

## New lichenicolous fungi growing on *Cladia* in New Zealand

Mikhail P. ZHURBENKO and Raquel PINO-BODAS

**Abstract:** The lichenicolous fungi *Endococcus cladiae* Zhurb. & Pino-Bodas, *Lichenopeltella soiliae* Zhurb. & Pino-Bodas and *Lichenosticta hoegnabbae* Zhurb. & Pino-Bodas are described as new to science from New Zealand growing on podetia of *Cladia* species. In addition to their host selection, *Endococcus cladiae* is distinguished by its ascospore size,  $(9.9\text{--}11.5\text{--}14.1\text{--}15.7) \times (2.7\text{--}3.1\text{--}3.9\text{--}4.6)$   $\mu\text{m}$ , *Lichenopeltella soiliae* by ascomata without ostiolar setae and production of 4-spored asci and 1-septate ascospore, occasionally with three pairs of setulae, and *Lichenosticta hoegnabbae* by comparatively long, bacilliform to fusiform conidia,  $(7.8\text{--}9.1\text{--}10.9\text{--}12.6) \times (1.9\text{--}2.1\text{--}2.3\text{--}2.7)$   $\mu\text{m}$ . *Niesslia cladonicola* is reported for the first time from Australasia on *C. aggregata* in New Zealand. A key to the lichenicolous fungi growing on *Cladia* is provided.

**Key words:** Australia, *Cladoniaceae*, new records, new species

Accepted for publication 10 August 2015

### Introduction

*Cladia* is a genus of lichenized fungi in the family *Cladoniaceae*, mostly distributed in the Southern Hemisphere (Ahti 2000). In modern circumscription the genus comprises 24 species, including the former genera *Heterodea* and *Ramalinora*, 15 of which belong to the *Cladia aggregata* complex (Lumbsch *et al.* 2010; Parmen *et al.* 2010, 2012, 2013). *Cladia aggregata*, the type of the genus, is the most widely distributed species, occurring from South America, South Africa, Australasia and South-East Asia to southern Japan and India. In spite of important recent contributions to the knowledge of lichenicolous fungi in the Southern Hemisphere (e.g., Aptroot 2002; Etayo 2002; Etayo & van den Boom 2006; Etayo & Sancho 2008; Flakus *et al.* 2008; Flakus & Kukwa 2012), the diversity of these fungi in this part of the world is still far from well known. To date, just four species of lichenicolous fungi have been reported from *Cladia* species, viz.

*Echinothecium cladoniae* Keissl. nom. nud. (on *C. aggregata* from Columbia; Etayo 2002), *Lichenonium echinosporum* D. Hawksw. (on *C. muelleri* from Australia; Hawksworth 1977), *Roselliniella heterodeae* Matzer & Hafellner (on *C. muelleri* from Australia; Matzer & Hafellner 1990) and *Pyrenidium actinellum* Nyl. agg. (on *C. aggregata* from Columbia; Etayo 2002). In the course of a revision of *Cladia* specimens in the herbarium of the University of Helsinki, a few new species of lichenicolous fungi were found. The new data, along with a key to the lichenicolous fungi occurring on *Cladia*, are presented here.

### Materials and Methods

This study is based on 14 specimens of lichenicolous fungi found among 257 viewed specimens of *Cladia* species. Most of the specimens examined were collected by Professor Soili Stenroos and Dr Filip Högnabba during their field trip to New Zealand in 2010. The material was examined and photographed using Zeiss microscopes Stemi 2000-CS and Axio Imager A1 equipped with Nomarski differential interference contrast optics. Microscopic examination was carried out with material mounted in water, 10% KOH (K), Lugol's iodine, directly (I) or after a KOH pre-treatment (K/I), or phloxin; considerable variation in the size of the ascospores and conidia in these media was not observed. The length, breadth and length/breadth ratio (l/b) of asci, ascospores and conidia are given (when  $n > 10$ ) as:  $(\text{min--})(\bar{x} - \text{SD}) - (\bar{x} + \text{SD})(\text{--max})$ , where min and max are the extreme values,  $\bar{x}$  the arithmetic mean, and SD

M. P. Zhurbenko: Laboratory of the Systematics and Geography of Fungi, Komarov Botanical Institute, Russian Academy of Sciences, Professor Popov 2, St.-Petersburg, 197376, Russia. Email: zhurb58@gmail.com

R. Pino-Bodas: Botanical Museum, Finnish Museum of Natural History, P.O. Box 7, FI-00014 University of Helsinki, Finland.

the corresponding standard deviation. Specimens examined are housed in the herbaria H or LE.

### The Taxa

#### **Endococcus cladiae** Zhurb. & Pino-Bodas sp. nov.

Mycobank No.: MB 813735

Lichenicolous fungus. Ascomata perithecioid, (75–)85–100 (–115)  $\mu\text{m}$  diam., protruding up to finally semi-immersed. Hamathecium of aseptate, brown external periphyses, 8–16  $\times$  2.0–3.5  $\mu\text{m}$ . Asci 32–50  $\times$  7.5–11.0  $\mu\text{m}$ , 8-spored. Ascospores evenly light brown, very narrowly obovate, occasionally almost fusiform or clavate with thinner lower cell, (9.9–)11.5–14.1 (–15.7)  $\times$  (2.7–)3.1–3.9 (–4.6)  $\mu\text{m}$ , 1-septate, smooth-walled, non-halonate, diagonally uni- to biseriolate in an ascus. Similar to *Endococcus parentus*, which mainly differs in its host selection (*Pseudocyphellaria* vs. *Cladia*), and in having (0–)1-septate, on average slightly shorter, ascospores.

Type: New Zealand, Stewart Island, Port Pegasus, North Arm, 47°10'S, 167°41'E, track margin at a secondary bog on a burnt area in lowland rainforest, on *Cladia sullivanii* (podetia), 24 March 1927, G. E. & G. Du Rietz 2205:3a (H—holotype).

(Fig. 1)

*Vegetative hyphae* scarce, immersed, pale brown, 1.1–2.5  $\mu\text{m}$  diam.

*Ascomata* perithecioid, black, glossy, subglobose to pyriform, often conical above, (75–)85–100 (–115)  $\mu\text{m}$  diam. ( $n = 33$ ), with pore 10–15  $\mu\text{m}$  across, erumpent, protruding in the upper part to finally semi-immersed, dispersed; wall dark reddish brown throughout, pigmentation even, amorphous, K–, in surface view of *textura angularis*, composed of cells 3.3–8.8  $\times$  2.8–6.5  $\mu\text{m}$ , in section 10–15  $\mu\text{m}$  thick, composed of 3–4 layers of radially compressed thick-walled cells. *Interascal gel* I+ red, K/I+ blue. *Hamathecium* not observed except aseptate brown external filaments 8–16  $\times$  2.0–3.5  $\mu\text{m}$  around the ostiole, which correspond to external periphyses *sensu* Etayo & Sancho (2008: 88, 90). *Asci* subcylindrical to narrowly obclavate, wall apically sometimes markedly thickened, occasionally with small indentation *c.* 1  $\mu\text{m}$  tall, 32–50  $\times$  7.5–11.0  $\mu\text{m}$  ( $n = 8$ , in I), 8-spored. *Ascospores* evenly light brown, very narrowly obovate, occasionally almost fusiform or clavate (narrowly obskittle-shaped) with thinner, occasionally markedly thinner, lower cell,



FIG. 1. *Endococcus cladiae* (holotype). Ascospores in K. Scale = 10  $\mu\text{m}$ . In colour online.

straight to slightly curved, ends rounded to occasionally rather acute, (9.9–)11.5–14.1 (–15.7)  $\times$  (2.7–)3.1–3.9 (–4.6)  $\mu\text{m}$ ,  $l/b = (2.2–)3.2–4.2 (–5.0)$  ( $n = 88$ , in water, I or K/I), 1-septate, not or sometimes constricted at the septum, smooth-walled, non-halonate, usually with 2 (–3) large guttules in each cell, diagonally uni- to biseriolate in an ascus.

*Conidiomata* not observed.

*Notes.* The new species fits the *Endococcus* concept *sensu* Kainz & Triebel (2004), though the presence of brown external periphyses was not mentioned by these authors. However, such periphyses are described, for example, in *Endococcus pallidosporus* Etayo and *E. parentus* Etayo (Etayo & Sancho 2008). Among the other species of the genus, *Endococcus cladiae* is most

similar to *E. alectoriae* (D. Hawksw.) D. Hawksw. (on *Alectoria*), *E. pallidosporus* (on *Pseudocyphellaria*), *E. parentus* (on *Pseudocyphellaria*) and *E. ramalinarius* (Linds.) D. Hawksw. (on *Ramalina*). Whereas almost all species of *Endococcus* are confined to a specific host genus (Lawrey & Diederich 2015), none of them have been reported from members of *Cladoniaceae*, where *Cladia* belongs. Additionally, *Endococcus alectoriae* differs in having comparatively much wider ascospores (Hawksworth 1971: Fig. 1), *E. pallidosporus* has K/I+ red interascal gel and shorter ascospores, (8.0–)9.0–11.0(–12.5) × 3.0–3.5(–4.0) μm (Etayo & Sancho 2008), *E. parentus* has on average slightly shorter ascospores, (8.5–)9.0–14.0(–15.0) × 3–4 μm (Etayo & Sancho 2008), and *E. ramalinarius* has slightly shorter and wider ascospores, 10–13 × 4.0–4.5 μm (Hawksworth 1976: Fig. 3C). Among the pyrenocarpous cladoniicolous fungi, the most similar to *Endococcus cladiae* is *Stigmidium cladonicola* Zhurb. & Diederich, which also has narrowly obskittle-shaped ascospores of similar size, (9.0–)11.5–15.0(–16.5) × 3.0–4.0(–5.0) μm. However, it clearly differs from the latter in often having sessile and smaller ascomata 30–80 μm diam., I–, K/I– hymenial gel and colourless ascospores (Zhurbenko & Diederich 2008).

**Distribution and hosts.** Known from three localities in New Zealand, growing on healthy-looking and darkened parts of *Cladia retipora* and *C. sullivanii* podetia. An adverse effect on the host was not observed.

**Additional specimens examined** (both on podetia of *Cladia retipora*). **New Zealand:** *South Island:* west-facing roadside near Ferguson Science Reserve, Highway 6 south of Westport, 42°58.9'S, 42°41.4'E, 0–20 m, 1999, S. Hammer 7524a (H); Southern Lakes, secus viam 9 km ad australem versus ad Te Anau, 45°37'06.0"S, 167°35'48.0"E, 210 m, 27 i 1984, M. E. Hale (H).

### **Lichenopeltella soiliae Zhurb. & Pino-Bodas sp. nov.**

Mycobank No.: MB 813736

Lichenicolous fungus. Ascomata catathecioid, broadly conical, sometimes truncated above, ostiolar region often raised and forming a collar, without setae, (30–)46–62

(–70) μm diam. Asci ellipsoid, ovoid to narrowly pyriform, (18.8–)20.6–26.2(–30.0) × (9.0–)9.7–11.7(–12.5) μm, 4-spored. Ascospores oblong, fusiform or very narrowly clavate, (11.2–)12.0–13.4(–14.5) × (2.8–)2.9–3.5(–4.0) μm, 1-septate, usually with 4 large guttules, rarely with 3 pairs of setulae. Similar to *Lichenopeltella minuta*, which mainly differs in its host selection (*Omphalina* vs. *Cladia*) and in having ascospores permanently without setulae.

**Type:** New Zealand, South Island, Southland, Wilderness Scientific Reserve, 6 km E of crossing to Manapouri on State Highway 94, 45°31'55.2"S, 167°51'21.6"E, open shrubland with *Halocarpus bidwillii*, on *Cladia aggregata* s. lat. (podetia), 6 May 2010, S. Stenroos 5778a (H—holotype; LE 264438—isotype; accompanied by *Niesslia cladoniicola*).

(Fig. 2)

**Ascomata** catathecioid, medium to dark brown, usually much darker (often almost black) around the ostiole (better seen in wet state), glossy, broadly conical, sometimes truncated above, with central ostiole mainly *c.* 10 μm diam., sometimes gaping up to 30 μm across, ostiolar region often raised and forming a collar, without setae, (30–)46–62(–70) μm diam. (*n* = 75), ascomatal margin entire, somewhat sinuate; upper wall medium to dark brown around the ostiole, pale to medium brown at the periphery, K+ grey-olive, one cell thick, composed of radially-arranged more or less rectangular or trapezoidal cells which are smaller, darker, more equilateral, and thick-walled around the ostiole, sometimes associated with brown branched hyphae 3–5 μm thick; lower wall similar in structure to the upper wall; ascomata usually slightly immersed in the cortex of the host thallus, dispersed, but occasionally adjacent. **Paraphyses** not observed. **Asci** ellipsoid, ovoid to narrowly pyriform, apical cap conspicuously thickened, foot not seen, (18.8–)20.6–26.2(–30.0) × (9.0–)9.7–11.7(–12.5) μm (*n* = 18, in water, K or K/I), I–, K/I–, 4-spored. **Ascospores** hyaline, oblong, fusiform or very narrowly clavate (slightly wider above), rounded at the apices, (11.2–)12.0–13.4(–14.5) × (2.8–)2.9–3.5(–4.0) μm, l/b = (3.3–)3.6–4.2(–4.8) (*n* = 43, in water, K or K/I), 1-septate, homopolar, occasionally slightly constricted at the septum, smooth-walled, non-halonate, usually with 4 large guttules, rarely with 3 pairs of setulae (seen in 5% of ascospores).

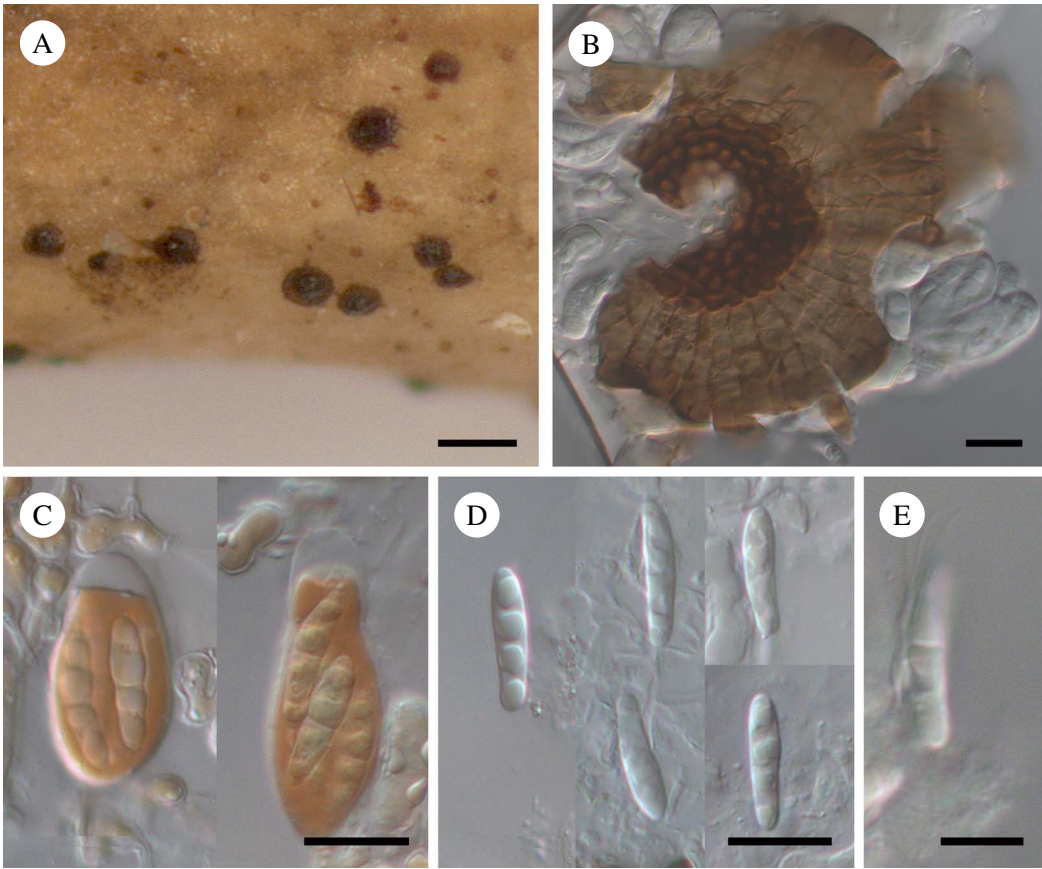


FIG. 2. *Lichenopeltella soiliae* (holotype). A, habitus; B, squashed ascoma in water (surface view); C, asci in K/I; D, ascospores in K; E, ascospore with 3 pairs of setulae in water. Scales: A = 100  $\mu\text{m}$ ; B–D = 10  $\mu\text{m}$ ; E = 5  $\mu\text{m}$ . In colour online.

**Etymology.** The species is named after the Finnish lichenologist Professor Soili Stenroos who collected the type.

**Notes.** Most species of *Lichenopeltella* are known from a specific host lichen genus, and none of them have been reported on *Cladia*. Three species of the genus have been reported from members of *Cladoniaceae*, viz. *L. cladoniarum* E. S. Hansen & Alstrup, *L. rangiferina* Brackel and *L. uncialicola* Brackel, all believed to be confined to species of *Cladonia*. All of these clearly differ from *Lichenopeltella soiliae*: *L. cladoniarum* has 8-spored asci and larger ascospores, 18–21  $\times$  5–6  $\mu\text{m}$ , without setulae (Hansen & Alstrup 1995); *L. rangiferina* has ostiolar

setae and (1–)3-septate, slightly longer ascospores, (13.0–)13.9–15.5(–16.0)  $\times$  (3.0–)3.3–4.0  $\mu\text{m}$  (Brackel 2011); *L. uncialicola* has ostiolar setae and ascospores without setulae (Brackel 2010). Among the other species of the genus, *Lichenopeltella soiliae* seems to be morpho-anatomically closest to *L. minuta* R. Sant., found on the basidiolichen *Marchandiomphalina foliacea* in South America (Santesson 1989). It differs from the latter by the ascospores which occasionally bear setulae and by a different host selection.

**Distribution and host.** Known from five localities in Australia and New Zealand, growing on healthy-looking and also darkened parts of *Cladia aggregata* s. lat. podetia. An

adverse effect on the host not observed, even with abundant development of the fungus.

*Additional specimens examined* (all on podetia of *Cladia aggregata* s. lat.). **Australia:** *New South Wales:* Great Dividing Range, 10 km ESE of Michelago, S. Tinderry Pic, 35°45'S, 148°18'E, 1250 m, dry sclerophyll forest, 1998, S. Hammer 7008a (H).—**New Zealand:** *South Island:* Southland, Wilderness Scientific Reserve, 6 km E of crossing to Manapouri on State Highway 94, 45°31'55.2"S, 167°51'21.6"E, open shrubland with *Halocarpus bidwillii*, 2010, S. Stenroos 5772a, 5774a, 5776a (all in H). *North Island:* Wellington, Tararau Forest Park, track from Kiriwhakapapa entrance to Blue Range Hut, before crossing of Cow Creek Hut and Blue Range Hut tracks, 40°47'52.8"–40°48'28.8"S, 175°32'45.6"E, 310–930 m, old-growth broadleaf forest, 2010, F. Högnabba 1864a (H, LE 264268); Manawatu-Wanganui, Tongariro National Park, Mt. Ruapehu, E of Whakapapa Village, Upper Taranaki Fall Track and Tama Lakes Tramping Track, about 500 m E of Taranaki Falls, 39°11'52.8"–39°12'00.0"S, 175°32'34.8"–175°34'12.0"E, 1140–1240 m, shrubland, 2010, F. Högnabba 1932a (H; accompanied by *Lichenosticta hoegnabbae*).

### *Lichenosticta hoegnabbae* Zhurb. & Pino-Bodas sp. nov.

Mycobank No.: MB 813737

Lichenicolous fungus. Conidiomata pycnidial, blackish (dry) or brown with dark rim around ostiole (wet), 100–150(–200) µm diam., first immersed then up to half-erumpent. Conidiophores multi-septate, flexuous, branched, c. 2.0–2.5 µm diam. Conidiogenous cells lageniform or subcylindrical, mainly 6.5–11.5 × 1.5–2.5 µm, distinct collarette and proliferations not observed. Conidia bacilliform to fusiform, straight to slightly curved, rounded at the apex and attenuated and truncated at the base, (7.8–)9.1–10.9(–12.6) × (1.9–)2.1–2.3(–2.7) µm. Similar to *Lichenosticta alcicorniaria*, which mainly differs in its host selection (*Cladonia* vs. *Cladia*), and in having lacrimiform and broader conidia of (6.0–)6.5–10.0(–11.0) × (2.0–)3.0–4.5(–6.0) µm.

Type: New Zealand, North Island, Manawatu-Wanganui, Tongariro National Park, Mt. Ruapehu, E of Whakapapa Village, Upper Taranaki Fall Track and Tama Lakes Tramping Track to c. 500 m E of Taranaki Falls, 39°11'52.8"–39°12'00.0"S, 175°32'34.8"–175°34'12.0"E, c. 1200 m elev., shrubland, on *Cladia aggregata* s. lat. (podetia), 21 May 2010, F. Högnabba 1932a (H—holotype; accompanied by *Lichenopeltella soiliae*).

(Fig. 3)

*Conidiomata* pycnidial, blackish (dry) or brown with dark rim around ostiole (wet), subglobose to broadly pyriform, sometimes

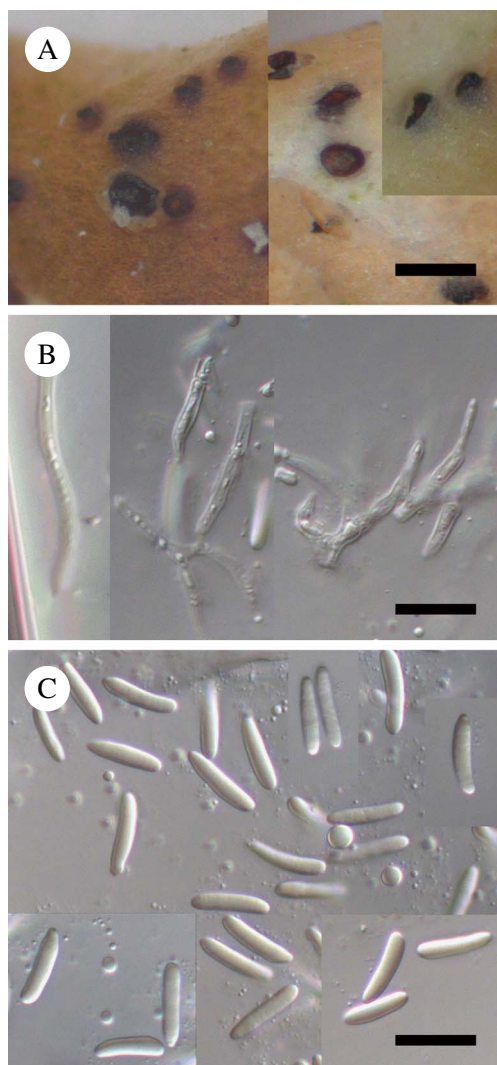


FIG. 3. *Lichenosticta hoegnabbae* (holotype). A, habitus; B, conidiophores and conidiogenous cells in water; C, conidia in water. Scales: A = 200 µm; B & C = 10 µm. In colour online.

indistinctly papillate, 100–150(–200) µm diam., ostiolate, sometimes opening by irregular aperture up to 80 µm across, first immersed then up to half-erumpent, arising singly; wall dark brown around the ostiole, otherwise medium brown throughout, K+ olive-brown, in surface view of *textura epidermoidea* or partly of *textura angularis*. *Conidiophores* hyaline, multi-septate, flexuous,

branched, *c.* 2.0–2.5 µm diam., lining the pycnidial cavity. *Conidiogenous cells* hyaline, enteroblastic, phialidic, integrated into chains, lageniform or subcylindrical, mainly 6.5–11.5 × 1.5–2.5 µm, distinct collarete and proliferations not observed. *Conidia* hyaline, acro-pleurogenous, bacilliform to fusiform, straight to slightly curved, rounded at the apex and attenuated and truncated at the base, (7.8–)9.1–10.9(–12.6) × (1.9–)2.1–2.3(–2.7) µm, l/b = (3.4–)4.1–5.1(–6.0) (*n* = 122, in water, K or phloxin), aseptate, smooth-walled, usually with 2–6 guttules clearly seen in K, excretion in a gelatinous drop not observed.

*Etymology.* The species is named after the Finnish lichenologist Dr Filip Högnabba who collected the holotype.

*Notes.* The coelomycetous lichenicolous genus *Lichenosticta* Zopf so far includes four species, *viz.* *Lichenosticta alcicorniaria* (Linds.) D. Hawksw. (on species of *Cladonia*), *L. dombrowskae* Zhurb. (on *Stereocaulon*), *L. jurgae* Kukwa & Flakus (on *Lecanora*), and *L. lecanorae* (Vouaux) Brackel & Zhurb. comb. ined. (on *Lecanora*). All of these clearly differ from *L. hoegnabbae* in the shape and size of conidia, which are lacrimiform, (6.0–)6.5–10.0(–11.0) × (2.0–)3.0–4.5(–6.0) µm in *L. alcicorniaria* (Hawksworth 1981); narrowly to broadly ellipsoid, occasionally almost oblong or circular, (4.5–)6.5–8.5(–11.0) × (3.0–)4.0–4.5(–5.5) µm in *L. dombrowskae* (Zhurbenko 2010); broadly ellipsoid to oblong, rarely lacrimiform or pyriform, (4–)5–6(–8) × (2.0–)2.5–3.0(–3.5) µm in *L. jurgae* (Flakus & Kukwa 2012); ellipsoid to oblong, (2.7–)3.1–4.3(–5.5) × (1.5–)1.6–2.0(–2.2) µm in *L. lecanorae* (M. P. Zhurbenko, A. Frisch. Y. Ohmura & G. Thor, unpublished data).

*Distribution and host.* Known from two localities in New Zealand, growing on podetia of *Cladia aggregata* s. lat. An adverse effect on the host not observed.

*Additional specimen examined.* **New Zealand:** South Island: Wilderness Scientific Reserve, 6 km E of crossing to Manapouri on State Highway 94, open shrubland with *Halocarpus bidwillii*, 45°31'55.2"S, 167°51'21.6"E, on *Cladia aggregata* s. lat. (podetia), 2010, S. Stenroos 5774b (H).

### **Niesslia cladoniicola D. Hawksw. & W. Gams**

*Notes.* New to Australasian region. *Cladia* is a new host genus.

*Specimens examined* (both on podetia of *Cladia aggregata* s. lat.). **New Zealand:** South Island: Southland, Kepler Track, outside of the Dock Bay entry to Fiordland National Park, 45°26'31.2"S, 167°41'16.8"E, open mossy and grassy seepage, 2010, S. Stenroos 5802a (H); Wilderness Scientific Reserve, 6 km E of crossing to Manapouri on State Highway 94, 45°31'55.2"S, 167°51'21.6"E, open shrubland with *Halocarpus bidwillii*, 2010, S. Stenroos 5778a (H; accompanied by *Lichenopeltella soiliae*).

### **Discussion**

A total of eight species of lichenicolous fungi are currently known to grow on species of *Cladia*. Four of them have also been reported on other host genera: *Echinothecium cladoniae*, *Lichenocoenium echinosporum* and *Niesslia cladoniicola* grow on species of *Cladonia* in the same family *Cladoniaceae* (Hawksworth 1975; Suija *et al.* 2010; Brackel 2014), and *Pyrenidium actinellum* agg., probably representing a group of species (P. Diederich, pers. comm.), is known on many non-related host genera.

### **Key to the lichenicolous fungi occurring on *Cladia***

Species of lichenicolous fungi also known on other host genera are given in parentheses.

- 1 Conidia produced in pycnidial conidiomata, aseptate . . . . . 2  
Ascospores produced in catathecioid or perithecioid ascomata, 0–4-septate . . . . . 3

- 2(1) Conidia hyaline, bacilliform to fusiform, wall smooth, (7.8–)9.1–10.9(–12.6) × (1.9–)2.1–2.3(–2.7) µm . . . . . **Lichenosticta hoegnabbae**  
 Conidia brown, subglobose to irregularly obpyriform, wall echinulate, 4.0–5.5 × 3–4 µm. Lit.: Hawksworth (1977) . . . . . (**Lichenonium echinosporum**)
- 3(1) Ascomata catathecioid, asci 4-spored, ascospores, (11.2–)12.0–13.4(–14.5) × (2.8–) 2.9–3.5(–4.0) µm, 1-septate, rarely with 3 pairs of setulae . . . . . **Lichenopeltella soiliae**  
 Ascomata perithecioid . . . . . 4
- 4(3) Ascomata setose, ascospores hyaline or pale brown . . . . . 5  
 Ascomata without setae, ascospores brown . . . . . 6
- 5(4) Ascomata mainly 100–130 µm diam., setae usually more than 25 µm long, always macroscopically conspicuous, subulate, with acute apex, often concolorous with the ascomatal wall, ascospores 1-septate, permanently hyaline and smooth-walled. Original data . . . . . (**Niesslia cladoniicola**)  
 Ascomata mainly 60–80 µm diam., setae usually up to 25 µm long, sometimes much reduced and macroscopically inconspicuous, not subulate, with more or less rounded apex, much darker than ascomatal wall, ascospores (0–)1-septate, hyaline and smooth-walled or occasionally pale brown and granulose. Original data . . . . . (**Echinothecium cladoniae**)
- 6(4) Interascal filaments absent, ascospores 1-septate, (9.9–)11.5–14.1(–15.7) × (2.7–) 3.1–3.9(–4.6) µm . . . . . **Endococcus cladiae**  
 Interascal filaments present . . . . . 7
- 7(6) Ascomata 200–400 µm diam., wall brown throughout, interascal filaments not branched and anastomosed, ascospores 1(–2)-septate, hyaline then orange-brown, (18–)19–25(–27) × (8–)9–13 µm. Lit.: Matzer & Hafellner (1990) . . . . . **Roselliniella heterodeae**  
 Ascomata 150–200 µm diam., wall bluish-greenish near ostiole otherwise brown, interascal filaments abundantly branched and anastomosed, ascospores (2–)3(–4)-septate, brown, 20–25(–30) × 7–10 µm. Lit.: Hafellner & Mayrhofer (2007), Navarro-Rosinés & Roux (2007) . . . . . (**Pyrenidium actinellum agg.**)

The Department of Conservation of New Zealand is thanked for the collection permits granted to Prof. S. Stenroos and Dr F. Högnabba in 2010. We are indebted to Paul Diederich and Teuvo Ahti for their valuable comments on the manuscript, to Rod Seppelt for providing details of collecting localities in New Zealand and to Paul Lockley who kindly revised the English. Mikhail P. Zhurbenko carried out this research project no. 01201255604 funded by Komarov Botanical Institute Russian Academy of Sciences. Raquel Pino-Bodas received funding from the European Union's Seventh Framework Programme (FP7/2007–2013) under grant agreement no. PIEF-GA-2013-625653.

## REFERENCES

- Ahti, T. (2000) *Cladoniaceae. Flora Neotropica Monograph 78*: 1–363.
- Aptroot, A. (2002) New and interesting lichens and lichenicolous fungi in Brazil. *Fungal Diversity* **9**: 15–45.
- Brackel, W. von. (2010) Some lichenicolous fungi and lichens from Iceland, including *Lichenopeltella uncialicola* sp. nov. *Herzogia* **23**: 93–109.
- Brackel, W. von. (2011) *Lichenopeltella rangiferinae* sp. nov. and some other lichenicolous fungi from Iceland. *Acta Botanica Islandica* **15**: 51–60.
- Brackel, W. von. (2014) Kommentierter Katalog der flechtenbewohnenden Pilze Bayerns. *Bibliotheca Lichenologica* **109**: 1–476.

- Etayo, J. (2002) Aportación al conocimiento de los hongos liquenícolas de Colombia. *Bibliotheca Lichenologica* **84**: 1–154.
- Etayo, J. & Sancho, L. G. (2008) Hongos liquenícolas del Sur de Sudamérica, especialmente de Isla Navarino (Chile). *Bibliotheca Lichenologica* **98**: 1–302.
- Etayo, J. & van den Boom, P. P. G. (2006) Some lichenicolous fungi from Guatemala, with the description of a new species. *Herzogia* **19**: 191–197.
- Flakus, A. & Kukwa, M. (2012) New species of lichenicolous fungi from Bolivia. *Lichenologist* **44**: 469–477.
- Flakus, A., Ahti, T., Kukwa, M. & Wilk, K. (2008) New and interesting records of *Cladonia* and their lichenicolous fungi from Andean cloud forest in Bolivia. *Annales Botanici Fennici* **45**: 448–454.
- Hafellner, J. & Mayrhofer, H. (2007) A contribution to the knowledge of lichenicolous fungi and lichens occurring in New Zealand. *Bibliotheca Lichenologica* **95**: 225–266.
- Hansen, E. S. & Alstrup, V. (1995) The lichenicolous fungi on *Cladonia* subgenus *Cladina* in Greenland. *Graphis Scripta* **7**: 33–38.
- Hawksworth, D. L. (1971) *Tichothecium alectoriae* sp. nov. on *Alectoria ochroleuca*. *Transactions of the British Mycological Society* **57**: 338–339.
- Hawksworth, D. L. (1975) Notes on British lichenicolous fungi, I. *Kew Bulletin* **30**: 183–203.
- Hawksworth, D. L. (1976) New and interesting microfungi from Slapton, South Devonshire: Deuteromycotina III. *Transactions of the British Mycological Society* **67**: 51–59.
- Hawksworth, D. L. (1977) Taxonomic and biological observations on the genus *Licheniconium* (*Sphaeropsidales*). *Persoonia* **9**: 159–198.
- Hawksworth, D. L. (1981) The lichenicolous Coelomycetes. *Bulletin of the British Museum (Natural History), Botany Series* **9**: 1–98.
- Kainz, C. & Triebel, D. (2004) *Endococcus*. In *Lichen Flora of the Greater Sonoran Desert Region, Vol. 2* (T. H. Nash III, B. D. Ryan, P. Diederich, C. Gries & F. Bungartz, eds): 648–651. Tempe, Arizona: Lichens Unlimited, Arizona State University.
- Lawrey, J. D. & Diederich, P. (2015) *Lichenicolous fungi – worldwide checklist, including isolated cultures and sequences*. Available at: <http://www.lichenicolous.net> (accessed 3.6.2015).
- Lumbsch, H. T., Parmen, S., Rangsiruji, A. & Elix, J. A. (2010) Phenotypic disparity and adaptive radiation in the genus *Cladia* (*Lecanorales*, Ascomycota). *Australian Systematic Botany* **23**: 239–247.
- Matzer, M. & Hafellner, J. (1990) Eine Revision der lichenicolen Arten der Sammelgattung *Rosellinia* (Ascomycetes). *Bibliotheca Lichenologica* **37**: 1–138.
- Navarro-Rosinés, P. & Roux, C. (2007) *Pyrenidium*. In *Lichen Flora of the Greater Sonoran Desert Region, Vol. 3* (T. H. Nash III, C. Gries & F. Bungartz, eds): 404–405. Tempe, Arizona: Lichens Unlimited, Arizona State University.
- Parmen, S., Rangsiruji, A., Mongkolsuk, P., Boonpragob, K., Elix, J. A. & Lumbsch, H. T. (2010) Morphological disparity in *Cladoniaceae*: the foliose genus *Heterodea* evolved from fruticose *Cladia* species (*Lecanorales*, lichenized Ascomycota). *Taxon* **59**: 841–849.
- Parmen, S., Rangsiruji, A., Mongkolsuk, P., Boonpragob, K., Nutakki, A. & Lumbsch, H. T. (2012) Using phylogenetic and coalescent methods to understand the species diversity in the *Cladia aggregata* complex (Ascomycota, *Lecanorales*). *PloS One* **7**: e52245.
- Parmen, S., Leavitt, S. D., Rangsiruji, A. & Lumbsch, H. T. (2013) Identification of species in the *Cladia aggregata* group using DNA barcoding (Ascomycota: *Lecanorales*). *Phytotaxa* **115**: 1–14.
- Santesson, R. (1989) Parasymbiotic fungi on the lichen-forming basidiomycete *Omphalina foliacea*. *Nordic Journal of Botany* **9**: 97–99.
- Suija, A., Czarnota, P., Himelbrant, D., Kowalewska, A., Kukwa, M., Kuznetsova, E., Leppik, E., Motiejūnaitė, J., Piterāns, A., Schiefelbein, U., et al. (2010) The lichen biota of three nature reserves in island Saaremaa, Estonia. *Folia Cryptogamica Estonica* **47**: 85–96.
- Zhurbenko, M. P. (2010) Lichenicolous fungi and lichens growing on *Stereocaulon* from the Holarctic, with a key to the known species. *Opuscula Philolichenum* **8**: 9–39.
- Zhurbenko, M. P. & Diederich, P. (2008) *Stigmidium cladonicola*, a new lichenicolous fungus from Northern Ural, Russia. *Graphis Scripta* **20**: 13–18.