

New Records and Range Extensions of Rare Lichens from Waterfalls and Sprayzones in Inland British Columbia, Canada

CURTIS R. BJÖRK

Box 131, Clearwater, British Columbia V0E 1N0, Canada; email: crbjork@gmail.com

TREVOR GOWARD

Box 131, Clearwater, British Columbia V0E 1N0, Canada; email: tgoward@interchange.ubc.ca

TOBY SPRIBILLE

Institute of Plant Sciences, University of Graz, Holteigasse 6, A-8010 Graz, Austria; email: tspribi@gwdg.de

Abstract. The importance of waterfalls and whitewater for lichen diversity is well known among field lichenologists but seldom has it been documented in the literature. We call attention here to a string of occurrences of eleven regionally rare lichens from waterfalls in inland British Columbia. *Pseudocyphellaria mallota* is reported as new to British Columbia and *Haematomma ochroleucum* new to Idaho. *Psoroglaena stigonemoides* is new to North America.

INTRODUCTION

The importance of riparian corridors as cool, moist and relatively unchanging environments for lichens is widely recognized. The special significance of waterfalls and whitewater stretches of rivers is widely known colloquially among lichenologists, but is only rarely discussed in the literature. Vevle (1975) and Odland et al. (1991) pointed to the significance of waterfall spray zones in Norway for rare lichens and since then a small but focused body of literature has developed around the significance of waterfall spray zones for rare biota in general, and the detrimental effects of hydroelectric projects that impede flows (Zilihona & Nummelin 2001; Quinn et al. 2005; Cordeiro et al. 2006).

Recently Goward & Björk (2009) called attention to the ecological significance of waterfall spray zones as hotspots of lichen diversity in British Columbia ahead of a wave of planned hydroelectric projects focused on waterfalls and steep stream gradients. Already Goward (1994) has reported on the presence of the otherwise strictly coastal *Lobaria oregana* in an oldgrowth stand within the mist zone of Oregana Creek, in the upper Adams River Valley of south-central British Columbia (51° 49'N, 119° 06'W). This record appears to be the only known locality for this species in interior North America. The closest documented population is located 350 km to the west in the Coast Ranges. The presence of *L. oregana* so far disjunct in a glaciated region may be taken as strong evidence of

long-distance dispersal. In this case it is an especially noteworthy disjunction inasmuch as this species appears to have exceptionally poor powers of dispersal (Silleet et al. 2000). In any event, the presence of this species in the upper Adams River Valley can be taken as evidence that waterfall spray zones do indeed act as ports of entry for lichens arriving from considerable distances. No additional populations have been found in nearby waterfall spray zones, perhaps suggesting rather recent arrival at Oregana Creek. The stream, it can be noted, was actually named after the lichen.

Similarly, Spribille (2002) reported the only inland North American occurrence of *Pseudocyphellaria crocata* from two waterfalls in the Selkirk Mountains of British Columbia, and since then we have been steadily accruing evidence for many other rare oceanic species of lichens around inland waterfalls and white-water courses. Spribille et al. (2009) reported the only known location of the new crust lichen *Absoconditella amabilis* from a waterfall in the same mountain range and half of the records of the probably undescribed *Bacidina* sp. A in the same paper originate from waterfall spray zones.

In another paper, we will discuss the functional roles of waterfalls as range outposts, ports of entry, stable source populations and lichen diversity support systems in complex lichen landscapes. The purpose of the present paper is to report individual range extensions and new records of lichens that have come to light since the publication of the first British Columbia macrolichen floras (Goward et al. 1994, Goward 1999). We also include

some crust lichens here to the extent data are presently available.

THE SPECIES

Arctomia delicatula Th.Fr.

CANADA. British Columbia. West Kootenays, Selkirk Mountains, Gardner Creek above main Kuskanax Road, 50°17'N, 117°43'W, in waterfall spray zone, 670 m, 11 May 2001, *Spribille 10815* (UBC); Quesnel/Shuswap Highlands, Clearwater Valley, west shore Clearwater Lake, above Osprey Falls, on mossy branch of *Tsuga* at lake edge, 685 m, 23 November, 2006, *Björk 13946* (UBC).

This continues to be a rarely collected species in inland British Columbia, where it is associated with waterfall spray zones or fast-flowing streams. It was also reported from an old-growth cedar hemlock forest in NW Montana by Pérez-Ortega & Spribille (2009); that locality is also along a white water torrent. All of our material is from twigs or mosses over bark of conifers.

Arthopyrenia antecellens (Nyl.) Arnold

CANADA. British Columbia. West Kootenays, Purcell Mountains, canyon of Howser Creek just above Duncan Road, 50°27.8'N, 116°54.9'W, on lower branches of a small *Pseudotsuga* on ledges above roiling water, 582 m, 18 Oct 2009, *Spribille 32150* (BG, CANL, UBC).

This species was previously reported from British Columbia (Haida Gwaii) and Washington by Harris (1975). This is the first report of the species inland in western North America.

***Chrysothrix granulosa* G.Thor**

Canada: British Columbia.

Quesnel/Shuswap Highlands, Clearwater Valley, Sabretooth Rapids of the Clearwater River, on twig sheltered by overhanging rock, in the cooling mist influence of the river, 425 m elev., 51° 41'N 120° 2.5'W, 10 May, 2007, *Björk 14996* (UBC).

In British Columbia, this species was known from the coast, where it is limited to open, well ventilated sites on the outer coast and in the Gulf Islands. In high-precipitation climates, it grows where sheltered from rain splash, as with the interior population reported above.

***Haematomma ochroleucum* (Necker) J.R. Laundon**

CANADA. British Columbia.

Quesnel/Shuswap Highlands, Clearwater Valley, Sabretooth Rapids of the Clearwater River, on siliceous rock in the cooling mist influence of the river, 425 m elev., 51° 41'N 120° 2.5'W, 26 May, 2006, *Björk 12789b* (UBC); Quesnel/Shuswap Highlands, Clearwater Valley, Dawson Falls, on basalt cliffs in waterfall sprayzone, 790 m elev., 51° 58'N 120° 8'W, 29 March, 2006, *Björk 12475* (UBC); Selkirk Mountains, falls of the Kuskanax River above hot springs resort, 50°17.8'N, 117°40.7'W, 884 m, 17 Oct 2009, *Spribille 32085* (CANL); Purcell Mountains, canyon of Howser Creek just above Duncan Road, 50°27.8'N, 116°54.9'W, on vertical rock faces, 582 m, 18 Oct 2009, *Spribille 32151* (CANL). U.S.A. Idaho. Kootenai County, Q'emlin Park, on basalt in sprayzone of Post Falls, 640 m elev., 47° 42'N 116° 58'W, 22 March, 2007, *Björk 14215* (UBC).

The species was first reported for inland British Columbia by Brodo (2008), citing a collection from near a waterfall. It forms large patches on rock underhangs and on large trunks of *Populus trichocarpa*.

***Hypogymnia oceanica* Goward**

CANADA. British Columbia. Selkirk Mountains, Selkirk Mountains, Gardner Creek above main Kuskanax Road, 50°17'N, 117°43'W, in waterfall spray zone, 670 m, 11 May 2001, *Spribille 10813* (UBC); Incomappleux River, area of confluence of main river and Battle Brook, 50°59.9'N, 117°34.9'W, 615 m elev., 14 Sept 2002, *Spribille 12304* (UBC), 12346 (UBC), 12385 (UBC); Kootenay Trench, north end of Duncan Lake, Hall Creek, 15 Sept 2002, *Spribille 12413* (UBC); N Arm of Quesnel Lake above mouth of Roaring River, 29 Sept 2007, *Spribille 24334* (UBC); Goat Range, Kuskanax River just upstream of confluence with Gardner Creek, 50°17.3'N, 117°43.2'W, 695 m, 19 Oct 2009, *Spribille 32209* (UBC).

This coastal species is known from a few inland localities away from waterfall spray zones in the highest precipitation areas of the Robson Valley (Fraser Plateau east of Prince George). However, outside of these limited forest occurrences the species is extremely rare. The southern- and easternmost localities in inland British Columbia are restricted to whitewater corridors.

***Loxosporopsis corallifera* Brodo & Henssen**

CANADA. British Columbia. Selkirk Mountains, Goat Range, Wilson Falls, 31 Aug 2002, *Spribille 12022* (UBC); same

locality, 7 Aug 2004, T. Spribille 15574 & V. Wagner (UBC); Incomappleux River drainage, Boyd Creek about East Fish River Rd. bridge, 50°54'N, 117°34.5'W, in box canyon above whitewater with heavy wet canyon wind, 560 m, 22 Aug 2005, *Spribille 17770* (UBC).

A coastal species described by Brodo & Henssen (1995) from the Haida Gwaii and extending from Alaska to Oregon. These are the first published inland records.

***Nephroma occultum* Wetmore**

CANADA. British Columbia. Kootenay Trench, north end of Duncan Lake, Hall Creek, 15 Sept 2002, *Spribille 12418* (UBC); Goat Range, Kuskanax River just upstream of confluence with Gardner Creek, 50°17.3'N, 117°43.2'W, on *Alnus* bark at river edge, 695 m, 19 Oct 2009, *Spribille 32210* (UBC).

Nephroma occultum is a rare species confined to old forests of the coast and inland rainforests and has been a species of concern under the Committee for the Status of Endangered Wildlife in Canada (COSEWIC 2006). In inland British Columbia, it is known from several localized old-growth sites mainly along the windward slopes of the Columbia Mountains and in the Robson Valley (COSEWIC 2006). The only localities outside of these, the southern and easternmost localities in inland British Columbia, are in the vicinities of waterfalls and whitewater near Duncan Lake and the town of Nakusp (the latter the new southernmost record in inland British Columbia).

***Opegrapha zonata* Körber**

CANADA. British Columbia. Quesnel/Shuswap Highlands, Clearwater Valley, Sabretooth Rapids of the Clearwater River, on siliceous rock in the cooling mist influence of the river, 425 m elev., 51° 41'N 120° 2.5'W, 26 May, 2006, *Björk 12789a* (UBC); Selkirk Mountains, falls of the Kuskanax River above hot springs resort, 50°17.8'N, 117°40.7'W, 884 m, 17 Oct 2009, *Spribille 32085* (CANL, sub *Haematomma ochroleucum*).

Reported as new to North America by Tønsberg & Brodo (1992) from along a river in Nova Scotia and first reported for British Columbia by Aptroot (1996), also from a waterfall (Cypress Falls, near Vancouver). The above records are the first from interior western North America.

***Pseudocyphellaria crocata* (L.) Vainio**

CANADA. British Columbia. Cariboo Mountains, Azure Lake, Rainbow Falls, on *Tsuga* twig in waterfall spray zone, 680 m elev., 52° 23'N, 119° 58'W, 5 August, 1992, *Goward 92-1132* (UBC).

First reported from inland British Columbia by Spribille (2002) from two waterfall spray zones in the Kootenay region, and still one of the rarest inland macrolichens.

***Pseudocyphellaria mallota* (Tuck.)**

H. Magn.

CANADA. British Columbia. Goat Range, Kuskanax River just upstream of confluence with Gardner Creek, 50°17.3'N, 117°43.2'W, on *Tsuga heterophylla* twig, 695 m, 19 Oct 2009, *Spribille 32208* (CANL).

New for British Columbia. This species was only first confirmed as new to North America by Tønberg (1999) from the Olympic Peninsula, Washington. It has since been found in Oregon (McCune & Geiser 2009) and reported (as “cf.”) from Juneau, Alaska by Krog (1968). We have found it in a few sites on the outer coast of British Columbia, the nearest of which is almost 500 km from the inland population.

***Psoroglaena stigonemoides* (Orange)
Henssen**

CANADA. British Columbia. Selkirk Mountains, Glacier National Park, Bear Creek Falls, on branch of fallen *Tsuga* in waterfall sprayzone, 870 m elev., 51° 18'N 117° 25'W, 6 August, 2005, *Goward 05-700* (UBC).

New to North America. Previous records are from maritime regions of western Europe. This peculiar species is well illustrated in Orange (1989). It is characterized by its mats or clusters of minute coralloid upgrowths that sometimes disintegrate into granules. Its cortex is distinctly papillate, at least at branch tips, and it contains an unknown green alga with a branching pattern that resembles that of *Stigonema*. Occasionally, pale tan perithecia are produced, though the specimen cited here is sterile. The spores are fusiform-elliptic, (13-) 16-21 x (4-) 5-6 microns, with 3-4 (-5) transverse septae. For its minute size and branching growth *P. stigonemoides* could be mistaken for moss protonemata.

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LITERATURE CITED

- Aptroot, A. 1996: New records of lichens and lichenicolous fungi from British Columbia. *The Bryologist* 99(2): 196-198.
- Brodo, I.M. 2008. *Haematomma* (Lecanoraceae) in North and Central America, including the West Indies. *The Bryologist* 111: 363-423.
- Brodo, I.M. & Henssen, A. 1995. A new isidiate crustose lichen in northwestern North America. - In: Farkas, E.E., Lücking, R. & Wirth, V. (eds.): *Scripta Lichenologica - Lichenological Papers Dedicated to Antonín Vězda*. Bibliotheca Lichenologica, J. Cramer, Berlin, Stuttgart, pp. 27-41.
- Cordeiro, N.J., Lovett, J.C., Mulungu, E. 2006. Initial trends of bird assemblages before and after river diversion in an endemic-rich African forest. *Biodiversity and Conservation* 15: 971-983
- COSEWIC 2006. COSEWIC assessment and update status report on the cryptic paw *Nephroma occultum* in Canada. Committee on the Status of Endangered Wildlife in Canada. Ottawa. vi + 28 pp. (www.sararegistry.gc.ca/status/status_e.cfm).
- Goward, T. 1994. Notes on oldgrowth-dependent epiphytic macrolichens in the humid oldgrowth forests in inland British Columbia, Canada. *Acta Botanica Fennica* 150: 31-38.
- Goward, T. 1999. *The Lichens of British Columbia, Illustrated Keys. Part 2, Fruticose Species*. - British Columbia Ministry of Forests, Victoria. 319 pp.

- Goward, T. & C.R. Björk. 2009. Wilf Schofield: a waterfall tribute. Botanical Electronic News #404. <http://www.ou.edu/cas/botany-micro/ben/ben404.html>
- Goward, T., McCune, B., Meidinger, D. 1994. *The Lichens of British Columbia. Illustrated Keys. Part 1 - Foliose and Squamulose Species.* - Special Report Series, 8, Research Program, B.C. Ministry of Forests, Victoria. 181 pp.
- Harris, R.C. 1975. A taxonomic revision of the genus *Arthopyrenia s. lat* in North America. PhD dissertation. Michigan State University. East Lansing. 288 pp.
- Krog, H. 1968. The macrolichens of Alaska. *Norsk Polarinstitut Skrifter* 144: 1-180.
- McCune, B. & L. Geiser. 2009. *Macrolichens of the Pacific Northwest.* Oregon State University Press. Corvallis. 464 pp.
- Odland, A., Birks, H.H., Botnen, A., Tønsberg, T. 1991. Vegetation change in the spray zone of a waterfall following river regulation in Aurland, western Norway. *Regulated Rivers: Research and Management* 6: 147-162.
- Orange, A. 1989. *Macentina stigonemoides* (Verrucariaceae), a new lichenized species from Great Britain and Ireland. *The Lichenologist* 21: 229-236.
- Pérez-Ortega, S. & T. Spribille. 2009. Three new species of *Lichinopeltella* (Microthyriaceae: Ascomycota) from northwest North America. *Nova Hedwigia* 89: 219-228.
- Quinn, C.H., Ndangalasi, H.J., Gerstle, Lovett, J.C. 2005. Effect of the Lower Kihansi Hydropower Project and post-project mitigation measures on wetland vegetation in Kihansi Gorge, Tanzania. *Biodiversity and Conservation* 14: 297-308.
- Sillett, S. C., B. McCune, J. E. Peck, T. R. Rambo, and A. Ruchty. 2000. Dispersal limitations of epiphytic lichens result in species dependent on old-growth forests. *Ecological Applications* 10:789-799.
- Spribille, T. 2002. *Pilophorus clavatus* and *Pseudocyphellaria crocata* new to the interior of western North America. - *Evansia* 19(3): 81-82.
- Spribille, T., Björk, C.R., Ekman, S., Elix, J.A., Goward, T., Printzen, C., Tønsberg, T., Wheeler, T. 2009. Contributions to an epiphytic lichen flora of northwest North America. I. Eight new species from British Columbia inland rainforests. *The Bryologist* 112: 109-137.
- Tønsberg, T. 1999. *Pseudocyphellaria arvidssonii* new to Africa and *P. mallota* new to North America. - *The Bryologist* 102: 128-129.
- Tønsberg, T., Brodo, I.M. 1992. *Enterographa zonata* and *Opegrapha gyrocarpa* new to North America. - *The Bryologist* 95: 225-226.
- Vevele, O. 1975. *Stereocaulon coniophyllum* in Norway. - *Norwegian Jour. Bot.* 22: 133-137
- Zilihona, I.J.E., Nummelin, M. 2001. Coleopteran diversity and abundance in different habitats near Kihansi waterfall, in the Udzungwa Mountains, Tanzania. *Biodiversity and Conservation* 10: 769-777.