

## Three new species of *Lichenopeltella* (Microthyriaceae, Ascomycota) from northwest North America

by

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With 4 figures

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**Abstract:** Three new species of *Lichenopeltella* are described based on recent floristic work on lichens and lichenicolous fungi in the Pacific Northwest, bringing the total number of species recognized in North America to six. All three newly described species grow on epiphytic crustose lichens: *Lichenopeltella biatorae* grows on *Biatora flavopunctata* (British Columbia, Washington), *L. arctomiae* on *Arctomia delicatula* (Montana) and *L. leprosulae* on *Myochroidea leprosula* (British Columbia). The new species are compared with the morphologically most similar species of the genus, and a key to all known species of *Lichenopeltella* in North America is provided.

**Key words:** *Arctomia*, *Biatora*, Canada, key, *Myochroidea*, lichenicolous fungi, Pacific Northwest, U.S.A.

### Introduction

The genus *Lichenopeltella* is a widespread member of the family Microthyriaceae, which comprises highly specialized species, both saprophytic and lichenicolous (Jones & Hawksworth 2001). Most of the core species of *Lichenopeltella* were originally described under the generic names of *Actinopeltis*, *Micropeltis* or *Trichothyrina*, with the latter two now considered to be synonyms of *Lichenopeltella* (Santesson 1989, 1991). The presence of numerous epiphytic species described within these

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three genera deserves further study (Cole & Hawksworth 2002) as it is likely that many of them actually belong to *Lichenopeltella*. Diederich (in Aptroot et al. 1997) described 11 new species in *Lichenopeltella* and provided a key to all 26 lichenicolous species known at the time. Since then, an additional seven new species have been described or recombined into the genus: *Lichenopeltella quinquecladiopsis* (E.B.G.Jones, Sivichai & Hywel-Jones) E.B.G.Jones & D.Hawksw., a saprophyte on submerged twigs in streams in Thailand (Jones et al. 1999, Jones & Hawksworth 2001), *L. nigroannulata* (J.Webster) D.Sierra, a saprophyte on decaying plants (Sierra 2006) and five lichenicolous species, namely *L. heterodermiicola* M.S.Cole & D.Hawksw. from Arkansas (U.S.A.) and Ecuador on *Heterodermia speciosa* and *H. lutescens* (Cole & Hawksworth 2002, Diederich 2003), *L. coppinsii* Earland-Bennet & D.Hawksw. from England on *Verrucaria muralis* (Earland-Bennet & Hawksworth 1999), *L. thelidii* Diederich from Luxembourg on *Thelidium minutulum* (Molitor & Diederich 1997), *L. hydrophila* R.Sant. from Luxembourg, on *Verrucaria* sp. (Santesson 2001), *L. thamnoliae* R.Sant. from the Andes on *Thamnolia vermicularis* (Santesson 1998). The last two taxa were also keyed out in Aptroot et al. (1997).

As part of recent intensified surveys of crustose lichens and their lichenicolous fungi in northwest North America, we discovered three new species of *Lichenopeltella* on three species of epiphytic microlichens: *Arctomia delicatula*, *Biatora flavopunctata* and *Myochroidea leprosula*. We here describe them and provide a key to all currently known North American species. A wider revision of the genus is necessary but is beyond the scope of the present paper; future research should be done in this direction. The addition of our three species brings to six the number of known *Lichenopeltella* species in North America, of which five are found in the Pacific Northwest. *Lichenopeltella thamnoliae* R.Sant., included on the North American checklist by Esslinger (2007), should be deleted, as all records to date are from South America (Diederich 2003).

## Material and methods

Macroscopic characters were studied using a Zeiss Stemi SV11 stereoscope. Microscopic characters were studied in hand sections mounted in water, 10% KOH (K), Lugol's iodine solution (I) or lactophenol cotton blue, using a Zeiss Axioskop2plus microscope. All measurements were made in water. For ascospore size, size ranges were calculated after manually rejecting 10% of the highest and 10% of the lowest measured values; ranges are provided as lowest value-*average*-highest value (extreme measured values are in parentheses). Pictures were taken with a Canon PowerShot G2 digital camera fitted to the microscope and dissecting scope.

## Taxonomy

### *Lichenopeltella arctomiae* Pérez-Ortega & T.Sprib. sp. nov.

*Lichenopeltella insignis* catatheciis 85–155 µm diam., 65–115 µm altis, setis nullis, ascis 4-sporis, 35–46 × 10–14 µm et ascospori 17–18.6–20(–22) × (4.5–)5–5.9–6.5(–7) µm, cum 3 pari setularum.

TYPE: U.S.A.: Montana, Sanders Co., Kootenai National Forest, East Fork Bull River, St. Paul Lake trailhead, 48°07'18"N 115°42'00"W, 895 m elev., on *Arctomia delicatula* on bark of *Thuja plicata*, 28 July 2006, Pérez-Ortega & Spribille (GZU, holotype).

Ascomata lichenicolous on *Arctomia delicatula* (Fig 1A), catathecioid, 85–155 µm wide (Fig. 1B), arising singly or in groups, conical, 65–115 µm high, dark brown to black; ascomatal layer one cell thick, composed of radially arranged, dark brown, elongated cells 5–7 × 4–5 µm (Fig. 1E), slightly longer (up to 8 µm) in the lower part of the ascomata, with a dark granulose pigment; ostiolate; ostiole central, up to 25 µm wide in transverse sections, slightly raised, without ostiolar setae; basal layer one cell thick, brownish; margin irregular; paraphyses not observed; inner part of the ascomatal wall covered in the middle by two-cell-long filaments 4–6 × 1.5–2.5 µm (Fig. 1F); asci subcylindrical, 35–46 × 10–14 µm (Fig. 1G); ascospores 4 per ascus, narrowly ellipsoid, hyaline, with a single median septum, slightly constricted at the septum, 17–18.6–20(–22) × (4.5–)5–5.9–6.5(–7) µm (n = 36), smooth, lower cell distinctly longer and slightly narrower than the upper cell, upper cell bearing 3 pairs of setulae, attached near the apex (Figs 1C & D; Fig. 4B).

HOST: *Lichenopeltella arctomiae* was found growing on the thallus or, more rarely, apothecia of *Arctomia delicatula*, which was muscicolous on bark of *Thuja plicata*.

ETYMOLOGY: The epithet *arctomiae* refers to the host genus.

DISTRIBUTION: So far, *L. arctomiae* is only known from the type locality in the Cabinet Mountains of extreme western Montana, the area with the highest annual precipitation in the state.

NOTES: *Lichenopeltella arctomiae* is a rather distinctive taxon since its setulae are placed at the apex of the upper cell, whereas setulae in other species are usually placed near the septum. *L. quinquecladiopsis* is a saprophytic species on submerged twigs in which spore appendages are also apical (Jones et al. 1999). However, it differs in having larger ascomata (150–250 µm), 8-spored asci and smaller ascospores (7.5–12.5 × 2.5–4.5 µm). *L. coppinsii* Earland-Bennett & D.Hawksw., which grows on *Verrucaria muralis*, also has setulae that occasionally appear near the apex (Earland-Bennet & Hawksworth 1999), but this species has 8-spored asci and smaller ascospores (12.5–15 × 4.5–5 µm).

*L. arctomiae* recalls *L. leptogii* Diederich which likewise has 4-spored asci of a similar size (15.5–20 × 5–6 µm) as well as similarly sized ascospores (35–52 × 8.5–13 µm) (Aptroot et al. 1997). However, in *L. leptogii* the setulae are located near the septum and not apically and the catathecia are smaller (75–125 µm) than in *L. arctomiae* (85–155 µm). The host of the latter is furthermore the genus *Leptogium*. *L. cladoniarum* E.S.Hansen & Alstrup has also similarly sized ascospores (18–21 × 5–6 µm), but its asci are 8-spored and ascomata smaller (50–70 µm in diam.) and its ascospores lack setulae (Hansen & Alstrup 1995). Differences compared with *L. leprosulae* are discussed under that species.

The presence of short filaments covering the inner part of the ascomatal wall has not been heretofore recorded in the genus *Lichenopeltella*. Diederich (in Aptroot et al. 1997) pointed out the presence of branched paraphyses in some species within the genus, and highlighted the problems observing them.

The specimen of *Arctomia delicatula* reported here is the first of this species for Montana and the contiguous Pacific Northwest. The species is rare in northwest

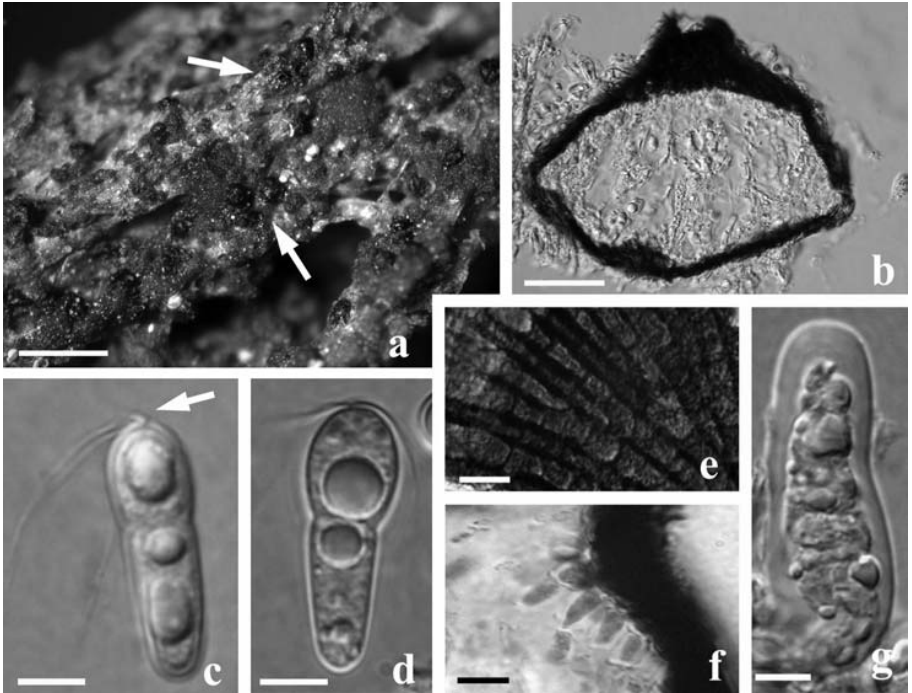


Fig. 1. *Lichenopeltella arctomiaae*, holotype (GZU). A: Habitus; B: Transverse section of catathecium; C: Ascospore, arrow indicates the apical insertion point of setulae; D: Ascospore; E: Detail of granulose wall of ascogonium; F: Detail of cells covering the inner wall of ascogonium; G: Detail of young ascus. B, C, D, F, G: Differential contrast. F in lactophenol blue, rest in water. Scale bars: A: 0.5 mm; B: 40  $\mu$ m; C, D, E, F, G: 5  $\mu$ m.

North America, with most recent records coming from wet inland rainforests in eastern British Columbia, where it grows as an epiphyte in old forests (Spribille, unpublished; T.Goward, pers. comm.). According to Goward et al. (1994), a previous record for British Columbia (Noble et al. 1987) was based on a misidentification. In western North America *A. delicatula* has otherwise only been reported from southeast Alaska (Geiser et al. 1998), but the supporting specimen has not been seen by us.

ADDITIONAL MATERIAL STUDIED OF *A. DELICATULA*: U.S.A.: Montana, Sanders Co., Kootenai National Forest, East Fork Bull River, St. Paul Lake trailhead, 28.VII.2006, Pérez-Ortega & Spribille (GZU, hb. Pérez-Ortega).

### ***Lichenopeltella biatorae* Pérez-Ortega & T.Sprib. sp. nov.**

*Lichenopeltella insignis* catatheciis 65–110  $\mu$ m diam., 40–68  $\mu$ m altis, setis nullis, ascis 4-sporis, 24–40  $\times$  8–11  $\mu$ m et ascospori (12–)13.5–15.2–16.5(–18)  $\times$  (3.5–)4–4.5–5(–6)  $\mu$ m, cum 4 pari setularum.

TYPUS: CANADA: British Columbia, Selkirk Mountains, Comaplix Mountain, 50°51.205'N 117° 41.612'W, subalpine parkland (complex of meadows and heath with *Abies lasiocarpa*-*Picea*

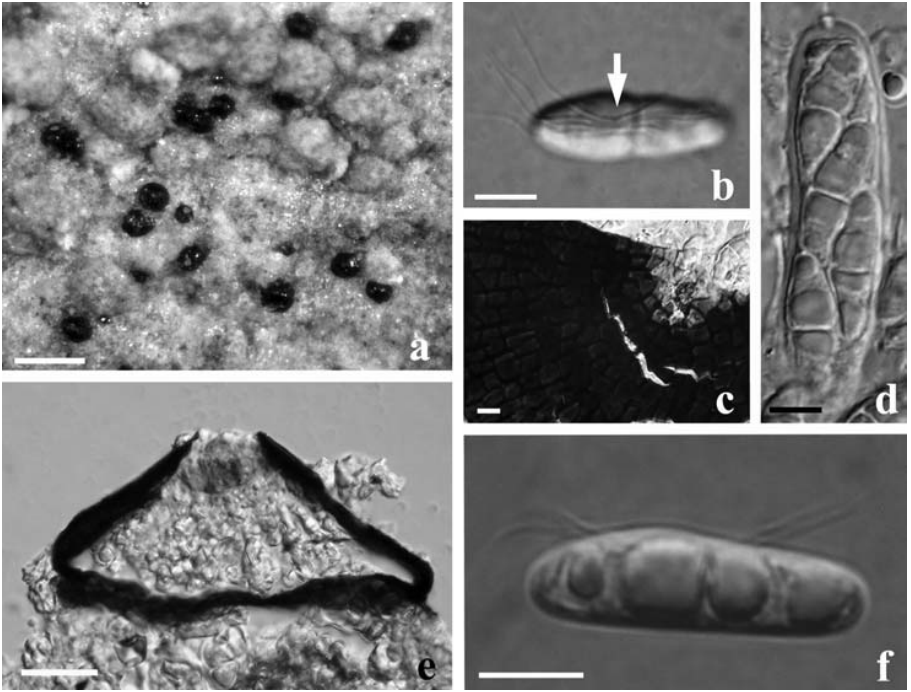


Fig. 2. *Lichenopeltella biatorae*, holotype (GZU). A: Habitus; B: Ascospore bearing 4 pairs of setulae, arrow indicates the insertion point; C: Detail of ascomata wall; D: Ascus with 4 ascospores; E: Transverse section of a catathecium; F: Ascospore. B, D, E, F: Differential contrast. All preparations in water. Scale bars: A: 0.25 mm; B, C, D, F: 5  $\mu$ m; E: 50  $\mu$ m.

*engelmannii* forest patches), 1700–1800 m elev., on *Biatora flavopunctata* on stalks of *Rhododendron albiflorum* at ground level, 23 July 2005, T.Spribille 18282 & C.Pettiitt (GZU, holotype).

Ascomata lichenicolous on *Biatora flavopunctata* (Fig. 2A), catathecioid, c. 65–110  $\mu$ m wide, arising singly or in groups, flat or slightly convex, c. 40–68  $\mu$ m high (Fig. 2E), dark brown to black; upper ascomatal layer one cell thick, composed of radially arranged, dark brown rectangular cells 4–5  $\times$  4–5  $\mu$ m in the upper part (Fig. 2C) and 4–5  $\times$  6–7  $\mu$ m in the lower part; ostiolate; ostiole central to slightly lateral, not or little raised, without ostiolar setae; basal layer one cell thick, composed of brownish rectangular cells of similar size or slightly longer to those in the upper part; margin entire; paraphyses not observed; asci bitunicate, subcylindrical, I-, c. 24–40  $\times$  8–11  $\mu$ m, 4-spored (Fig. 2D); ascospores ellipsoid, hyaline, with a single median septum, slightly constricted at the septum, smooth, non-halonate, straight or slightly curved, (12–)13.5–15.2–16.5(–18)  $\times$  (3.5–)4–4.5–5(–6)  $\mu$ m ( $n = 35$ ), the upper cell usually larger than lower cell and bearing 4 pairs of setulae, attached near the septum, setulae c. 8–16  $\mu$ m long (Figs 2B & F, 4A).

HOST: On thallus of *Biatora flavopunctata*.

ETYMOLOGY: The epithet *biatorae* refers to the host genus.

DISTRIBUTION: *L. biatorae* is currently known from Washington (U.S.A.) and British Columbia (Canada).

NOTES: Among the previously described species of *Lichenopeltella*, the morphologically closest species to *L. biatorae* is *L. thamnoliae* R.Sant, which grows on *Thamnolia vermicularis* in the Andes (Santesson 1998). Although the ascomata (60–100 µm) and ascospores (11.5–16 × 2.5–5 µm) of *L. thamnoliae* are of a similar size and the asci are also 4-spored, it differs from *L. biatorae* in its shorter asci (26–29 × 8–9 µm) and lack of setulae on the ascospores. Ascospores in *Lichenopeltella biatorae* resemble those of *L. ramalinae* Etayo & Diederich, a species growing on *Ramalina* sp. which also has 4-spored asci and ascospores of a similar size (13–15.5 × 3.5–5 µm) (Aptroot et al. 1997). This species, however, differs in bearing only two pairs of setulae; ascomatum (100–125 µm) and ascus sizes (35–50 µm) are slightly larger in *L. ramalinae* than in *L. biatorae*. The ascospores of *L. cetrariicola* (Nyl.) R.Sant. are of a similar length but narrower (14–16 × 2.5–3.5 µm) and they only have a single pair of setulae (Aptroot et al. 1997). *L. bunodophoris* Diederich growing on *Bunodophoron* sp. is likewise a species with 4-spored asci and ascospores with 4 pairs of setulae (Aptroot et al. 1997), but both asci and ascospores in this species are smaller (37–49 × 9–11 µm and 16–18 × 4.5–5.5 µm respectively).

This is the first report of a lichenicolous fungus on *Biatora flavopunctata*, one of the more common crustose lichens on ericaceous shrubs in upper montane forests in northwest North America. During the course of the present study, another lichenicolous fungus was commonly found growing on *B. flavopunctata*; it had superficial and globular perithecia, bearing brown long setae around the ostiole, somewhat recalling species of *Capronia* or *Niesslia*. However, although dozens of specimens were cut, they were always too old and neither asci nor ascospores were found.

ADDITIONAL MATERIAL EXAMINED: U.S.A.: Washington, Pierce Co., Mt. Rainier National Park, Wonderland Trail N of White River Campground, Printzen 5050 (FR, GZU, Hb. Pérez-Ortega).

### ***Lichenopeltella leprosulae* Pérez-Ortega & T.Sprib. sp. nov.**

*Lichenopeltella insignis* catatheciis 100–135 µm diam., 65–95 µm altis, setis nullis, ascis 3-sporis, 54–60 × 8–12 µm et ascospori (19–)20–20.8–23 × (5–)5.5–6.1–6.5 µm, cum 3 pari setularum.

TYPE: CANADA: British Columbia, Selkirk Mountains, Comaplix Mountain, ca. 50°51.205'N 117°41.612'W, subalpine parkland (complex of meadows and heath with *Abies lasiocarpa*-*Picea engelmannii* forest patches), 1700–1800 m elev., on *Myochroidea leprosula* on stalks of *Rhododendron albiflorum* at ground level, 23 July 2005, T.Spribille 18280-B & C.Pettitt (GZU, holotype).

Ascomata lichenicolous on *Myochroidea leprosula* (Fig. 3A), catathecioid, 105–135 µm wide, arising singly or in groups, slightly convex, 65–95 µm high (Fig. 3A), dark brown to black; upper ascomatal layer one cell thick, composed of radially arranged, dark brown rectangular cells 4–5.5 × 5–10 µm (Fig. 3C); ostiolate; ostiole central to slightly lateral, not or little raised, without ostiolar setae; basal layer one cell thick, composed of brownish rectangular cells of similar size or slightly smaller than those in the upper part; margin entire; paraphyses not observed, asci subcylindrical, 54–64 × 8–12 µm, 4-spored (Fig. 3D); ascospores ellipsoid, hyaline, with a single median septum, slightly constricted at the septum, smooth, non-halonate, straight or sometimes

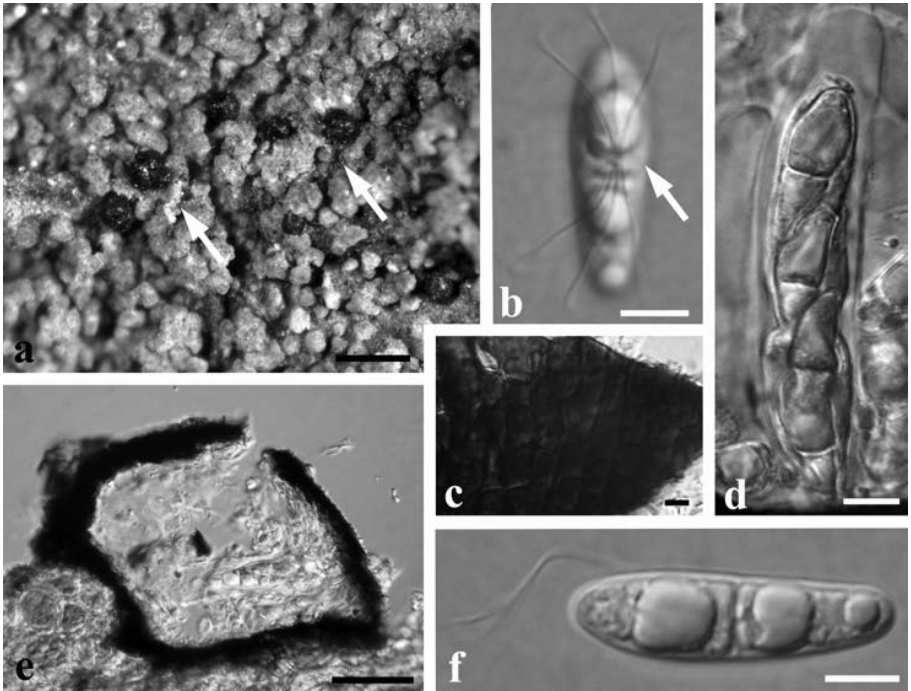


Fig. 3. *Lichenopeltella leprosulae*, holotype (GZU). A: Habitus; B: Ascospore, detail of setulae, arrow indicates point of insertion; C: Detail of ascomata wall; D: Ascus with 4 spores; E: Detail of a transverse section of a catathecium; F: Ascospore. B, D, E, F: Differential contrast. D: Lugol, rest in water. Scale bars: A: 0.25 mm, E: 50 µm; B, D, D, F: 5 µm.

slightly curved,  $(19-20-20.8-23 \times (5-5.5-6.1-6.5 \mu\text{m})$  ( $n = 35$ ), upper cell usually larger than lower cell and bearing 3 pairs of setulae, attached near the septum, setulae 12–20 µm long (Figs 3B & F, 4C).

HOST: *Myochroidea leprosula*.

DISTRIBUTION: The species is thus far known only from the type locality in southeastern British Columbia (Canada).

NOTES: *L. leprosulae* is a rather distinctive species, characterized by the size of its ascomata and ascospores and the presence of three pairs of setulae close to the ascospore septum. Similar ascomatum and ascus sizes are to be found in *L. physciae* Diederich, a species found on *Physcia solediosa*, *L. megalosporae* Diederich, growing on *Megalospora* cf. *halei*, *L. hydrophyla* R.Sant., growing on aquatic *Verrucaria* sp. and *L. leptogii* Diederich, growing on *Leptogium* spp. (Aptroot et al. 1997). The most similar of these species to *L. leprosulae* is *L. leptogii*, with which it has in common 4-spored asci and ascospores with three pairs of setulae. However, both asci and ascospores are slightly smaller than in *L. leprosulae* ( $35-52 \times 8.5-11 \mu\text{m}$

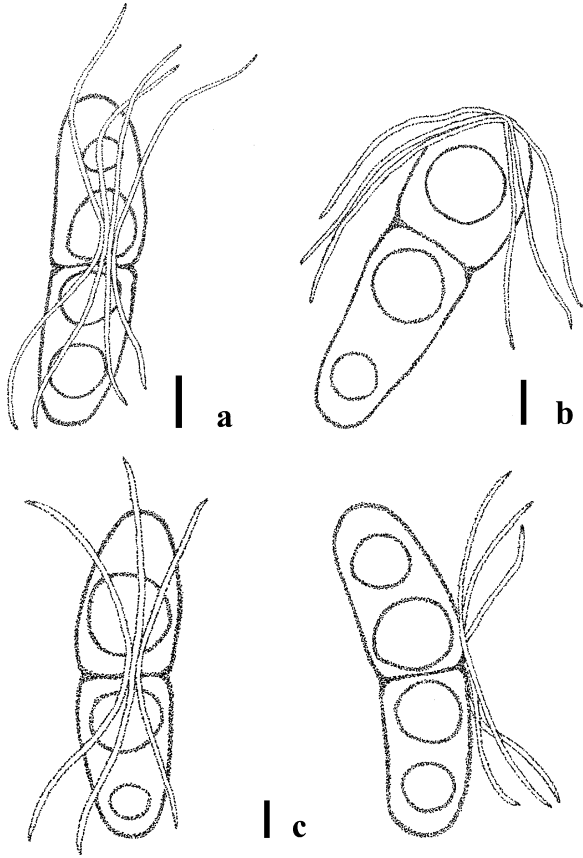


Fig. 4. A: *L. biatorae* ascospore; B: *L. arctomiae* ascospore; C: *L. leprosulae* ascospores. Scale bars: 2.5  $\mu\text{m}$ .

and 15.5–20  $\times$  5–6  $\mu\text{m}$  respectively). *L. physciae* has 8-spored asci and its ascospores are smaller (13–15  $\times$  5–5.5  $\mu\text{m}$ ). *L. megalosporae* likewise has smaller ascospores (13–17  $\times$  4.5–5  $\mu\text{m}$ ), and these have 2 pairs of setulae and are 8 per ascus. *L. hydrophyla* also has smaller ascospores (13–16  $\times$  5–6  $\mu\text{m}$ ) and 8-spored asci. By contrast, *L. cladoniarum* E.S.Hansen & Alstrup has ascospores of similar size (18–21  $\times$  5–6  $\mu\text{m}$ ), but differs in that its asci are 8-spored, its ascomata smaller (50–70  $\mu\text{m}$  in diam), and it lacks setulae on its ascospores (Hansen & Alstrup 1995). *L. arctomiae*, also described in this work, resembles *L. leprosulae* in ascomata size and 4-spored asci, but differs in its slightly smaller asci (35–46  $\times$  10–14  $\mu\text{m}$ ) and ascospores (17–20  $\times$  5–6.5  $\mu\text{m}$ ) with 3 pairs of setulae disposed near the apex of the upper cell, whereas in *L. leprosulae* the setulae are placed close to the septum in the upper cell.

*L. leprosulae* is the first lichenicolous fungus to be reported from *Myochroidea leprosula*. *M. leprosula* is part of a distinct group of recently revised, montane, corticolous species found in western North America and Europe (Printzen et al. 2008).

**Key to the known lichenicolous *Lichenopeltella* species from North America:**

1. Ostiolar setae present..... 2
1. Ostiolar setae absent..... 3
2. Ascomata 50–70 µm wide, asci 25–35 × 9–11 µm, ascospores 15–22 × 3.5–4.5 µm with 3 pairs of setulae; on *Peltigera*, British Columbia, Chihuahua..... *L. peltigericola*
2. Ascomata 100–160 µm wide, asci 36–50 × 9–12 µm, ascospores 16–20 × 2.5–3.5 µm, without setulae; on *Peltigera*, British Columbia, Oregon, Washington..... *L. santessonii*
3. Ascospores lacking setulae; on *Heterodermia*, Arkansas..... *L. heterodermicola*
3. Ascospores clearly bearing setulae on the upper cell..... 4
4. Setulae located at the apex of the upper cell; on *Arctomia delicatula*, Montana..... *L. arctomiae*
4. Setulae close to the septum in the upper cell..... 5
5. Ascomata 65–110 µm wide, ascospores 13.5–16.5 × 4–5 µm, bearing 4 pairs of setulae; on *Biatora flavopunctata*, British Columbia and Washington..... *L. biatorae*
5. Ascomata 105–135 µm wide, ascospores 20–23 × 5.5–6.5 µm, bearing 3 pairs of setulae; on *Myochroidea leprosula*, British Columbia..... *L. leprosulae*

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