to white pruina. Hypothecium hyaline. Ascoma initials sometimes covered by a dense yellow pruina, which later changes to violet red. Mazaedium in mature ascomata sometimes slightly pruinose, pale ochraceous. Asci formed singly, well-stalked, cylindrical to narrowly clavate, 21–27 × 4.0–5.5 µm, with uniseriately arranged or somewhat overlapping spores. Spores globose, 5–6 µm diam., to broadly ellipsoidal, hyaline, often with particles adhering to the wall. Spore wall with a minute, verrucose ornamentation.

Chemistry. No secondary substances have been identified. The yellow pruina of the ascomata is K–, whereas the violet red pruina dissolves in K and then plate-like, violet red crystals precipitate.

Habitat. On lignum of deciduous trees, particularly Fraxinus, but also known from *Acer*, *Fagus* and *Ulmus* in fringe areas of old deciduous stands.

Distribution. Known from Denmark, Norway and southern Sweden. **D:** NJy. **N:** Op, NT. **S:** Sk, Bl, Sm, Hl, Dls, Vg, Upl. Originally described from New Zealand, but also occurring in temperate North America. In Europe only known from Denmark and Sweden. – Map 67.

Note. Characterized by the rather large size, the yellowish to brownish stalks, the pale ochraceous mazaedium and rather small spores. The spores are larger in the Nordic material than in New Zealand. Recently discovered in Europe.

2. Sclerophora coniophaea (Norman) Mattsson & Middelborg

in Middelborg & Mattsson, Sommerfeltia 5: 61 (1987). – *Coniocybe coniophaea* Norman, K. Norske Vidensk.-Selsk. Skr. 5: 362 (1868). – Type: Norway, "ad Kirkesnaes convallis. Maalselven", Norman (O, lectotype; designated on p. 72).

F: härmähuhmarjäkälä. **N:** rustdoggnål. **S:** rödbrun blekspik.

Redlisted in: **S**.

Literature: Middelborg & Mattsson, Sommerfeltia 5: 61 (1987); Tibell, Svensk Bot. Tidskr. 72: 182–183 (1978).

Ascomata 0.9–1.5 mm high. Stalk 0.1–0.2 mm diam., reddish brown, covered by a thick reddish-brown or rarely a pale pruina. Stalk consisting of periclinally arranged, medium brown hyphae. Capitulum lenticular to subspherical, excipulum 0.3–0.5 mm diam. Excipulum without collar, 30–65 µm thick, consisting of almost isodiametric to elongated large cells, 5–9 × 3–6 µm tending to be anticlinally orientated in the outer part. Lower side of excipulum covered by a thick and coarse reddish brown pruina. Hypo-thecium hyaline, 65–100 µm high. Ascoma initials covered by a dense reddish brown pruina. Mazaedium pale ochraceous to rusty red when covered by the pruina. Asci formed singly, well-stalked, cylindrical, 25–33 × 3.5–4.5 µm, with uniseriately arranged spores. Spores globose, 4.5–6.0 µm diam., with a reticulate to verrucose ornamentation.

Chemistry. No secondary substances have been identified. The reddish brown pruina of the ascomata is K+ pale red in a transient reaction, then a precipitate of violet red plate- to featherlike crystals is formed.

Habitat. In southern Sweden and Finland on coarse bark of old *Quercus*, occasionally on *Alnus*, *Betula*, *Salix caprea* and *Ulmus* in mature stands, fringe areas of parklands and Alnus swamps. In northern Sweden and Norway at the base of trunks and stumps of *Betula*, *Picea*, *Salix*, *Alnus* and rarely on *Pinus* in shaded and humid situations in mature forests.

Distribution. Scattered and rather rare, but widely distributed in Finland, Norway and Sweden. **F:** V, St, EH, PK, Kn, OP, Ks. **N:** He, Op, Bu, Vf, Te, MR, ST, NT, No, Tr, Fi. **S:** Sk, SmI, Vg, Ög, Srm, Vrm, Vsm, Upl, Dlr, Gst, Hls, Ång, Jmt, ÅsL, LyL, PL, LuL, TL. Also occurring in Estonia and very rare in Continental Europe. – Map 68.

Note. Characterized by the pale ochraceous mazaedium, the coarse, reddish brown pruina, which covers both the stalk and the outer surface of the excipulum, by not having a collar-like basal extension of the excipulum and by the medium-sized, ornamented spores.

3. Sclerophora farinacea (Chevall.) Chevall.

Fl. env. Paris 1: 315 (1826). – *Fulgia farinacea* Chevall., J. Physique 1822: 58 (1822). – Type: Not seen.

Syn. Coniocybe farinacea (Chevall.) Nyl.

F: jauhehuhmarjäkälä. **N:** blådoggnål. **S:** brunskaftad blekspik.

Redlisted in: **F**, **S**.

Literature: Tibell, Svensk Bot. Tidskr. 67: 451–452 (1973).

Ascomata 0.7–1.2 mm high. Stalk 0.09–0.14 mm diam., medium brown, epruinose, shining, consisting of hyaline, non-sclerotized, strictly periclinally arranged, sparingly branched hyphae. Capitulum broadly obovate to lenticular, 0.3–0.4 mm diam. Excipulum forming a distinct collar 30–110 µm thick surrounding the stalk at the base of the capitulum. Excipulum collar consisting of hyaline, radiating, apically sparingly branched, thin hyphae 1.0–1.5 µm diam. Agglomerations of colourless crystals forming wedge-like intrusions between the excipulum hyphae penetrate into the excipulum and form a more or less continuous layer over the surface of the excipulum seen as a white, granular, crystalline pruina. Hypothecium pale yellowish brown, with slightly convex upper surface, 70–100 µm high, formed by intricately interwoven hyphae, 1 µm diam. Ascoma initials first with a white or sulphur yellow pruina, then the pruina turns faintly violet red. Mazaedium in mature ascomata sometimes slightly pruinose, pale ochraceous. Pruina of semi-mature ascomata K+ deeper violet red, HNO_3+ yellowish red. Ochraceous pruina of mature ascomata K+ reddish, HNO_3–. The K+ reaction is soon followed by the formation of a precipitate of violet red plate- to featherlike crystals. Mazaedium densely inspersed with minute, dark yellow crystals which also adhere to the spores and paraphyses. Asci formed singly, well-stalked, cylindrical to narrowly clavate, 27–32 × 5–6 µm, with uni- seriately arranged spores. Spores globose, 7–8 µm diam., hyaline, with a verrucose ornamentation.

Chemistry. No secondary substances have been identified. The yellow pruina of the ascomata is K–, whereas the violet red pruina dissolves in K and then plate-like, violet red crystals precipitate.

Habitat. On coarse bark of deciduous trees in semi-shaded situations, particularly of *Fraxinus* and *Ulmus*, but also of *Acer*, *Quercus* and *Tilia* in fringe areas of old deciduous stands and old parklands.

Distribution. Rare in southern Finland, Norway and Sweden. **F:** A. **N:** Ak, Bu, Vf, Te, SF**. S:** Sk, SmI, Vg, Ög, Srm, Vsm, Upl. Also known from the British Isles, Continental Europe, Caucasus and North America. – Map 69.

Note. Characterized by having a thick white pruina on the lower side of the excipulum, dark brown stalks and large, ornamented spores. Sometimes similar to *S. amabilis*, but differing in stalk colour, pruinosity and spore size.

4. Sclerophora nivea (Hoffm.) Tibell

Nova Hedwigia Beih. 79: 679 (1984). – *Trichia nivea* Hoffm., Vegetabilia cryptogamia 2: 14 (1790). – Type: Not seen.

Syn. *Coniocybe pallida* (Pers.) Fr.

D: gulmelet blegnålelav. **N:** bleikdoggnål. **S:** gulvit blekspik.

Redlisted in: **D**, **F**.

Literature: Tibell, Svensk Bot. Tidskr. 72: 186–187 (1978).

Ascomata 0.4–0.7 mm high. Stalk 0.06–0.10 mm diam., straw yellow or in decaying specimens pale to grey, epruinose, consisting of hyaline, non-sclerotized, strictly periclinally arranged, sparingly branched hyphae 1.5 µm diam. Ascoma initials sessile, covered by a bright yellow pruina. Capitulum broadly obovate to lenticular, 0.25–0.32 mm diam. Excipulum forming a distinct collar 50–80 µm thick surrounding the stalk at the base of the capitulum. Ex-

cipulum collar consisting of hyaline, radiating, branched, hyphae 1.5–3.0 µm diam. Surface of excipulum covered by an irregular layer of colourless or yellow crystals forming a pruina on the lower side of the capitulum. Hypo-thecium pale yellowish brown, with slightly convex upper surface, 30–45 µm high, formed by intricately interwoven hyphae, 1.5 µm diam. Mazaedium in mature ascomata pale ochraceous. The yellow pruina of the excipulum and upper part of stalk K–. Mazaedium densely inspersed with minute, dark yellow crystals which also adhere to the spores and paraphyses, K+ pale red in a transient reaction. Sometimes this K+ reaction is soon followed by the formation of a precipitate of violet red plate- to featherlike crystals. Asci formed singly, well-stalked, clavate, 28–34 × 4–6 µm, with biseriately arranged spores. Spores globose, 7–8 µm diam., hyaline, with a verrucose ornamentation.

Chemistry. No secondary substances have been identified. The yellow pruina of the excipulum is K–, whereas the granular material in the mazaedium partly dissolves in K and then sometimes a precipitate of plate-like, violet red crystals is formed.

Habitat. On bark of deciduous trees in rather open situations, on solitary and roadside trees, particularly on *Fraxinus* and *Tilia*, more rarely on *Acer*, *Quercus* and *Ulmus*.

Distribution. Not uncommon in some areas of southern Sweden. In Norway it reaches Nord-Trøndelag. Very rare in Finland and only known from the extreme southwest. **F:** A, V. **N:** Øf, Ak, He, Op, Bu, Vf, Te, AA, VA, Ro, Ho, SF, MR, NT. **S:** Sk, Gtl, Sm, Bh, Dls, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Gst. Widely distributed in the Northern Hemisphere and also known from the British Isles, Continental Europe, Siberia and North America. – Map 70.

Note. Characterized by the small size and the pale yellow or grey colour of the ascomata, the yellow pruinose ascoma initials and the large, ornamented spores.

5. Sclerophora peronella (Ach.) Tibell

Nova Hedwigia Beih. 79: 679 (1984). – *Lichen peronellus* Ach., Lich. suec. prodr.: 84 (1799). – Type: Without locality (BM-ACH 213, lectotype, Tibell, Lichenol. 10: 174, 1978).

Syn. *Coniocybe peronella* (Ach.) Tibell, *Coniocybe hyalinella* Nyl.

D: liden blegnålelav. **F:** koivunhuhmarjäkälä. **N:** kystdogg-nål. **S:** liten blekspik.

Redlisted in: **D**, **F**, **S**.

Literature: Tibell, Svensk Bot. Tidskr. 67: 453 (1973); Lichenologist 10: 174 (1978).

Ascomata short, 0.5–0.8 mm high, pale carneous, or covered by a thick white pruina. Stalk 0.06–0.12 mm diam., dull greyish, epruinose. Capitulum hemispherical, 0.2–0.3 mm wide. Young ascomata with a faint, K–, lemon yellow pruina covering the capitulum. Excipulum of variable thickness, sometimes strongly thickened, without collar, 30–90 µm thick, consisting of irregularly intertwined hyphae, 1.5 µm diam. Excipulum surface with a 3–4 µm thick, amorphous, yellowish red layer. Hypothecium yellowish red, 70–110 µm high, with convex upper surface, consisting of irregularly intertwined hyphae, 1.5 µm diam. Mazaedium pale carneous to ochraceous or covered with a white pruina. Stalk consisting of hyaline, non-sclerotized, periclinally arranged hyphae, 1.5 µm diam., in section yellowish red, with a 8–14 µm thick hyaline coat. The inner part of the stalk reddish brown and visible when the ascomata are wet, outer part hyaline but opaque when dry. Asci formed singly, well-stalked, cylindrical, 21–27 × 2.5–3.0 µm, with biseriately arranged spores. Spores globose, 3.0–3.5 µm diam., smooth.

Chemistry. No secondary substances have been identified. A K–, lemon yellow pigment occurs as a pruina of the ascomata.

Habitat. On bark and lignum of old deciduous trees such as *Acer*, *Fagus*, *Fraxinus*, *Quercus*, *Sorbus*, *Tilia* and *Ulmus* in humid and rather shaded situations. More rarely on lignum of *Alnus*, *Betula*, *Fagus*, *Populus* and *Malus*.

Distribution. Rare in Denmark, Norway and south and central Sweden, very rare in southernmost Finland. **D:** ØJy. **F:** A, V, U. **N:** Op, Vf, Ro, Ho, SF, MR, ST, NT, No. **S:** Sk, Sm, Bh, Dls, Vg, Ög, Srm, Vrm, Upl, Dlr, Gst, Hls, Jmt. Also known from the British Isles and Central Europe. – Map 71.

Note. Characterized by the pale carneous ascomata, a reddish central core of the stalk (best visible in water) and the small, smooth spores.

Sphaerophorus Pers.

Ann. Bot. (Usteri) 7: 23 (1794).

Literature: Tibell, Svensk Bot. Tidskr. 74: 62–65 (1980); Wedin, Pl. Syst. Evol. 187: 231–232 (1993); Wedin, Symb. Bot. Ups. 31(1): 91–96 (1995).

Thallus fruticose, terete, moderately to richly branched, brown to pale greyish, forming extensive colonies or single tufts. Branching anisotomic to isotomic dichotomous or

irregular. Medulla I+ deep blue or I–. Ascomata terminal, spherical, immersed in the branches. Mazaedium opening terminally, often surrounded by irregular flaps of thalline tissue. Asci cylindrical, with uniseriately arranged spores, disintegrating before the spores are mature. Spores globose to broadly ellipsoidal, 7–13 × 6–11 µm, bluish or reddish blue when young, black and with a thick, irregular ornamentation when mature. Ornamentation formed within the asci. Conidiomata formed in the tips of the terminal branches, pycnidial, ostiolate, black. Conidiophores branched with both terminal and intercalar conidiogenous cells. Conidia simple, hyaline, ellipsoidal to obovate, 3.0–4.5 × 1.5–2.0 µm.

Chemistry. Sphaerophorin occurs in all species along with ß-orcinol depsides.

Note. A bipolar genus with one exclusively Northern Hemisphere species, one species endemic to New Zealand and one species occurring widely in the Northern Hemisphere, in southernmost South America and on the Antarctic Peninsula. The species grow as epiphytes or on rocks or the ground in arctic/antarctic, alpine and temperate to cool temperate areas.

1 Thallus 3–6 cm high, with distinct main branches and short, coralloid lateral branches, brownish, with pale apices. Medulla I+ dark blue ..... 1 *S. globosus*

– Thallus 2–3 cm high, mainly dichotomously branched, without distinct main branches, brown or grey, without pale apices. Medulla I– ..... 2 *S. fragilis*

1. Sphaerophorus fragilis (L.) Pers.

Ann. Bot. (Usteri) 7: 23 (1794). – *Lichen fragilis* L., Sp. Pl. 1154 (1753). – Type: Without locality (LINN 1273.261, lectotype, Wedin, Pl. Syst. Evol. 187: 229, 1993).

D: skør kuglelav. **F:** pikkukorallijäkälä. **N:** grå korallav. **S:** sprödlav.

Redlisted in: **D**.

Literature: Tibell, Svensk Bot. Tidskr. 74: 62–64 (1980).

Thallus terete, 2–3 cm high, erect, brittle, often forming cushions, 5–12 cm diam., pale greenish grey or pale brown to blackish at the base, apices not conspicuously pale. Sterile branches terete, di- or trichotomously and often richly branched apically, isotomic to anisotomic in the lower part but clearly dichotomous and isotomic towards the apices, 0.4–0.5 mm wide. Strongly compacted tufts with numerous, minute sterile branches are sometimes formed. Fertile branches rising above the cushions, simple, sometimes uneven, 0.6–1.1 mm wide. Medulla I–. Ascomata not abundant, subglobose, 1.5–2.8 mm diam. Asci cylindrical, 38–46 × 4.5–6 µm. Spores globose or broadly ellipsoidal, 9–12 µm (maximum diam.), covered by a dark, irregular ornamentation. Conidiomata 0.10–0.14 mm diam., black, semi-immersed in the apices of branchlets. Conidia narrowly ellipsoidal, 3–4 × 1 µm.

Chemistry. Cortex K–, C–, KC–, PD–; medulla K+ yellow or K–, PD+ yellow or PD–, I–. Contains (1) sphaerophorin and hypothamnolic acid; (2) sphaerophorin only; (3) sphae-rophorin and squamatic acid or (4) sphaerophorin, squa-matic acid and hypothamnolic acid.

Habitat. On acidic rocks in exposed situations and more rarely on soil, among mosses.

Distribution. Occurring over most of Norway, Sweden and western and northern Finland, but more common in the northern parts. Also common on Iceland, the Faroes and in the Arctic Islands. Rare in Denmark. **D:** NJy, Fyn, Brn. **Gr. Fa. F:** A, V, U, EK, St, EH, ES, EP, PK, OP, PeP, Ks, KiL, SoL, EnL, InL. **I:** Isu, IVe, IMi, IAu, INv, INo. **N:** Öf, Ak, He, Op, Bu, Vf, Te, AA, VA, Ro, Ho, SF, MR, ST, NT, No, Tr, Fi. **AI:** Sb. **S:** Sk, Bl, Gtl, Sm, Bh, Dls, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Hls, Mpd, Ång, Jmt, Vb, Nb, ÅsL, LyL, PL, LuL, TL. Widely distributed in oceanic parts of arctic and cool temperate areas of the Northern Hemisphere (Europe, Greenland, East Asia, North America). – Map 72.

Note. Characterized by forming more or less dense cushions, the predominantly dichotomous, isotomic branching, the grey to brown thalline colour and the I– medulla.

2. Sphaerophorus globosus (Huds.) Vain.

Result. Voyage. S. Y Belgica, Bot., 35 (1903). – *Lichen globosus* Huds., Fl. angl.: 460 (1762). – Type: "*Coralloides cupressiforme, capitulis globosis*", Dillenius, Hist. Musc., Fig. XVII: 35, 1742 (lectotype, Wedin, Pl. Syst. Evol. 187: 230, 1993).

D: almindelig kuglelav. **F:** isokorallijäkälä. **N:** brun koral-lav. **S:** korallav.

Redlisted in: **D**.

Literature: Tibell, Svensk Bot. Tidskr. 74: 62–65 (1980); Wedin, Symb. Bot. Ups. 31(1): 91–94 (1995).

Thallus terete, 3–6 cm high, erect, brittle, often forming large, loose colonies or cushions up to 15 cm diam., with distinct main branches and short, coralloid lateral branchlets, glossy, pale to dark brown or reddish brown to greyish, often with pale apices. Branching anisotomic in fertile branches and anisotomic to irregular in secondary branch-

es. Fertile branches 0.7–1.1 mm diam., sparsely branched but often with numerous coralloid secondary branchlets, somewhat uneven. Medulla I+ dark blue. Ascomata subglobose, 1.3–1.7 mm diam. Asci cylindrical, 43–47 × 5–6 µm. Spores subglobose to broadly ellipsoidal, 8–11 µm (maximum diam.), covered by a dark, irregular ornamentation. Conidiomata semi-immersed, 0.15–0.19 mm in diameter, protruding parts black, and with a distinct ostiolum. Pycnidium wall in the upper part blackish brown, 11–14 µm thick, consisting of 3–4 layers of strongly pigmented, spherical, conglutinated cells. In the lower part the wall is poorly delimited, non-pigmented, consists of tangentially arranged hyphae 2.5–3 µm diam., and is covered by cortex tissue. Pycnidium ontogeny of the Umbilicaria-Type. Conidiophores branched or simple, consisting of 3.0–5.0 × 2.0 µm large, branched and sometimes anastomosing cells, of Vobis' Type V or VI. Conidia acrogenous or pleurogenous. Conidia hyaline, non-septate, ellipsoidal to obovate, 3.0–4.5 × 1.5–2.0 µm.

Chemistry. Cortex C–, K–, KC–, PD–; medulla K+ yellow or K–, PD+ yellow or PD–, I+ dark blue. Contains (1) sphaerophorin only; (2) sphaerophorin and thamnolic acid; (3) sphaerophorin and squamatic acid; (4) sphaerophorin and hypothamnolic acid; (5) sphaerophorin, squamatic acid and hypothamnolic acid or (6) sphaerophorin, squamatic acid and thamnolic acid.

Habitat. Widely distributed on soil in arctic-alpine areas, also in bogs and further south on acidic rocks in rather open to exposed situations and on soil, among mosses and bark of *Alnus*, *Betula*, *Picea* and *Quercus*, particularly in areas with an oceanic climate.

Distribution. Occurring over most of Denmark, Norway and Sweden, western and northern Finland and also on Iceland and Greenland, the Faroes and in the Arctic Islands. **D:** NJy, ØJy, VJy, Sjæ, Brn. **Gr. Fa. F:** A, V, U, EK, St, EH, ES, EP, PH, PeP, Ks, KiL, SoL, EnL, InL. **I:** ISu, IVe, IMi, IAu, INv, INo. **N:** Öf, Ak, He, Op, Bu, Vf, Te, AA, VA, Ro, Ho, SF, MR, ST, NT, No, Tr, Fi. **AI:** Bi, Sb. **S:** Sk, Bl, Sm, Hl, Bh, Dls, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Mpd, Hrj, Jmt, ÅsL, PL, LuL, TL. Widely distributed in oceanic areas of the Northern Hemisphere (Europe, East Asia, North America) and also occurring in southernmost South America and Antarctica. – Map 73.

Note. Usually recognized by its brownish colour, the prominent main branches, the coralloid lateral branches and often pale apices of the branches. Poorly developed and sterile specimens may be difficult to distinguish from *S. fragilis*, but differ in their I+ deep blue to blackish reaction of the medulla.

Sphinctrina Fr.:Fr.

Syst. Orb. Veg.: 120 (1825): Fr., Elench. fung. 2: 148 (1828).

Literature: Löfgren & Tibell, Lichenologist 11: 109–137 (1979); Tibell, Svensk Bot. Tidskr. 74: 55–67 (1980); Tibell, Nova Hedwigia Beih. 79: 682–683 (1984).

Parasitic or parasymbiotic. Ascomata sessile to short stalked, black. Capitulum obovoid. Excipulum well-developed, of dark brown to reddish brown or in part pale, more or less periclinally arranged and intertwined hyphae, with constricted and frequently slightly thickened margin. Stalk of largely periclinally arranged hyphae, inner part pale, outermost part dark brown or reddish. Asci cylindrical, formed singly from ascogenous hyphae with croziers, with uniseriate spores, 30–75 µm long. Mazaedium well-developed, black. Spores simple, subglobose, 4.5–10 µm diam., or 1-septate, ellipsoidal, up to 16 µm long. Spore wall dark brown, thick, and in semi-mature stages with a hyaline coat, ornamented with warts or ridges, or smooth, not rupturing at maturity. Conidiomata not known.

Chemistry. No secondary substances have been identified. The ascomata of some of the species contain a pigment which changes to more intensely reddish when K is added as observed under the microscope.

Note. Sphinctrina is widely distributed in temperate to tropical areas of both hemispheres. *Sphinctrina* occurs mainly on corticolous species of *Pertusaria*, but it has also been collected on rocks. Rarely it grows on *Lecanora* and *Diploschistes*.

1 Spores ellipsoidal, 1-septate ..... 3 *S. porrectula*
– Spores globose to subglobose, non-septate 2
2 Ascomata sessile, excipulum in section reddish, K+ intensified ..... 4 *S. turbinata*
– Ascomata well-stalked, excipulum not red in section 3
3 Stalk only slightly higher than wide, spores 7–10 µm diam., with a minute ornamentation of tiny warts ..... 1 *S. anglica*
– Stalk 3–4 times as high as wide, spores 4–6 µm diam., ornamentation indistinct or lacking ..... 2 *S. leucopoda*

1. Sphinctrina anglica Nyl.

Mém. Soc. Imp. Sci. nat. Cherbourg 5: 334 (1858). – Type: Czech Republic, Bohemia, Malíkov, 1961 Vezda (Vezda, Lich. sel. exs. no 104, BM, neotype, Löfgren & Tibell, Lichenologist 11: 122 (1979).

F: aidaspampukka. **S:** ladparasitspik.

Redlisted in: **F**, **S**.

Literature: Tibell, Svensk Bot. Tidskr. 74: 63–66 (1980).

Ascomata 0.2–0.4 mm high, with a short but distinct stalk, 0.6–1.7 times as long as the width of the capitulum, black or rarely dark brown. Capitulum 0.1–0.2 mm diam., spherical but often somewhat irregular, shining black. Excipulum dark brown in section, sclerotized, in the upper part consisting of 6–8 layers of isodiametric to irregularly branching cells, 2–7 µm diam. Lower part of excipulum with sclerotized, isodiametric cells forming a 5–7 µm thick cover over 4–6 layers of periclinally arranged, narrow hyphae. Hypothecium hyaline, 40–50 µm high, consisting of isodiametric to irregular cells. Stalk consisting of largely periclinally arranged, intertwined and sometimes anastomosing hyphae with strongly gelatinized walls, 3–4 µm diam. Stalk surface in the upper part of the stalk consisting of a layer of isodiametric, sclerotized cells, up to 8 µm diam. All parts of the ascoma K–. Asci 49–57 × 7–8 µm. Spores dark brown, subglobose, non-septate, 7–10 × 7–9 µm. Ornamentation distinct under the light microscope, consisting of minute warts. Spore coat thin, not always visible in water-mounts of semi-mature spores.

Chemistry. No secondary substances have been identified. No pigments occur in the ascomata and all parts of the ascomata are K–.

Habitat. On *Protoparmelia oleagina* on lignum.

Distribution. A rare species with a few recent occurrences in southern Sweden. **F:** U, EH, PH. **S:** Sk, Öl, Sm, Dls, Ög, Nrk, Srm, Vsm, Upl, Dlr, Jmt. Widely distributed in the Northern Hemisphere, also occurring in Central and Western Europe and North America. – Map 74.

2. Sphinctrina leucopoda Nyl.

Syn. Lich. 1(2): 144 (1860). – Type: U.S.A., Virginia, Tuckerman (H-NYL 40993, holotype).

Syn. *Sphinctrina pedata* (Stenh.) R.Sant.

S: liten parasitspik.

Redlisted in: **S**.

Literature: Tibell, Svensk Bot. Tidskr. 74: 64–66 (1980).

Ascomata 0.2–0.3 mm high, distinctly stalked. Stalk 0.8–2.4 times as long as the width of the capitulum, light to dark brown or rarely black. Capitulum 0.1–0.2 mm diam., spherical but sometimes slightly compressed, regular and smooth, shining dark brown to black, and distinctly darker than the stalk. Excipulum dark brown, sclerotized, in the upper part consisting of 4–6 layers of isodiametric to irregular cells, 4–7 µm diam. Lower part of excipulum with sclerotized, isodiametric cells forming a 5–7 µm thick cover over 1–2 layers of periclinally arranged hyphae with rectangular cells. Hypothecium hyaline, 25–36 µm high, consisting of isodiametric to irregular cells. Stalk consisting of largely periclinally arranged cells with strongly gelatinized walls, 3–4 µm diam. All parts of the ascoma K–. Asci 32–45 × 4.5–6 µm. Spores dark brown, subglobose, non-septate, 4.5–6.0 × 4.0–6.0 µm. Only a very minute ornamentation of irregular folds or cracks visible under the light microscope. Spore coat thick and distinct in water-mounts of semi-mature spores.

Chemistry. No secondary substances have been identified. No pigments occur in the ascomata and all parts are K–.

Habitat. On the thallus of *Pertusaria coccodes* and P. *pertusa*, mainly on old *Quercus* or other deciduous trees – or very rarely on *Lecanora* on rocks.

Distribution. A rare and vanishing species known only from southern Sweden apart from a single collection from Norrland. **S:** Sk, Bl, Gtl, Sm, Bh, Vg, Ög, Nrk, Srm, Vsm, Upl, Ång. Otherwise it has a wide distribution occurring in Central Europe, the Mediterranean, North America, Australasia, and South America. – Map 75.

Note. A very variable species with respect to size and colour of the stalk and is sometimes hard to distinguish from S. turbinata, which differs in having non-stalked ascomata, a red, K+ intensified red pigment in the excipulum and by having the excipulum formed by periclinally arranged, branched hyphae.

3. Sphinctrina porrectula Nyl.

Flora 57: 6 (1874). – Type: Finland, Tavastia australis, Asikkala, Kaila, 1870 Norrlin (H-NYL 40922, holotype).

F: suomenpampukka.

Redlisted in: **F**.

Ascomata 0.2–0.5 mm high, distinctly stalked. Stalk 1.6–4.8 times as long as the width of the capitulum, dark brown or black. Capitulum 0.07–0.12 mm diam., smooth, regular, shining black to dark brown, with constricted excipulum margin. Excipulum dark brown in section, sclerotized, in the upper part 25–30 µm thick, consisting of an outer layer of 4–6 layers of isodiametric to irregular cells, 2–4 µm diam and an inner layer of periclinally arranged, branched hyphae c 1.5 µm diam. Lower part of excipulum 10–12 µm thick, consisting of 2–3 layers of sclerotized, isodia-metric cells up to 5 µm diam. Stalk consisting of

largely periclinally arranged cells with strongly gelatinized walls. All parts of the ascoma K–. Asci 40–53 × 3.5–5.0 µm. Spores dark brown, ellipsoidal, 1-septate, 5.5–9.0 × 3.0–5.0 µm. Ornamentation indistinct or absent. Spore coat thin but usually visible in water-mounts, sometimes wrinkled.

Chemistry. No secondary substances have been identified. No pigments occur in the ascomata and all parts are K–.

Habitat. On twigs of *Picea abies*. Whether it is lichenized or a parasymbiont or parasite is not clear.

Distribution. An extremely rare species only known from two localities from Finland, collected in 1870 and 1890 respectively. **F:** EH, SoL? (locality uncertain). – Map 76.

Note. A remarkable species for having 1-septate spores. It may easily be mistaken for a *Calicium* species, but has a strongly constricted and swollen excipulum margin and spores with a gelatinous spore coat.

4. Sphinctrina turbinata (Pers.: Fr.) De Not.

G. Bot. ital. 2: 314 (1846). – *Calicium turbinatum* Pers., Tent. disp. meth. fung.: 59 (1797): Fr., Elench. fung. 2: 148 (1828). – Type: Without locality (L-Pers., neotype, Löfgren & Tibell, Lichenologist 11: 133, 1979).

Syn. *Sphinctrina gelasinata* (With.) Zahlbr.

D: kortstilket parasitnål. **S:** kortskaftad parasitspik.

Redlisted in: **D**, **F**, **S**.

Literature: Tibell, Svensk Bot. Tidskr. 74: 66–67 (1980).

Ascomata 0.2–0.3 mm high, short-stalked to sessile. Stalk at most as long as the width of the capitulum, dark brown to light brown or rarely black. Capitulum 0.2–0.4 mm diam., spherical but often slightly irregular, shining black or dark brown. Excipulum dark ruby red in section, not sclerotized, 50–85 µm thick, consisting of largely peri-clinally orientated, intricately interwoven, branched hyphae 3–4 µm diam., K+ intensified red. Surface layer in upper part slightly sclerotized, in the lower part gelatinose, hyaline. Hypothecium hyaline, 35–50 µm high, consisting of isodiametric to irregular cells. Stalk consisting of largely periclinally arranged, ruby red cells with strongly gelatinized walls, 3–4 µm diam. Stalk surrounded by a sometimes up to 35 µm thick gelatinous coat. Asci 40–51 × 5–7 µm. Spores dark brown, subglobose, non-septate, 5.0–7.0 × 4.5–7.0 µm. Ornamentation usually distinct, consisting of minute pores but easily interpreted as verrucose under the light microscope. Old spores often with some irregular cracks. Spore coat thick and distinct in water-mounts of semi-mature spores, sometimes wrinkled.

Chemistry. No secondary substances have been identified. A reddish, K+ pigment occurs in the ascomata. The K reaction is variable, but usually quite distinctive with the excipulum turning intensely violet red.

Habitat. On the thallus of *Pertusaria pertusa* and more rarely on other Pertusaria species growing on old *Quercus* and *Fagus*, mainly in oceanic areas, where it occurs in well-lit and not too dry situations.

Distribution. A rather rare and vanishing species occurring in Denmark and southern Finland, Norway and Sweden. **D:** NJy, Sjæ, Brn. **F:** EH. **N:** Vf. **S:** Sk, Bl, Öl, Gtl, Sm, Hl, Bh, Dls, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Ång, Jmt. Also known from Continental Europe, Caucasus, Africa and North America. – Map 77.

Note. For a comparison with S. leucopoda, see above.

Stenocybe Nyl. ex Körb.

Syst. lich. Germ.: 306 (1855). – *Calicium* subg. *Stenocybe* Nyl., Mém. Soc. Sci. Nat. Cherbourg 3: 167 (1855).

Literature: Schmidt, Mitt. Staatsinst. Allg. Bot. Hamburg 13: 111–166 (1970); Tibell, Nova Hedwigia Beih. 79: 683–684 (1984).

Saprobic or parasitic. Ascomata well stalked, black to plumbeous. Capitulum obovoid to subspherical. Excipulum well developed, consisting of dark brown, periclinally arranged hyphae and with porrectulate and often strongly thickened margin. Hymenium covered by a thin layer of dark hyphae, the epithecium. Stalk consisting of dark brown periclinally arranged hyphae. Asci cylindrical, with uniseri-ately arranged spores, 70–250 µm long, formed singly from ascogenous hyphae with hooks. Asci with uniformly thickened apex, persisting until the spores are ejaculated. No mazaedium. Spores 3–7-septate, fusiform, 12–75 × 4–21 µm, uniseriately arranged in the asci. Spore wall rather thick to very thick, dark brown, uniform or unevenly thickened and with angular lumina, smooth. Spore apex often pale.

Chemistry. No secondary substances have been identified.

Note. The genus occurs mainly in cool temperate to warm temperate areas of the Northern Hemisphere, with one species occurring in New Zealand. The species occur as saprobes or possibly weak parasites on branches of trees and shrubs, and are very host-specific. One anomalous species occurs on liverworts. The generic delimitations in Mycocaliciaceae are in need of revision, particularly with respect to *Stenocybe* versus *Phaeocalicium* and *Phaeocalicium* versus *Chaenothecopsis*.

1 Ascomata large, 0.8–1 mm high mm, spores 32–35 × 13–15 µm, on liverworts.....1 *S. bryophila*

– Ascomata minute, less than 0.5 mm high, spores less than 20 µm long, on thin branches of Alnus.....2 *S. pullatula*

1. Stenocybe bryophila Walt. Watson

London J. Bot. 65: 130 (1925). – Type: Wales, Caernarvonshire, near Llanberis, Cwm-y-glo, Sept 1924 Watson (BM; lectotype, designated on p. 72).

Literature: Øvstedal & Vevle, Blyttia 25: 124–125 (1967).

Saprobic or parasitic on liverworts. Ascomata 0.8–1 mm high, plumbeous grey to dark olive, shiny, with strongly thickened excipulum edge surrounding a small, immersed, black disc. Capitulum obconical, 0.4–0.6 mm diam. Epithecium poorly developed, with some carbonized material. Paraphyses intricately branched and anastomosing, very thin, ca 0.5–1 µm diam. Hypothecium narrowly obconical, up to 120 µm high, dark brown, consisting of largely periclinally arranged, carbonized hyphae 3–4 µm diam. Excipulum brown in section, in the strongly swollen uppermost part 135–195 thick, formed by intricately interwoven, strongly gelatinized, pale brown hyphae with narrow lumina over 3–6 layers of periclinally arranged, sclerotized hyphae. Surface layer hyaline, gelatinized, 8–13 µm thick. Lower part of excipulum 35–55 µm thick, consisting of irregularly intertwined, less swollen cells, 3–4 µm diam covering an internal lining of dark brown, periclinally arranged hyphae formed by 8–16 layers of narrow hyphae. Stalk 0.2–0.3 mm diam. Central part of stalk dark brown, with sclerotized hyphae in a largely periclinal arrangement. Outer part of stalk with irregularly arranged, paler hyphae. Asci narrowly cylindrical, 188–200 × 14–15 µm. Spores 3-septate, medium brown, broadly ellipsoidal and with pale, minute end cells, 32–35 × 13–15 µm, appearing smooth under the light microscope.

Chemistry. No secondary substances have been identified.

Habitat. On liverworts over rocks in shaded and humid situations in very oceanic areas. In the Nordic area collected from *Plagiochila* and *Frullania*.

Distribution. Only known from western Norway. **N:** Ho. Also known from oceanic areas of the British Isles and Macaronesia. – Map 78.

Note. Characterized by the large, plumbeous grey to dark olivaceous ascomata with strongly thickened excipulum margin, the large, 3-septate spores with minute and pale end cells and by growing on liverworts.

2. Stenocybe pullatula (Ach.) Stein

in Cohn, Krypt. Fl. 2(2): 298 (1879). – *Calicium pullatulum* Ach., K. Vetensk.-Acad. Handl. 1816: 121 (1816). – Type: Sweden, Uppland, Älvkarleby par., Storön, 1942 Ahlner (UPS, neotype, Tibell, Ann. Bot. Fenn. 24: 273, 1987).

Syn. *Stenocybe byssacea* (Fr.) Körb.

Saprobic or parasitic on branches of Alnus. Ascomata 0.23–0.5 mm high, black, shiny, sometimes branched and with 2–5 capitula. Branches form in the uppermost part of the stalk and the branches diverge at wide angels. Capitulum lenticular to elongated, with somewhat constricted margin, 0.10–0.13 mm diam. Epithecium dark, 4–6 µm thick, consisting of intricately interwoven sclerotized hyphae. Young ascomata covered by a 6–8 µm thick layer of hyphae parallel with the upper surface. Hypothecium poorly developed, hyaline, consisting of periclinally arranged hyphae 1.5–2.0 µm diam. Excipulum brown, 8–11 µm thick, formed by 4–7 layers of periclinally arranged, sclerotized hyphae. Stalk 0.07–0.08 mm diam., consisting of largely periclinally arranged, sclerotized hyphae, 1.5–3.0 µm diam. Stalk surrounded by a 3–5 µm thick hyaline gelatinous coat. Asci narrowly cylindrical, 84–89 × 4.5–6.0 µm. Spores 1–3-septate, medium brown, narrowly ellipsoidal, 11–16 × 4–5 µm, with an ornamentation of minute warts under the light microscope. Septa poorly pigmented and 3 septa only visible in fully mature spores.

Chemistry. No secondary substances have been identified.

Habitat. On thin, decaying branches and trunks of *Alnus incana* and *A. glutinosa*, particularly close to streams and lakes.

Distribution. Widely distributed in Finland, Norway and Sweden. Rare in Denmark. **D:** NJy. **F:** U, St, EH, ES, EP, PH, PS, Kn, OP, PeP, Ks, KiL, InL. **N:** Øf, Ak, Op, Te, VA, Ro, Ho, MR, ST, NT, No, Fi. **S:** Bl, Öl, Sm, Hl, Bh, Dls, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Hls, Hrj, Jmt, Vb, Nb, ÅsL, PL, LuL, TL. Also known from cool temperate and temperate areas of the Northern Hemisphere (the British Isles, Continental Europe, Caucasus, North America). – Map 79.

Note. Characterized by the minute and often branching ascomata, the narrowly ellipsoidal spores which at maturity are 3-septate and the occurrence on twigs of *Alnus*.

Thelomma A. Massal.

Atti Reale Ist. Veneto Sci., ser. 3, 5: 268 (1860).

Literature: Tibell, Bot. Notiser 129: 221–249 (1976).

Thallus crustose, episubstratic, verrucose, areolate or placodioid, grey to yellowish or brownish. Cortex simple, ca 15 µm thick, consisting of intertwined hyphae or thicker, 25–45 µm, consisting of densely aggregated, vertically arranged hyphae which form compacted strands penetrating deep into the medulla. Ascomata immersed in verrucae 0.8–2.5 mm diam., about as high as wide. Excipulum thin and pale laterally, only forming a collar at the edge of the hypothecium. Hypothecium blackish brown, thick. Mazae-dium black. Asci cylindrical, formed singly and dissolving early. Spores non-septate and globose or 1-septate and broadly ellipsoidal. Spore wall thick, blackish brown, in most species with distinctive, electron dense granules. Spores with a minute to coarse ornamentation consisting of irregular ridges, faint parallel ridges or irregular cracks. Photobiont trebouxioid.

Chemistry. Containing orcinol depsides, orcinol and ß-orcinol depsidones, usnic acid, the anthraquinon skyrin and tetronic acid derivatives.

Note. Characterized by the immersed ascomata with thin, pale lateral excipulum and the large ascomata.

1. Thelomma ocellatum (Körb.) Tibell

Bot. Notiser 129: 240 (1976). – Acolium ocellatum Körb., Parerg. lich.: 285 (1861). – Type: Switzerland, St Moritz, Hepp (Hepp, Flechten Eur. 331, L-Körb., lectotype, Tibell, Svensk Bot. Tidskr. 65: 154, 1971).

Syn. *Cyphelium ocellatum* (Körb.) Trevis.

S: thelomma.

Literature: Middelborg & Mattsson, Sommerfeltia 5: 65 (1987); Tibell, Bot. Notiser 129: 221–249 (1976); Svensk Bot. Tidskr. 74: 67–68 (1980); Nova Hedwigia Beih. 79: 685–686 (1984).

Thallus crustose, well developed, with flattened verrucae or subareolate, grey. Small, globular isidia formed in dense groups in well delimited, irregular, black patches on the thallus surface. Individual isidia almost spherical, short-stalked and covered by a dark cortex. Isidia abound in sterile thalli, but are less frequent in fertile specimens. Medulla I+ dark blue. Ascomata rare, immersed in old verrucae. Fertile verrucae 1.5–2 mm diam., with uneven surface. Ma-zaedium black, 0.5–1.0 mm diam., flat, sometimes with a greenish pruina. Excipulum not sclerotized and poorly developed laterally. Hypothecium blackish brown, 140–220 µm high. Asci cylindrical, with uniseriately arranged spores, 58–67 × 5–6 µm. Spores 1-septate, dark brown, slightly constricted at the septum and with a slightly uneven surface, 24–28 × 13–14 µm.

Chemistry. Thallus K–, C–, KC–, PD– Medulla I+ dark blue. The mazaedium and the edge of the excipulum contain epanorin and rhizocarpic acid Usnic acid, atranorin and norstictic acid have been reported to occasionally occur in the thallus of some specimens.

Habitat. On lignum, particularly on coniferous wooden fences and particularly at tops of wooden posts adjacent to fields and pasture areas. These localities are rich in nitrogen and other nutrients and sterile thalli are often extensive.

Distribution. Widely distributed and not uncommon in Norway and Sweden except for the northernmost parts, probably overlooked in Finland. **F:** A, V, U, EK, EH, ES, EP, OP, PeP, Ks. **N:** Øf, Ak, He, Op, Bu, Te, Ho, SF, MR, ST, No, Tr, Fi. **S:** Sk, Öl, Gtl, Sm, Bh, Vg, Ög, Nrk, Srm, Vrm, Vsm, Upl, Dlr, Gst, Hls, Mpd, Ång, Hrj, Jmt, LyL. Also known from the British Isles, Continental Europe and North America. – Map 80.

Note. Fertile specimens are very rare and in the Nordic countries they have only been found at moderate altitudes in Norway.

Tholurna Norman, nom. cons.

Flora 44: 409 (1861).

Note.: Only one species known.

1. Tholurna dissimilis (Norman) Norman

Flora 44: 409 (1861). – *Podocratera dissimilis* Norman, Förh. Skand. naturf. möte 1860: 726 (1860). – Type: "In Gudbrandsdalia Norvegiae meridionalis J. M. Norman" (O, lectotype; designated on p. 72).

D: nordisk urnelav. **F:** tuulijäkälä. **N:** trollav. **S:** urnlav.

Redlisted in: **N**, **S**.

Literature: Ahlner, Acta Phytogeogr. Suec. 22: 91–95, 213–214 (1948) Tibell, Nova Hedwigia Beih. 79: 686–688 (1984).

Thallus dark olivaceous to brownish grey, forming spherical to hemispherical cushion-like colonies, 15–25 mm diam consisting of densely clustered, radially protruding digitate podetia carrying one ascoma apically. The podetia emerge from a crustose, verrucose to irregularly thickened sterile thallus surrounding the bases of the podetia. Podetia strongly furrowed, with greyish ridges. Podetia 1.5–2

mm high. Cortex of varying thickness, in part 13–15 µm thick and divided into a brownish outer and hyaline inner layer, but strongly thickened towards the apex of the podetia and at the ridges. In the thickened areas the cortex is 65–100 µm thick and consists of periclinally arranged, thin hyaline hyphae. Ascomata sessile, singly at the apex of the podetia, 0.4–0.6 mm high and 0.3–0.6 mm wide. Exci-pulum slightly bell shaped, 40–55 µm thick, consisting of isodiametric cells, with an outermost layer of brown, sclerotized isodiametric cells, 4–8 µm diam., and an hyaline interior part of intricately interwoven hyphae, 1.5–2.0 µm diam. Mazaedium black, epruinose. Asci 50–68 × 4.5–6.0 µm, cylindrical, formed singly and dissolving at early stages. Spores 1-septate, 17–20 × 9–10 µm, constricted at the septum. Spore wall thick, dark brown and with a very distinctive ornamentation of spirally arranged ridges. Conidiomata immersed in the dactyliform lobes, spherical 0.1–0.2 mm in diameter. Mature pycnidia with a single locule, spherical, slightly pear-shaped to irregular, with a ruptured, pigmented ostiolum. Pycnidium wall poorly differentiated, at the base consisting of 1–3 layers of isodia-metric cells, 2–4 µm diam. Ostiolar area formed by 4–6 µm wide, isodiametric, strongly sclerotized cells. The ontogeny is of the *Umbilicaria*-Type. Conidiophores simple or sparingly branched, formed by almost isodiametric cells, ca 2.5–3.5 µm large. Conidiogenous cells both intercalar and terminal. Acrogenous conidiogenous cells 3.0–6.0 × 2.0–2.5 µm. Intercalar conidiogenous cells producing conidia on one side only. Conidia formed on very thin, 2–3 µm long stalks. Conidiophores of Vobis' Type V. Conidia non-septate, hyaline, 3.0–4.0 × 1.0–1.5 µm, with both or one end distinctly thickened. Photobiont trebouxioid.

Chemistry. No secondary substances have been identified.

Habitat. On bird-manured twigs in tops of isolated low shrubby spruce trees in exposed situations above the timberline. Also in the top of higher spruce trees in bogs at lower altitudes. Altitudinal range: 300–1100 m.

Distribution. A rare species mainly occurring in alpine and subalpine areas of Norway and Sweden. **N:** He, Op, Bu, Te, ST, NT, No. **S:** Dlr, Hrj, Jmt, ÅsL, LyL, PL. Also known form Central Europe, Northwestern Russia and North America (Newfoundland, British Columbia, Northwest Territories). – Map 81.

Note. Easily recognized by its cushion-like colonies, the digitate podetia and the large spores which have a very conspicuous ornamentation.

Literature cited

Middelborg, J. & Mattsson, J. (1987). Crustaceous lichenized species of the Caliciales in Norway. – Sommerfeltia 5: 1–71.

Tibell, L. (1991). The Asterophoma anamorph of Chaenothecopsis savonica and its hyphomycetous synanamorph. – Can. J. Bot. 69: 2427–2433

Tibell, L. (1992). Crustose lichens as indicators of forest continuity in boreal coniferous forests. – Nord. J. Bot. 12: 427–450.

Tibell, L. (1993a). The anamorphs of Chaenothecopsis viridireagens. – Nord. J. Bot. 13: 331–335.

Tibell, L. (1993b). The anamorphs of Chaenotheca deludens. – Nord. J. Bot. 13: 441–445.

Tibell, L. (1995). The anamorph of Chaenothecopsis debilis. – Mycologia 87: 245–252.

Tibell, L. & Constantinescu, O. (1991). Catenomycopsis rosea gen. and sp. nov. (Hyphomycetes), the anamorph of Chaenothecopsis haematopus. – Mycol. Res. 95: 556–560.

Titov, A. & Tibell, L. (1993). Chaenothecopsis in the Russian Far East. – Nord. J. Bot. 13: 313–329.

Tønsberg, T. (1992). The sorediate and isidiate, corticolous, crustose lichens in Norway. – Sommerfeltia 14: 1–331.

APPENDIX

Nomenclatural novelties

All nomenclatural novelties in this flora are for practical reasons collected here and presented the briefest possible way. The names are treated in alphabetic order.

Calicium quercinum Pers.
Type: Without locality (L-Pers, lectotype; designated here).

Calicium salicinum Pers.
Type: ”*Calycium salicinum* Pers. In Salica cava No 28.” (L-Pers, lectotype; designated here).

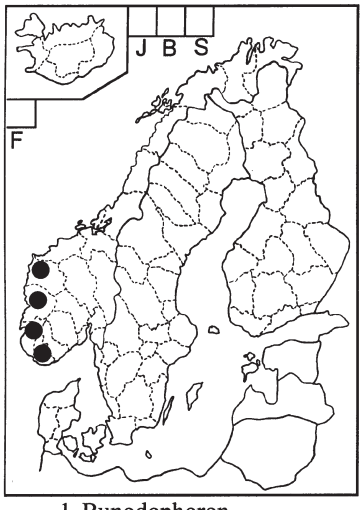
Calicium viride Pers.
Type: Sweden, Västmanland, Ängsö, 1969 Moberg 1146a (UPS, neotype; designated here).

Chaenothecopsis savonica (Räsänen) Tibell
Type: Finland, Savonia borealis, Pielavesi, 1947 Huuskonen (Räsänen, Lichenoth Fenn. 296) (H, lectotype; designated here).

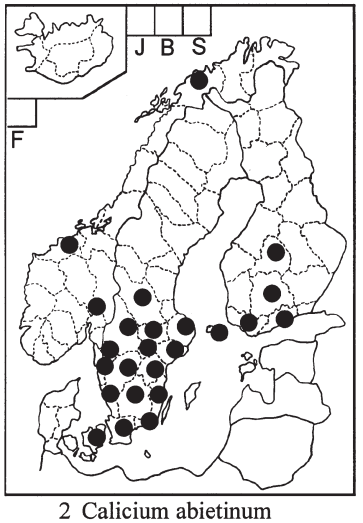
Sclerophora coniophaea (Norman) Mattsson & Middelborg
Type: Norway, ”ad Kirkesnaes convallis. Maalselven J. M. Norman” (O, lectotype; designated here).

Stenocybe bryophila W.Watson
Type: Wales, Caernarvonshire, near Llanberis, Cwm-y-glo, Sept 1924 Watson (BM, lectotype; designated here).

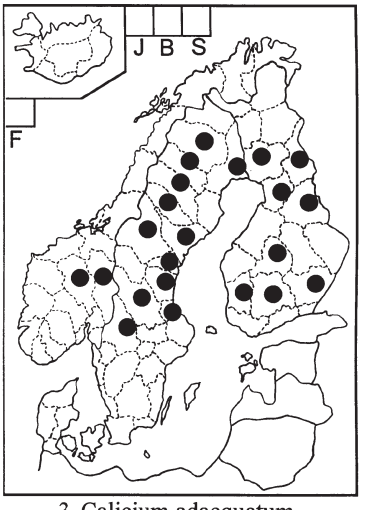
Tholurna dissimilis (Norman) Norman
Type: “In Gudbrandsdalia Norvegiae meridionalis J. M. Norman” (O, lectotype; designated here).



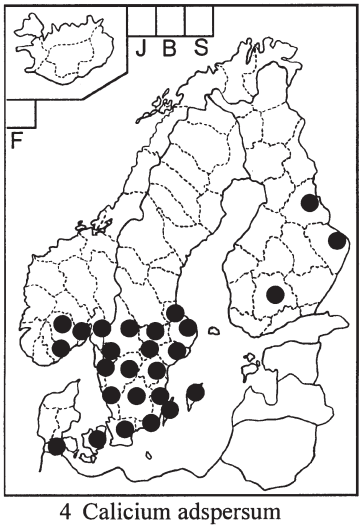
1 Bunodophoron melanocarpum



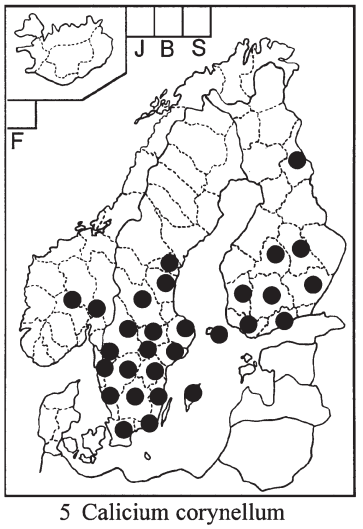
2 Calicium abietinum



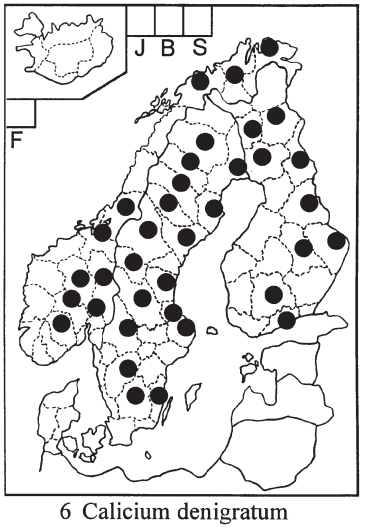
3 Calicium adaequatum



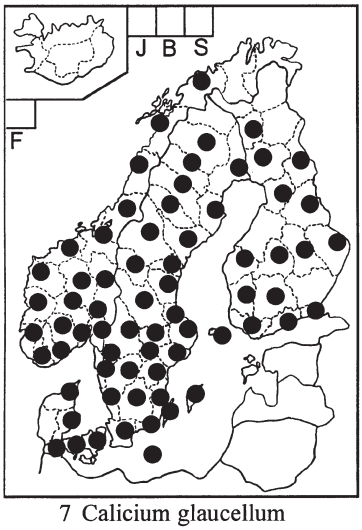
4 Calicium adspersum



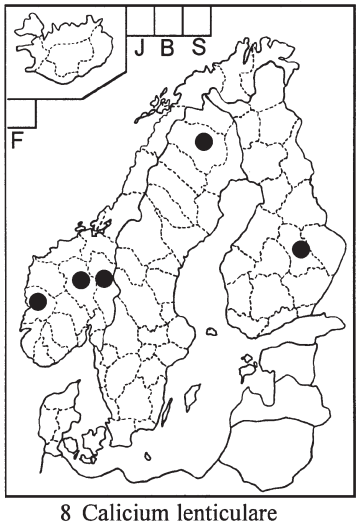
5 Calicium corynellum



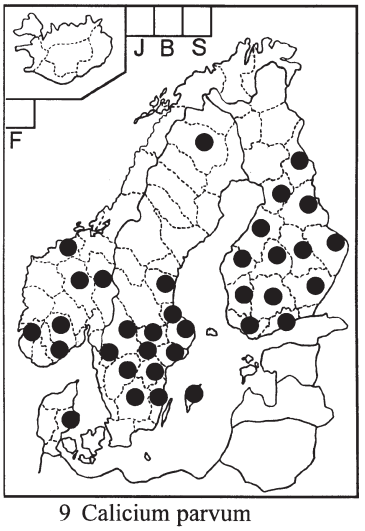
6 Calicium denigratum



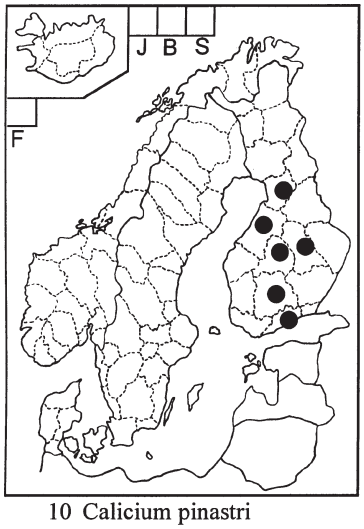
7 Calicium glaucellum



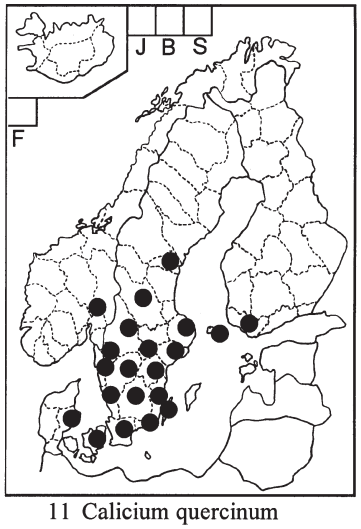
8 Calicium lenticulare



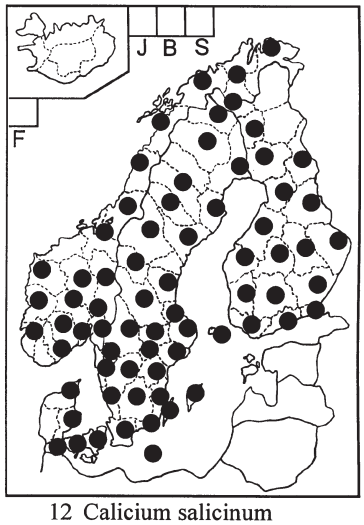
9 Calicium parvum



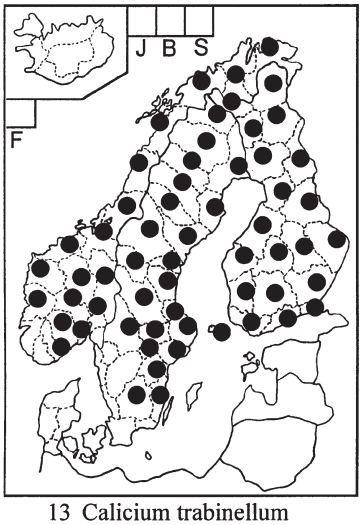
10 Calicium pinastri



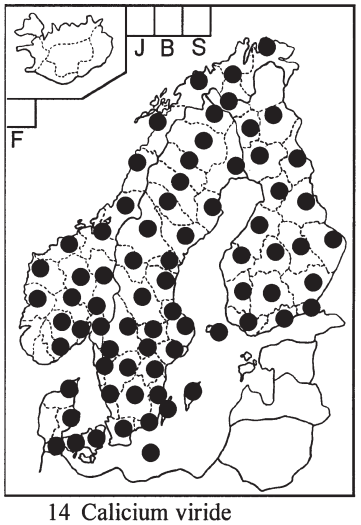
11 Calicium quercinum



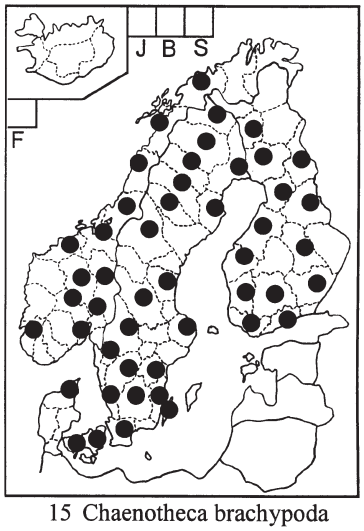
12 Calicium salicinum



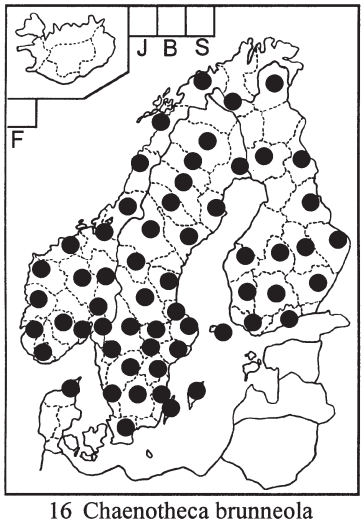
13 Calicium trabinellum



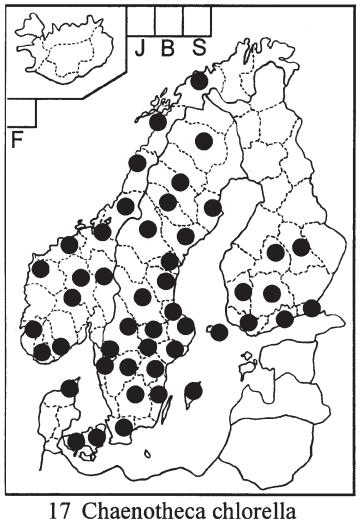
14 Calicium viride



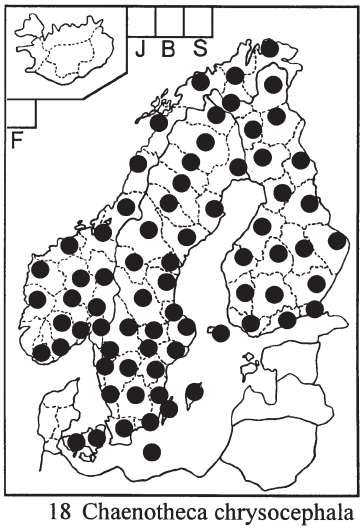
15 Chaenotheca brachypoda



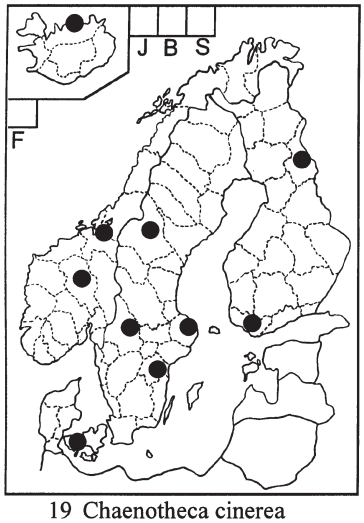
16 Chaenotheca brunneola



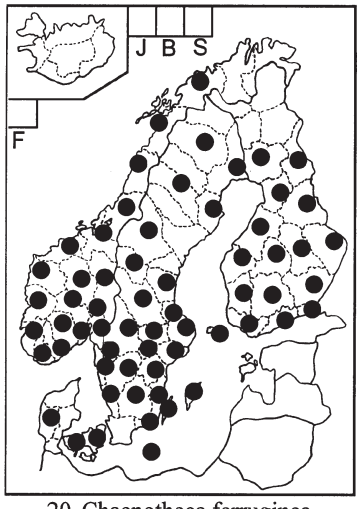
17 Chaenotheca chlorella



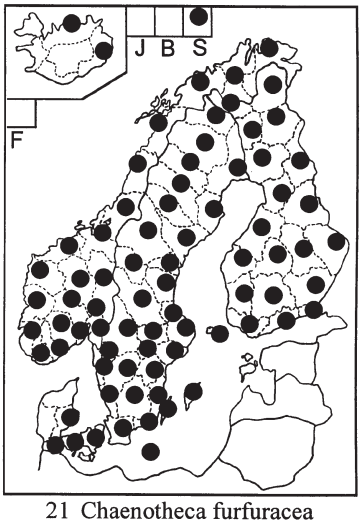
18 Chaenotheca chrysocephala



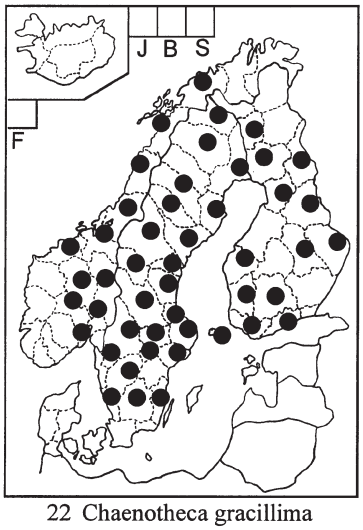
19 Chaenotheca cinerea



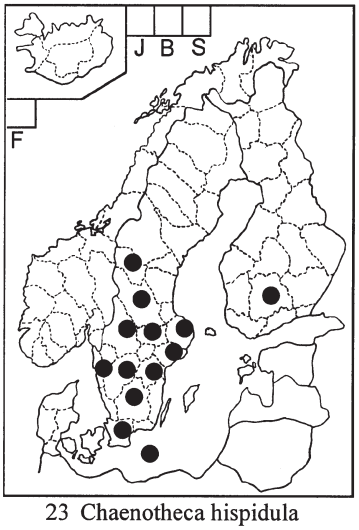
20 Chaenotheca ferruginea



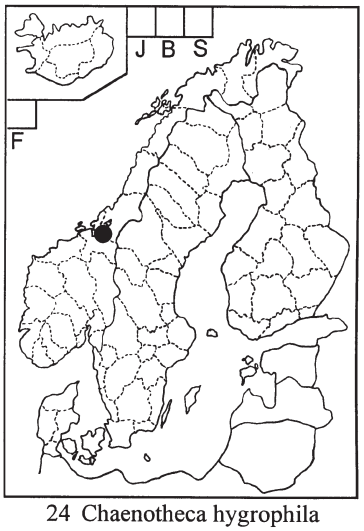
21 Chaenotheca furfuracea



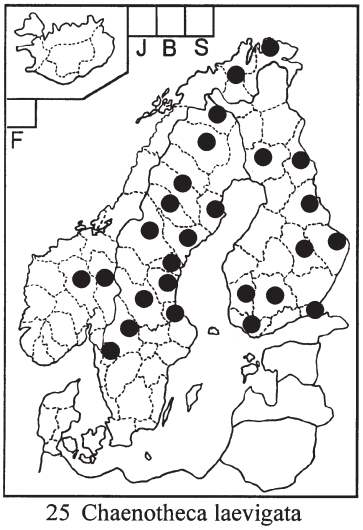
22 Chaenotheca gracillima



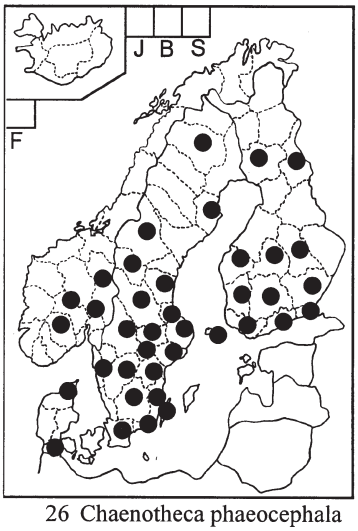
23 Chaenotheca hispidula



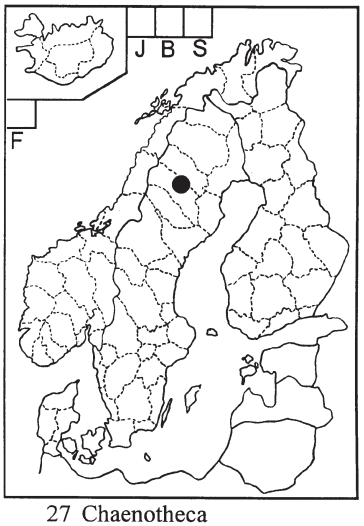
24 Chaenotheca hygrophila



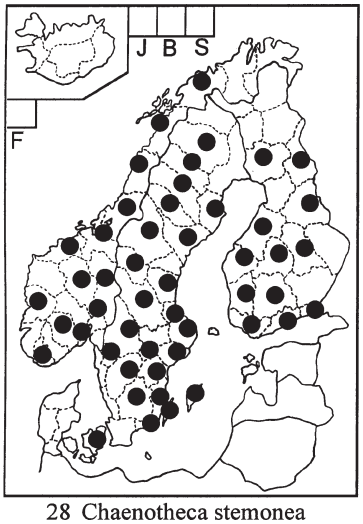
25 Chaenotheca laevigata



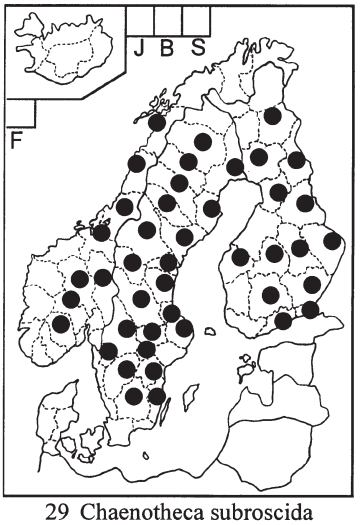
26 Chaenotheca phaeocephala



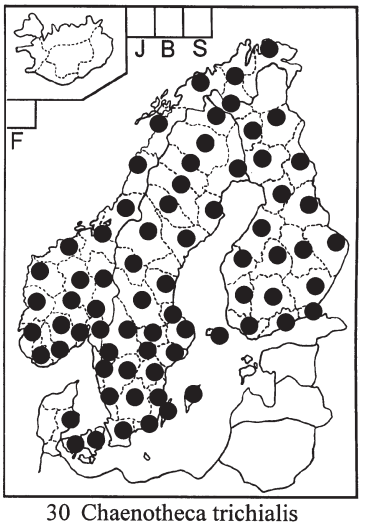
27 Chaenotheca sphaerocephala



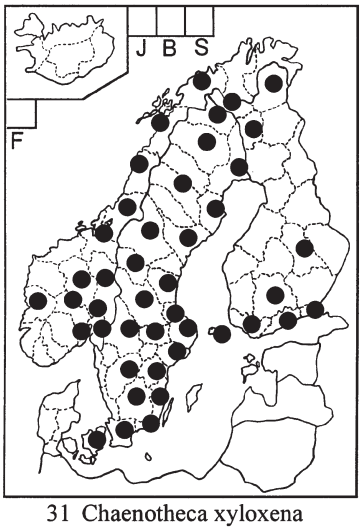
28 Chaenotheca stemonea



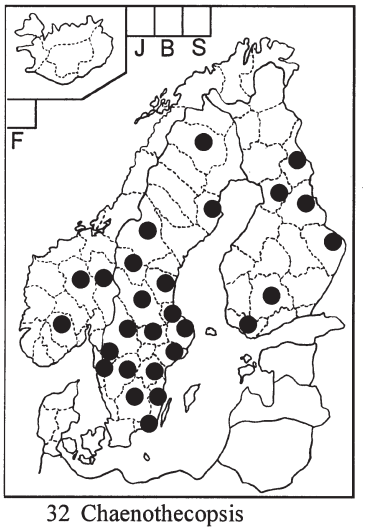
29 Chaenotheca subroscida



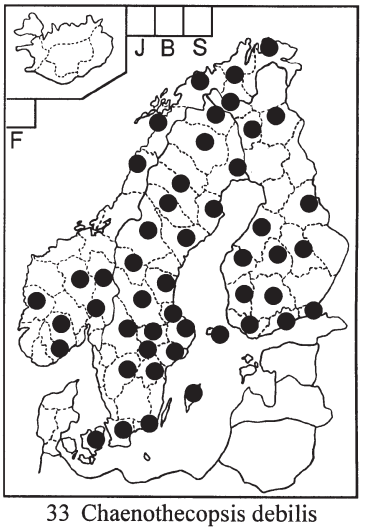
30 Chaenotheca trichialis



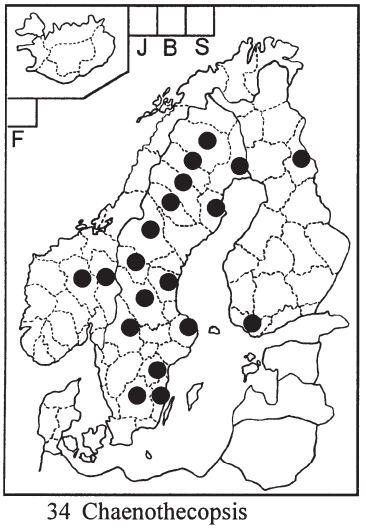
31 Chaenotheca xyloxena



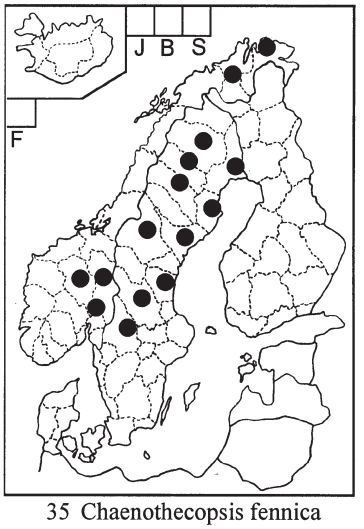
32 Chaenothecopsis concociata



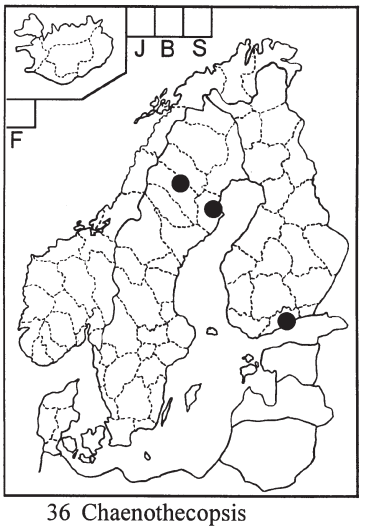
33 Chaenothecopsis debilis



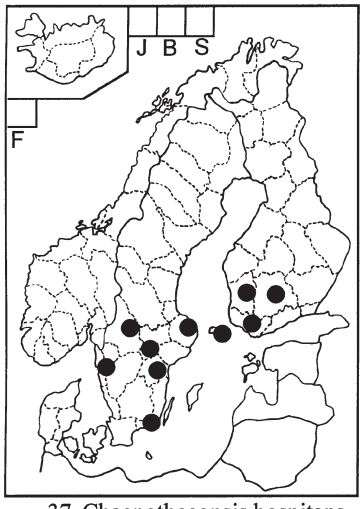
34 Chaenothecopsis epithallina



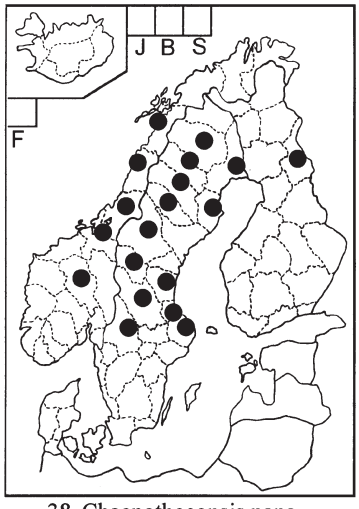
35 Chaenothecopsis fennica



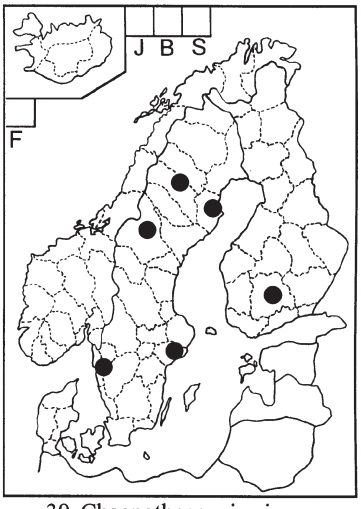
36 Chaenothecopsis haematopus



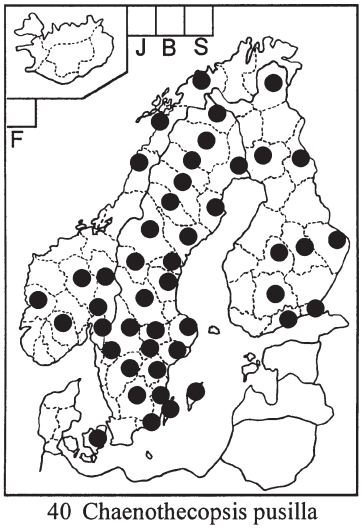
37 Chaenothecopsis hospitans



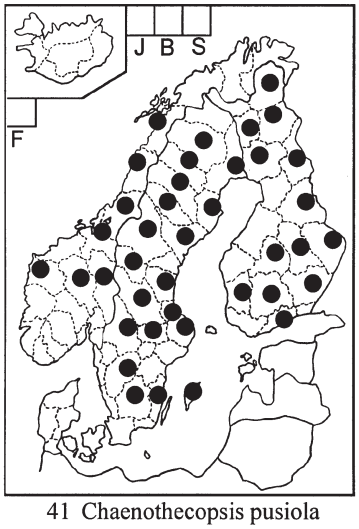
38 Chaenothecopsis nana



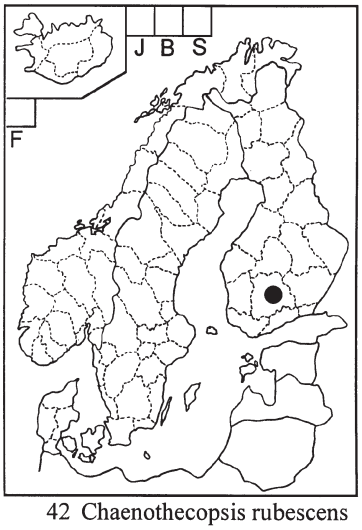
39 Chaenothecopsis nigra



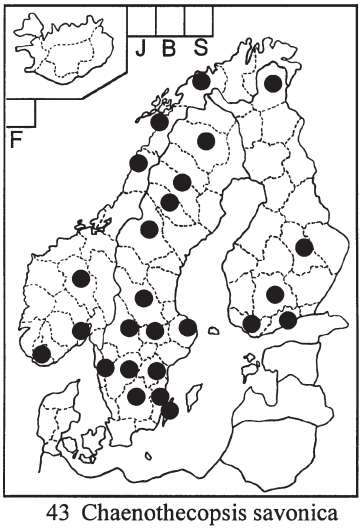
40 Chaenothecopsis pusilla



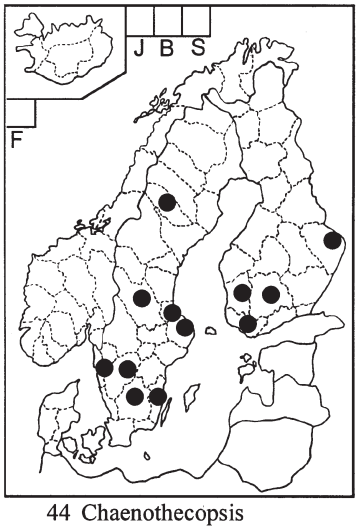
41 Chaenothecopsis pusiola



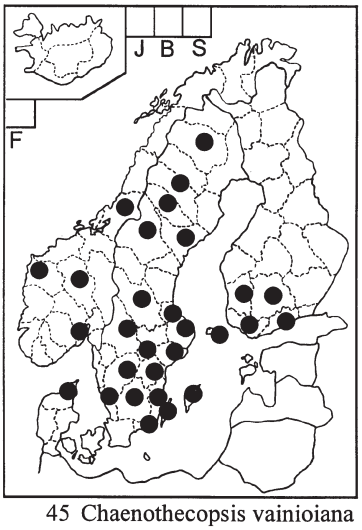
42 Chaenothecopsis rubescens



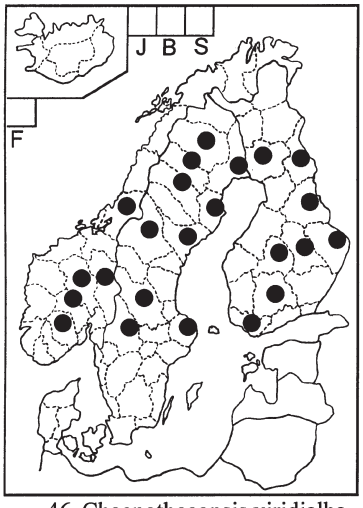
43 Chaenothecopsis savonica



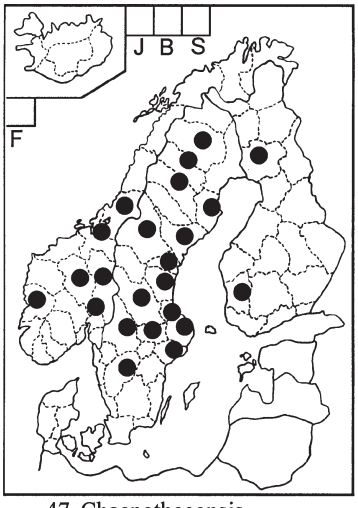
44 Chaenothecopsis subparoica



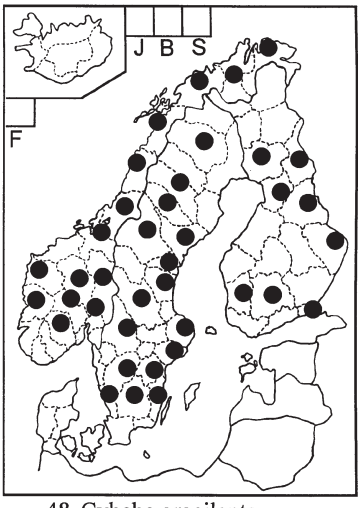
45 Chaenothecopsis vainioiana



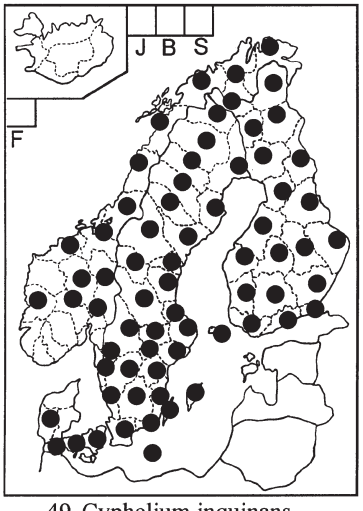
46 Chaenothecopsis viridialba



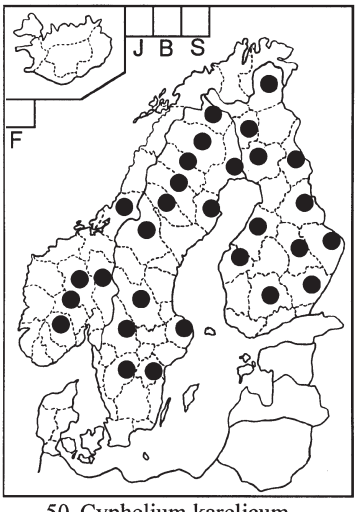
47 Chaenothecopsis viridireagens



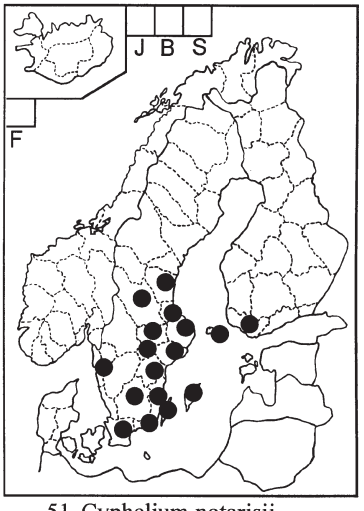
48 Cybebe gracilenta



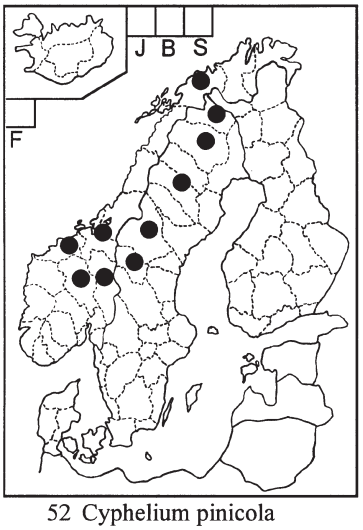
49 Cyphelium inquinans



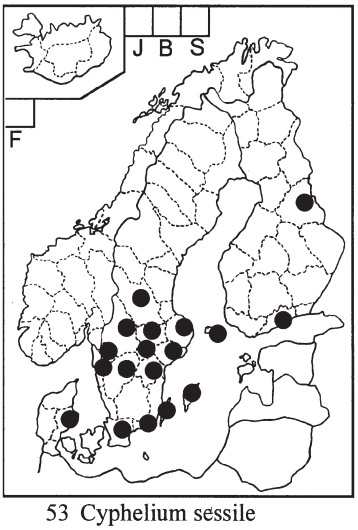
50 Cyphelium karelicum



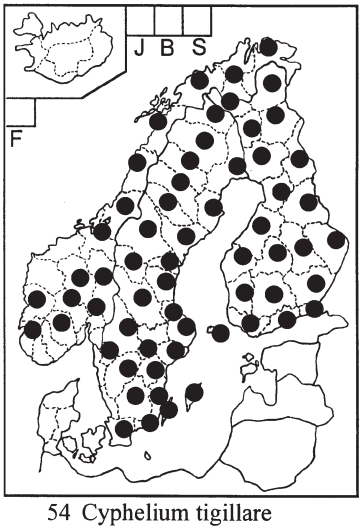
51 Cyphelium notarisii



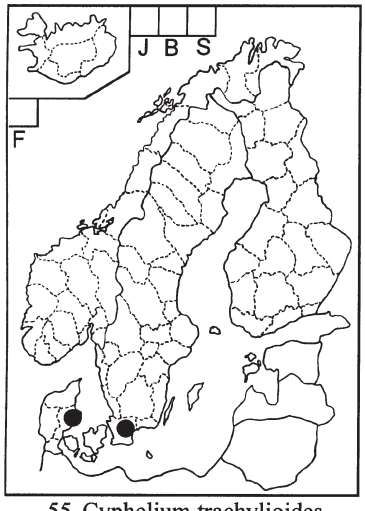
52 Cyphelium pinicola



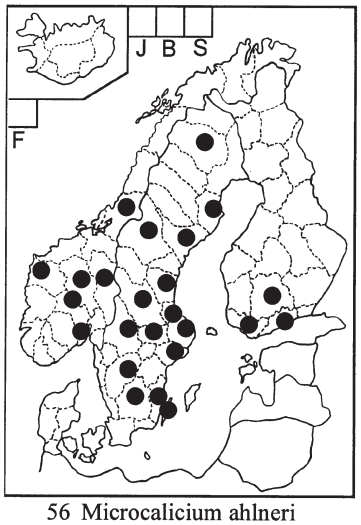
53 Cyphelium sessile



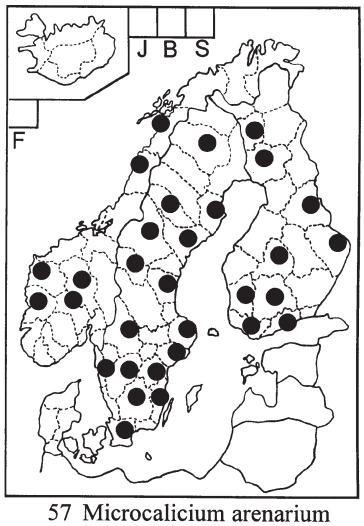
54 Cyphelium tigillare



55 Cyphelium trachylioides



56 Microcalicium ahlneri



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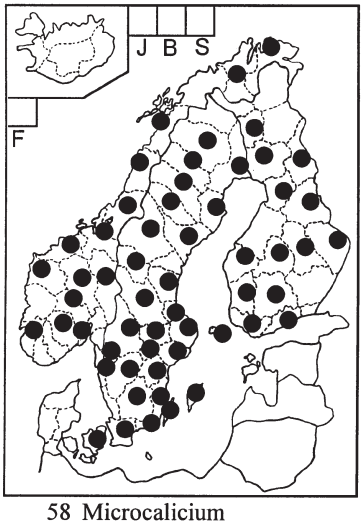
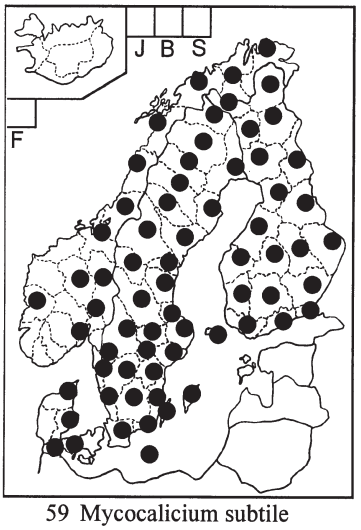
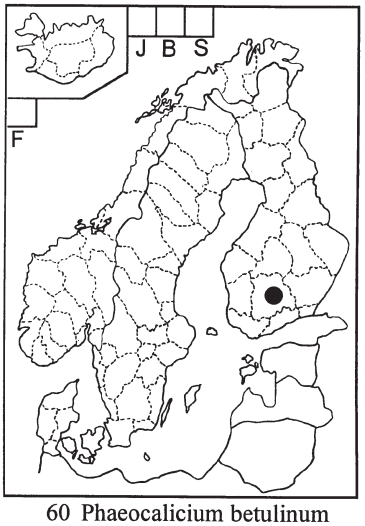


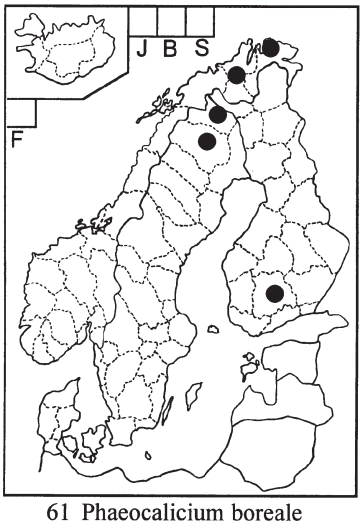
58 Microcalicium disseminatum



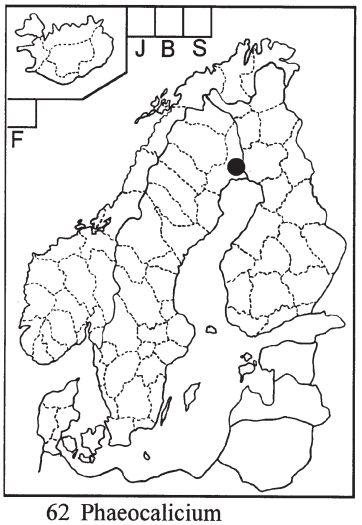
59 Mycocalicium subtile



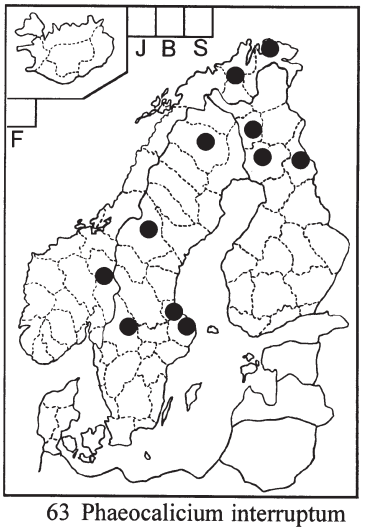
60 Phaeocalicium betulinum



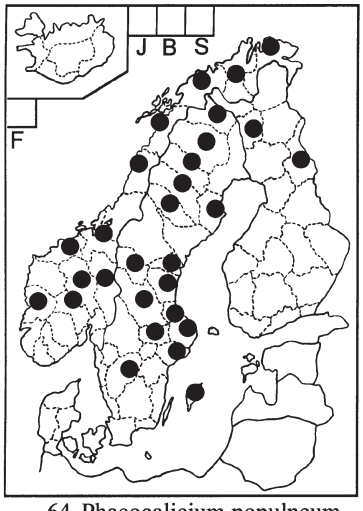
61 Phaeocalicium boreale



62 Phaeocalicium flabelliforme



63 Phaeocalicium interruptum



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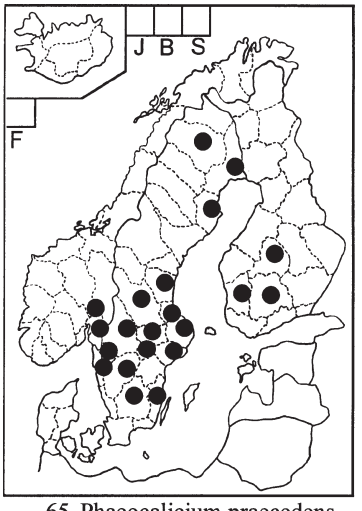

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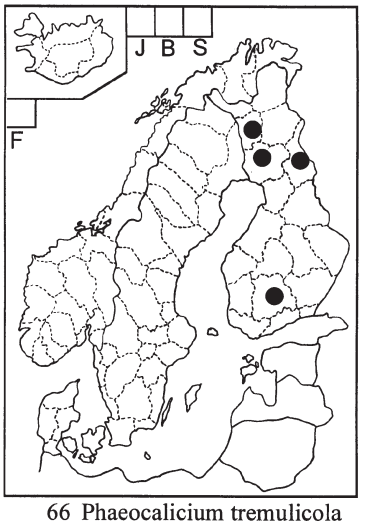
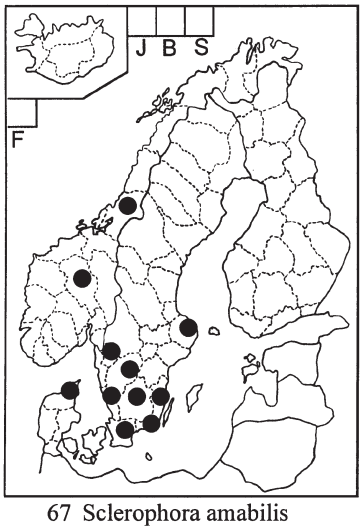
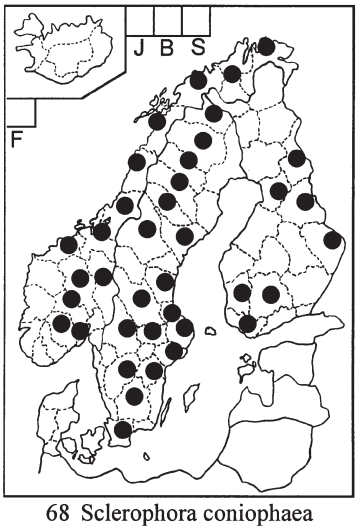


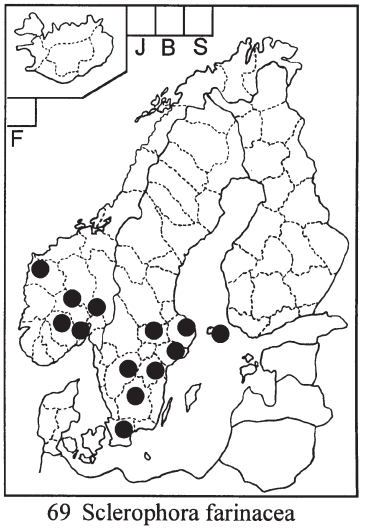
66 Phaeocalicium tremulicola



67 Sclerophora amabilis



68 Sclerophora coniophaea



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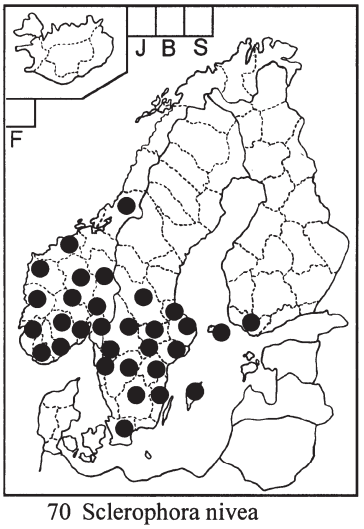

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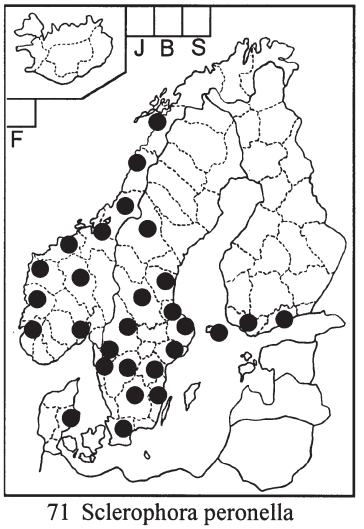

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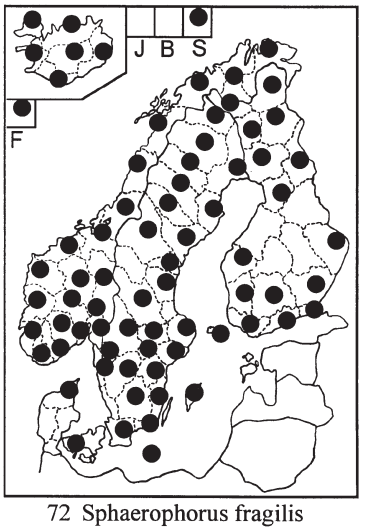
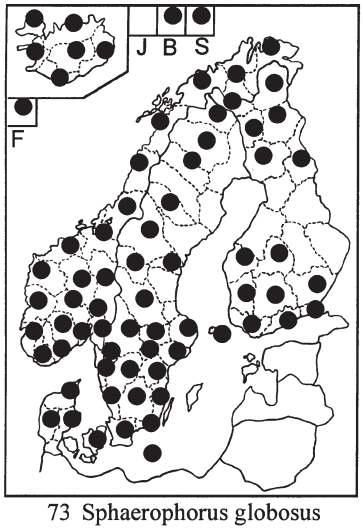
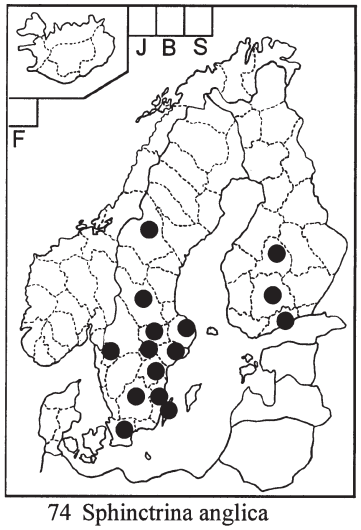


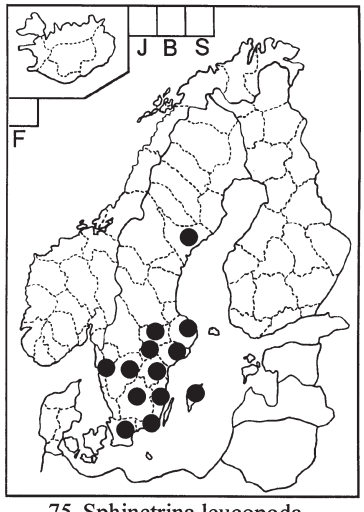
72 Sphaerophorus fragilis



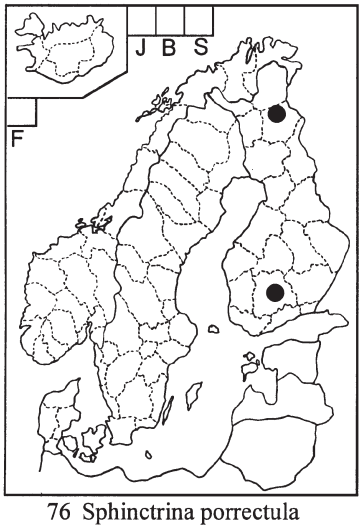
73 Sphaerophorus globosus



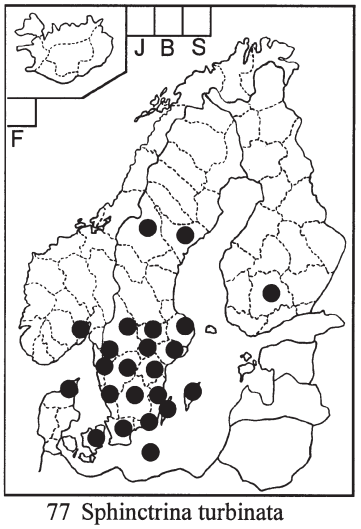
74 Sphinctrina anglica



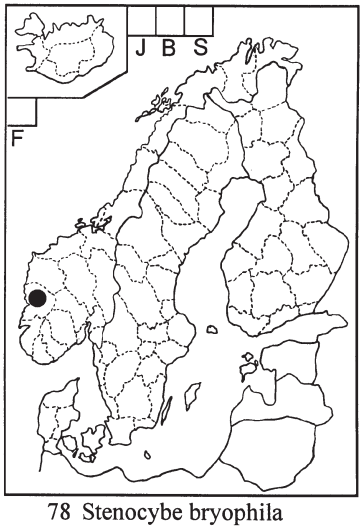
75 Sphinctrina leucopoda



76 Sphinctrina porrectula



77 Sphinctrina turbinata



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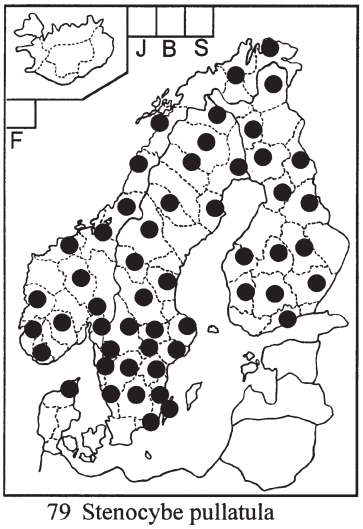
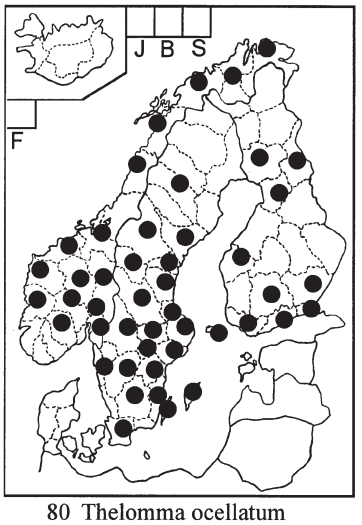
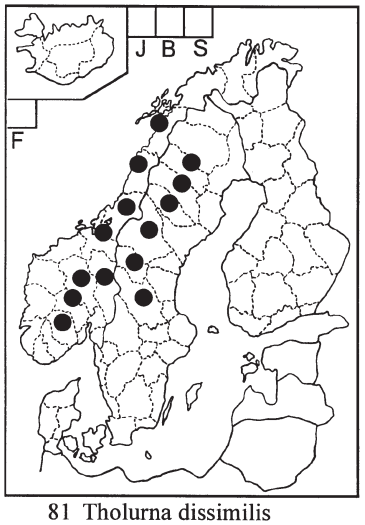


79 Stenocybe pullatula



80 Thelomma ocellatum



81 Tholurna dissimilis

Calicium abietinum x25

Calicium adaequatum x35

Calicium adspersum x10

Calicium corynellum x35

Calicium denigratum x20

Calicium glaucellum x20

Calicium lenticulare x25

Calicium parvum x20

Calicium pinastri x20

Calicium quercinum x25

Calicium salicinum x20

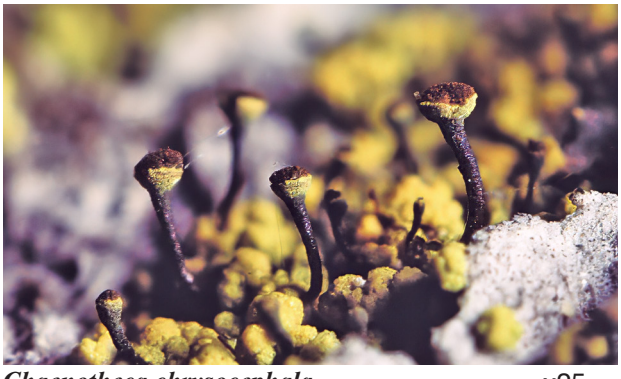
Calicium trabinellum x20

Calicium viride x15

Chaenotheca brachypoda x12

Chaenotheca brunneola x30

Chaenotheca chlorella x35



Chaenotheca chrysocephala x25

Chaenotheca cinerea x25

Chaenotheca ferruginea x20

Chaenotheca furfuracea x5

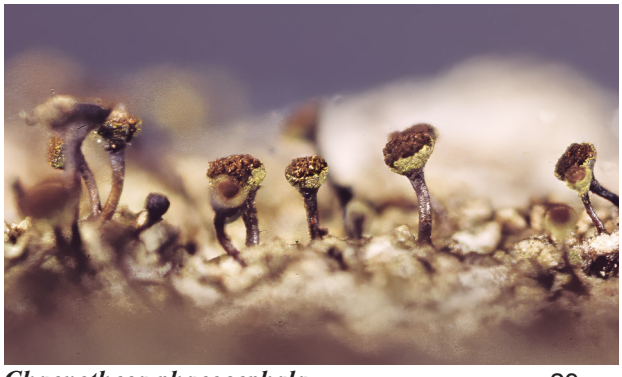
Chaenotheca furfuracea x20

Chaenotheca gracillima x10

Chaenotheca hispidula x30

Chaenotheca hygrophila x30

Chaenotheca laevigata x20



Chaenotheca phaeocephala x20

Chaenotheca sphaerocephala x20

Chaenotheca stemonea x20

Chaenotheca subroscida x20

Chaenotheca trichialis

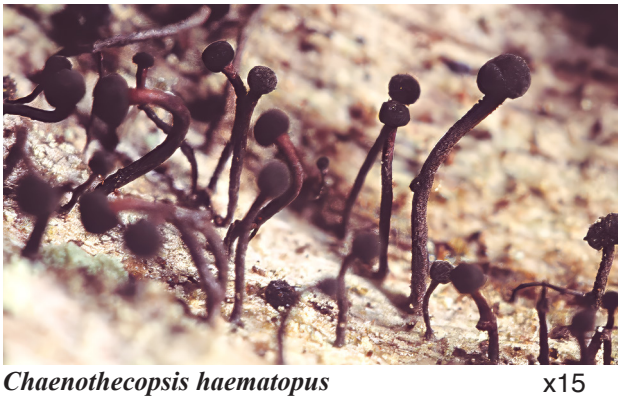
Chaenotheca xyloxena x15

Chaenothecopsis consociata x25

Chaenothecopsis debilis x15

Chaenothecopsis epithallina x15

Chaenothecopsis fennica x22



Chaenothecopsis haematopus x15

Chaenothecopsis hospitans x25

Chaenothecopsis nana x20

Chaenothecopsis nigra x16

Chaenothecopsis pusilla x50

Chaenothecopsis pusiola x30

Chaenothecopsis rubescens x25

Chaenothecopsis savonica x25

Chaenothecopsis subparoica x28

Chaenothecopsis vainioana x25

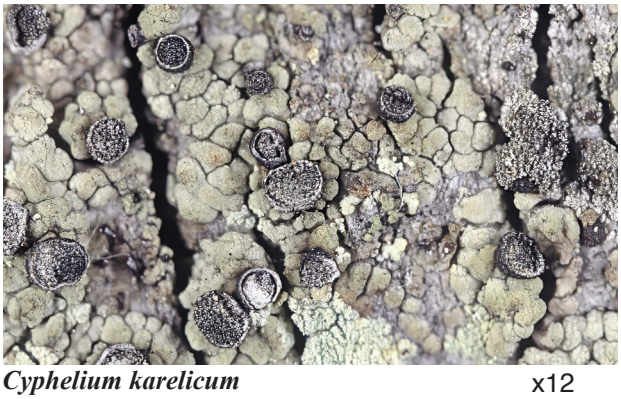
Chaenothecopsis viridialba x20

Chaenothecopsis viridireagens x20

with anamorph x35

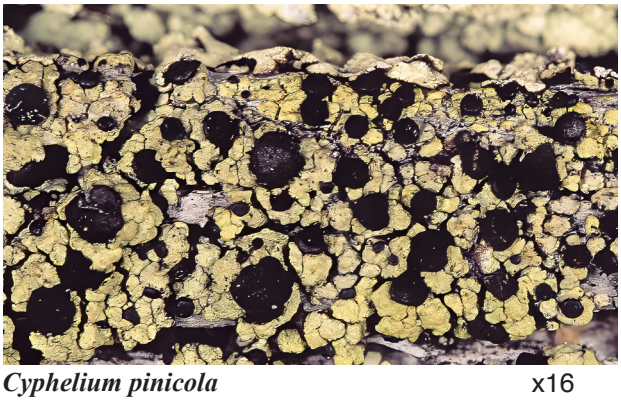
Cybebe gracilenta x10

Cyphelium inquinans x6



Cyphelium karelicum x12

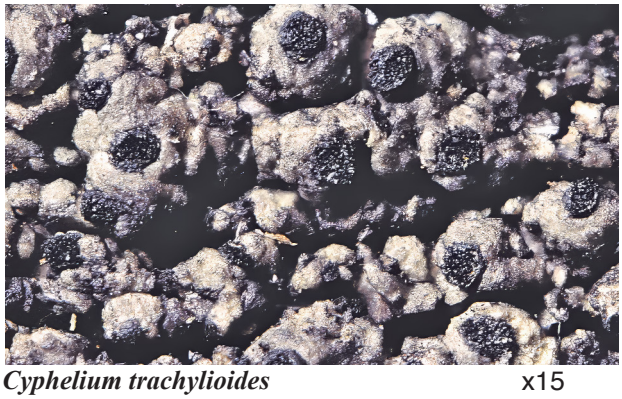
Cyphelium notarisii x15



Cyphelium pinicola x16

Cyphelium sessile x25

Cyphelium tigillare x10



Cyphelium trachylioides x15

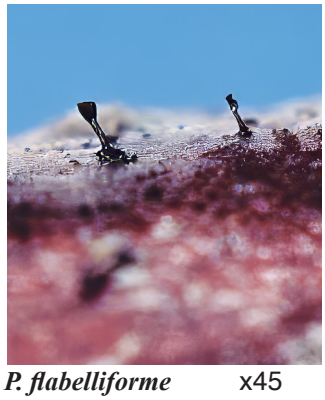
Microcalicium ahlneri x15

Microcalicium arenarium x15

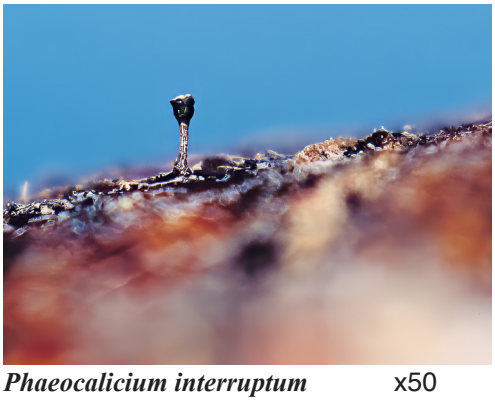
Microcalicium disseminatum x30

Mycocalicium subtile x23

Phaeocalicium boreale x45

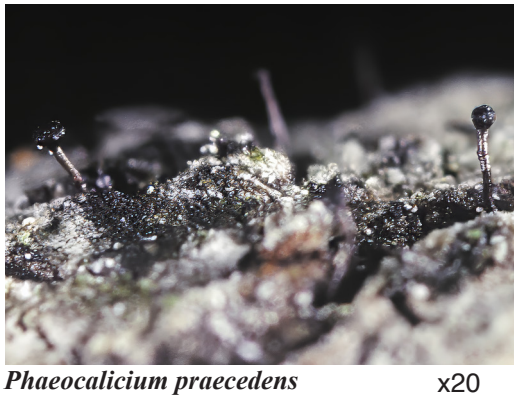


P. flabelliforme x45

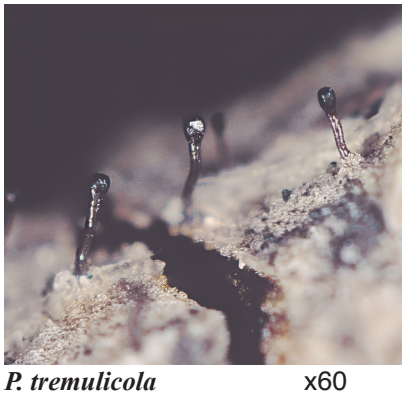


Phaeocalicium interruptum x50

P. populneum x35



Phaeocalicium praecedens x20

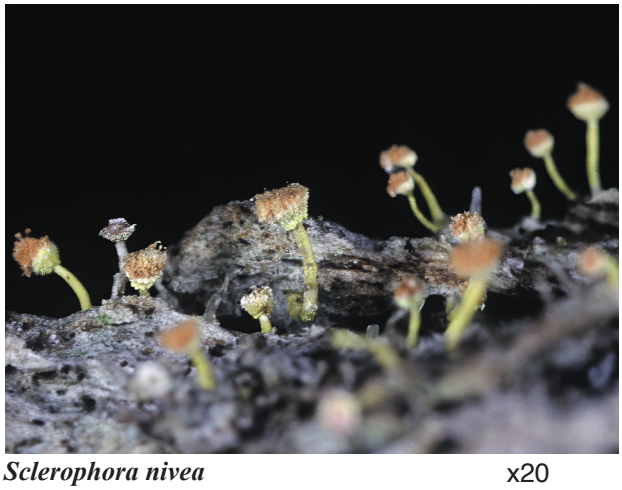


P. tremulicola x60

Sclerophora amabilis x15

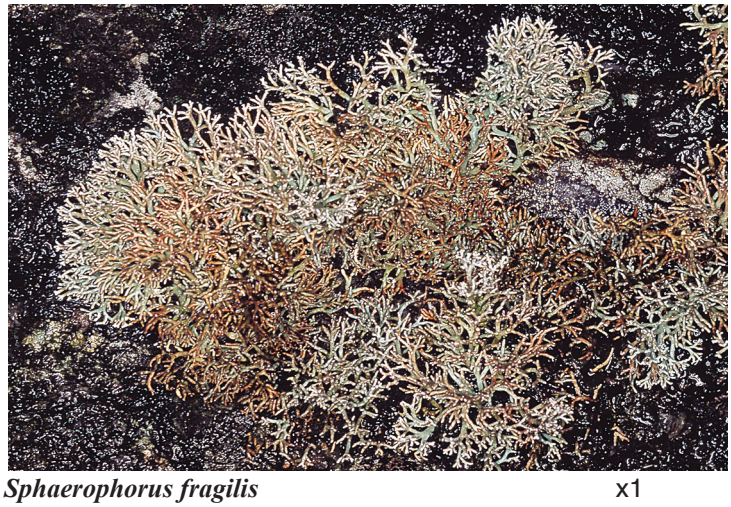
Sclerophora coniophaea x12

Sclerophora farinacea x18



Sclerophora nivea x20

Sclerophora peronella x15

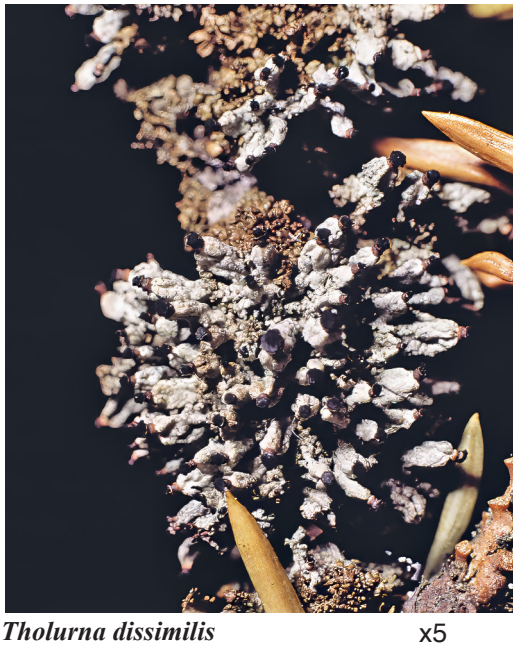


Sphaerophorus fragilis x1

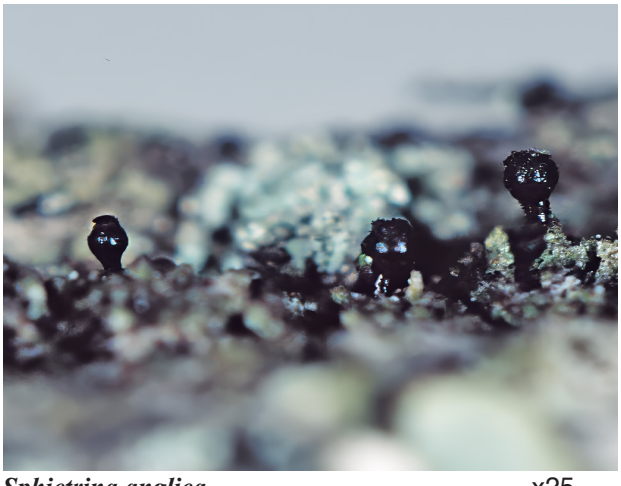
Bunodophoron melanocarpum x2

Bunodophoron melanocarpum x2

Sphaerophorus globosus x0,5



Tholurna dissimilis x5

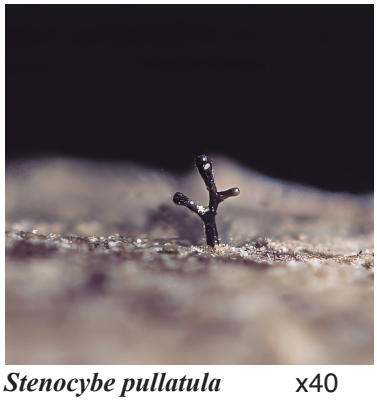


Sphictrina anglica x25

Sphictrina leucopoda x25

Sphictrina turbinata x17

Stenocybe bryophila x20



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The lichen flora of the Nordic countries has been regarded as one of the best known in the world, containing about 2000 species. The lichenological research of the region has been going on continuously since the days of the father of lichenology, the Swede Erik Acharius (1757-1819). It has, however, been a painful and awkward fact that there is no modern flora treatment of the region, the last attempt being that of Th. M. Fries in the 1870-ies, a work (Lichenographia scandinavica) that was left unfinished.

A number of Nordic lichenologists have united forces to produce such a work, and now in the last year of our millenium proudly present the first volume, comprising the ecologically important group Calicioid lichens and fungi. This group contains many environmentally important indicator species, which now hopefully will be easier to recognize. We hope to succeed better than Fries, and to produce subsequent volumes with annual or biennial intervals, as the texts become available from the authors.