

# *Phaeocalicium* (Mycocaliciaceae, Ascomycetes) in Northern Europe

Leif Tibell

*Tibell, L., Department of Systematic Botany, Villavägen 6, S-752 36 Uppsala, Sweden*

*Received 7 February 1996, accepted 28 May 1996*

The taxonomy, distribution and ecology of eight species of *Phaeocalicium* A. F. W. Schmidt (Mycocaliciaceae, Ascomycetes) occurring in the Nordic countries and Greenland are described. They are parasitic or saprophytic mainly on thin twigs of trees and shrubs such as *Alnus*, *Betula*, *Populus* and *Salix* and are often quite host-specific. A key to the species is supplied. Two new species, *Ph. boreale* Tibell and *Ph. flabelliforme* Tibell are described. A lectotype is selected for *Calicium praecedens* Nyl., *Mycocalicium pusiolum* (Ach.) Räsänen var. *macrospora* Räsänen and *Stenocybe tremulicola* Norrl. ex Nyl., and a neotype is selected for *Phaeocalicium populneum* (Brond. ex Duby) A. F. W. Schmidt. The new combination *Ph. tremulicola* (Norrl. ex Nyl.) Tibell is proposed.

**Key words:** Ascomycetes, Caliciales, Mycocaliciaceae, *Phaeocalicium*, taxonomy

## INTRODUCTION

The ascomycete genus *Phaeocalicium* belongs to Mycocaliciaceae in Caliciales *s. lat.* (Tibell 1984). The North European species occur as saprobes and/or weak parasites mostly on thin, decaying branches of deciduous trees or shrubs. The genus occurs mainly in cool temperate to temperate areas of the Northern Hemisphere, with one species each occurring in Australasia and South America. *Phaeocalicium* was described by Schmidt (1970) and in that paper *Ph. compressulum*, *Ph. populneum* and *Ph. praecedens* were dealt with in detail. As conceived there *Phaeocalicium* includes species in Mycocaliciaceae with rather large, simple or 1-septate spores, large asci and a strongly and evenly thickened ascus apex. As noted earlier (Tibell 1984, 1995), the generic relationships between *Phaeocalicium*, *Chaenothecopsis*, *Mycocalicium* and *Steno-*

*cybe*, as conceived by Schmidt (1970), are unsatisfactory and in need of revision. Thus as an example spore septation does not seem to be consistent evidence for generic delimitation. In the present paper a group of similar and presumably closely related species has provisionally been accommodated in *Phaeocalicium* pending a detailed analysis based on macromolecular evidence in progress. Notwithstanding a regional revision of *Phaeocalicium* in the USSR by Titov (1986), the genus is still incompletely known. In this paper eight species occurring in Northern Europe are treated, two of which are previously undescribed.

## MATERIAL AND METHODS

The study has been based on field studies and material collected by the author (kept in UPS), additional material from

the herbaria at C, H, LD, O, S, UPS, as well as the private herbaria of S. Hultengren (Stenungsund), A. Nordin (Uppsala), M. Karström (Vuollerim), L.-E. Muhr (Karlskoga), and D.-O. Övstedal (Bergen).

Estimates of the size of ascomata height, capitulum width, stalk width, ascus length, ascus width, spore length ( $l$ ) and spore width ( $w$ ) are given as  $l^-l^+ \times w^-w^+$  where  $l^-$  and  $w^-$  represent the arithmetic mean minus 1 standard deviation and  $l^+$  and  $w^+$  the arithmetic mean plus 1 standard deviation. If the measurements have been estimated by statistical methods they are followed by a parenthesis in which the arithmetic mean ( $X$ ), the standard deviation ( $s$ ), the number of observations ( $n$ ) and the number of collections measured ( $co$ ) are given. If statistical estimates are not given the sizes indicated represent common ranges.

## PHAEOCALICIUM A. F. W. SCHMIDT

Mitt. Staatsinst. Allg. Bot. Hamburg 13: 128. 1970. — Type: *Calicium praecedens* Nyl. = *Phaeocalicium praecedens* (Nyl.) A. F. W. Schmidt.

Saprophytic 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 or isodiametric hyphae. Hymenium covered by a thin epithecium. Stalk consisting of dark brown to aeruginose or pale, periclinally arranged hyphae. *Asci* narrowly cylindrical, with uniseriately arranged spores, 70–100  $\mu\text{m}$  long, formed singly from ascogenous 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 ejected. No mazaedium. Spores 10–18  $\times$  4–6  $\mu\text{m}$ , 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. Conidiomata unknown.

*Chemistry.* No secondary substances identified. Some species contain pigments which change colour with a change of pH yielding reactions with KOH and HNO<sub>3</sub> observable under the microscope.

### Key to the species

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

- Excipulum consisting of periclinally arranged hyphae, without isodiametric cells, spores dark brown, with a minute ornamentation ..... 3. *Ph. compressulum*
- 4. Excipulum edge not thickened, ascomata 0.6–0.9 mm high, on *Populus* ..... 7. *Ph. praecedens*
- Excipulum edge strongly thickened, ascomata 0.3–0.4 mm high, on *Populus* and *Salix* ..... 5. *Ph. interruptum*
- 5. Capitula strongly flattened ..... 4. *Ph. flabelliforme*
- Capitula not strongly flattened ..... 6
- 6. Ascomata 0.4–0.7 mm high, excipulum consisting of periclinally arranged hyphae, on *Populus* ..... 6. *Ph. populneum*
- Ascomata 0.3–0.4 mm high, excipulum consisting of isodiametric or periclinally arranged cells, on *Alnus*, *Betula*, *Populus* and *Salix* ..... 7
- 7. Excipulum edge strongly thickened, spores 9–11  $\times$  4–4.5  $\mu\text{m}$  ..... 5. *Ph. interruptum*
- Excipulum edge not strongly thickened, spores 11–17  $\times$  4–6  $\mu\text{m}$  ..... 8
- 8. Excipulum and stalk reddish in section, K+ intensified reddish, stalk finally dark reddish grey ..... 2. *Ph. 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 isodiametric cells with thick walls 5–6  $\mu\text{m}$  wide ..... 8. *Ph. 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 (Fig. 1)

Ann. Bot. Fennici 28: 118. 1991. — *Calicium pallescens* Nyl. f. *betulinum* Nyl., Flora 50: 370. 1867. — Type: Finland. Tavastia australis, Asikkala, 1866 *Norrin* (H-NYL 40730, lectotype, designated by Tibell, Ann. Bot. Fennici 28: 118. 1991; isotypes: H).

Saprophytic or parasitic on *Betula*. Ascomata 0.27–0.36 mm high ( $X = 0.31$  mm,  $s = 0.05$  mm,  $n = 20$ ,  $co = 3$ ), shiny. Capitulum blackish brown, strongly flattened, 0.08–0.13 mm wide ( $X = 0.11$  mm,  $s = 0.03$  mm,  $n = 20$ ,  $co = 3$ ), epruinose. Epithecium brown, 6–8  $\mu\text{m}$  thick. Hypothecium c. 75  $\mu\text{m}$  high, hyaline, consisting of mainly periclinally arranged, winding and sparsely branched, thin-walled hyphae, 1.5–2  $\mu\text{m}$  diam. Excipulum medium brown, 14–25  $\mu\text{m}$  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  $\mu\text{m}$  diam. The inner part of the excipulum consists of 2–4 layers of periclinally arranged hyphae 1–1.5  $\mu\text{m}$  diam. Excipulum and epithecium HNO<sub>3</sub>- and K-. Stalk pale, olivaceous brown, 0.04–0.05 mm diam., K-, HNO<sub>3</sub>-, in section very pale olivaceous brown,

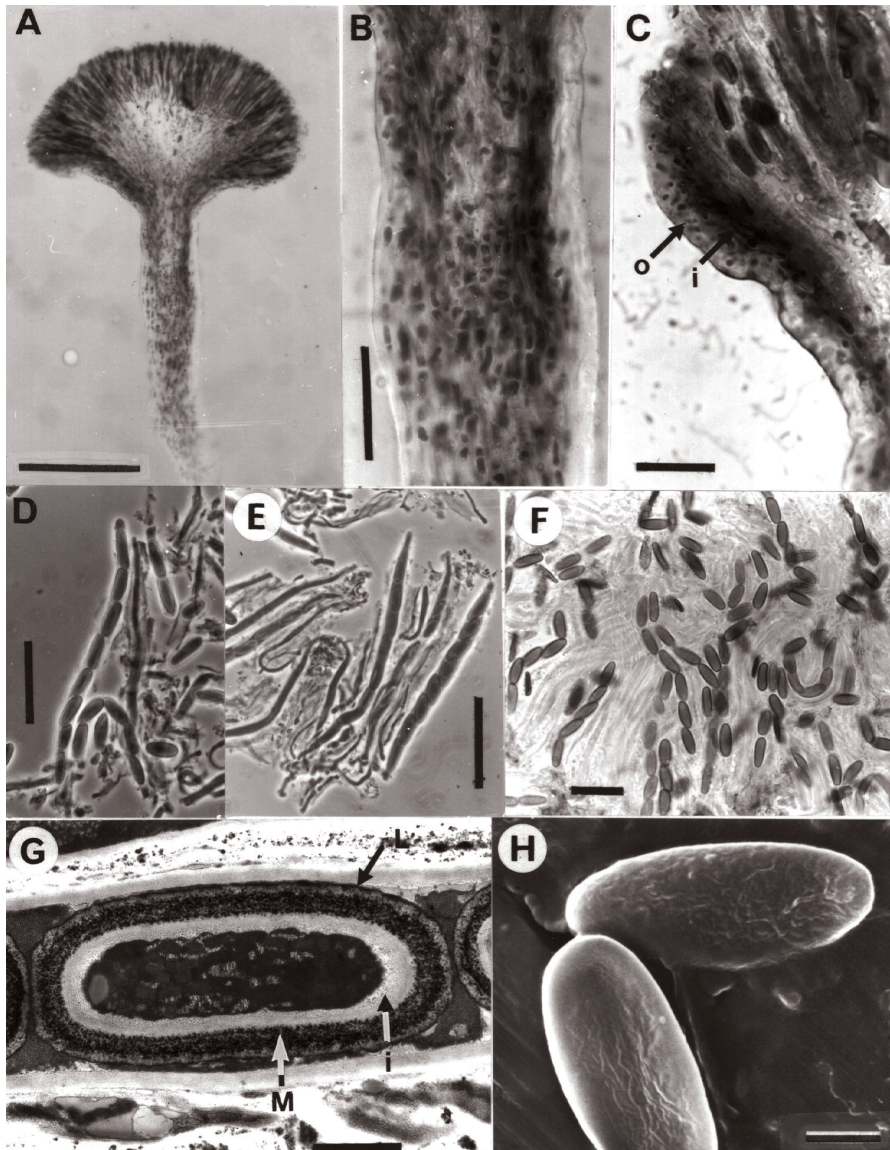


Fig. 1. *Phaeocalicium betulinum* (Nyl.) Tibell. — A: Longitudinal section of ascoma. — B: Longitudinal section of ascoma stalk with gelatinous coat. Stalk moderately pigmented, consisting of periclinally arranged, short-celled, slightly intertwined hyphae. — C: Excipulum consisting of two layers. The outer layer (o) is formed by isodiametric to irregular, slightly sclerotized, thick-walled cells, the inner part (i) by 2–4 layers of periclinally arranged, sclerotized hyphae. — D, E: Mature asci. Phase contrast micrograph. — F–H: Mature spores. Under the light microscope the spores appear smooth. In TEM the almost mature spores have a wall consisting of three layers: an outermost, thin layer with a very electron-dense lining (L); a thick middle layer with irregularly distributed pigment granules (M); and an electron-lucent innermost layer (i). Surface of the spore only very slightly and irregularly uneven. In SEM the spore surface with a very minute and irregular ornamentation partly consisting of longitudinally arranged wrinkles. — A–D, F: Lectotype; E, G, H: isotype, H. — Scales: A: 50  $\mu\text{m}$ ; B: 25  $\mu\text{m}$ ; C–F: 20  $\mu\text{m}$ ; G–H: 2  $\mu\text{m}$ .

consisting of periclinally arranged, short-celled, slightly intertwined hyphae, 1.5–2  $\mu\text{m}$  diam., surrounded by a 2–5  $\mu\text{m}$  thick hyaline gelatinous coat.

*Asci* 47.6–70.7  $\times$  4.4–5.1  $\mu\text{m}$  ( $X = 59.2 \mu\text{m}$ ,  $s = 11.5 \mu\text{m}$ ,  $n = 25$ ;  $X = 4.9 \mu\text{m}$ ,  $s = 0.5 \mu\text{m}$ ,  $n = 25$ ,  $co = 3$ ). *Spores* non-septate, rather pale brown, el-

lipsoïdal,  $10.2\text{--}13.1 \times 4.4\text{--}5.4 \mu\text{m}$  ( $X = 12.1 \mu\text{m}$ ,  $s = 0.96 \mu\text{m}$ ,  $n = 28$ ;  $X = 4.9 \mu\text{m}$ ,  $s = 0.5 \mu\text{m}$ ,  $n = 29$ ,  $co = 3$ ), appearing smooth under the light microscope. In TEM the almost mature spores have a wall consisting of three layers: The outermost layer is rather thin ( $0.13\text{--}0.20 \mu\text{m}$ ) and covered by a very electron-dense lining; the middle layer is rather thick ( $0.33\text{--}0.47 \mu\text{m}$ ) strongly pigmented from minute, irregularly distributed granules; the innermost layer rather thick ( $0.26\text{--}0.40 \mu\text{m}$ ) and completely electron-lucent. Surface of the spore only very slightly and irregularly uneven. In SEM the spores are seen to be provided with a very minute and irregular ornamentation partly consisting of longitudinally arranged wrinkles.

*Distribution and ecology.* Very poorly known. Known from bark of *Betula* from a few 19:th century collections from Southern Finland. Present status unknown.

*Remarks.* Characterized by the non-septate spores, the strongly flattened capitula, the excipulum anatomy, the smooth spores, the K<sup>-</sup> reaction of the ascomata and the occurrence on *Betula*. Similar to *Phaeocalicium flabelliforme*, but has a different excipulum anatomy and non-septate spores.

*Specimens examined.* — **Finland.** Tavastia australis, Padasjoki, Vieru, 1872 *Lang* (H-NYL 40.694); Padasjoki, Nyystölä, 1872 *Lang* 261 (H-NYL 40.729); Asikkala, 1866 *Norrlin* (type material).

## 2. *Phaeocalicium boreale* Tibell, n. sp. (Fig. 2)

*Saprophyticum vel parasiticum in ramis Alni, Betulae et Salicis. Ascomata 0.37–0.70 mm alta, olivacea ad cinereobrunnea vel fere nigra, nitida. Capitulum obconicum ad anguste lenticulare. Excipulum e 2–4 stratis cellularum membranarum crassis scleroideis texturam epidermoideam formantium. Stipes in sectione pallide violaceoruber ad atrovioleaceus. Asci anguste cylindrici, 63–75 × 4.5–6 μm, apex saepe tumidus subsphaericus praecipue in ascis semimaturis. Sporae vulgo 1–3-septate, 12–16 × 4.5–6 μm.*

Type: Sweden. Torne Lappmark, Jukkasjärvi par., 3.5 km SW of Abisko, at junction between Abiskojärkka and Nissanjärkka, 68°20'N, 18°46'E. 26.V.1989 *Tibell* (holotype, UPS).

Saprophytic or parasitic on branches of *Alnus*, *Betula* and *Salix*. *Ascomata* 0.37–0.70 mm high ( $X = 0.53 \text{ mm}$ ,  $s = 0.17 \text{ mm}$ ,  $n = 15$ ,  $co = 3$ ), olivaceous to greyish

brown or almost black, shiny. *Capitulum* obconical to narrowly lenticular, 0.12–0.23 mm wide ( $X = 0.18 \text{ mm}$ ,  $s = 0.05 \text{ mm}$ ,  $n = 15$ ,  $co = 3$ ), 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 mosaic pattern in surface view. Excipulum and epithecium K<sup>+</sup> intensified reddish, HNO<sub>3</sub><sup>-</sup> or turning more yellowish red. *Stalk* 0.04–0.07 mm diam., black, in section pale to deep violet red, HNO<sub>3</sub><sup>+</sup> intensified, violet red, consisting of largely periclinally arranged, slightly intertwined hyphae, 1–2 μm diam., with swollen walls. *Stalk* K<sup>+</sup> dark reddish grey, strongly swelling. *Stalk* without or surrounded by a very thin or up to 6 μm thick, hyaline gelatinous coat. *Asci* 62.5–75.1 × 4.4–6.2 μm ( $X = 71.6 \mu\text{m}$ ,  $s = 9.1 \mu\text{m}$ ,  $n = 15$ ,  $co = 3$ ;  $X = 5.3 \mu\text{m}$ ,  $s = 0.9 \mu\text{m}$ ,  $n = 16$ ,  $co = 3$ ), 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, 11.9–15.6 × 4.3–5.8 μm ( $X = 13.8 \mu\text{m}$ ,  $s = 1.8 \mu\text{m}$ ,  $n = 17$ ,  $co = 3$ ;  $X = 5.1 \mu\text{m}$ ,  $s = 0.8 \mu\text{m}$ ,  $n = 17$ ,  $co = 3$ ), with poorly pigmented septum, smooth under the light microscope or with a very minute ornamentation of small dots. 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. In TEM the nearly mature spores have a wall consisting of two layers: The outermost layer is thick (0.67–0.79 μm), heavily pigmented by mostly fused minute pigment granules; the inner layer rather thin (0.11–0.20 μm) and electron-lucent. There is a differentiation into two sublayers delineated by a slightly darker zone in this part of the wall, and both sublayers contribute to the septum, which has an electron-lucent mid-lamella. The surface of the spore is only very slightly and irregularly uneven. In SEM the spores are seen to be provided with a very minute and irregular ornamentation.

*Distribution and ecology.* Overlooked or rare, growing on twigs of *Alnus incana* and *Salix* (*S. caprea*) in low, shrubby stands, on trunks of *Betula* in subalpine situations in altitudes up to 500 m, and on *Ribes rubrum*. Only known from a

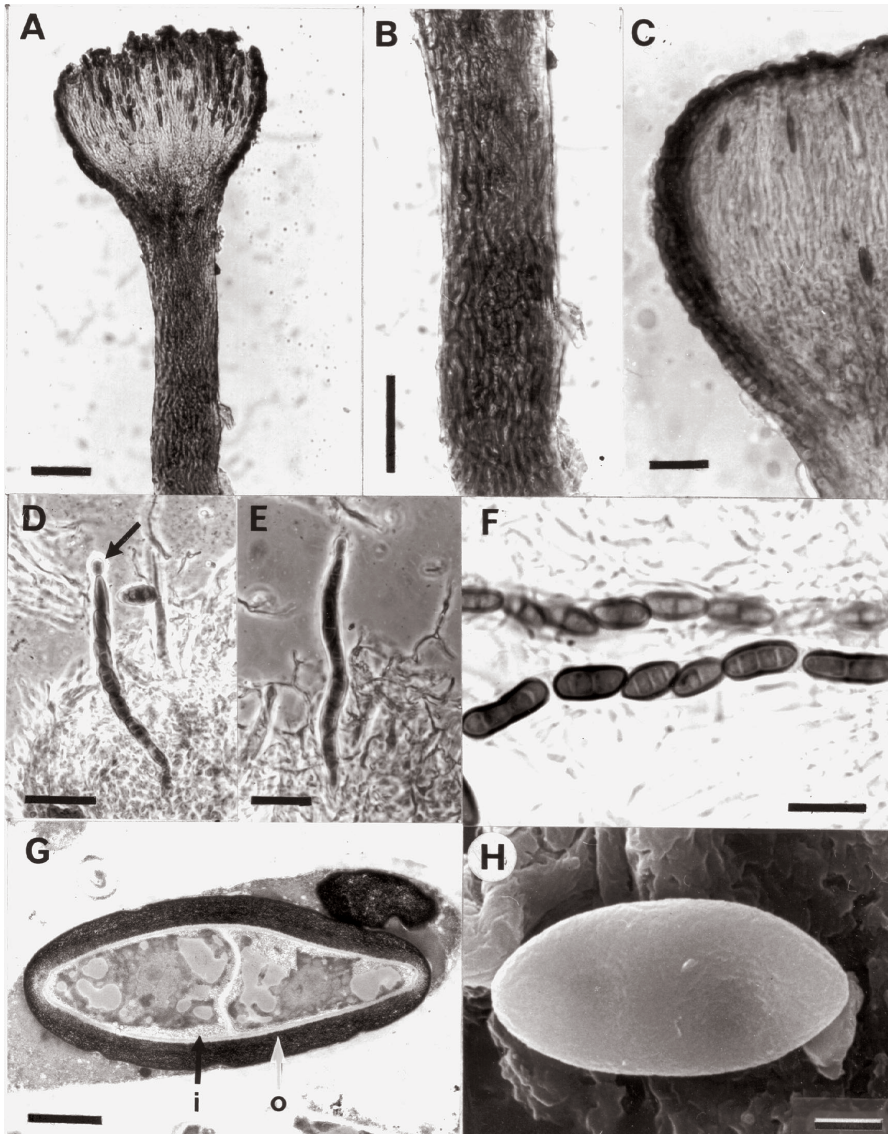


Fig. 2. *Phaeocalicium boreale* Tibell. — A: Longitudinal section of ascoma. — B: Longitudinal section of ascoma stalk. Stalk strongly pigmented, consisting of largely periclinally arranged hyphae. — C: Excipulum formed by 2–4 layers of irregularly intertwined, sclerotized and thick-walled cells. — D, E: Mature asci with swollen apex (arrow). Phase contrast micrographs. — F–H: Mature spores. Under the light microscope the 1–3-septate spores appear smooth. In TEM the spore wall consists of two layers; an outermost, thick layer heavily pigmented by mostly fused minute, pigment granules surrounded by a thin, very electron-dense lining (o) and a thin electron-lucent inner layer (i). Septum unpigmented, with an electron-lucent mid-lamella. The surface of the spore only very slightly and irregularly uneven. In SEM the spores have a very minute and irregular ornamentation. — A, B, H: Holotype. C: Norway, Polmak, *Th. M. Fries* (UPS). D–G: *Tibell 7147* (UPS). — Scales: A–B: 50  $\mu$ m; C–E: 20  $\mu$ m; F: 10  $\mu$ m; G–H: 2  $\mu$ m.

few localities in northernmost Norway and Sweden and westernmost North Russia.

*Remarks.* Characterized by the 1–3-septate spores, the violet red colour of the well-pigmented

stalk (section), the K+ dark greyish red reaction of the stalk, the well defined, reddish brown excipulum consisting of irregularly arranged cells, and the swollen ascus apex.



Fig. 3. *Phaeocalicium compressulum* (Nyl. ex Szatala) A. F. W. Schmidt. — A: Longitudinal section of ascoma. — B: Longitudinal section of ascoma stalk. Stalk with heavy pigmentation, consisting of periclinally arranged hyphae, surrounded by a gelatinous coat. Phase contrast micrograph. — C: Excipulum consisting of 3–5 layers of periclinally arranged, moderately sclerotized hyphae. Phase contrast micrograph. — D: Excipulum in surface view. — E: Mature ascus. Phase contrast micrograph. — F–H: Mature spores. In TEM the spore wall consists of three layers. The outer layer (o) has a pigmentation consisting of irregularly distributed pigment granules concentrated towards the surface of the spore; inner layer (i) thin and electron-lucent. The surface of the spore is somewhat uneven. In SEM the spores are provided with a minute ornamentation of low, polygonal to rounded elevations. — A–C: Russia, Baikal; Darscha, 1983 *Titov* (UPS); D, E: Greenland, 1976 *Alstrup* 76725 (C); F, H: Switzerland, *Holm* 3267 (UPS); G: Romania, Retezat, 1874 *Lojka* (H-NYL 40712). — Scales: A: 50  $\mu$ m; B: 25  $\mu$ m; C–E: 20  $\mu$ m; F: 10  $\mu$ m; G: 1  $\mu$ m; H: 2  $\mu$ m.

*Specimens examined.* — **Norway.** Finmark, Tanen, Polmak, 1857 *Th. M. Fries* (UPS). **Sweden.** Lule Lappmark, Kvikkjokk par., SE slope of Nammatj, 66:56N, 17:42E, 1977 *Tibell* 7147 (UPS); Torne Lappmark, holotype; Jukkasjärvi par., 2 km S of Abisko, Marmorbrottet, 68:21N, 18:47E, 1986

*Tibell* 16355 (UPS). **Russia.** Regio kuusamoensis, River Tuntsa, Hassersokka, 1938 *Laurila* (Räsänen, Lich. Fenn. exs. 685, together with *Ph. interruptum*; H, UPS); Auhtijärvi, Haukkakallio, 1937 *Laurila* (H); Karelia onegensis, Suojärvi, Mökkö, 1870 Norrlin (H).

### 3. *Phaeocalicium compressulum* (Nyl. ex Szatala) A. F. W. Schmidt (Fig. 3)

Mitt. Staatsinst. Allg. Bot. Hamburg 13: 130. 1970. — *Mycocalicium compressulum* Nyl. ex Szatala, Magyar Bot. Lapok 1930: 63. 1930. — Type: Bulgaria. Rila planina, in valle flum. "Levi Iskaer", alt. ca 1 500–2 000 m; supra ram. Alni viridis, legi d. 19.VI.1929 (ex herb. Magnusson, UPS, syntype).

Saprophytic or parasitic on twigs of *Alnus*. *Ascomata* 0.25–0.34 mm high ( $X = 0.29$  mm,  $s = 0.04$  mm,  $n = 28$ ,  $co = 3$ ). *Capitulum* blackish, stalk olivaceous to dark brown, shiny. *Capitulum* of young ascomata obconical, but in mature ascomata strongly flattened,  $0.08\text{--}0.15 \times 0.02\text{--}0.05$  mm ( $X = 0.11$  mm,  $s = 0.03$  mm,  $n = 28$ ,  $co = 3$ ;  $X = 0.04$ ,  $s = 0.02$   $\mu\text{m}$ ,  $n = 28$ ,  $co = 3$ ), epruinose. Epithecium brown, sclerotized. Hypothecium obconical, c. 45  $\mu\text{m}$  high, hyaline to medium brown, consisting of more or less isodiametric cells. Excipulum brown, 11–16  $\mu\text{m}$  thick, consisting of 3–5 layers of periclinally arranged, sclerotized hyphae 2–3  $\mu\text{m}$  diam. Excipulum and epithecium K–. *Stalk* 0.03–0.05 mm diam., K–medium brown in the central part, consisting of periclinally arranged, slightly intertwined hyphae, 1–2  $\mu\text{m}$  diam., surrounded by an up to 6  $\mu\text{m}$  thick gelatinous coat. *Asci* 66.4–79.4  $\times$  4.2–5.1  $\mu\text{m}$  ( $X = 72.9$   $\mu\text{m}$ ,  $s = 6.5$   $\mu\text{m}$ ,  $n = 30$ ,  $co = 3$ ;  $X = 4.6$   $\mu\text{m}$ ,  $s = 0.4$   $\mu\text{m}$ ,  $n = 30$ ,  $co = 3$ ), with uniseriately arranged spores. Ascus apex c. 3  $\mu\text{m}$  high, not conspicuously thickened and with the ascus plasma cut off abruptly horizontally. *Spores* non-septate, brown, ellipsoidal,  $10.4\text{--}12.2 \times 4.3\text{--}5.3$   $\mu\text{m}$  ( $X = 11.3$   $\mu\text{m}$ ,  $s = 0.9$   $\mu\text{m}$ ,  $n = 30$ ,  $co = 3$ ;  $X = 4.8$   $\mu\text{m}$ ,  $s = 0.5$   $\mu\text{m}$ ,  $n = 30$ ,  $co = 3$ ), with a minute verrucose ornamentation under the light microscope. In TEM the nearly mature spores have a wall consisting of three layers: The outermost layer is rather thin (0.18–0.25  $\mu\text{m}$ ) and poorly delineated, has no electron-dense lining and with a pigmentation consisting of irregularly distributed pigment granules often concentrated towards the surface of the spore; the middle layer is moderately thick (0.29–0.43  $\mu\text{m}$ ), less pigmented than the outermost layer, the pigment occurring as minute, irregularly distributed granules; the innermost layer rather thin (0.11–0.21  $\mu\text{m}$ ) and completely electron-lucent. The surface of the spore is somewhat uneven, with the outermost spore wall layer being interrupted by minute invaginations. In SEM the spores are seen to be provided with a minute but distinctive ornamentation of low, polygonal to rounded elevations forming the structural elements. In the central part of the

spore there are some 7–9 structural elements along a transverse line across the widest part of the spore.

*Distribution and ecology.* On thin, decaying branches of *Alnus*. Known from Greenland (on *Alnus crispa*) where it seems to be not uncommon in some parts. Also known from Central and Southern Europe, Russia to the Far East and North America.

*Remarks.* Characterized by the non-septate spores, the strongly flattened capitula, the excipulum anatomy, the ornamented spores, the K– reaction of the ascomata and the occurrence on *Alnus*. Similar to *Phaeocalicium betulinum* and *Ph. flabelliforme*, but differs from the latter in having non-septate spores and from the former in excipulum anatomy. Also known from Eastern and Central Europe, Asia and North America.

*Specimens examined.* — **Greenland.** Godthåbsfjord, Ilulialik, 1976 *Alstrup* 76234, 76497, 76571, 765915 (C); Karra, 1976 *Alstrup* 76637 (C); Sagdlerssuaq, 1976 *Alstrup* 76725 (C); Ivnajaugtoq, 1976 *Alstrup* 76282 (C); Isortoq, Igdlut kangigdlit, 1977 *Alstrup* 77932b (C); Pingo, 1977 *Alstrup* 77119a (C); Quvernup qaqa, 1977 *Alstrup* 77026a (C).

### 4. *Phaeocalicium flabelliforme* Tibell, n. sp. (Fig. 4)

*Species in Betula saprophytica vel parasitica.* *Ascomata* 0.25–0.29 mm alta, capitulo nigro stipite pallidiore olivaceobrunneo, nitido. *Capitulum ascomatum juvenium obconicum sed valde complanatum in ascomatibus maturis.* Excipulum e 3–4 stratis hypharum periclinaliter dispositarum. *Asci anguste cylindrici*, 76–96  $\times$  4.5–5.5  $\mu\text{m}$ . *Spore semper septatae septo uno vel raro septis duobus*, 11.5–14.0  $\times$  4–5  $\mu\text{m}$ .

Type: Sweden. Norrbotten, Korpilombolo par., 15 km SSE of Kainulasjärvi, Vinsanlehto, along Kurkijoki, 66:52N, 22:35E, 17.VII.1977 Tibell 6820 (holotype, UPS).

Saprophytic or parasitic on *Betula*. *Ascomata* 0.25–0.29 mm high. *Capitulum* black, stalk paler, olivaceous brown, shiny. *Capitulum* of young ascomata obconical, but in mature ascomata strongly flattened,  $0.14\text{--}0.24 \times 0.05\text{--}0.07$  mm, epruinose. Epithecium brown, sclerotized, 5–8  $\mu\text{m}$  thick. Hypothecium obconical, ca. 55  $\mu\text{m}$  high, hyaline, consisting of more or less isodiametric cells. Excipulum medium brown, 11–13  $\mu\text{m}$  thick, consisting of 3–4 layers of periclinally arranged, moderately sclerotized hyphae 2–3  $\mu\text{m}$  diam. Excipulum and epit-

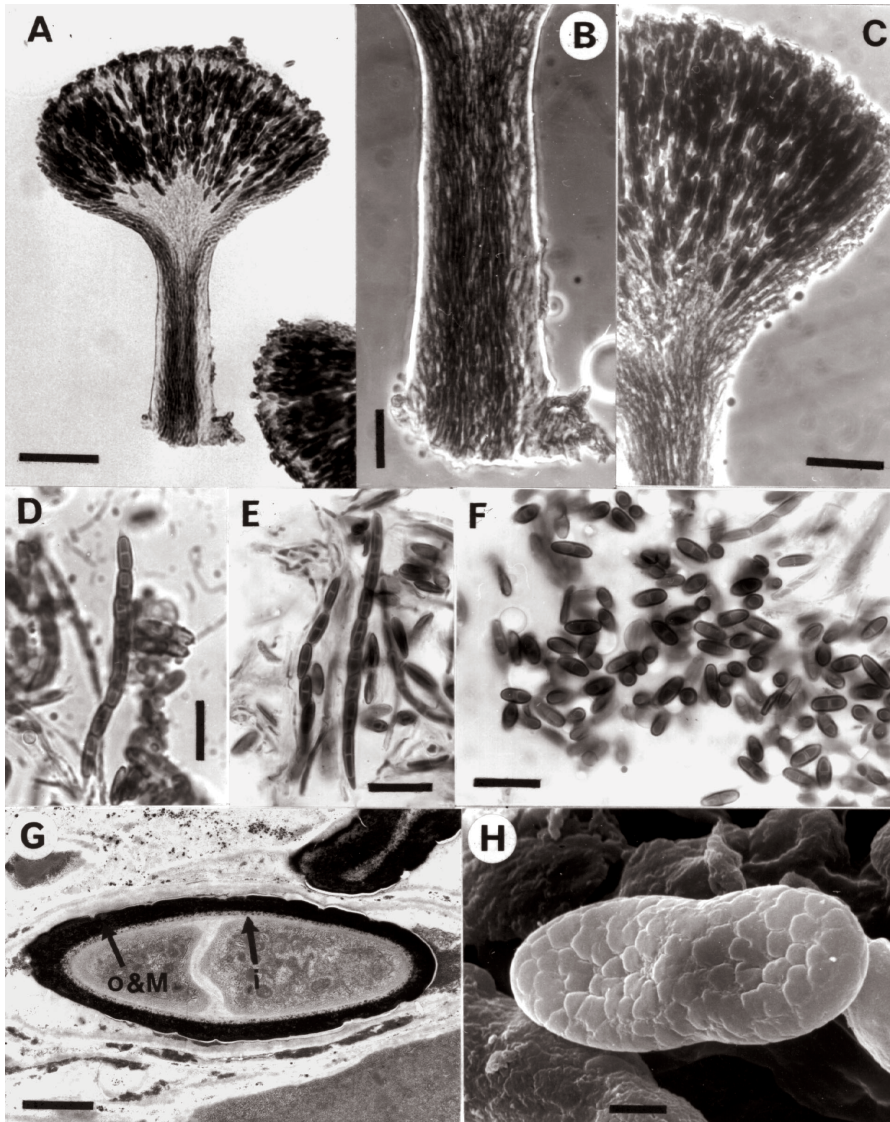


Fig. 4. *Phaeocalicium flabelliforme* Tibell. — A: Longitudinal section of ascoma. — B: Longitudinal section of ascoma stalk. Stalk with heavy pigmentation in the central part, consisting of periclinally arranged hyphae, surrounded by a thin gelatinous coat. Phase contrast micrograph. — C: Excipulum consisting of 3–4 layers of periclinally arranged, moderately sclerotized hyphae. Phase contrast micrograph. — D, E: Mature asci. — F–H: Mature spores. Under the light microscope the spores appear smooth. In TEM the almost mature spores have a wall consisting of three layers. The outermost layer (o) is thin and strongly pigmented, has no electron-dense lining and is poorly delineated; the middle layer (M) moderately thick, less homogeneously pigmented than the outermost layer; innermost layer (i) thin and electron-lucent. Spore septum not pigmented. The surface of the spores is somewhat uneven. In SEM the spores have a minute ornamentation of low, polygonal to rounded elevations. — A–E, G, H: Holotype. F: *Tibell* 6796 (UPS). — Scales. A: 25  $\mu$ m; B, D–F: 20  $\mu$ m; C: 30  $\mu$ m, G–H: 2  $\mu$ m.

hecium K–. *Stalk* 0.03–0.04 mm diam., K–, medium brown in the central part, consisting of periclinally arranged, slightly intertwined hyphae, 2–3  $\mu$ m diam., surrounded by an up to 8  $\mu$ m thick gelatinous coat.

*Asci* 76.1–95.6  $\times$  4.5–5.3  $\mu$ m, 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,  $11.6\text{--}14.0 \times 4.1\text{--}5.1 \mu\text{m}$ , appearing smooth under the light microscope or with a very minutely ornamented surface. Spore septum not pigmented. In TEM the almost mature spores have a wall consisting of two layers: The outer layer is thick ( $0.55\text{--}0.92 \mu\text{m}$ ) and well pigmented by irregularly distributed pigment granules concentrated towards the surface of the spore; inner wall layer thin ( $0.10\text{--}0.16 \mu\text{m}$ ) and electron-lucent. The surface of the spores is somewhat uneven, with the outermost spore wall layer being interrupted by minute invaginations. In SEM the spores are seen to be provided with a minute but distinctive ornamentation of low, polygonal to rounded elevations forming the structural elements. In the central part of the spore there are some 5–7 structural elements along a transversal line across the widest part of the spore.

*Distribution and ecology.* Overlooked or rare, growing on thin, decaying branches of *Betula* along streams in mixed *Picea abies*–*Betula* forests. Only known from one locality in Northern Sweden.

*Remarks.* Characterized by the one-septate spores, the strongly flattened capitula, the excipulum anatomy, the K- reaction of the ascogonia and the occurrence on *Betula*. Similar to *Phaeocalicium asciiforme*, which occurs in New Zealand, but *Ph. flabelliforme* differs in having a thinner excipulum, in section a brown rather than aeruginose stalk and darker brown spores. It is very similar to *Ph. compressulum*, which differs in having non-septate spores.

*Specimens examined.* — Sweden. Norrbotten, Korpilombolo par., 15 km SSE of Kainulasjärvi, Vinsanlehto, along Kurkijoki, 66:52N, 22:35E, 17.VII.1977 Tibell 6796 (UPS, paratype); holotype.

## 5. *Phaeocalicium interruptum* (Nyl.) Tibell (Fig. 5)

Ann. Bot. Fennici 28: 119. 1991. — *Calicium pallescens* Nyl. var. *interruptum* Nyl. in Norrlin, Not. Sällsk. Fauna Flora Fennica Förhandl. 13: 316. 1873. — Type: Finland. Muonio, 1867 Norrlin (H-NYL 40728, lectotype designated by Tibell, Ann. Bot. Fennici 28: 118, 1991).

*Mycocalicium pusiolum* Räsänen var. *macrospora* Räsänen, Ann. Soc. Zool.-Bot. Fenn. Vanamo 3,8: 343. 1926. — Lectotype (designated here): Finland. Ostrobothnia borealis, Simo, Jokisuu ..., 26.V.1922 Räsänen, ex herb. Räsänen (H), isotypes: TUR-VAIN 29709, 29710.

Saprophytic or parasitic on branches of *Populus* and *Salix*. Ascogonia 0.24–0.44 mm high

( $X = 0.32 \text{ mm}$ ,  $s = 0.08 \text{ mm}$ ,  $n = 21$ ,  $co = 4$ ). Capitulum campanulate, dark brown to black, 0.08–0.15 mm wide ( $X = 0.10 \text{ mm}$ ,  $s = 0.04 \text{ mm}$ ,  $n = 20$ ,  $co = 4$ ), epruinose, with thickened excipular edge. Epithecium poorly developed. Hypothecium poorly developed, 20–30  $\mu\text{m}$  high, hyaline, consisting of largely periclinally arranged, short-celled hyphae, 2–3  $\mu\text{m}$  diam. Excipulum thin at the base, 7–15  $\mu\text{m}$  thick, consisting of 1–2 layers of isodiametric to irregular, sclerotized cells, 2–5  $\mu\text{m}$  diam., forming a mosaic in surface view. Upper part of excipulum strongly widened, 38–44  $\mu\text{m}$  thick, consisting of an outer layer of the same structure as further down and an inner part which widens strongly towards the top. The inner layer consists of largely periclinally arranged or somewhat intertwined, hyaline hyphae 2–4  $\mu\text{m}$  diam. All parts of the excipulum and epithecium K–. Stalk 0.03–0.05 mm diam., olivaceous brown, rather pale, glossy, in section pale violet red, consisting of largely periclinally arranged, slightly intertwined hyphae with swollen walls, 2–4  $\mu\text{m}$  diam. Stalk K+ intensified violet red, strongly swelling. Stalk surrounded by a 5–8  $\mu\text{m}$  thick hyaline gelatinous coat. Asci 46.1–57.4  $\times$  3.4–4.3  $\mu\text{m}$  ( $X = 51.8 \mu\text{m}$ ,  $s = 5.7 \mu\text{m}$ ,  $n = 20$ ,  $co = 4$ ;  $X = 3.9 \mu\text{m}$ ,  $s = 0.5 \mu\text{m}$ ,  $n = 20$ ,  $co = 4$ ), with uniseriately or sometimes overlapping and almost biseriately arranged spores. Ascus apex uniformly and not strongly thickened. Spores usually non-septate, but often 1-septate, medium brown, ellipsoidal to narrowly ellipsoidal, 8.8–10.8  $\times$  3.7–4.5  $\mu\text{m}$  ( $X = 9.8 \mu\text{m}$ ,  $s = 1.0 \mu\text{m}$ ,  $n = 22$ ,  $co = 4$ ;  $X = 4.1 \mu\text{m}$ ,  $s = 0.4 \mu\text{m}$ ,  $n = 22$ ,  $co = 4$ ), smooth under the light microscope or with a very minute ornamentation of small dots. Spore septa not pigmented. The spores continue to grow after having left the asci, eventually measuring up to 15  $\times$  6.5  $\mu\text{m}$ , 1–3-septate and with a coarse, areolate ornamentation. In TEM the almost mature spores have a wall consisting of two layers: The outermost layer is thick (0.40–0.53  $\mu\text{m}$ ), heavily pigmented by rather coarse (0.06–0.12  $\mu\text{m}$ ), partly fusing, pigment granules and with a more or less distinctive, very electron-dense thin surface layer; inner layer thinner (0.23–0.37  $\mu\text{m}$ ) and electron-lucent. There is a differentiation into two sublayers in this part of the wall with the innermost layer being slightly darker, and both sublayers contributing to the septum, which has a wide electron-lucent mid-lamella. The surface of the spore is provided with irregular invaginations breaking the outermost electron-dense layer. In SEM the spores have a minute but distinctive ornamenta-

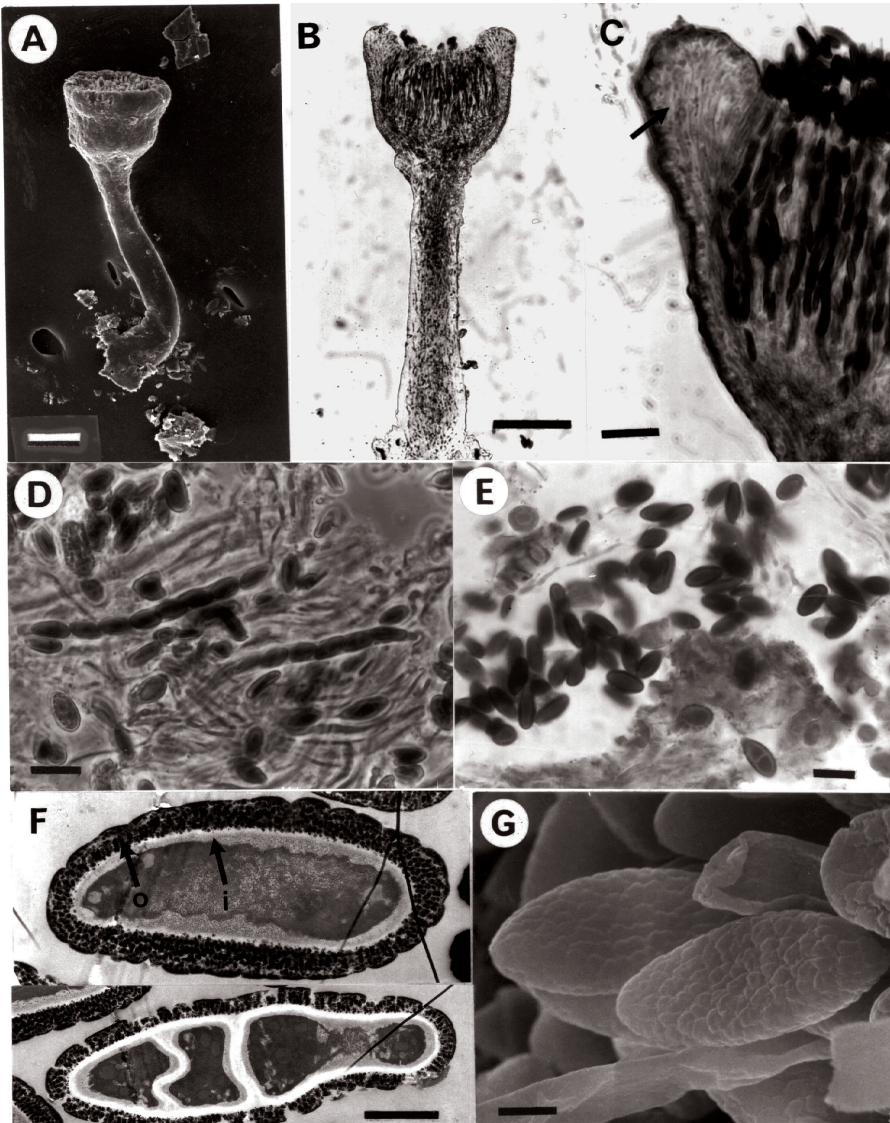


Fig. 5. *Phaeocalicium interruptum* (Nyl.) Tibell. — A: Ascoma. SEM micrograph. — B: Longitudinal section of ascoma. Stalk with weak pigmentation, consisting of intertwined hyphae surrounded by a gelatinous coat. — C: Excipulum thin at the base, consisting of 1–2 layers of isodiametric to irregular, thick-walled, sclerotized cells. Upper part of excipulum strongly widened, consisting of an outer layer of the same structure as at the base and an inner part of periclinally arranged or somewhat intertwined, hyaline hyphae, which widens strongly upwards (arrow). — D: Mature asci. Phase contrast micrograph. — E–G: Mature spores. Under the light microscope the spores have a minute verrucose ornamentation. In TEM the spore wall two-layered with outer thick layer (o) heavily pigmented by coarse, partly fusing, pigment granules and with an electron-dense surface layer; inner layer (i) thinner and electron-lucent. Septum non-pigmented, with a wide electron-lucent mid-lamella. The surface of the spore is provided with irregular invaginations. In SEM the spores are seen to be provided with a minute ornamentation of low, polygonal to rounded elevations. — A, B, G: Finland, Kuusamo, 1937 *Laurila* (H); C: isotype (UPS); D, E: Sweden, Värmland, *Sundell 1922* (UPS); F: lectotype. — Scales: A: 50  $\mu$ m; B: 100  $\mu$ m; C: 20  $\mu$ m; D, E: 10  $\mu$ m; F–G: 2  $\mu$ m.

tion of low, polygonal to rounded elevations forming the structural elements. In the central part of the

spore there are 7–8 structural elements along a transverse line across the widest part of the spore.

*Distribution and ecology.* On twigs of *Salix* and *Populus tremula*. Has been found on *Salix caprea*, *S. glauca*, *S. nigricans*, *S. pentandra* and *S. phylicifolia* x *S. nigricans*. Known from only a few localities in Finland, Russia, Norway and Sweden, but probably overlooked.

*Specimens examined.* — **Finland.** Ostrobothnia borealis, Simo (type of *Mycocalicium pusiolum* var. *macrospora*); Regio kuusamoensis, Sovajoki, Kaita-Tervajärvi, 1937 *Laurila* (H, UPS); Lapponia kittilensis, Muonio, 1867 *Norrlin* (type). **Norway.** Hedmark, Vinger par., E of Foskersjøen, 1948 *Ahlner* (S); Finnmark, Varanger, Nyborg, 1857 *Th. M. Fries* (UPS). **Sweden.** Lule Lappmark, Gällivare par., 15.5 km NE of Malmberget, 4 km NNE of Muorjevaare, Kutsajoki, 1995 *Tibell 21014* (UPS); Värmland, Östra Ämtervik par., Bössviken, 1960 *Sundell* (UPS); Uppland, Danmark par., Karlsro, 1945 *Svenomius* (UPS); Skogstibble par., Friberga, 1946 *Degelius* (UPS); Gästrikland, Valbo par., between Järvsta and Lärkbo, 1948 *Ahlner* (S); Jämtland, Revsund par., Grötingen, 1951 *Ahlner* (S). **Russia.** Regio kuusamoensis, River Tuntsa, Hassersokka, 1938 *Laurila* (Räsänen, Lich. Fenn. exs. 685, together with *Ph. boreale*; H, UPS; not exsiccata: H); Paanajärvi, Kornetta, Verilammet, 1938 *Laurila* (H).

*Note.* This species is not easily accommodated either in *Phaeocalicium* or in *Stenocybe* in a traditional sense, and a revision of the generic delimitation is needed. The situation is further complicated by the fact that *Stenocybe* as now conceived seems to consist of several natural groups. A thickening of the excipular edge akin to that met with in *Ph. interruptum* is found in some *Stenocybe* species, but the spore size and spore shape of *Ph. interruptum* is much more similar to that of *Phaeocalicium*. The spores of *Stenocybe* have 3–9 transverse septa, whereas in *Phaeocalicium* as traditionally conceived the spores are non- or 1-septate. In *Ph. 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 *Ph. interruptum* is similar to *Ph. boreale*, which it also resembles in ascoma size and ecology. *Phaeocalicium interruptum* is recognized by the thickened excipulum edge, the thin apical ascus wall and smaller spores. Differs from *Stenocybe pulatula* in not having branched stalks, the apical thickening of the excipulum and in having shorter spores.

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

Mitt. Staatsinst. Allg. Bot. Hamburg 13: 132. 1970. — *Calicium populneum* Brond. ex Duby, Bot. Gall. 2: 638.

1830. — Type: France. Paris, St. Cloude, 1861 *Pelvet* (neotype, proposed here, UPS).

Saprophytic or parasitic on branches of *Populus*. *Ascomata* 0.46–0.70 mm high ( $X = 0.58$  mm,  $s = 0.12$  mm,  $n = 27$ ,  $co = 4$ ), olivaceous to greyish brown or almost black, shiny. *Capitulum* lenticular, 0.18–0.28 mm wide ( $X = 0.23$  mm,  $s = 0.04$  mm,  $n = 27$ ,  $co = 4$ ), epruinose. Epithecium brown to reddish brown, 5–12  $\mu$ m thick, consisting of layers of anticlinally arranged, sclerotized hyphae. Hypothecium 30–60  $\mu$ m 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  $\mu$ m thick, formed by 3–6 layers of periclinally arranged, sclerotized hyphae. Excipulum and epithecium  $\text{HNO}_3$ - 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 unchanged or slightly reddish brown,  $\text{HNO}_3$ + slightly reddish brown, consisting of largely periclinally arranged, slightly intertwined, sclerotized, dark hyphae, 2  $\mu$ m diam., with a reddish brown or aeruginose tinge. *Stalk* surrounded by a 2–5  $\mu$ m thick hyaline gelatinous coat. *Asci* 74.1–86.2  $\times$  4.3–5.2  $\mu$ m ( $X = 80.1$   $\mu$ m,  $s = 6.1$   $\mu$ m,  $n = 27$ ,  $co = 4$ ;  $X = 4.7$   $\mu$ m,  $s = 0.5$   $\mu$ m,  $n = 27$ ,  $co = 4$ ). *Spores* 1-septate, medium brown, ellipsoidal and with a poorly pigmented septum which forms rather late, 11.6–13.2  $\times$  4.2–4.9  $\mu$ m ( $X = 12.6$   $\mu$ m,  $s = 1.2$   $\mu$ m,  $n = 27$ ,  $co = 4$ ;  $X = 4.8$   $\mu$ m,  $s = 0.5$   $\mu$ m,  $n = 27$ ,  $co = 4$ ), young spores appearing smooth under the light microscope, ageing spores with a minute ornamentation. In TEM the almost mature spores have a wall consisting of two layers: The outermost layer is moderately thick (0.38–0.46  $\mu$ m), heavily pigmented by minute, partly fusing, pigment granules and with a distinctive, very electron-dense thin surface layer; inner layer thinner (0.29–0.33  $\mu$ m), electron-lucent. Septum pigmented in a narrow, central zone. The surface of the spores is somewhat uneven, with the outermost spore wall layer being interrupted by slight invaginations. In SEM some spores appear nearly smooth whereas some have an ornamentation of low, polygonal to rounded elevations forming the structural elements. In ageing spores the ornamentation is coarser, with deep cracks.

*Distribution and ecology.* On thin, decaying branches of *Populus tremula* and introduced *P. balsamifera*. Alt. 30–720 m. Widely distributed in Norway and Sweden.

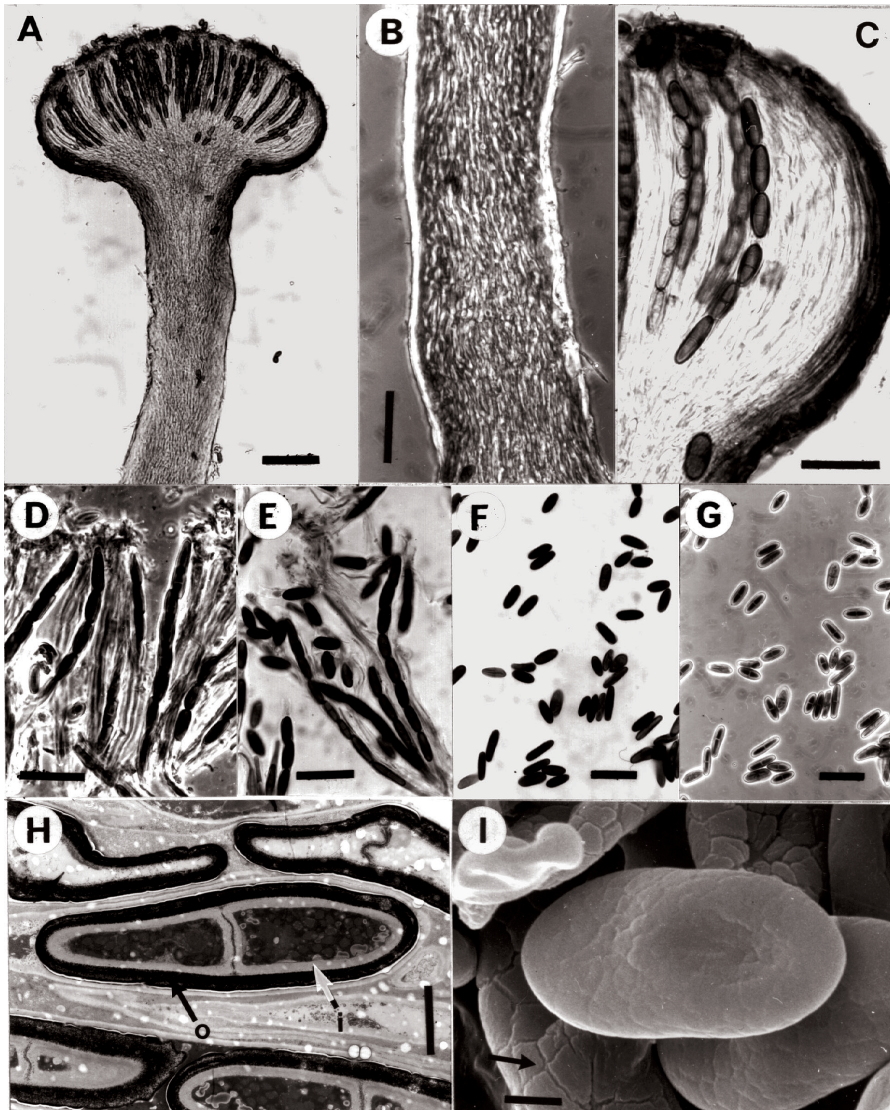


Fig. 6. *Phaeocalicium populneum* (Brond. ex Duby) A. F. W. Schmidt. — A: Longitudinal section of ascoma. — B: Longitudinal section of ascoma stalk. Stalk with moderate pigmentation, consisting of periclinally arranged hyphae. Phase contrast micrograph. — C: Excipulum formed by 3–6 layers of periclinally arranged, sclerotized hyphae. — D, E: Mature asci (D: phase contrast micrograph). — F–I: Mature spores with poorly pigmented septum appearing smooth under the light microscope (G: phase contrast micrograph). In TEM the spore wall is two-layered: Outermost wall layer (o) moderately thick, heavily pigmented by minute, pigment granules and with an electron-dense surface layer; inner wall layer (i) thinner, electron-lucent. Septum pigmented in a narrow, central zone. Outermost spore wall layer interrupted by slight invaginations. In SEM some spores appear nearly smooth whereas some have an ornamentation of low, polygonal to rounded elevations. Ageing spores with a coarse areolate ornamentation (arrow, partly hidden spores in Fig. I). — A–C, I: Sweden, Gotland, Stånga, 1963 *I. Nordin* (UPS); D–G: Sweden, Västmanland. Järnboås 1994 *Hermansson 3762* (UPS); H: Sweden, Härjedalen, Tännäs, 1990 *Hermansson 2419* (UPS). — Scales: A: 50  $\mu\text{m}$ ; B: 30  $\mu\text{m}$ ; C–G: 20  $\mu\text{m}$ ; H, I: 2  $\mu\text{m}$ .

Rare in Finland. Also known from cool temperate and temperate areas of the Northern Hemisphere: the British

Isles, continental Europe, Western Russia, Siberia and the Far East of Russia and North America.

*Remarks.* Characterized by the 1-septate spores with poorly pigmented septum, the olivaceous or greyish brown colour of the stalks, the smooth spores, the K– or faint K+ reddish reaction of the stalk and the occurrence on twigs of *Populus*. Indicator species of long forest continuity.

I have not been able to locate any original material, and a neotype from France is proposed.

*Specimens examined.* — **Finland.** Kuusamo, Paljakka, Kuusiniinjoki, Kiukaankorva rapids, 1981 *Muhr 3811* (UPS); Lapponia kittilensis, Muonio, Olostunturi, 1867 *Norrin* (H); 7 km ESE of Muonio, NE slope of Mt. Olostunturi, 1995 *Tibell 21006* (UPS). **Norway.** Finmark, Skoganvarre, 1915 *Lyng* (O); Hordaland, Granvin par., 1906 *Havaas* (O); 1939 *Ahlner & Havaas* (S); Nordland. Ankenes par., between Katterat and Rombaksbotn, 1986 *Tibell 16273a* (UPS); Møre og Romsdal, Ålesund, 1976 *Rösberg* (Hb. Övstedal); Nordland, Brønnøysund, 1977 *Degelius* (UPS); Vega par., Vega Island, Eidem, Sturshaugen, 1979 *Degelius V-2346* (UPS); Oppland, Vang par., between Beitimyri and Öyangen, 1985 *Tibell 15862* (UPS). **Sweden.** Dalarna, Särna par., Brattfjället, 1991 *Hermansson 2622* (UPS); Gästrikland, Hille par., Testeboån, Storströmmen, 2 km SE of Oslåttfors, 1987 *A. Nordin 2190* (Hb. A. Nordin); Valbo par., Oppala, Nälltärnberg, 1988 *A. Nordin 2304* (Hb. A. Nordin); Gotland, Stånga par., at Stånga Church, 1963 *I. Nordin 1798* (UPS); Väskinde par., 0.5 km N of Skäggs, 1990 *A. Nordin, Sundin & Thor* (S); Hälsingland, Ramsjö par., 14 km NNW of Ramsjö, 1977 *Tibell 7318* (UPS); Härjedalen, Ljusnedal par., Ormberget, 1973 *Tibell 5508* (Tibell, Calic. exs. 46, UPS); Tännäs par., Fröstsjöberget, 1990 *Hermansson 2419* (UPS); Lule Lappmark. Gällivare par., 12 km W of Skröven, 1990 Lindahl 90-226 (Hb. Karström); Jokkmokk par., 14 localities (Hb. Karström, S, UPS); Vuollerim par., 15 km S of Vuollerim, Östra Aspberget, 1995 *Tibell 21026* (UPS); Lycksele Lappmark, Stensele par., Kirjesäländet, 1986 *Tibell 16090* (UPS); Pite Lappmark, Arvidsjaur par., 22 km SW of Kåbdalis, 1990 Lindahl 90-387 (Hb. Karström); Lövberget, 1990 *Aronsson 90-408* (Hb. Karström); 23 km SW of Kåbdalis, N. Granberget, 1990 *Aronsson 90-381* (Hb. Karström); ca 20 km NE of Boden, Sörilandshuvudet, 1991 *Karström 911* (Hb. Karström); Södermanland, Huddinge par., Lissna, 1961 *Hasselrot* (S); Överjärna par., Tuna, 1956 *Hasselrot* (S); Uppland, Skogstibble par., Friberga, 1948 *Hasselrot* (S); Vaksala par., Norr-Hällby, 1945 *Hasselrot* (S); Västerbotten, Vindelns par., 6.5 km NNW of Vindeln, 1989 *Tibell 18632* (UPS); Västmanland, Järnboås par., Nora. Limberget, 1994 *Hermansson 3768* (UPS); Nora par., Tinäset, 1982 *Tibell 13800* (UPS); Åsele Lappmark, Vilhelmina par., 20 km ESE of Saxnäs, 1991 *Wedin 3886a* (UPS). **Russia.** Paanajärvi, Kaijanlampi, 1937 *Laurila* (Räsänen, Lich. Fenn. exs. 684, UPS, S).

## 7. *Phaeocalicium praecedens* (Nyl.) A. F. W. Schmidt (Fig. 7)

Mitt. Staatsinst. Allg. Bot. Hamburg 13: 131. 1970. — *Calicium praecedens* Nyl., Flora 50: 370 (1867). — Type:

Finland. Evois, 1866 *Norrin* (H-NYL 40719, lectotype, designated here).

Saprophytic or parasitic on branches of *Populus*. *Ascomata* 0.56–0.85 mm high ( $X = 0.70$  mm,  $s = 0.15$  mm,  $n = 27$ ,  $co = 4$ ), dark greyish to black, shiny. *Capitulum* lenticular, 0.18–0.28 ( $X = 0.23$  mm,  $s = 0.05$  mm,  $n = 27$ ,  $co = 4$ ) mm diam., epruinose. Epithecium brown, 7–17  $\mu$ m thick, consisting of anticlinally arranged, sclerotized hyphae. Hypothecium 75–110  $\mu$ m 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  $\mu$ m 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  $\mu$ m diam. *Stalk* usually without but sometimes surrounded by a 4–6  $\mu$ m thick hyaline gelatinous coat. *Asci* 61.6–75.4  $\times$  4.1–5.3  $\mu$ m ( $X = 68.5$   $\mu$ m,  $s = 6.9$   $\mu$ m,  $n = 27$ ,  $co = 4$ ;  $X = 4.7$   $\mu$ m,  $s = 0.6$   $\mu$ m,  $n = 27$ ,  $co = 4$ ). *Spores* non-septate, medium brown, ellipsoidal, 10.1–12.8  $\times$  4.3–5.6  $\mu$ m ( $X = 11.5$   $\mu$ m,  $s = 1.3$   $\mu$ m,  $n = 27$ ,  $co = 4$ ;  $X = 5.0$   $\mu$ m,  $s = 0.7$   $\mu$ m,  $n = 27$ ), young spores appearing smooth under the light microscope, ageing spores with a minute ornamentation. In TEM the almost mature spores have a wall consisting of two layers. Outer layer moderately thick (0.43–0.53  $\mu$ m), heavily pigmented by minute, partly fusing, pigment granules and with a very electron-dense thin surface layer; inner layer thinner (0.13–0.20  $\mu$ m). Surface of the spores somewhat uneven, with outermost spore wall layer interrupted by slight invaginations. In SEM some spores appear nearly smooth whereas some have an ornamentation of low, polygonal to rounded elevations forming the structural elements. In ageing spores the ornamentation is coarser, with deep cracks.

*Distribution and ecology.* Uncommon on thin, decaying branches of *Populus tremula*. Scattered or possibly overlooked in Finland and Sweden. Endemic to Northern Europe and also known from Scotland.

*Remarks.* Characterized by the non-septate smooth spores, the K+ aeruginose reaction of the stalk,

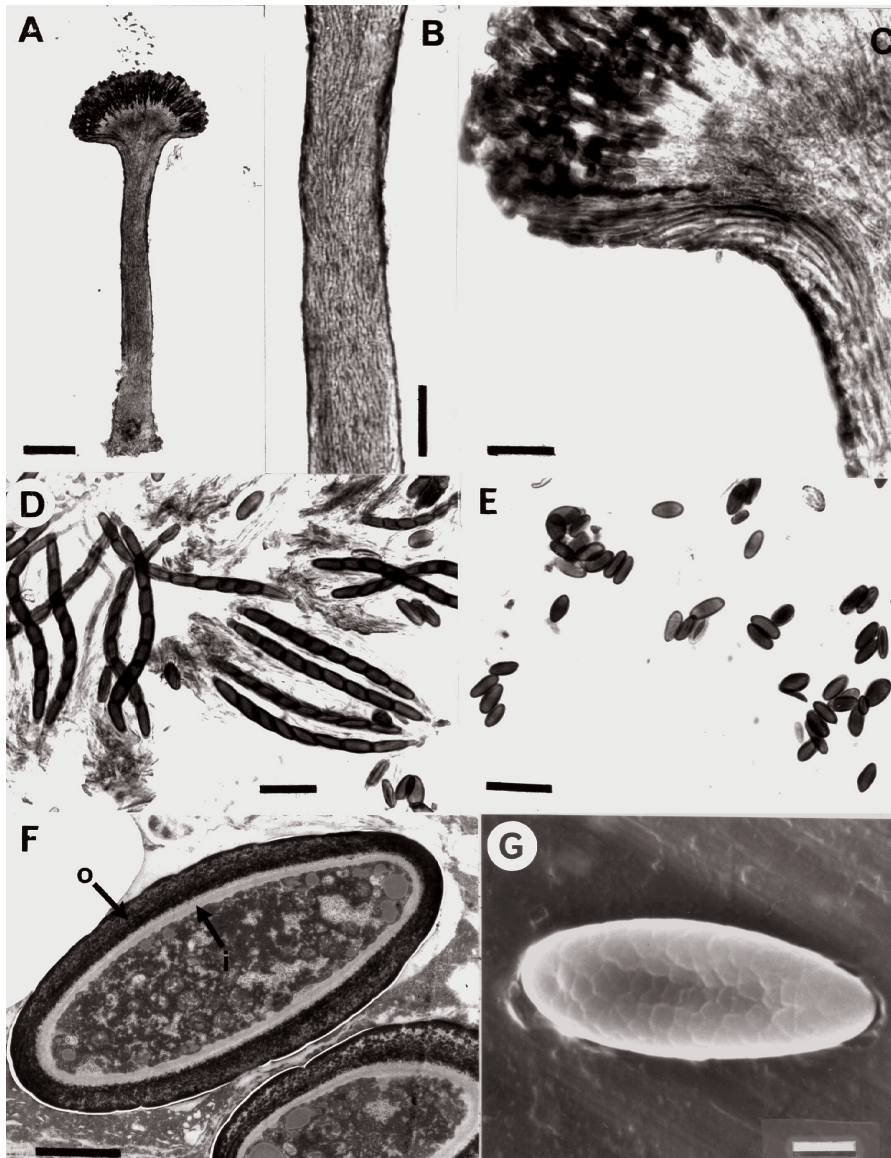


Fig. 7. *Phaeocalicium praecedens* (Nyl.) A. F. W. Schmidt. — A: Longitudinal section of ascoma. — B: Longitudinal section of ascoma stalk. Stalk with moderate pigmentation, consisting of periclinally arranged hyphae. — C: Excipulum formed by 5–12 layers of periclinally arranged moderately sclerotized hyphae. — D: Mature asci. — E–G: Mature spores appearing smooth under the light microscope. In TEM the spores have a two-layered wall: Outer layer (o) moderately thick, heavily pigmented by minute, partly fusing, pigment granules and with a very electron-dense surface layer; inner layer (i) thinner, electron-lucent. Outermost spore wall layer interrupted by slight invaginations. In SEM the spores have a minute ornamentation of low, polygonal to rounded elevations. — A–G: Sweden, Lule Lappmark, *Karström 902* (UPS). — Scales: A: 100  $\mu$ m; B: 50  $\mu$ m; C: 30  $\mu$ m; D, E: 20  $\mu$ m; F–G: 2  $\mu$ m.

the brown hypothecium, the strongly swollen hyphae of the stalk and the occurrence on twigs of *Populus*.

*Specimens examined.* — **Finland.** Satakunta, Kankaanpää, Venesjärvi, 1936 *Laurila* (UPS); Tavastia australis, Evois

(lectotype, H-NYL 40719); Hollola, 1882 *Norrlin* (H-NYL 40717, UPS); Tavastia borealis, Pihlajavesi, 1871 *Norrlin* (H, H-NYL 40693). **Norway.** Rogaland, Forsand par., the Frafjord Valley, 1947 *Degelius* (UPS). **Sweden.** Dalsland, Edsleskog par., Klöverudsbranterna, 1994 *Kennesten* (UPS); Nössemark

par., Grå Kulle, 1994 *Hultengren 951* (Hb. Hultengren); Bokullen, 1994 *Hultengren 671* (Hb. Hultengren); Gästrikland. Hille par., Iggön, 1946 *Ahlner* (UPS); Lule Lappmark, Jokkmokk par., 9 localities (Hb. Karström, UPS); Norrbotten, Hietaniemi par., 9 km SW of Övertorneå, 1995 *Tibell 20096* (UPS); Övertorneå par., 7.5 km SW of Juoksengi, 1995 *Tibell 21001* (UPS); Närke, Götlunda par., Torpstång, 1869 *Blomberg* (LD); Södermanland, Dunker par., Dunker, 1891 & 1894 *Blomberg* (LD, UPS, S); Örnö par., Mörby, 1951 *Ahlner* (S); Nacka, Storängen, 1920 *Vestergren* (Magnusson, Lich. sel. scand. exs. 331, UPS, S); Uppland, Åland par., E of Fallet, 1945 *Hasselrot & Svenonius* (UPS); Balingsta par., Kumlaborg, 1975 *K. & L. Holm 422c* (UPS); Danderyd par., Danderydsberget, 1949 *Ahlner* (S); Ekeby par., Högbergsmossen, 1995 *Hermansson 4757* (UPS); Skogstibble par., Friberga, 1946 *Degelius* (UPS); Vaksala par., Högtomt, 1946 *Ahlner* (S); Vänge par., Fiby, 1981 *Anderberg 615* (S); Älvkarleby par., Harön, 1988 *Tibell 88142* (UPS); Värmland, Degerfors par., Krontorp, 1978 *Muhr 882* (Hb. Muhr); Ölsdalen, 1981 *Muhr 3569* (Hb. Muhr); Holmedal par., Grötnäs, 1968 *Sundell 6506* (LD); Järnskog par., Kronan, 1965 *Sundell 4496* (LD); Munkfors, SE of Småpottorna, 1957 *Sundell 970* (UPS); Kronan, 1969 *Sundell 7115a* (S); Fiskevik, 1956 *Sundell 879* (LD); Västerbotten, Vindelö par., Kulbäcksliden, 1989 *Tibell 18625* (UPS); Västmanland, Järnboås, Erikaberget, 1994 *Hermansson 3770* (UPS); Kungö, 1878 *Blomberg* (LD).

## 8. *Phaeocalicium tremulicola* (Norrl. ex Nyl.) Tibell, *comb. nova* (Fig. 8)

*Stenocybe tremulicola* Norrl. ex Nyl., *Flora* 66: 531. 1883. — Type: Finland. *Tavastia australis*, Hollola, 1882 *Norrlin* (H-NYL 40571, lectotype, designated here).

Saprophytic or parasitic on branches of *Populus*. *Ascomata* 0.25–0.33 mm high ( $X = 0.29$  mm,  $s = 0.04$  mm,  $n = 40$ ,  $co = 4$ ), black, shining, often with olivaceous to greyish brown stalk. *Capitulum* obovate to narrowly lenticular, 0.04–0.13 mm wide ( $X = 0.09$  mm,  $s = 0.05$  mm,  $n = 40$ ,  $co = 4$ ), epruinose. Epithecium medium brown, 7–10  $\mu$ m high, consisting of small cells with partly melanized walls. Hypothecium 35–45  $\mu$ m high, hyaline, consisting of largely periclinally arranged, intricately interwoven branching and thin-walled hyphae. Excipulum medium brown, 9–13  $\mu$ m thick, formed by an outer layer of large, sclerotized and thick-walled cells, 4–7  $\mu$ m 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  $\mu$ m diam., with swollen walls. Stalk enclosed in a 5–

8  $\mu$ m thick, hyaline layer. *Asci* 75.0–91.0  $\times$  4.5–5.7  $\mu$ m ( $X = 83.0$   $\mu$ m,  $s = 8.0$   $\mu$ m,  $n = 40$ ,  $co = 4$ ;  $X = 5.1$   $\mu$ m,  $s = 0.6$   $\mu$ m,  $n = 40$ ,  $co = 4$ ), with uniseriately arranged spores. Ascus apex with uniformly thickened apical wall. *Spores* when mature 3-septate, brown, narrowly ellipsoidal, 14.4–17.3  $\times$  4.8–5.5  $\mu$ m ( $X = 15.9$   $\mu$ m,  $s = 1.4$   $\mu$ m,  $n = 40$ ,  $co = 4$ ;  $X = 5.4$   $\mu$ m,  $s = 0.6$   $\mu$ m,  $n = 40$ ,  $co = 4$ ), smooth under the light microscope. The spores often remain unseptate or have one septum only. Spore septa strongly pigmented. In TEM the almost mature spores have a wall consisting of three layers. Outermost layer thin (0.11–0.17  $\mu$ m) and less electron-dense than the middle layer; middle layer rather thick (0.39–0.50  $\mu$ m) strongly pigmented, pigment granules large, sometimes nearly as wide as the middle wall layer; innermost layer rather thick (0.28–0.39  $\mu$ m) and completely electron-lucent. Septum strongly pigmented in a central zone around an electron-lucent mid-lamella. Surface of the spores only very slightly and irregularly uneven. In SEM the spores appear nearly smooth.

*Distribution and ecology.* On thin and decaying twigs of *Populus tremula*. Only known from a few localities in Central and Northern Finland and adjacent parts of Russia. Also recorded from Central Europe.

*Remarks.* 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*.

*Specimens examined.* — **Finland.** *Tavastia australis*, lectotype; Korpilahti, 1874 *Lang* (H-NYL 40569); Evois, 1866 *Norrin* (H-NYL 40568); Ostrobothnia borealis, Turtola, 1867 *Norrin* (H); Regio kuusamoensis, Kitkajoki, Juuma, Jäkälävuoma, 1938 *Laurila* (H). **Russia.** Regio Kuusamoensis, Salla, Auktijärvi, 1937 *Laurila* (H); Kutsajoki, Niluntjärvi, 1937 *Laurila* (H); Alimmainen-Kursujärvi, 1937 *Laurila* (H); Paanajärvi, Kyökkäysvaara, 1937 *Laurila* (Räsänen, Lich. fenn. exs. 544, UPS; not exsiccata: H).

*Acknowledgements.* I am indebted to the curators of the herbaria of C, H, LD, O, S, TUR and UPS for loan of material for this study. S. Hultengren (Stenungsund), A. Nordin (Uppsala), M. Karström (Vuollerim), L.-E. Muhr (Karlskoga) and D.-O. Övstedal (Bergen) kindly provided material from their private herbaria at my disposal. Ms K. Ryman (Uppsala) supported me with excellent technical assistance. Ms U.-B. Sahlström is thanked for skilfully producing the prints for the illustrations. The electron microscopy was carried out in cooperation with the Unit for Biological Structure Analysis of the University of Uppsala. Ms A. Axén embedded and sectioned the material for transmission electron microscopy. The Swedish Natural Science Council provided funds for the work within the project "Taxonomy of Caliciales".

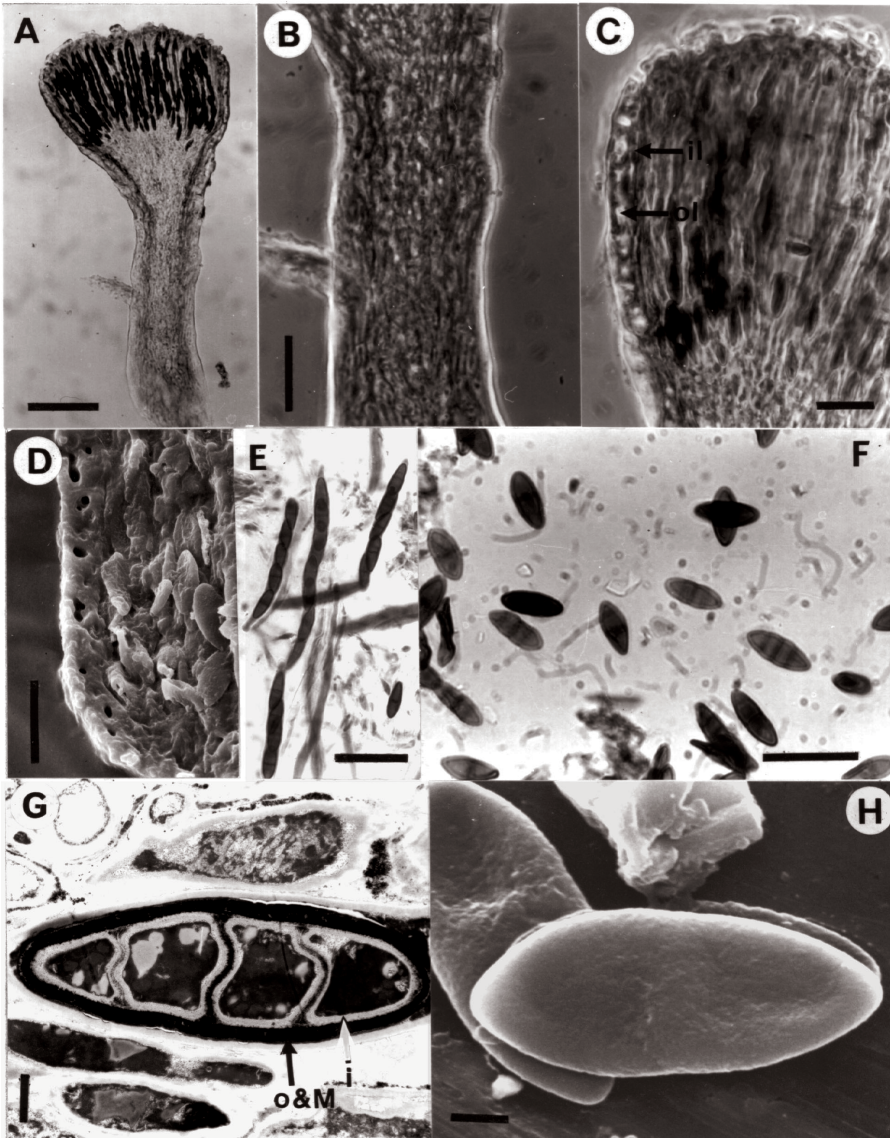


Fig. 8. *Phaeocalicium tremulicola* (Norrl. ex Nyl.) Tibell. — A: Longitudinal section of ascoma. — B: Longitudinal section of ascoma stalk. Stalk with weak pigmentation, consisting of largely periclinally arranged, intertwined and rather short-celled hyphae. Phase contrast micrograph. — C: Excipulum in longitudinal section consisting of an outer layer (ol) of large, isodiametric sclerotized and thick-walled cells (arrows), 4–7  $\mu\text{m}$  diam. covering a thin layer (il) of periclinally arranged hyphae, 1–3 cells thick. Phase contrast micrograph. — D: Longitudinal section of excipulum with an outer lining of isodiametric cells. — E: Mature asci. — F–H: Mature spores. In TEM the almost mature spores have a wall consisting of three layers: Outermost layer (o) thin and less electron-dense than the middle layer; middle layer (M) rather thick strongly pigmented, pigment granules large, sometimes nearly as wide as the middle wall layer; innermost layer (i) rather thick and completely electron-lucent. Septum quite strongly pigmented in a central zone around an electron-lucent mid-lamella. Surface of the spores only very slightly and irregularly uneven. In SEM the spores appear nearly smooth. — A–C: Finland, Turtola, 1867 *Norrlin* (H); D, F, G: Russia, Paanajärvi, 1937 *Laurila* (H); E, H: Russia, Auktijärvi, 1937 *Laurila* (H). — Scales: A: 50  $\mu\text{m}$ ; B–D, E: 30  $\mu\text{m}$ ; F: 20  $\mu\text{m}$ ; G, H: 2  $\mu\text{m}$ .



## REFERENCES

- Schmidt, A. 1970: Anatomisch-taxonomische Untersuchungen an europäischen Arten der Flechtenfamilie Caliciaceae. — Mitt. Staatsinst. Allg. Bot. Hamburg 13: 111–166.
- Tibell, L. 1984: A reappraisal of the taxonomy of Caliciales. — Nova Hedwigia Beih. 79: 597–713.
- Tibell, L. 1991: Some taxa of Caliciales described by W. Nylander. — Ann. Bot. Fennici 28: 117–121.
- Tibell, L. 1995: The anamorph of *Chaenothecopsis debilis*. — Mycologia 87: 245–252.
- Titov, A. 1986: The genus *Phaeocalicium* (Mycocaliciaceae) in the USSR. — Botanicheskii Zhurnal 71: 384–389.