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The lichenicolous *Phoma* species (coelomycetes) on *Cladonia*

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Abstract: The lichenicolous *Phoma* species on *Cladonia* are revised. A statistical analysis of the conidial size suggests that three species are involved: *P. cladoniicola* sp. nov. a common and widespread species in the Northern Hemisphere occurring on a wide range of *Cladonia* species; *P. foliaceiphila* sp. nov. known from *C. foliacea* and *C. fimbriata* in Europe; and *P. grumantiana* sp. nov. known from *C. symphycarpia* and *C. mateocyatha* in Svalbard and the USA.

Key words: anamorphic fungi, conidial fungi, mitosporic fungi

Introduction

In his revision of lichenicolous coelomycetes, Hawksworth (1981) accepted five lichenicolous species of *Phoma*. Subsequently, more species were described, and a revised key, accepting 14 species, was recently published by Hawksworth & Cole (2004). With our current knowledge, they are all host specific, either confined to one genus or to several closely related genera, but can be distinguished and keyed out on their morphological characteristics regardless of the host lichens. These authors explain that *Phoma* taxonomy is now based mainly on cultural characteristics, recently also supported by molecular work. As no lichenicolous taxa have ever been cultured, naming lichenicolous *Phoma* species must be regarded as a pragmatic means of communication, without necessarily conveying accurate phylogenetic information.

Several *Phoma* species have been reported from *Cladonia* thalli: *Phoma cladoniae* (Allesch. & Schnabl) Keissl., described from *C. fimbriata*, is a synonym of *Lichenosticta alcicornaria* (Linds.) D. Hawksw., and *P. uncialicola* (Zopf) Vouaux, described from *C. uncialis*, is now called *Bachmanniomyces uncialicola* (Zopf) D. Hawksw. *Phoma lichenis* Pass. has been reported from a variety of hosts, including *C. rangiferina* and *C. rangiformis*. However, the type of *P. lichenis* could not be located by Hawksworth (1981), who suggested that it merely represents pycnidia of *Physconia distorta*. Thus, no named *Phoma* species parasitizing *Cladonia* is currently known. Nevertheless, *Cladonia* thalli with *Phoma* infections are relatively frequent, and we have been able to examine many such specimens from Europe and North America (e.g., Diederich & Sérusiaux 2003; Kocourková 2000; Zhurbenko & Alstrup 2004). The aim of this paper is to revise all the *Phoma* material on *Cladonia* available to us.

Material and Methods

Herbarium specimens are deposited in JACA, LE, LG, NY and PRM, and in the private collections of P. Diederich, J. Etayo and P. van den Boom. The

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microscopical examination (including all measurements) was carried out using thin hand-cut sections mounted in water. Although the smallest unit on the micrometer scale was 0·6 µm, for statistical purposes we estimated conidial size by dividing each unit into three, resulting in measurements with an accuracy of 0·2 µm. Conidial measurements are indicated as (minimum–) $\bar{X} - \sigma_x - \bar{X} + \sigma_x$ (–maximum), followed by the number of measurements (*n*); the length/breadth ratio of conidia is indicated as l/b and given in the same way.

Results

The *Phoma* material on *Cladonia* is quite uniform macroscopically, but most variable regarding conidial size, for example, conidia from a French specimen on *C. foliacea* (Pas-de-Calais, *Sérusiaux*, LG) measured 6·3–7·4 × 2·5–2·9 µm (l/b 2·2–2·9) (*n*=20), while those from a French specimen on *C. rangiformis* (Ardennes, *Diederich* 16154) were much shorter and slightly narrower, 4·4–4·9 × 2·2–2·5 µm (l/b 1·8–2·2) (*n*=20), and those from an American specimen on *C. mateocyatha* (Alabama, *Harris* 28516) were still narrower, 4·8–5·6 × 1·8–2·1 µm (l/b 2·3–3·0) (*n*=21). An initial statistical analysis of conidial size of a selection of specimens gave the impression that conidia of at least some specimens on *C. foliacea* are much longer than those from other hosts and that the collection on *C. mateocyatha* has narrower conidia than most other specimens, and we wondered if several *Phoma* species might be involved, each of them possibly confined to one or several *Cladonia* species. To test this hypothesis, we analysed the conidial size of most collections in detail, with at least 20 measurements from each specimen (Table 1).

The material on *C. foliacea* appears to belong to two distinct entities, one with relatively short and broad conidia (4·7–5·8 × 2·6–3·1 µm; l/b 1·7–2·0; *n*=120) and one with relatively long and narrow conidia (5·9–7·2 × 2·2–2·7 µm; l/b 2·3–3·0; *n*=80) (Fig. 1A). The material on *C. furcata* and *C. rangiformis* corresponds entirely to the entity with short and broad conidia (4·6–5·7 × 2·4–3·0 µm; l/b 1·7–2·2; *n*=160) (Fig. 1B). The material on *C. pyxidata* and *C. pocillum* (syn. *C. pyxidata* subsp. *pocillum*) has relatively short and broad conidia (4·6–6·1 × 2·3–2·8 µm; l/b 1·9–2·3; *n*= 103) (Fig. 1C), but is somewhat intermediate between the two entities from *C. foliacea*. Conidia from *Etayo* 20228 on *C. fimbriata* match those of the entity with long and narrow conidia (5·5–6·7 × 2·1–2·4 µm; l/b 2·4–3·0; *n*=23) (Fig. 1D). Several other European specimens on *C. cervicornis*, *C. convoluta*, *C. phyllophora*, *C. ramulosa* and *C. symphycarpia* fit the entity with short and broad conidia or are intermediate between both entities. The conidia from the specimens on *C. symphycarpia* from Svalbard and on *C. mateocyatha* from the USA are narrower than those from all other hosts (Figs 1 & 2).

A one-way analysis of conidial variance (ANOVA, α=0·05) was carried out between different sets of specimens, and the length/breadth ratio of conidia proved to be the most useful character to be tested. Between the three putative species (*n*=472 for the specimens with short and broad conidia, *n*=100 for the specimens with long and relatively narrow conidia, and *n*=121 for the specimens with short and narrow conidia), the hypothesis that they have the same mean value was rejected (conidial length: $P<0{\cdot}001$; breadth: $P<0{\cdot}001$; l/b: $P<0{\cdot}001$). Between the ten specimens on *C. foliacea*, the results were similar (l/b: $P=10^{-51}$). Between the four specimens on *C. foliacea* with long and relatively narrow conidia, the hypothesis of same mean value was not rejected (l/b: $P=0{\cdot}35$). Between the six specimens on *C. foliacea* with short and broad conidia, the hypothesis of same mean value was not clearly rejected (l/b: $P=0{\cdot}03$).

All these results suggest that three species are involved: (a) a species with short and narrow conidia known from *C. mateocyatha* and *C. symphycarpia*; (b) a species with long and relatively narrow conidia, on *C. foliacea* and *C. fimbriata*; (c) a species with short and broad conidia, known from many *Cladonia* species, incl. *C. foliacea* and *C. symphycarpia*. The conidial size of these three species is given in Fig. 2.

TABLE 1. *Conidial dimensions* of* Phoma *specimens on* Cladonia

Number†	Specimen	Host	Length	Breadth	l/b
1	*Diederich* 16286	*C. symphycarpia*	4·6 (0·2)	2·6 (0·1)	1·78 (0·11)
2	PRM 907320	*C. cervicornis*	5·6 (0·3)	2·6 (0·2)	2·14 (0·17)
3	PRM 900149	*C. ramulosa*	4·8 (0·4)	2·8 (0·2)	1·73 (0·21)
4	PRM 907327	*C. phyllophora*	6·1 (0·5)	2·9 (0·2)	2·13 (0·23)
5	*Etayo* 20216	*C. convoluta*	5·6 (0·5)	2·7 (0·2)	2·09 (0·27)
6	PRM 900143	*C. pocillum*	6·2 (0·4)	2·8 (0·2)	2·25 (0·26)
7	PRM 906893	*C. pocillum*	5·9 (0·3)	2·8 (0·2)	2·11 (0·17)
8	*Diederich* 13807	*C. pocillum*	4·5 (0·3)	2·2 (0·1)	2·03 (0·18)
9	*Etayo* 18999	*C. pocillum*	5·6 (0·6)	2·5 (0·2)	2·21 (0·24)
10	*Buck* 20859A	*C. pyxidata*	4·8 (0·4)	2·5 (0·2)	1·89 (0·16)
11	PRM 758568	*C. furcata*	5·4 (0·4)	2·9 (0·3)	1·88 (0·25)
12	PRM 896159	*C. furcata*	5·5 (0·4)	3·1 (0·2)	1·81 (0·22)
13	*Diederich* 13806	*C. rangiformis*	4·9 (0·3)	2·4 (0·1)	2·09 (0·15)
14	PRM 896192	*C. rangiformis*	4·8 (0·4)	2·6 (0·2)	1·85 (0·22)
15	PRM 907324	*C. rangiformis*	4·8 (0·3)	2·9 (0·2)	1·70 (0·14)
16	*Diederich* 16154	*C. rangiformis*	4·6 (0·3)	2·3 (0·2)	2·00 (0·17)
17	PRM 907318	*C. rangiformis*	5·6 (0·5)	2·6 (0·2)	2·13 (0·19)
18	*Diederich* 16289	*C. foliacea*	4·7 (0·3)	2·7 (0·2)	1·76 (0·16)
19	PRM 907322 (pycn. 1)	*C. foliacea*	5·4 (0·4)	3·0 (0·2)	1·83 (0·15)
20	PRM 907322 (pycn. 2)	*C. foliacea*	5·2 (0·2)	2·8 (0·1)	1·90 (0·13)
21	PRM 907321	*C. foliacea*	4·9 (0·5)	2·6 (0·2)	1·90 (0·19)
22	PRM 907325	*C. foliacea*	5·8 (0·4)	3·1 (0·2)	1·90 (0·17)
23	PRM 907319	*C. foliacea*	5·7 (0·5)	3·0 (0·2)	1·90 (0·19)
24	PRM 896164	*C. foliacea*	6·6 (0·6)	2·5 (0·3)	2·71 (0·37)
25	*Diederich* 9806	*C. foliacea*	6·0 (0·8)	2·3 (0·2)	2·66 (0·32)
26	*van den Boom* 27863	*C. foliacea*	6·6 (0·4)	2·5 (0·2)	2·67 (0·20)
27	*Sérusiaux* 25 ii 01	*C. foliacea*	6·8 (0·5)	2·7 (0·2)	2·54 (0·32)
28	*Etayo* 20228	*C. fimbriata*	6·1 (0·6)	2·2 (0·2)	2·73 (0·29)
29	*Zhurbenko* 03232	*C. symphycarpia*	4·6 (0·5)	2·0 (0·2)	2·36 (0·38)
30	*Harris* 28516	*C. mateocyatha*	5·2 (0.4)	1·9 (0·1)	2·68 (0·33)

*mean (SD); $n=20$ or more measurements for each specimen.
†1–23 *P. cladoniicola*, 24–28 *P. foliaceiphila*, 29–30 *P. grumantiana*; 19 & 20 refer to two pycnidia from the same specimen.

Key to the lichenicolous *Phoma* species on *Cladonia*

Note: Conidial measurements are indicated as $\bar{X} - \sigma_x - \bar{X} + \sigma_x$, which means that the largest 16% and the smallest 16% are ignored.

1 Conidia relatively short and narrow, mostly 4·1–5·2 × 1·7–2·2 µm . . . . . **P. grumantiana**
Conidia broader, mostly 2·2–3·0 µm broad 2

2(1) Conidia broadly ellipsoid, mostly 4·7–5·9 × 2·4–3·0 µm, l/b 1·7–2·2 . . . . . **P. cladoniicola**
Conidia elongate ellipsoid, mostly 5·8–7·1 × 2·2–2·7 µm, l/b 2·4–3·0 . . . . . **P. foliaceiphila**

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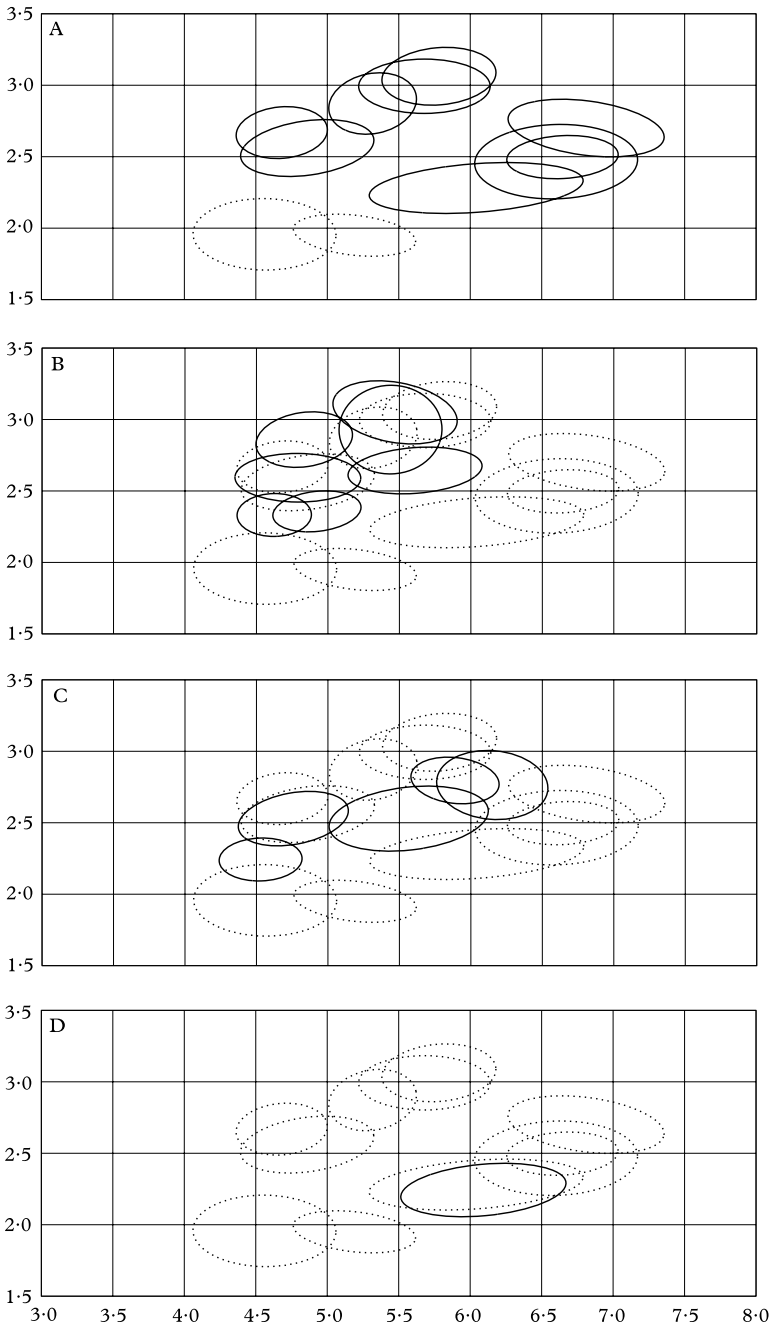

FIG. 1. *Phoma* specimens on different *Cladonia* species, dimensions of conidia (μm). A, on *C. foliacea* (solid lines), compared with specimens with narrow conidia on *C. mateocyatha* and *C. symphycarpia* (*Zhurbenko* 03232) (dashed lines); B, on *C. furcata* and *C. rangiformis* (solid lines), compared with specimens from A (dashed lines); C, on *C. pocillum* and *C. pyxidata* (solid lines), compared with specimens from A (dashed lines); D, on *C. fimbriata* (solid line), compared with specimens from A (dashed lines). Each ellipse represents one specimen (large radius of ellipse = standard deviation (SD) of conidial length; small radius = SD of conidial breadth; slope of major axis = slope of linear regression line).

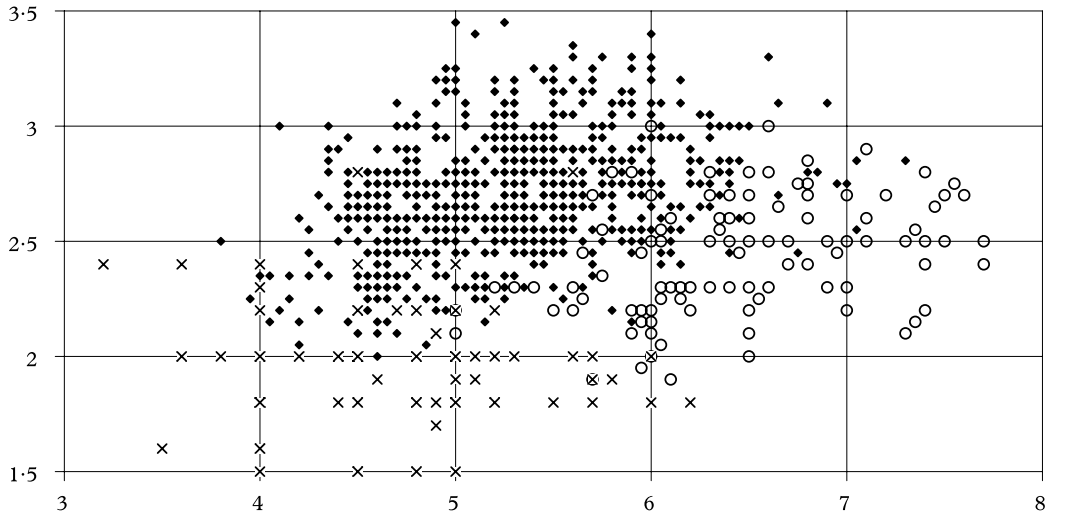

FIG. 2. Conidial dimensions (µm) of the three *Phoma* species on *Cladonia*. [When several conidia had the same values, their dimensions were slightly increased or decreased, so as to visualize all conidia on the graphics]. ◆ *P. cladoniicola*; ○ *P. foliaceiphila*; × *P. grumantiana*.

The Species

Phoma cladoniicola Diederich, Kocourk. & Etayo sp. nov.

Phoma lichenicola in *Cladoniae* thallis vigens, insignis pycnidiis atris, immersis ad partim erumpescentibus, (40–)50–100(–140) µm diam., cellulis conidiogenis breviter ampulliformibus, 4–5·5 × 2·5–5 µm, conidiis (3·8–)4·7–5·9(–7·3) × (2·0–)2·4–3·0(–3·5) µm, l/b (1·4–)1·7–2·2(–2·8).

Type: USA, Minnesota, Cottonwood County, *c.* 2 miles W of US 71, *c.* 14·5 miles N of Windom, 44°06′40″N, 95°04′30″W, 400 m alt., seasonally dry, flat, Sioux quartzite outcrop on N side of road, on *Cladonia pyxidata*, 28 September 1991, *W. R. Buck* 20859A (NY—holotypus; hb. Diederich—isotypus).

(Figs 1–3, 6)

Conidiomata pycnidial, immersed in the host thallus or partially erumpent, black, subspherical to pyriform, ostiolate, (40–)50–100(–140) µm diam.; vegetative mycelium immersed, brown, smooth-walled, mostly 1·5–2·5 µm thick; pycnidial wall brown, pseudoparenchymatous, 10–12 µm thick, composed of several layers of polyhedral cells, outer cells dark brown, 5–8(–10) µm diam., inner cells hyaline. *Conidiophores* absent. *Conidiogenous cells* lining the inner wall of the pycnidial cavity, short-ampulliform, not proliferating, hyaline, smooth-walled, 2·5–4·5 µm high, 2·5–4 µm wide, conidiogenesis enteroblastic. *Conidia* abundantly produced, arising singly, ellipsoid, apically rounded, hyaline, simple, smooth-walled, biguttulate, with a small guttule near each apex, (3·8–)4·7–5·9(–7·3) × (2·0–)2·4–3·0(–3·5) µm, l/b (1·4–)1·7–2·2(–2·8) (n=472).

Distribution and hosts. The new species appears to be widespread and common in the Northern Hemisphere. It is currently known from Europe (Czech Republic, France, Germany, Spain) and North America (USA: Minnesota). It grows on squamules of the primary thallus and on podetia of *C. cervicornis*, *C. convoluta*, *C. fimbriata*, *C. foliacea*, *C. furcata*, *C. phyllophora*, *C. pocillum*, *C. pyxidata*, *C. ramulosa*, *C. rangiformis* and *C. symphycarpia*. Infected parts of thalli are frequently bleached and often surrounded by a blackish necrotic line.

Notes. Amongst the lichenicolous *Phoma* species keyed out by Hawksworth & Cole (2004), four have ellipsoid conidia more than 2·5 µm wide and pycnidia >50 µm diam. *Phoma fuliginosa* M. S. Cole & D. Hawksw. is distinguished from *P. cladoni-*

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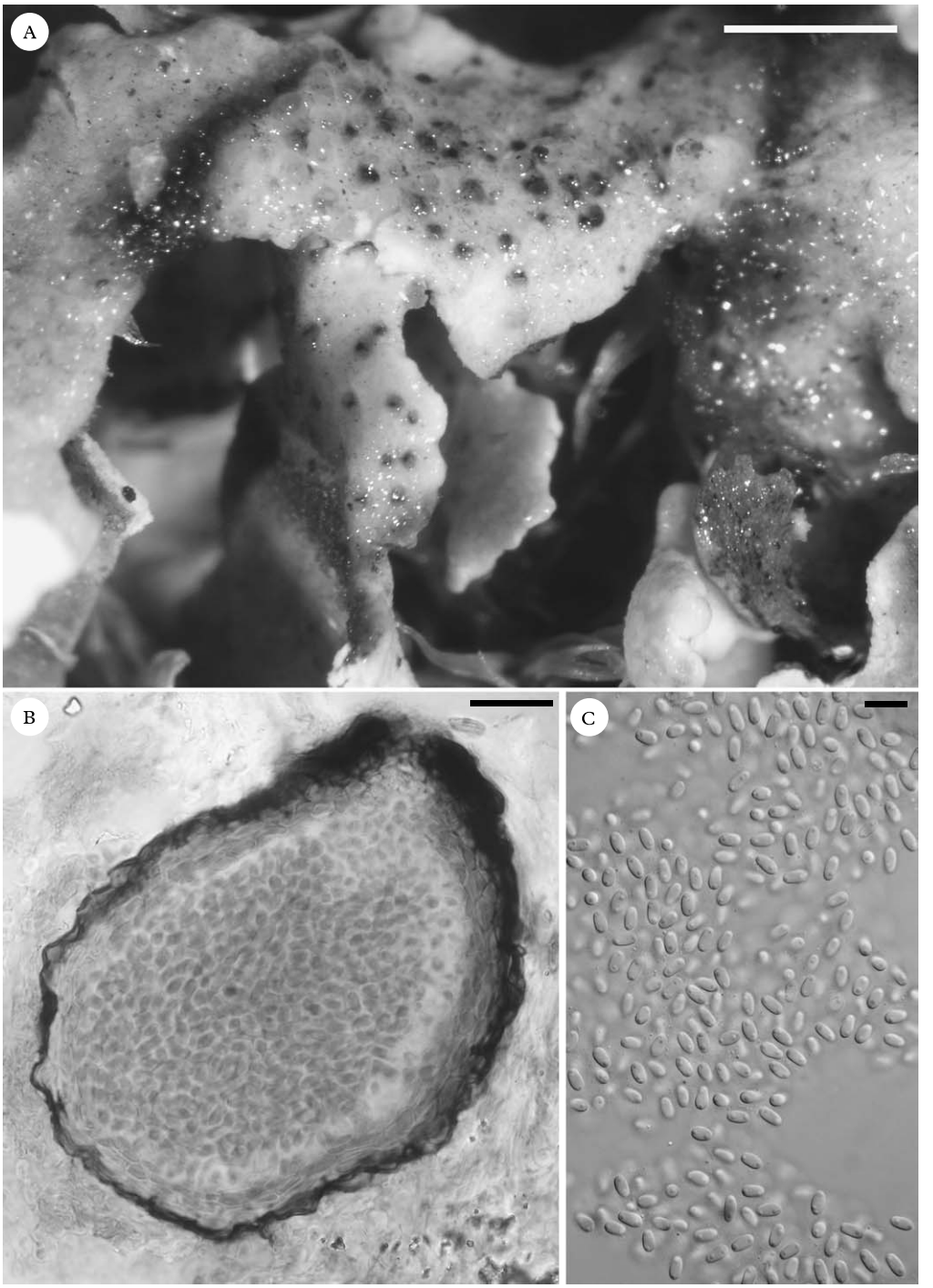

FIG. 3. *Phoma cladoniicola*. A, pycnidia on thallus of *Cladonia foliacea* (PRM 907322), note the bleached thallus surrounded by a black necrotic line; B, section through a conidioma (in lactophenol cotton blue) (holotype); C, conidia (PRM 907325). Scale bars: A=1 mm; B & C=10 μm.

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icola by broader conidia (5–6·5 × 3–3·5 µm), slightly larger conidiogenous cells (5–7·5 × 3–6 µm), and slightly smaller conidiomata (50–75 µm); *P. denigricans* Hafellner has larger conidia (7–8 × 3–4 µm) and conidiogenous cells (7–9 × 4–5 µm); *P. physciicola* Keissl. has larger conidiomata (100–150 µm) and shortly ellipsoid conidia (l/b 1·5–1·7); *P. epiphyscia* Vouaux also has larger conidiomata (80–150 µm) and slightly longer conidia [6–7 × (2–)3 µm]. Some specimens of *P. cladoniicola* with narrower conidia could be mistaken for *P. peltigerae* (P. Karst.) D. Hawksw. or *P. maculiformans* Ihlen, but both these species have distinctly larger pycnidia (100–150 µm and 120–200 µm respectively). Furthermore, all these species have different hosts.

Additional specimens examined (abbreviations: *D* for *Diederich*, *E* for *Etayo*, *K* for *Kocourková*, h for the private herbarium of the collector). **Czech Republic:** *Central Bohemia*: distr. Rakovník, Křivoklátsko protected landscape area, *c.* 1·5 km S of Milíčov, on *C. furcata*, 1999, *K* (PRM 758568); *ibid.*, on *C. ramulosa* (PRM 900149); distr. Rakovník, Křivoklátsko protected landscape area, between Nezabudice and Roztoky villages, Nezabudické skály nature reserve, on *C. furcata*, 2002, *K* (PRM 896159); distr. Beroun, Křivoklátsko protected landscape area, Trubín, on *C. rangiformis*, 1996, *K* (PRM 896192); distr. Beroun, Křivoklátsko protected landscape area, Hýskov, on *C. foliacea*, 2005, *K* & *von Brackel* (PRM 907325); Praha, Dolní Liboc, Divoká Šárka nature reserve, Kozákova rock, on *C. foliacea*, 1998 *K* (PRM 907322); Praha, Suchdol, protected area Sedlecké rocks, on *C. foliacea* and *C. rangiformis*, 2002, *K* (PRM 907319, 907318); Praha, Malá Ohrada, Albrechtův hill by Prokopský brook, on *C. pocillum*, 1999, *K* (PRM 900143); Praha, Hlubočepy, Prokopské valley, Dlouhý crest at Děvín, on *C. cervicornis*, 2004, *K* (PRM 907320); Praha, between Bohnice and Troja, Salabka nature monument, on *C. foliacea*, 2002, *K* (PRM 907321); Praha, Pitkovice, Pitkovická stráň nature reserve, on *C. rangiformis*, 2005, *K* (PRM 907324). *Southern Moravia*: Distr. Blansko, Moravský kras protected landscape area, Ostrov u Macochy, Balcarka, on *C. pocillum*, 2003, *K* (PRM 906893).—**France:** *Ardennes*: Rochers de Petit-Chooz (rive droite de la Meuse), entre la ferme d'Aviette et le point de vue en face du pont, sur *C. rangiformis*, 1999, *D* 16154; *ibid.*, on *C. symphycarpia*, *D* 16286; *ibid.*, on *C. foliacea*, *D* 16289. *Moselle*: 600 m NNW of Montenach, Koppenacherberg, on *C. pocillum*, 1999, *D* 13807 (h), *ibid.*, on *C. rangiformis*, *D* 13806 (h); W of Metz, mont Saint-Quentin, on *C. convoluta*, 1985, *D* 6222 (h).—**Germany:** *Bavaria*: Oberfranken, Hof, Wojaleite protected area near Wurlitz, on *C. phyllophora*, 2005, *K* & *von Brackel* (PRM 907327).—**Spain:** *Zaragoza*: Bulbuente, Restaurante R. Perochena, km 72, on *C. pocillum*, 2002, *E* 18999 (h); camino de Nuévalos a Jaraba, 1 km antes del túnel, on *C. convoluta*, 2002, *E* 20216 (h).

Phoma foliaceiphila Diederich, Kocourk. & Etayo sp. nov.

Phoma lichenicola in *Cladoniae* thallis vigens, insignis pycnidiis atris, immersis ad partim erumpescentibus, 50–100 µm diam., cellulis conidiogenis breviter ampulliformibus, 4–5·5 × 2·5–5 µm, conidiis (5·0–)5·8–7·1 (–7·5) × (2·0–)2·2–2·7(–3·0) µm, l/b (2·0–)2·4–3·0(–3·5).

Type: Czech Republic, Central Bohemia, distr. Rakovník, Křivoklátsko protected landscape area, between Nezabudice and Roztoky villages, Nezabudické skály nature reserve, 50°01′N, 13°51′E, 255 m alt., in *Quercus petraea* forest below steep slope of rocky outcrops, on *Cladonia foliacea*, 2002, *J. Kocourková* (PRM 896164—holotypus).

(Figs 1, 2, 4 & 6)

Conidiomata pycnidial, immersed in the host thallus or partially erumpent, black, subspherical to pyriform, ostiolate, 50–100 µm diam.; vegetative mycelium immersed, brown, smooth-walled, mostly 1·5–2·5 µm thick; pycnidial wall brown, pseudoparenchymatous, 10–12 µm thick, composed of several layers of polyhedral cells, outer cells dark brown, 5–8(–10) µm diam., inner cells hyaline. *Conidiophores* absent. *Conidiogenous cells* lining the inner wall of the pycnidial cavity, short-ampulliform, not proliferating, hyaline, smooth-walled, 4–5·5 × 2·5–5 µm, conidiogenesis enteroblastic. *Conidia* abundantly produced, arising singly, ellipsoid, apically rounded, hyaline, simple, smooth-walled, biguttulate, with a small guttule near each apex, (5·0–)5·8–7·1(–7·5) × (2·0–)2·2–2·7(–3·0) µm, l/b (2·0–)2·4–3·0(–3·5) (n=100).

Distribution and hosts. The species is known from Europe (Czech Republic, France, Luxembourg, the Netherlands and Spain), where it grows on squamules of the primary thallus of *C. fimbriata* and *C. foliacea*. Infected parts of thalli are frequently bleached and often surrounded by a blackish necrotic line.

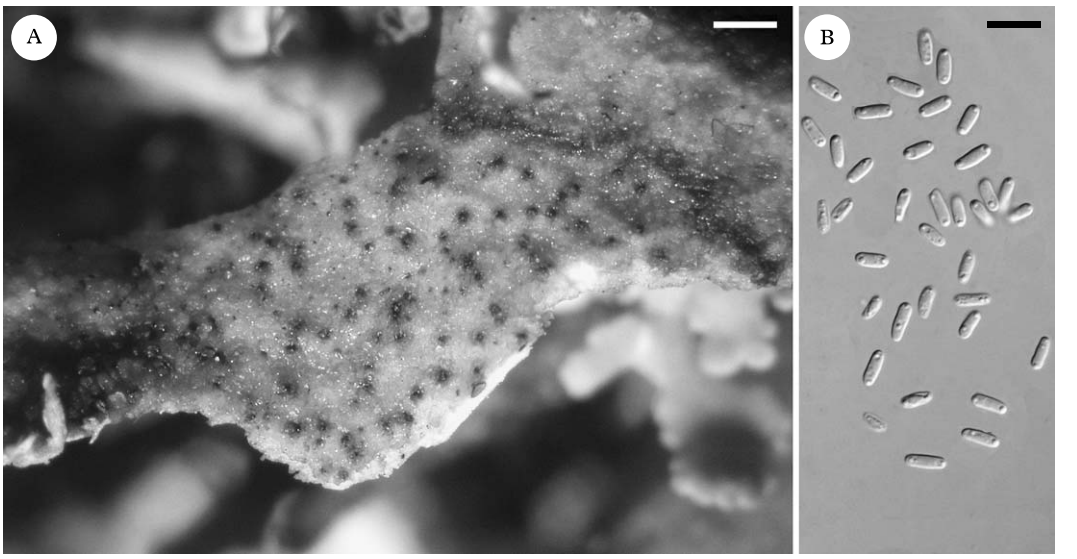

FIG. 4. *Phoma foliaceiphila*. A, pycnidia on thallus of *Cladonia foliacea* (*Sérusiaux*, LG), note the bleached thallus surrounded by a black necrotic line; B, conidia (holotype). Scale bars: A= 1 mm; B=10 µm.

Notes. This species differs from *Phoma cladoniicola* by longer and narrower conidia. *Phoma physciicola* is the only species keyed out by Hawksworth & Cole (2004) with similarly-sized conidia and pycnidia. However, the pycnidia of *P. physciicola* are larger (80–150 µm, versus 50–100 µm) and the conidia have a smaller l/b ratio (2–2·3, versus 2·4–3·0). That species is known from *Phaeophyscia orbicularis* and *P. sciastra*.

Additional specimens examined (abbreviations as for *P. cladoniicola*). **France:** *Pas-de-Calais*: au S de Boulogne, Dannes, massif du mont Saint-Frieux, on *C. foliacea*, 2001, *Sérusiaux* (LG).—**Luxembourg:** Hoscheid, Molberlay, on *C. foliacea*, 1991, *D* 9806 (h).—**Netherlands:** *Noord-Holland*: SW of Haarlem, NW of Hillegom, S of Zeventig Bunders, on *C. foliacea*, 2001, *van den Boom* 27863 (h).—**Spain:** *Zaragoza*: Camino de Nuévalos a Jaraba, 1 km antes del túnel, on *C. fimbriata*, 2002, *E* 20228 (JACA).

Phoma grumantiana Zhurb. & Diederich sp. nov.

Phoma lichenicola in *Cladoniae* thallis vigens, insignis pycnidiis atris, immersis ad partim erumpescentibus, 50–100 µm diam., cellulis conidiogenis ampulliformibus, *c*. 4–5 µm diam., conidiis (3·2–)4·1–5·2(–6·2) × (1·5–)1·7–2·2(–2·8) µm, l/b (1·3–)2·0–2·8(–3·4).

Type: Svalbard, Spitsbergen, Bünsow Land, NE extremity of Billefjorden near Kapp Napier, 8 km E of Pyramiden settlement, 2 km SW of Nordenskiöldbreen glacier, shore of Norddammen Lake near Brucebyen cabin, 78°38′N, 16°44′E, 10 m alt., mesic to moist dwarf shrub-moss-lichen tundra, on *Cladonia symphycarpia*, 25 July 2003, *M. Zhurbenko* 03232 (LE 210314—holotypus).

(Figs 1, 2, 5 & 6)

Conidiomata pycnidial, immersed in the host thallus or erumpent, black, subspherical to pyriform, ostiolate, 50–100 µm diam.; pycnidial wall brown, darker around the ostiole, pseudoparenchymatous, 10–14 µm thick, composed of several layers of polyhedral cells, outer cells dark brown, 6–8 µm diam., with cell wall *c*. 0·5–1 µm thick, inner cells hyaline, 4–6 µm diam. *Conidiophores* absent. *Conidiogenous cells* lining the inner wall of the pycnidial cavity, short-ampulliform, not proliferating, hyaline, smooth-walled, *c*. 4–5 µm diam., conidiogenesis enteroblastic. *Conidia* abundantly produced, arising singly, oblong to ellipsoid, straight to sometimes slightly bent, rarely narrower at one end, apically rounded, hyaline, simple, smooth-walled, 1–2(–3)-guttulate, generally with a small guttule near each apex, (3·2–)4·1–5·2(–6·2) × (1·5–)

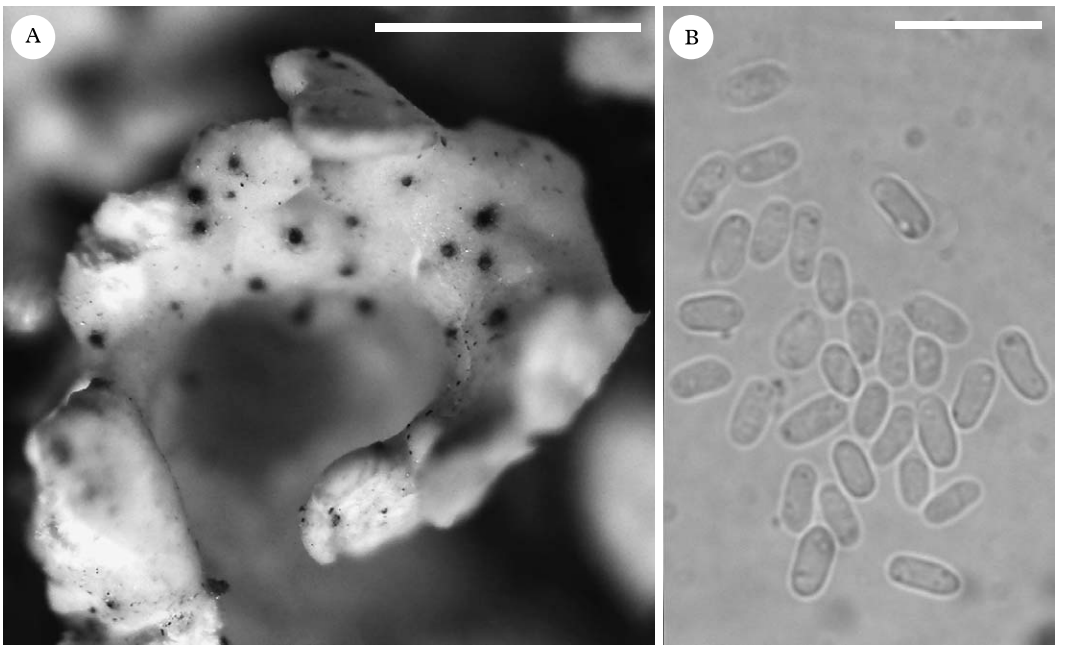

FIG. 5. *Phoma grumantiana*. A, pycnidia on thallus of *Cladonia symphycarpia* (holotype); B, conidia (holotype). Scale bars: A=1 mm; B=10 µm.

1·7–2·2(–2·8) µm, l/b (1·3–)2·0–2·8(–3·4) (*n*=121).

Etymology. The type collection is from "Grumant", a former Russian name of Svalbard.

Distribution and hosts. This species is known from Svalbard and from the USA (Alabama), where it grows on squamules of the primary thallus of *C. mateocyatha* and *C. symphycarpia*. Infected thalli are partly or entirely bleached.

Notes. This species differs from *Phoma cladoniicola* and from *P. foliaceiphila* by the narrower conidia. *Phoma cytospora* (Vouaux) D. Hawksw. (conidia 5–7 × 1·5–2 µm, pycnidia 40–80 µm), a common and widespread species known from a wide range of parmelioid lichens, differs by distinctly longer conidia and much smaller conidiogenous cells, 2–3 × 1–2 µm (Hawksworth 1981). *Phoma dubia* (Linds.) Sacc. & A. Trotter has slightly smaller conidia (3·5–5 × 1·5–2 µm) that are sometimes basally truncate, and thus might belong to a distinct genus, and smaller pycnidia, 25–60 µm. *Phoma peltigerae* and *P. maculiformans* both have much larger pycnidia (>100 µm) and slightly broader conidia (2–2·5 µm).

Additional specimen examined. **USA:** *Alabama*: Marion Co., North Fork Creek of Buttahatchee River at US Hwy 43, *c.* 2 mi N of Hamilton, on *C. mateocyatha*, 1992, *Harris* 28516 (NY, hb. Diederich).

Discussion

Phoma species are very poor in taxonomically useful morphological characters, and we were unable to find any other differences between specimens with short and with long conidia on *Cladonia*. Macroscopically, such specimens look exactly the same, and the response of the host is identical (compare Fig. 3, representing a specimen on *Cladonia foliacea* with short and broad conidia, i.e. *P. cladoniicola*, with Fig. 4, representing a specimen on the same host with long and narrow conidia, i.e. *P. foliaceiphila*). We did not

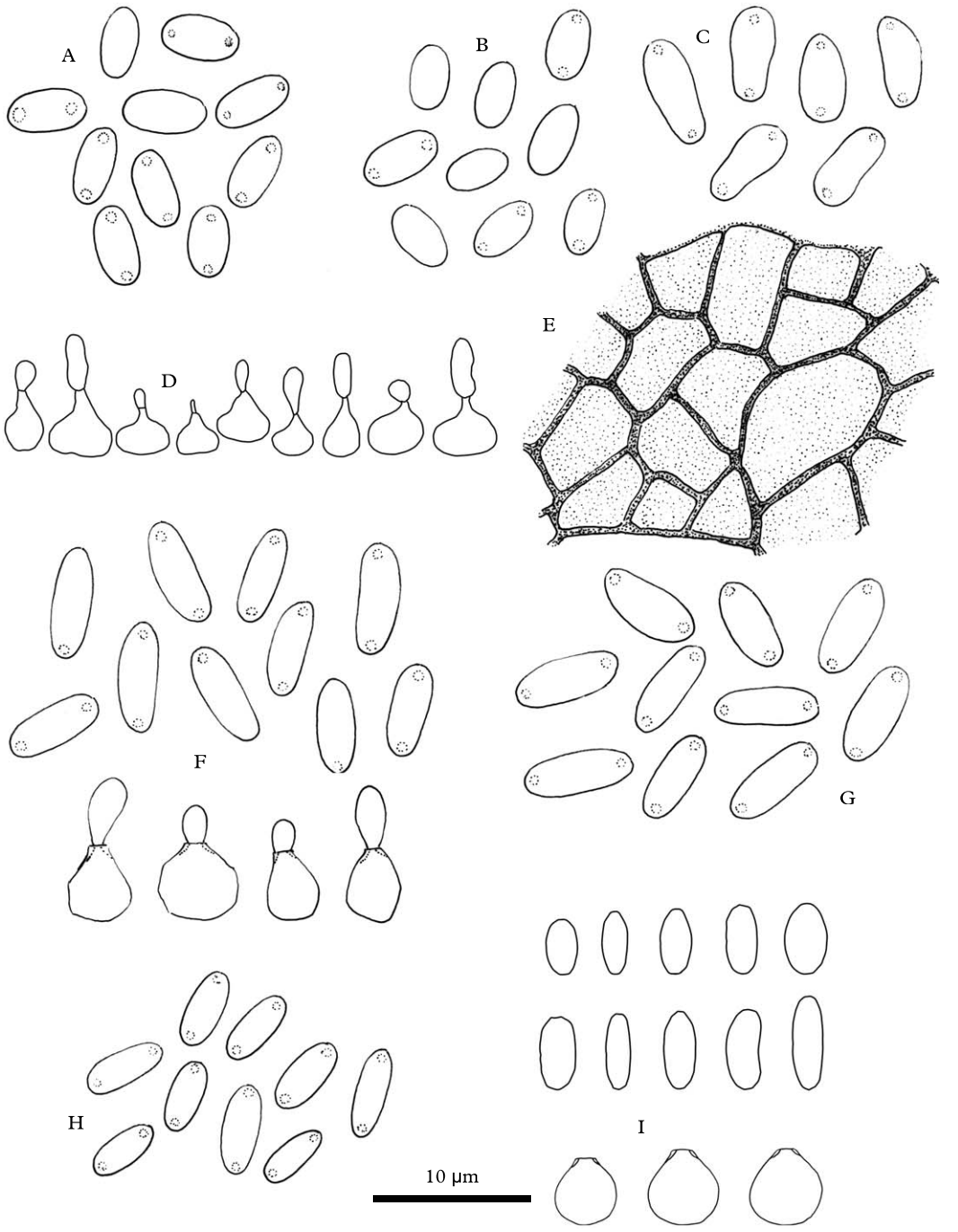

FIG. 6. Surface view of *Phoma* species growing on *Cladonia*, conidiogenous cells, conidia and conidiomatal wall. A–E, *P. cladoniicola* (A, D & E, holotype; B, *Diederich* 16154; C, *Etayo* 20216); F & G, *P. foliaceiphila* (F, *van den Boom* 27863; G, *Sérusiaux*, LG); H & I, *P. grumantiana* (H, *Harris* 28516; I, holotype).

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study the size of the conidiogenous cells statistically, as these were relatively difficult to observe, especially in overmature specimens, and the small number of such cells observed in a good condition was too small for statistical treatment. However, our observations suggest that the conidiogenous cells in all three species are similar in form and size. The pycnidial diameter could not be used for statistical analyses, as an accurate measurement of immersed pycnidia would have required sectioning of 20 pycnidia per specimen, a number that was not available in most specimens. Furthermore, the pycnidial diameter is often variable within one specimen and appears to be correlated with the age or the degree of maturity of the pycnidium.

The three new *Phoma* species should not be confused with other coelomycetes with aseptate, hyaline conidia specialized on *Cladonia* thalli. *Epicladonia* species are easily distinguished by basally truncate, sometimes 1-septate conidia, lacking the typical guttules near both conidial apices. *Bachmanniomyces uncialicola* has lens-shaped to pyriform, often asymmetrical conidia, with often attenuated apices, the base sometimes truncate, and also without the typical guttules of *Phoma* species. *Lichenosticta alcicornaria* has an entirely different conidiogenesis, with long, irregularly branched conidiophores, and lacriform conidia (Hawksworth 1981). *Stromatopogon cladoniae* Diederich & Sérus. produces, in addition to hyaline, aseptate conidia of 3·5–4·5 × 1–1·4 μm, muriform conidia within the same pycnidium (Diederich & Sérusiaux 2003).

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References

Diederich, P. & Sérusiaux, E. (2003) *Stromatopogon cladoniae* sp. nova, a remarkable new lichenicolous coelomycete from Belgium. *Bibliotheca Lichenologica* **86:** 103–106.

Hawksworth, D. L. (1981) The lichenicolous coelomycetes. *Bulletin of the British Museum* (*Natural History*), *Botany Series* **9:** 1–98.

Hawksworth, D. L. & Cole, M. S. (2004) *Phoma fuliginosa* sp. nov., from *Caloplaca trachyphylla* in Nebraska, with a key to the known lichenicolous species. *Lichenologist* **36:** 7–13.

Kocourková, J. (2000) ['1999'] Lichenicolous fungi of the Czech Republic (The first commented checklist). *Acta Musei Nationalis Pragae, Series B, Historia Naturalis* **55:** 59–169.

Zhurbenko, M. P. & Alstrup, V. (2004) Lichenicolous fungi on *Cladonia* mainly from the Arctic. *Symbolae Botanicae Upsalienses* **34**(1)**:** 477–499.

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