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***Cliostomum spribillei* (Ramalinaceae, lichenized Ascomycetes), a new species from western North America**

Tor Tønsberg¹, Trevor Goward²

¹Department of Natural History, University Museum, University of Bergen, Allégaten 41, P.O. Box 7800, N-5020 Bergen, Norway. email: tor.tonsberg@uib.no; ²Herbarium, Beaty Museum, University of British Columbia, Vancouver, BC, V6T 1Z4, Canada. Mailing address: Enlichened Consulting Ltd., 5369 Clearwater Valley Road, Upper Clearwater, BC, V0E 1N1, Canada. email: trevor.goward@botany.ubc.ca

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Corresponding author: Tor Tønsberg (tor.tonsberg@uib.no). Accepted for publication July 11, 2016.
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Abstract: *Cliostomum spribillei* Goward & Tønsberg is described as new to science from Canada (British Columbia) and the U.S.A. (Idaho, Oregon and Washington) where it is corticolous on conifers in oldgrowth coniferous forests at high altitudes. It is easily distinguished from other *Cliostomum* species by its yellow, granular-sorediate thallus and production of usnic acid alone.

Key words: *Abies lasiocarpa*, apothecia, dry ecological niche, fog, lichen, Northwest North America, pycnidia

Introduction: Ongoing surveys of the epiphytic lichens of northwestern North America have lately yielded several species new to science (e.g, Spribille et al. 2009, Goward et al. 2012, Velmala et al. 2014, Altermann et al., in press, Myllys et al., in press, Peterson and Goward, in press). Here we describe formally a striking new *Cliostomum* species apparently restricted to high-elevation oldgrowth forests in southern British Columbia and the American Pacific Northwest.

Materials and Methods: We first became aware of our new *Cliostomum* species during field work conducted in the late 1990s. Since then we have searched for it in several herbaria but without result. Accordingly, the present study is based on our own recent collections as well as on collections made by our colleagues Curtis Björk (UBC) and Toby Spribille (GRAZ). Specimens were examined under light microscopy and subjected to TLC according to the methods of Culberson and Kristinsson (1970), Culberson (1972), and the later modification by Culberson and Johnson (1982); all 3 solvent systems were used and glass plates were used in solvent C to allow for the possible detection of fatty acids. Previously unpublished information on the ecology of *Cliostomum flavidulum* Hafellner & K. Kalb. and *C. leprosum* (Räsänen) Holien & Tønsberg in the Pacific Northwest is based on material (32 and 9 specimens, respectively) in herbarium BG.

Results

Cliostomum spribillei Goward & Tønsberg sp. nov. (Fig. 1.)

Mycobank # MB816288

Type. CANADA. British Columbia, Clearwater River Drainage: near headwaters of Grouse Creek, 51°49'N 119°55'W, alt. 1750 m, Upper Oroboreal Zone, corticolous on trunks and branches of *Abies lasiocarpa* in open oldgrowth forest with *Abies* and *Picea*, near west-facing escarpment, 20 April 1997, Trevor Goward 97-

001 (UBC – holotype; isotypes – ANUC, ASU, BCC, BG, BM, C, CANL, DUKE, E, GZU, H, HO, LE, M, MIN, MSC, NY, O, OSC, PRA, TNS, TSB, UPS, US, and WTU).

Diagnosis. Similar to *Cliostomum leprosum* in forming apothecia with usnic acid and a thallus with granular soredia, but differs in the yellowish thallus with usnic acid alone (thallus whitish and with atranorin and caperatic acid in *C. leprosum*).

Etymology. *Cliostomum spribillei* is named in honour of our friend and colleague Toby Spribille (born 1975) for his many significant contributions to our knowledge of northwest North American lichens.

Description. *Thallus* crustose, yellowish green, episubstratal, forming irregular patches up to 7 cm diameter, rather variable; thin specimens often of irregular, loosely attached, initially dispersed, mostly rather coarse, granular soredia to 0.12 mm wide, becoming aggregated and forming lax, convex, irregular patches; thickish specimens uneven, rimose and ± continuous, usually with soredia, sometimes esorediate, here and there sometimes with irregular, convex, esorediate granules to 0.4 mm diameter. In squash preparation soredia are farinose to coarse, the smallest ones, 12–17 µm diameter, with one algal-cell only, the larger ones to 60 µm diam. and resemble consoredia (see Tønsberg 1992). Medullary hyphae 2–4 µm wide. Prothallus evident in thin specimens as a web of white hyphae connecting the granules. Photobiont chlorococcoid, to 15(–20) µm in diameter.

Ascomata apothecia, commonly present, biatorine; margin distinct, especially in simple apothecia, concolorous with thallus, often slightly raised above the level of the disc, to 0.1 mm wide, usually even and circular, rarely undulating, becoming indistinct in markedly convex apothecia, with numerous crystals. Excipulum in section to 72 µm high beneath hypothecium, in upper part with crystals dissolving in K. Disc

concolorous with thallus or, more commonly, somewhat darker yellow or with a pinkish orange tinge, rarely with a yellow pruina, simple (non-tuberculate) and up to 1.1(–1.5) mm wide, flat to convex or in part ± tuberculate and then up to 1.5 mm wide, sometimes becoming contiguous and tending to clump. Epihyemenium 5 µm high, with numerous crystals (in polarized light); crystals dissolving in K. Hymenium colorless beneath the epihyemenium, 40–48 µm high. Crystals in epihyemenium and excipulum golden yellowish brown. Subhyemenium/hypothecium of horizontally oriented hyphae, colorless, to 140 µm high. Paraphyses unbranched to sparingly branched, sometimes anastomosing, 2–2.5 µm wide; end cell (2.5–)3–5(–6) µm in length. Asci clavate, (23–)30–35 × 10–12 µm, of the *Biatora*-type of Hafellner (1984: 266–267); see also Smith et al. (2009: 27). Spores colorless, broadly to narrowly ellipsoid to irregularly fusiform, mostly straight, sometimes curved, (0–)1(–3)-septate, 11–15(–19) × 2.5–3.5 µm. Pycnidia common, prominent, black, up to 0.5 mm diameter, at first regularly rounded with a narrow ostiolum, later becoming more or less irregularly shaped, widely gaping and multilocular; wall brownish violet, K+ violet; conidiophores cylindrical, c. 10 × 1.5 µm; conidia colorless, simple, drop-shaped or ellipsoidal, 3–5 × 2–3 µm.

Chemistry. Thallus and apothecia: usnic acid only (TLC). Thallus: PD– or (in some specimens) PD+ slowly green-blue, K– (or appearing pale orange brown), C–, KC+ weak yellow (best seen on blotter paper); apothecia: PD–, K– (or appearing pale orange brown), C–, KC– KC+ weak yellow (check on blotter paper). The crystals noted in the margin of the apothecia probably represent usnic acid.

Ecology and distribution. *Cliostomum spribillei* is a species of oldgrowth coniferous forests where it occurs on trunks and branches of conifers, mainly *Abies lasiocarpa* (including *A. bifolia*), but also *A. amabilis*, *Picea engelmannii*, *Thuja plicata*, and *Tsuga heterophylla* (one collection). Long term studies of its ecological

behavior in and near the type locality suggest a strong association with the rain-sheltered trunks and branches of *Abies lasiocarpa* in oldgrowth conifer forests at subalpine elevations between about 1400 m and 1900 m. Here it appears to be further restricted to localities subject to frequent fog. Repeated searches for this species in habitats outside the montane fog belt have proved unsuccessful. Further work is needed to determine if these observations hold across its range.

The following species are present as associates in the holotype collection: *Alectoria sarmentosa* (Ach.) Ach. (sparse), *Bryoria fuscescens* (Gyeln.) Brodo & D. Hawksw. (sparse), *B. glabra* (Motyka) Brodo & D. Hawksw. (sparse), *Calicium viride* Pers., *Chaenotheca ferruginea* (Turner ex Sm.) Mig., *C. subroscida* (Eitner) Zahlbr., *C. trichialis* (Ach.) Th.Fr., *Chaenothecopsis nana* Tibell, *Cyphelium inquinans* (Sm.) Trevis, *Hypogymnia wilfiana* Goward, T.Sprib. & Ahti (sparse), *Mycoblastus affinis* (Schaer.) T. Schauer, *M. sanguinarius* (L.) Norman s. lat., *Parmeliopsis ambigua* (Wulfen) Nyl., *P. hyperopta* (Ach.) Arnold, and *Stenocybe major* Nyl. ex Körber. The frequent co-occurrence of hydrophobic genera including *Calicium*, *Cyphelium*, *Chaenotheca*, and *Chaenothecopsis* lends support to our observation that *Cliostomum spribillei* is a species of dry ecological niches. *Cresponia chloroconia* (Tuck.) Egea & Torrente, another indicator of dry niches, was noted in TT 25092.

Cliostomum spribillei appears to be endemic to the American Pacific Northwest and adjacent Canada, where it occurs south to northern Oregon (Hood River Co., 45.32°N; Spribille 29873), east to Idaho (Bonner Co., Spribille 11131), and north to southern intermontane British Columbia (Spahats Creek drainage, 51.76°N; Goward 04-201b). Its known elevational distribution ranges from 800 m (British Columbia, Whistler area, Goward 06-1508) to 1800 m (British Columbia, Clearwater River drainage, Battle Mtn, Goward 13-001 & D.

Haughland); only a few of the specimens examined are from altitudes below 1000 m.

Additional specimens examined

(selected): CANADA. British Columbia, W of Creston, Kootenay Pass Summit, just W of small lake, 49°03.6'N 117°02.5'W, alt. 1780 m, corticolous on *Abies* branches, 24 September 1998, T. Tønberg 26442 (BG, NY, OSC, UBC, UPS, WTU); between Hope and Merritt, along Hwy 5, Coquihalla Summit, 49°35.5'N 121°05.8'W, alt. 1200 m, corticolous on *Abies amabilis* trunk, 20 September 1998, T. Tønberg 26244 (BG); 21 km E of Boston Bar near pass, 49°52'N 121°08'W, alt. 825 m, trunk *Abies* in oldgrowth forest, 29 September 2006, T. Goward 06-903 (UBC); Murtle River drainage, Murtle Lake, above old ranger cabin, 50°06'N 119°42'W, 1050 m, trunk *Thuja* in oldgrowth forest, 29 May 1979, T. Goward 79-854b (UBC); Whistler area, N of town up 16 Mile Creek, 50°10'N 122°56'W, 800 m, trunk *Abies* in oldgrowth forest, 15 October 2006, T. Goward 06-1508 (UBC); N of Vancouver, Garibaldi Park, N of Wedgemount, along trail to Wedgemount Lake, 50°10.24'N 122°51.00'W, alt. 1150 m, corticolous on trunk of *Tsuga heterophylla* in old-growth coniferous forest, 25 Sept. 2000, T. Tønberg 28703 (BG-L-78657); N of Whistler, N of Pemberton Valley, along the road to Bralorne, alt. 1000 m, 50°34'N, 123°01'W, on *Abies* trunk, 16 September 1989, T. Tønberg 12889 (BG); Howser Creek drainage, near confluence with Tenise Creek, 50°35'N 116°42'W, alt. 1100 m, trunk *Abies* in oldgrowth forest, 13 September 1995, T. Goward 95-1287 (UBC); Albert River drainage, 37 km (air) E of Invermere, 13 km SW of Alberta Boundary, 50°37.69'N 115°32.97'W, alt. 1224 m, old *Thuja plicata* forest along river, on *Thuja plicata* trunk, 30 July 2005, T. Spribille 16757 (BG-L-92635); Sicamous Creek drainage, 10 km ESE of Sicamous, 50°50'N 118°50'W, alt 1550 m, twigs of *Picea* in oldgrowth forest, 8 August 1993, T. Goward 93-389 (UBC); Incomappleux River drainage, 38 km SE of Revelstoke, ridge NE of Incomappleux Mountain, 50°51.21'N 117°41.61'W, alt. 1767 m, on *Abies* branches, 23

September 2005, T. Spribille 18307 (BG-L-92637); Incomappleux River drainage, Boyd Creek area, in oldgrowth forest at end of road (in 2005), 50°51.83'N 117°31.64'W, alt. 1185 m, on *Abies lasiocarpa* bark, 23 August 2005, T. Spribille 17798 (BG-L-92636); Asulkan Creek drainage, near Glacier Station, 51°15'N 117°30'W, alt. 1260 m, trunk *Picea* in oldgrowth forest, 7 August 2005, T. Goward 05-989 (UBC); Beaver Creek drainage, near Parks Canada cabin, 51°17'N 117°23'W, alt. 1000 m, trunk *Abies* in oldgrowth forest, 18 July 2002, T. Goward 02-322 (UBC); Spahats Creek drainage, Silvertip Falls, 51°45.470'N 119°55.290'W, alt. 1400 m, corticolous, trunk *Abies lasiocarpa*, 2 April 2004, C. Björk 19973 (UBC); Spahats Creek drainage, below Silvertip Falls, 51°45.470'N 119°55.290'W, alt. 1400 m, trunk *Abies* in oldgrowth forest, 2 April 2004, T. Goward 04-201b (UBC); Clearwater River drainage, west slope of Battle Mountain, west of Fight Lake, 51.907°N 119.939°W, alt. 1800 m, Upper Oroboreal Subzone, open oldgrowth *Abies-Picea* forest on west-facing slope within cloud zone (as indicated by superabundant presence of *Alectoria sarmentosa*), corticolous on trunk of *Abies lasiocarpa*, 30 April 2013, T. Goward 2013-001 & D. Haughland (BG, UBC); Clearwater River drainage, 30 km NNE Clearwater, W slope of Battle Mtn, 51.907°N 119.939°W, alt. 1800 m, trunk of *Abies* in open oldgrowth *Abies-Picea* forest, 30 April 2013, T. Goward 13-001 & D. Haughland (UBC); Kokanee Creek drainage, NE of Nelson, road to Kokanee Glacier Provincial Park, on bark of *Thuja plicata*, 20 May 2001, T. Spribille 11037 (BG-L-92619); **U.S.A.** IDAHO. Latah Co., University of Idaho Experimental Forest, NE of Moscow Mt., 26 km NE of Moscow, 46°51'N 116°44'W, alt. 930 m, humid forest, on *Abies*, 20 May 2004, C. Björk 10521 (UBC); Bonner Co., Western Cabinet Mountains, Char Falls on Lightning Creek, 48°21.77'N 116°10.44'W, alt. 1230 m, on bark of *Abies bifolia*, 16 June 2001, T. Spribille 11131 (BG-L-92620); Boundary Co., Purcell Mountains, flats west of Canuck Pass; 48°55'N 116°5'W, alt. 1500 m, open subalpine forest, *Picea* branches, July 2006, C.

Björk 12969 (UBC). OREGON. Hood River Co., along Hwy. 38, 8 km SE of Mt. Hood, along highway, near snowmobile parking area (Teacup Lake Sno-Park parking): 45°19.230'N 121°37.324'W, alt. 1307 m, corticolous on trunk of *Abies amabilis*, 20 Sept 2008, T. Spribille 29873 (BG, UBC); WASHINGTON, Kittitas Co., along U.S. Route 97, 5.5 km (air) WSW of Blewett Pass (Swauk Pass), [18.9 km] 11.8 miles along Hwy 97 N of Virden, 2.3 miles along Hwy NE of Iron Creek, 47°19.8'N 120°38.7'W, alt. 1010 m, on *Abies* trunk, 24 September 1997, T. Tønberg 25092 (BG, NY, OSC, UPS, WTU).

Discussion: Diagnostic for *C. spribillei* is the disintegration of the upper surface into granular or soredia-like reproductive units combined with the production of usnic acid in both the thallus and the apothecial margin. *Cliostomum spribillei* is a distinctive species unlikely to be confused with other species in the genus. It shows some resemblance to sorediate species such as *C. flavidulum* and *C. leprosum*, both of which may form thick, leprose thalli. *Cliostomum flavidulum* is pale sulphur yellow to pale green to yellow green (Ekman 1997) becoming straw-colored in the herbarium, whereas *C. leprosum* is often whitish, sometimes pale green or pale green-yellow becoming whitish in the herbarium. These species are also chemically distinct from *C. spribillei*. *Cliostomum leprosum* has atranorin and caperatic acid in the thallus and usnic acid in the apothecia (Tønberg 1992), while (in northern portions of its range) *C. flavidulum* produces atranorin and fumarprotocetraric acid as major substances (Ekman 1997, Tønberg 1997). In addition to the morphological and chemical differences, these species differ ecologically from *C. spribillei*. *Cliostomum flavidulum* occurs on a variety of phorophytes, the most common being *Alnus rubra* and is further distinct in occurring mainly at low elevations, with only one specimen known from above 1000 m altitude (U.S.A., Oregon, Clackamas Co., 1130 m, 2001, TT 29154 (BG)). *Cliostomum leprosum* is similar to *C. spribillei* in being confined to conifers, but its altitudinal

distribution differs markedly as it also occurs near sea-level (e.g., U.S.A., Washington, Clallam Co., 1999, TT 27104 (BG)).

Usnic acid is also diagnostic (i.e., constant and present as a major substance in more than trace amounts) for three additional species, i.e., *C. coppinsii* Fryday & Kantvilas, *C. corrugatum* (Ach.: Fr.) Fr., and *C. nabimicum* V. Wirth & Kalb.. Only in the first and last of these species, however, does usnic acid occur in the thallus; in *C. corrugatum* it is restricted to the apothecial margins. Moreover, in *C. coppinsii* it is accompanied by atranorin and stictic acid. Actually the only *Cliostomum* besides *C. spribillei* that contains usnic acid alone is *C. nabimicum* (see, e.g., Ekman 1997, Gilbert & Fox 2009, Kantvilas & Fryday 2010, Wirth & Kalb 2011), though that species has immersed apothecia and is a saxicole of desert regions in western Africa.

Most specimens, including the type material, bear coarse, often granular soredia, though some specimens, e.g. TT 25092, are esorediate. As these specimens do not seem to differ in apothecial and chemical characters, they are here regarded as falling within the variation range of *C. spribillei*.

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Figure 1. *Cliostomum spribillei*. Part of holotype (UBC) showing sores, pycnidia and apothecia. Photo Tim Wheeler 2016.