RHODORA, Vol. 120, No. 983, pp. 229–253, 2018

doi: 10.3119/17-27; first published on-line August 20, 2018.

THE LICHENS AND ALLIED FUNGI OF THE CREDIT RIVER WATERSHED, ONTARIO, CANADA

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ABSTRACT. The Credit River Watershed contains a mosaic of habitat types, which support a large number of lichen species; however, no detailed inventories of the lichen diversity in this region exist. We present a checklist of 124 species of lichens and allied fungi discovered in the watershed. We report new collections of *Illosporium carneum, Microcalicium ahlneri,* and *Pseudoschismatomma rufescens*, which are provincially rare. In this checklist, twelve species are ranked as S1 (critically imperiled), S2 (imperiled), or S3 (vulnerable) in Ontario by the Natural Heritage Information Centre. Local municipalities and conservation authorities can use these baseline data to help monitor changes in populations and in determining areas of high biodiversity in the watershed.

Key Words: conservation, inventories, rare species, lichen diversity

Sound conservation strategies rely on understanding species distributions, abundances, life histories, and their susceptibility to environmental change. In recent years, biological surveys that include lichens have produced regional inventories in southern Ontario to address gaps in this fundamental knowledge (Brodo et al. 2013; McMullin and Lendemer 2016; McMullin and Lendemer 2013; McMullin and Lewis 2014; McMullin et al. 2014). Furthermore, these lichen inventories have resulted in range extensions, new provincial and national records (Lewis and Brinker 2017; McMullin and Lewis 2013; McMullin et al. 2015). The inventories contribute to the biological and ecological information on lichen occurrence, which can be used to identify sensitive ecosystems and rare species assemblages (Credit Valley Conservation 2011). This allows for more comprehensive environmental and ecological assessments including the implementation of long-term monitoring programs.

Surveys of lichens in Ontario have generally been conducted in mature, undisturbed natural areas outside of human settlements where

a high diversity of species can often be found (Brodo et al. 2013; Matthes et al. 2000; McMullin and Lendemer 2013; McMullin and Lewis 2014; Selva 2005; Wong and Brodo 1973, 1992). However, since most lichen studies are initiated in relatively undisturbed natural areas, a potential data gap remains for landscapes with historical anthropogenic disturbance. Greenspaces in urban and rural areas are still capable of harbouring a rich lichen biota and surveying these important areas of refuge will allow for a more comprehensive understanding of both the rarity and distribution of lichens across the province (McMullin and Lendemer 2013; McMullin et al. 2014).

The Credit River Watershed contains a mosaic landscape, representing heterogeneous habitat types, both common and uncommon in southern Ontario. This region is where both the Niagara Escarpment and the Oak Ridges Moraine intersect, a feature seldom found elsewhere in the province (Chapman and Putnam 1984). The habitat types found at these landforms could potentially support a large number of lichen species; yet, no comprehensive surveys have been conducted to document the lichen diversity in this area (Credit Valley Conservation 2011). As the watershed is situated in one of the most heavily populated and developed regions of Canada, factors such as declining air quality, habitat loss, and habitat degradation are likely to cause significant changes to the species composition of these lichen communities (Bates and Sizto 1987, 1989; Henderson 2000; Larsen et al. 2007; McMullin et al. 2016). Understanding the lichen species present in this region can support strategies which aim to protect the biodiversity and integrity of the watershed's ecosystems and communities. This checklist is a beginning in generating fundamental knowledge that supports this understanding.

The aim of this study was to inventory the lichens and allied fungi in the Credit River Watershed and identify which of these lichen species are of high conservation concern in Ontario. The results from this study will contribute to the body of knowledge about lichen diversity on landscapes with a history of human disturbance.

MATERIALS AND METHODS

Study site. The Credit River Watershed is located in southern Ontario west of Toronto (Figure 1). The watershed spans over parts of 11 municipalities, and totals over 860 square kilometers in size (Credit Valley Conservation 2011). The Credit River runs through the watershed from north to south and is almost 90 kilometers long, with nearly 1500 kilometers of streams and creeks draining into it. The

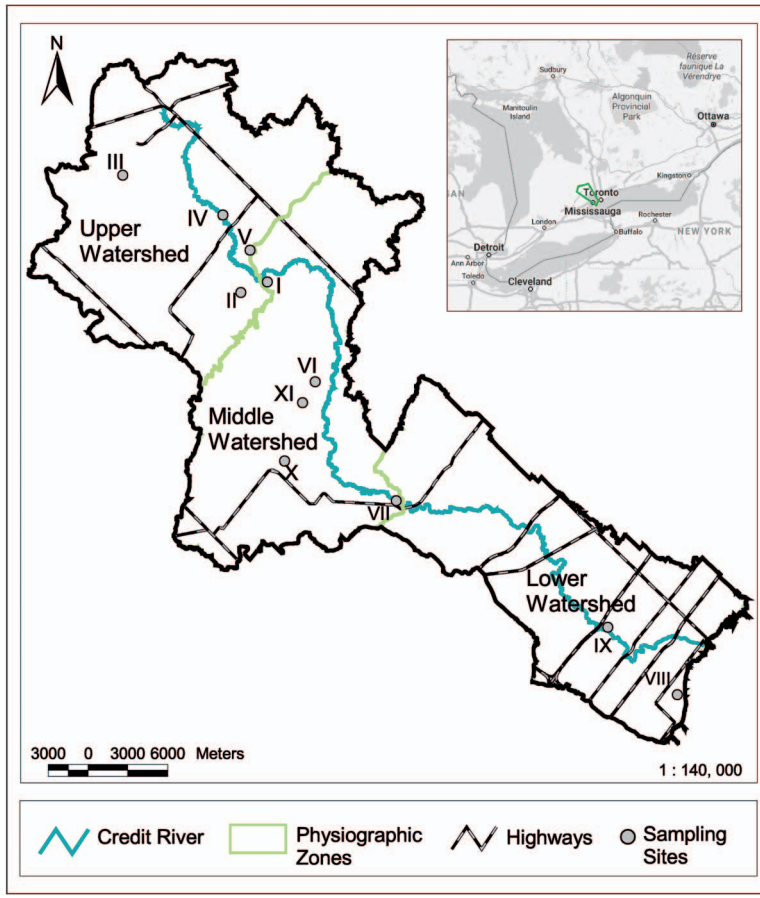

Figure 1. The location and boundary of the Credit River Watershed in Ontario and the 11 major collection sites within the watershed.

Niagara Escarpment and the Oak Ridges Moraine are also prominent provincial features that cross this landscape (Chapman and Putnam 1984). The Credit Valley Conservation (2011) lists three physiogeographic zones within the watershed based on the three broad physiogeographic regions that Chapman and Putnam (1984) describe: 1) the Upper Watershed (located above the Niagara Escarpment), 2) the Middle Watershed (encompassing the Niagara Escarpment and Oak Ridges Moraine), and 3) the Lower Watershed (below the Escarpment). The Upper Watershed is characterized by permeable

sandy loam soils, which support high groundwater recharge rates, whereas the Lower Watershed is comprised of clay loam soils with low permeability (Credit Valley Conservation 2011). Both types of soil are found in the Middle Watershed (Credit Valley Conservation 2011).

In the Credit River Watershed, the Deciduous Forest region meets the Great Lakes-St. Lawrence Forest region. Despite the substantial size of the watershed, only 35% of the land cover classifies as wetland, forest, cultural forest, successional, aquatic and other natural land, while the other 65% consists of urban, agriculture, or open space land use (Credit Valley Conservation 2011). The Upper Watershed primarily encompasses vegetation communities consisting of deciduous forests and white cedar swamps, where the main land use in the area has traditionally been agricultural (Credit Valley Conservation 2011). The Middle Watershed is also heavily forested with deciduous forests and white cedar swamps. The average slopes exceed 0.5m/km in this region and also contains some areas of exposed Escarpment with sharply defined cliff faces. In contrast to the other two regions, the Lower Watershed is highly urbanized with few natural woodlands and wetlands remaining. In this zone, there are also several creeks that drain directly into Lake Ontario.

Between 1981 and 2010, the mean annual rainfall in the Credit River Watershed was 741.5mm, with a mean annual snowfall of 135.9cm (Environment Canada 2017). A greater amount of precipitation was found in the northern regions of the watershed because of the effects of the Niagara Escarpment on storms originating from Lake Ontario. In addition, the mean air temperature in January from this timeframe was -6.3 (±3.2) °C; while in July, the mean air temperature was 20.0 (±1.3) °C (Environment Canada 2017).

Sampling. Between June 2016 and October 2017, the Credit River Watershed was inventoried for lichen and allied fungi diversity. Eleven locations encompassing all three physiographic zones and a wide range of vegetation community and habitat types were sampled (Figure 1; Table 1). Specimens were collected following the floristic habitat sampling methodology described by Newmaster et al. (2005). The nature of this sampling methodology allowed for greater capture of lichen and allied fungi species diversity, in comparison to small plot-based sampling protocols.

Identification and storage. Lichen specimens collected from the watershed were identified morphologically and chemically using stereo and compound microscopes, and an ultraviolet light chamber. Chemical spot tests were conducted with solutions of Lugol's iodine,

nitric acid, para-phenylenediamine in ethyl alcohol, 10% potassium hydroxide, and sodium hypochlorite (Brodo et al. 2001). Any unresolved specimens were examined with thin-layer chromatography following Culberson and Kristinsson (1970) and Orange et al. (2001) to determine additional chemical constituents for species identification. Selected specimens were photographed using a Hirox KH-7700 digital microscope. Vouchers were deposited in the Canadian Museum of Nature (CANL) in Gatineau, Québec, and in the Biodiversity Institute of Ontario Herbarium (OAC) at the University of Guelph in Guelph, Ontario.

RESULTS

We report 124 species of lichen and allied fungi in 83 genera from the Credit River Watershed (Appendix). Previous to this study, only 16 species of lichen were collected within the watershed (CNALH 2017). Five of these species: *Bacidia schweinitzii*, *Catinaria laureri*, *Lobaria quercizans*, *Peltigera leucophlebia*, and *Phaeophyscia orbicularis*, were not found in this study.

Twelve of the species found in this study are provincially rare (Table 2), ranked as S1 (critically imperiled), S2 (imperiled), or S3 (vulnerable) by the Natural Heritage Information Centre (NHIC) at the Ontario Ministry of Natural Resources (2017). Additionally, the 21 species that were either not ranked or not listed in the NHIC database (Ontario Ministry of Natural Resources 2017) are: *Arthonia caudata*, *Arthonia helvola*, *Athallia pyracea*, *Chaenotheca balsamconensis*, *Chaenotheca xyloxena*, *Dictyocatenulata alba*, *Diplotomma venustum*, *Illosporiopsis christiansenii*, *Illosporium carneum*, *Julella fallaciosa*, *Lecania croatica*, *Lecanora sambuci*, *Lecanora thysanophora*, *Lepraria finkii*, *Microcalicium ahlneri*, *Myriolecis semipallida*, *Ovicuculispora parmeliae*, *Protoparmelia hypotremella*, *Pseudoschismatomma rufescens*, *Rinodina freyi*, and *Xanthoria parietina*.

Noteworthy reports for Ontario. We report *Illosporium carneum* (Figure 2A) for the first time in Ontario, in almost 50 years. The first collection from the province was made by Irwin Brodo in 1969 in Moosonee, from the District of Cochrane (Figure 2B). This lichenicolous species is characterized by pale pink conidia that are erumpent through the upper cortex of the host thallus (Hawksworth 1979). In this study, this species was found in a coniferous swamp parasitizing *Peltigera elisabethae*.

Our records of *Microcalicium ahlneri* (Figure 2C) represent the second collection for this species in Ontario. The first record was made

Table 1. The major lichen collection sites in the Credit River Watershed. The roman numerals correspond with the map (Figure 1) and collections listed in the annotated species list. The descriptions for the vegetation community types visited follow the southern Ecological Land Classification for Ontario (Lee et al. 1998).

Site Number	Name	Latitude	Longitude	Vegetation Community Types
I	Belfountain (Escarpment)	43.801226	-79.987994	• Dry-Fresh White Cedar Carbonate Treed Talus • White Cedar Treed Carbonate Cliff • Dry-Fresh White Cedar - White Birch Mixed Forest
II	Belfountain Conservation Area	43.794201	-80.012901	• Dry-Fresh White Cedar - Hardwood Mixed Forest • Fresh-Moist White Cedar - Sugar Maple Mixed Forest
III	Caledon Lake Forest	43.874991	-80.122553	• Fresh-Moist Balsam Fir - Hardwood Mixed Forest • White Cedar - Conifer Organic Coniferous Swamp
IV	Charles Sauriol Conservation Area	43.847151	-80.029204	• White Cedar - Hardwood Organic Mixed Swamp • Fresh-Moist White Cedar - Sugar Maple Mixed Forest
V	Forks of the Credit Provincial Park	43.824847	-80.003568	• Alder Organic Thicket Swamp • Fresh-Moist Sugar Maple - Hardwood Deciduous Forest • White Cedar Organic Coniferous Swamp
VI	Jacquith Property	43.734705	-79.944041	• Fresh-Moist Poplar Deciduous Forest • Dry-Fresh Sugar Maple - White Birch - Poplar Deciduous Forest

Table 1. Continued.

Site Number	Name	Latitude	Longitude	Vegetation Community Types
VII	Norval Upper Canada College	43.653349	-79.869807	• Fresh-Moist Black Walnut Lowland Deciduous Forest • Mixed Conifer Coniferous Plantation • Reed Canary Grass Mineral Meadow Marsh
VIII	Rattray Marsh Conservation Area	43.518511	-79.609408	• Dry-Fresh Oak - Red Maple Deciduous Forest • Dry-Fresh White Ash Deciduous Forest
IX	Riverwood Park	43.565095	-79.673650	• Narrow-leaved Cattail Mineral Shallow Marsh • Dry-Fresh Sugar Maple - Hardwood Deciduous Forest
X	Silver Creek Conservation Area	43.681244	-79.973913	• Dry-Moist Old Field Meadow • White Cedar - Hardwood Mineral Mixed Swamp • Broad-leaved Cattail Mineral Shallow Marsh
XI	Terra Cotta Conservation Area	43.720618	-79.956101	• Dry-Fresh Sugar Maple - Hemlock Mixed Forest • Dry-Fresh Sugar Maple - Oak Deciduous Forest

by Selva in 2005 in southern Ontario, from the White Lakes region (Figure 2D). This species is distinguished from the other species within the genus by having stalked apothecia (0.2–0.3 mm tall) with a warty textured surface, and having mazaedia extruding well past the excipulum (Selva 2014). Specimens collected were lignicolous on *Betula papyifera* Marshall and *Thuja occidentalis* L., and corticolous on *Tsuga*

Table 2. List of 12 lichen species that are of high conservational concern in Ontario and are protected under the Provincial Policy Statement (Ontario Ministry of Municipal Affairs and Housing 2014).

S-Rank	Species Name
S1 (critically imperiled)	*Acrocordia cavata* (Ach.) R.C. Harris
	Chaenothecopsis savonica (Räsänen) Tibell
S1S2 (critically imperiled-imperiled)	*Blastenia ferruginea* (Huds.) A. Massal.
	Chaenothecopsis pusiola (Ach.) Vain.
S2S3 (imperiled-vulnerable)	*Chaenothecopsis debilis* (Sm.) Tibell
	Flavopunctelia soredica (Nyl.) Hale
	Micarea prasina Fr.
	Phaeocalicium polyporaeum (Nyl.) Tibell
S3 (vulnerable)	*Catillaria nigroclavata* (Nyl.) J. Steiner
	Coenogonium pineti (Ach.) Lücking & Lumbsch
	Placidium squamulosum (Ach.) Breuss
	Sphinctrina anglica Nyl.

canadensis (L.) Carrière. Furthermore, our collections were from mixed forests along a talus slope, and from conifer dominated swamps.

Pseudoschismatomma rufescens (Figure 2E) has been previously collected five times in Canada, with two of these collections made in Ontario from Bruce and Hastings County (Figure 2F). This species is mainly temperate, and with a widespread distribution, typically found on the smooth bark of deciduous trees. *Pseudoschismatomma rufescens* has short lirellae with a distinctive brown excipulum and harbours the alga *Trentepohlia* as a photobiont (Ertz et al. 2015). The single collection of this species from the watershed was in Silver Creek Conservation Area on the peeling bark of *Betula alleghaniensis* Britt.

DISCUSSION

The Credit River Watershed was found to support a number of lichens and allied fungi species, including species that have high conservational concern or have little documentation within the province. Although *Bacidia schweinitzii* (Fr. ex Tuck.) A. Schneid., *Catinaria laureri* (Hepp ex Th. Fr.) Degel., *Peltigera leucophlebia* (Nyl.) Gyeln., and *Phaeophyscia orbicularis* (Neck.) Moberg were not found in this study, these species have a widespread distribution, and most are likely still present within the region (CNALH 2017). However, *Lobaria quercizans* Michx. may no longer be present as it is a large conspicuous

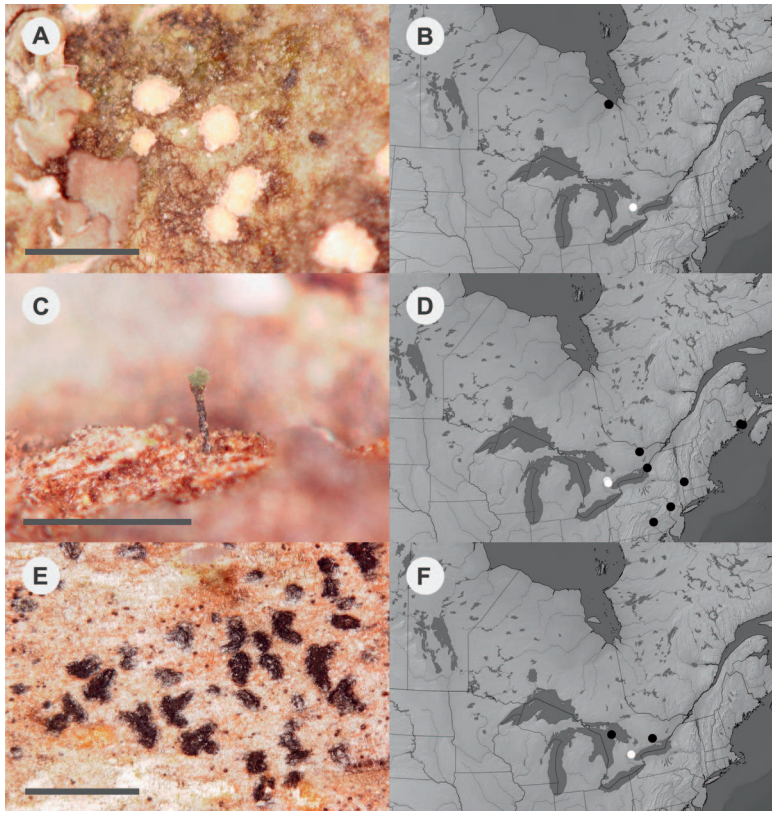

Figure 2. Photographs, and the distribution maps of Ontario and surrounding regions for *Illosporium carneum* (A, B), scale bar=0.5mm; *Microcalicium ahlneri* (C, D), scale bar=0.5mm; and *Pseudoschismatomma rufescens* (E, F), scale bar=1.0mm. White markers represent new records, and black markers are previous collections.

species that is unlikely to be overlooked and it is considered pollution sensitive (Will-Wolf et al. 2015).

Other biological inventories within southern Ontario have documented substantially higher species richness in comparison to this study (Brodo et al. 2013; McMullin and Lendemer 2013; McMullin and Lendemer 2016; McMullin and Lewis 2014). Lichen surveys at the Bruce Peninsula National Park and Fathom Five National Marine Park, Copeland Forest Resource Management Area, Awenda Provincial Park, and Sandbanks Provincial Park documented 365, 203, 156, and 128 lichen and allied fungi species, respectively (Brodo et al. 2013; McMullin and Lendemer 2013;

McMullin and Lendemer 2016; McMullin and Lewis 2014). Furthermore, McMullin et al. (2014) discovered 104 species within 165 ha of an urban setting. However, the poorer air quality and history of human disturbance are likely the primary reasons for the lower species richness documented in this study, as the Credit River Watershed is the closest in proximity to any major cities in comparison to the other inventories (Bates and Sizto 1989; Credit Valley Conservation 2011).

The three species highlighted in this study all have unranked status. These species are inconspicuous in size and morphology, becoming difficult to detect in floristic inventories. The distribution of *Illosporium carneum* in eastern North America is largely unknown because of the paucity of collections (CNALH 2017). *Microcalicium ahlneri* is likely under reported in the province because of the diversity of substrates and habitat types it was found on in this study. Lastly, the limited knowledge on the distribution of *Pseudoschismatomma rufescens* in Ontario may lead to this species going unnoticed in surveys (CNALH 2017).

Despite the Credit River Watershed's location in one of the most populated and fastest growing regions in Canada, it is still able to support provincially rare and unranked species in landscapes with a history of human disturbance. This could be attributed to the conservation efforts implemented by the Credit Valley Conservation Authority which involves the inventory and monitoring of sensitive or unique habitats (Credit Valley Conservation 2011). These inventory and monitoring activities inform strategic land acquisitions and management programs to identify and protect these high quality natural areas (Credit Valley Conservation 2011). The results from this study can aid land managers in identifying areas of high conservation value and help with evaluating the overall health of the watershed.

ACKNOWLEDGMENTS. We would like to thank Christina Kovacs, Heather Lynn, and Joe Pearson for guidance and help on the Credit Valley Conservation Authority properties. We are grateful to Dave Ireland for the organization of the Ontario BioBlitz, and also Bill Elgie and Allie Abram for the organization of the Rare-Norval BioBlitz. We also thank Irwin Brodo for identification assistance. Finally, we express gratitude to Chris J. Lewis and an anonymous reviewer for their helpful comments to the manuscript.

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APPENDIX

LIST OF LICHEN SPECIES FOUND IN THE CREDIT RIVER WATERSHED

The lichen and allied fungi specimens reported below are sorted alphabetically by genus and species. The species preceded by a dagger ("†") are allied saprophytic fungi traditionally treated with lichens, whereas species preceded by one asterisk ("*") are lichenicolous fungi. Nomenclature follows the 21st edition of the North American Lichen Checklist (Esslinger 2016); any deviance from that list reflects the opinion of the authors. Taxonomic authorities generally follow Index Fungorum (2018). The roman numerals following collection numbers correspond to the georeferenced localities in Table 1.

The conservation status of each lichen species was determined from their respective Subnational Rank (S-rank) as assigned by the NHIC (Ontario Ministry of Natural Resources, 2017). These rankings account for number of occurrences, abundance, distribution, population trends, and threats when determining conservation status. The conservation status designation of each rank is: S1 = critically imperiled, S2 = imperiled, S3 = vulnerable, S4 = apparently secure, S5 = secure, SNR = 'not ranked' yet, and SU = 'unrankable' due to a lack of information (Ontario Ministry of Natural Resources 2017). Uncertain ranks are proceeded with a '?' and species that are not currently listed in the NHIC database were given a rank of SNR.

Species Name	Substrate	Collection Information	S-rank
Acarospora fuscata (Nyl.) Th. Fr.	Saxicolous on rock	*McMullin 17976*, II (CANL).	S5
Acarospora glaucocarpa (Ach.) Körb.	Saxicolous on calcareous rock	*McMullin 18001*, II (CANL). *Maloles 446*, I (CANL).	S4S5
Acrocordia cavata (Ach.) R.C. Harris	Corticolous on *Populus*	*McMullin 17910*, V (CANL).	S1
Alyxoria varia (Pers.) Ertz & Tehler Syn. *Opegrapha varia*	Corticolous on *Acer*	*McMullin 17973*, II; *17852*, V (CANL).	S4
Amandinea punctata (Hoffm.) Coppins & Scheid.	Corticolous on *Pinus strobus*, corticolous on branch, lignicolous on *Thuja occidentalis* fence post.	*McMullin 17877*, *17911*, *17923*, V (CANL).	S5

APPENDIX. CONTINUED.

Species Name	Substrate	Collection Information	S-rank
†*Arthonia caudata* Willey	Corticolous on *Pinus strobus*	*McMullin 18000*, II (CANL).	SNR
Arthonia helvola (Nyl.) Nyl.	Corticolous on mature *Betula alleghaniensis*	*McMullin 17938*, V; *17964*, II (CANL)	SNR
Arthonia radiata (Pers.) Ach.	Corticolous on *Acer*	*McMullin 17915*, V (CANL).	S5
Athallia holocarpa (Hoffm.) Arup, Frödén & Søchting Syn. *Caloplaca holocarpa*	Saxicolous on rock	*McMullin 17883*, V (CANL).	S5
Athallia pyracea (Ach.) Arup, Frödén & Søchting Syn. *Caloplaca pyracea.*	Corticolous on *Populus*	*McMullin 17928*, V (CANL). *Maloles 251*, X (OAC).	SNR
Bilimbia sabuletorum (Schreb.) Arnold	Bryicolous, saxicolous, corticolous on *Thuja occidentalis*	*McMullin 17979*, *17983*, II; *17886*, II; *17994*, XI (CANL). Maloles *277*, I; *285*, VI (OAC)	S5
Blastenia ferruginea (Huds.) A. Massal. Syn. *Caloplaca ferruginea.*	Saxicolous on cement	*McMullin 17958*, II (CANL).	S1S2
Caloplaca cerina (Hedw.) Th. Fr.	Corticolous on *Populus*	*McMullin 17930*, V (CANL). *Maloles 191*, X (OAC).	S5
Candelaria concolor (Dicks.) Arnold	Corticolous on *Acer*	*McMullin 17855*, *17867*, V; *17992*, X (CANL). *Maloles 303*, VIII; *304*, IX (OAC).	S5
Candelariella aurella (Hoffm.) Zahlbr.	Saxicolous on rock, saxicolous on cement	*McMullin 17957*, II; *17874*, V (CANL).	S5
Candelariella efflorescens R.C. Harris & W.R. Buck	Corticolous on fallen *Betula papyrifera*	*McMullin 17981*, II (CANL).	S5

APPENDIX. CONTINUED.

Species Name	Substrate	Collection Information	S-rank
Candelariella vitellina (Hoffm.) Müll. Arg.	Saxicolous on granite rock	*Maloles 310*, IX (OAC).	S5
Catillaria nigroclavata (Nyl.) J. Steiner	Corticolous on *Pinus strobus*, corticolous *Thuja occidentalis*, corticolous on branch	*McMullin 17878*, *17902*, *17912*, V (CANL).	S3
Chaenotheca balsamconensis J. L. Allen & McMullin	Fungicolous on polypore	*McMullin 17893*, V (CANL). *Maloles 224*, III; *241*, V (OAC).	SNR
Chaenotheca ferruginea (Turner) Mig.	Lignicolous on *Thuja occidentalis* snag	*Maloles 242*, V (OAC).	S4
Chaenotheca furfuracea (L.) Tibell	Lignicolous on *Thuja occidentalis* fence post, corticolous on conifer	*Maloles 234*, I; *201*, IV (OAC).	S4
Chaenotheca xyloxena Nádv.	Lignicolous on *Thuja occidentalis* snag, corticolous on *Betula papyifera*	*Maloles 233*, I; *194*, IV (OAC).	SNR
†*Chaenothecopsis debilis* (Sm.) Tibell	Lignicolous on snag, lignicolous on *Acer*, lignicolous on *Fraxinus* stump	*McMullin 17977*, X (CANL). *Maloles 185*, I; *213*, IV (OAC).	S2S3
†*Chaenothecopsis pusiola* (Ach.) Vain.	Lignicolous on *Picea glauca* snag with *Chaenotheca xyloxena*	*Maloles 287*, III; *262*, IV (OAC).	S1S2
†*Chaenothecopsis savonica* (Räsänen) Tibell	Lignicolous on fallen log	*Maloles 226*, I (OAC).	S1
Chrysothrix caesia (Flot.) Ertz & Tehler Syn. *Arthonia caesia*	Corticolous on *Quercus rubra*, corticolous on *Fraxinus*, corticolous on *Acer saccharum*, corticolous on *Rhamnus cathartica*	*McMullin 17960*, II; *17861*, V (CANL). *Maloles 228*, VI; *305*, VII (OAC).	S5
Cladonia chlorophaea (Flörke ex Sommerf.) Spreng.	Corticolous, saxicolous on a boulder	*McMullin 17906*, V (CANL). *Maloles 189*, I; *264*, IV (OAC).	S5
Cladonia fimbriata (L.) Fr.	Lignicolous on a log	*McMullin 17998*, II (CANL).	S5

APPENDIX. CONTINUED.

Species Name	Substrate	Collection Information	S-rank
Cladonia furcata (Huds.) Schrad.	On soil and bedrock with *Polytrichum*.	*Maloles 450*, VI (CANL).	S5
Cladonia macilenta var. *bacillaris* (Ach.) Schaer.	Lignicolous on a stump	*McMullin 17889*, II (CANL).	S5
Cladonia ochrochlora Flörke	Lignicolous on a stump, corticolous on base of tree	*McMullin 17889*, II; *17892*, *17907*, V; *17988*, X (CANL). *Maloles 190*, I (OAC).	S5
Cladonia pocillum (Ach.) O.J. Rich.	Terricolous on thin soil over calcareous rock	*McMullin 17995*, X (CANL)	S4S5
Cladonia pyxidata (L.) Hoffm.	Terricolous on boulder and bedrock	*Maloles 187*, I; *283*, X (OAC).	S5
Cladonia rangiferina (L.) Weber ex F.H. Wigg.	Saxicolous on bedrock	*Maloles 229*, VI (OAC).	S5
Cladonia rei Schaer.	Terricolous on thin soil on *Thuja occidentalis* fence rail, lignicolous on coniferous log	*McMullin 17921*, V (CANL). *Maloles 211*, IV; *268*, X (OAC).	S5
Cladonia cervicornis ssp. *verticillata* (Hoffm.) Ahti	Terricolous on soil	*Maloles 218*, V (OAC).	S4S5
Coenogonium pineti (Ach.) Lücking & Lumbsch	Lignicolous on burnt stump, terricolous on soil	*McMullin 17895*, *17896*, V (CANL).	S3
Cresponea chloroconia (Tuck.) Egea & Torrente	Corticolous on *Abies balsamea*	*Maloles 447a*, V (OAC).	S4
Cyphelium tigillare (Ach.) Ach.	Lignicolous on old *Thuja occidentalis* fence post	*McMullin 17926*, V (CANL). *Maloles 220*, III (OAC).	S4

APPENDIX. CONTINUED.

Species Name	Substrate	Collection Information	S-rank
Dictyocatenulata alba Finley & E.F. Morris	Corticolous on mature *Betula alleghaniensis*, corticolous on *Betula papyifera* snag	*McMullin 17965*, II; *17937*, V (CANL). *Maloles 275*, IV (OAC).	SNR
Diplotomma venustum (Körb.) Körb.	Saxicolous	*McMullin 17968*, II (CANL).	SNR
Evernia mesomorpha Nyl.	Corticolous on dead *Rhus typhina* branch, corticolous on deciduous snag, corticolous on *Abies balsamea*	*McMullin 17978*, II; *17939*, V (CANL). *Maloles 195*, IV; *288*, X (OAC).	S5
Flavoparmelia caperata (L.) Hale	Corticolous on *Acer*, corticolous on exposed *Ulmus americana*	*McMullin 17866*, *17933*, V; *17989*, X (CANL). *Maloles 208*, IV (OAC).	S5
Flavopunctelia flaventior (Stirt.) Hale	Lignicolous on *Thuja occidentalis* fence rail, corticolous on deciduous branch	*McMullin 17924*, V (CANL). *Maloles 207*, IV (OAC).	S5
Flavopunctelia soredica (Nyl.) Hale	Corticolous on large exposed *Fraxinus*, corticolous on *Picea glauca* branch	*McMullin 17949*, V (CANL). *Maloles 209*, IV (OAC)	S2S3
Graphis scripta (L.) Ach.	Corticolous on *Acer*	*McMullin 17916*, V; *17991*, X (CANL). *Maloles 244*, V; *300*, VIII (OAC).	S5
Gyalecta jenensis (Batsch) Zahlbr.	Saxicolous on calcareous rock	*McMullin 17980*, II (CANL).	S4
Gyalolechia flavovirescens (Wulfen) Søchting, Frödén & Arup Syn. *Caloplaca flavovirescens*	Saxicolous	*McMullin 17969*, II; *17887*, V (CANL).	S5
Hyperphyscia adglutinata (Flörke) H. Mayrhofer & Poelt	Corticolous on *Acer*	*McMullin 17865*, V (CANL).	S4

APPENDIX. CONTINUED.

Species Name	Substrate	Collection Information	S-rank
Hypocenomyce scalaris (Ach. ex Lilj.) M. Choisy	Lignicolous on stump	*Maloles 217*, IV (OAC).	S5
Hypogymnia physodes (L.) Nyl.	Corticolous on *Abies balsamea*	*Maloles 197*, IV (OAC).	S5
**Illosporiopsis christiansenii* (B.L. Brady & D. Hawksw.) D. Hawksw.	Lichenicolous on *Physcia*, on dead *Quercus rubra* branches	*McMullin 17940*, V (CANL).	SNR
**Illosporium carneum* Fr.	Lichenicolous on *Peltigera*	*Maloles 441a*, IV (OAC).	SNR
†*Julella fallaciosa* (Stizenb. ex Arnold) R.C. Harris	Corticolous on *Acer*, corticolous on *Betula papyifera*	*McMullin 17982*, II; *17943*, V; *17996*, XI (CANL). *Maloles 307*, VIII; *308* IX (OAC).	SNR
Lecania croatica (Zahlbr.) Kotlov	Corticolous	*McMullin 17909*, V (CANL).	SNR
Lecanora hybocarpa (Tuck.) Brodo	Corticolous on deciduous snag, corticolous on *Thuja occidentalis* branch	*McMullin 17913*, V (CANL). *Maloles 212*, IV (OAC).	S4S5
Lecanora pulicaris (Pers.) Ach.	Corticolous on *Pinus strobus*	*McMullin 17999*, II (CANL).	S5
Lecanora sambuci (Pers.) Nyl.	Corticolous on *Populus*	*McMullin 17929*, V (CANL).	SNR
Lecanora symmicta (Ach.) Ach.	Lignicolous on old *Thuja occidentalis* fence post, corticolous on *Picea glauca* branch	*McMullin 17927*, V (CANL). *Maloles 281*, IV (OAC).	S5
Lecanora thysanophora R.C. Harris	Corticolous on *Acer saccharum*	*McMullin 17978*, V (CANL). *Maloles 265*, IV (OAC).	SNR

APPENDIX. CONTINUED.

Species Name	Substrate	Collection Information	S-rank
Lecidella stigmatea (Ach.) Hertel & Leuckert	Saxicolous on rock, saxicolous on cement	*McMullin 17956*, *17967*, II (CANL).	S5
Lepra amara (Ach.) Hafellner. Syn. *Pertusaria amara, Variolaria amara*	Corticolous on *Betula papyifera*	*Maloles 188*, I; *267*, IV (OAC).	S4S5
Lepraria finkii (B. de Lesd.) R.C. Harris	Lignicolous on stump	*McMullin 17890*, II (CANL).	SNR
Leptogium cyanescens (Rabenh.) Korb.	Saxicolous on rock	*Maloles 448*, VI; *231*, X (OAC).	S5
Melanelixia subaurifera (Nyl.) O. Blanco et al.	Saxicolous on rock, corticolous on dead *Rhus typhina* branch	*McMullin 17882*, *17944*, V (CANL).	S5
Micarea prasina Fr.	Corticolous on *Thuja occidentalis*	*McMullin 17905*, V (CANL).	S2S3
†*Microcalicium ahlneri* Tibell	Corticolous on *Tsuga canadensis*, lignicolous on *Betula papyifera* cavity, lignicolous on *Thuja occidentalis*	*Maloles 235*, I; *243* IV; *442a*, V; *269*, X (OAC).	SNR
Multiclavula mucida (Fr.) R.H. Petersen	Lignicolous on *Tsuga canadensis* log	*Maloles 193*, VII (OAC).	S4?
†*Mycocalicium subtile* (Pers.) Szatala	Lignicolous on decorticated stump, lignicolous on snag	*McMullin 17908*, *17948*, V (CANL). *Maloles 222*, X (OAC).	S4S5
Myelochroa aurulenta (Tuck.) Elix & Hale	Corticolous on *Acer*	*McMullin 17917*, V (CANL).	S5
Myriolecis semipallida (H. Magn.) Śliwa, Zhao Xin & Lumbsch Syn. *Lecanora semipallida*	Saxicolous on cement	*McMullin 17959*, II (CANL).	SNR

APPENDIX. CONTINUED.

Species Name	Substrate	Collection Information	S-rank
Myriolecis hagenii (Ach.) Śliwa, Zhao Xin & Lumbsch Syn. *Lecanora hagenii.*	Lignicolous on *Thuja occidentalis* fence rail	*McMullin 17925*, V (CANL).	S5?
Ochrolechia arborea (Kreyer) Almb.	Corticolous on *Thuja occidentalis*	*McMullin 17901*, V (CANL).	S4S5
†*Ovicuculispora parmeliae* (Berk. & M.A. Curtis) Etayo	Lichenicolous on *Physcia* on *Quercus rubra*	*McMullin 17863*, V (CANL).	SNR
Parmelia sulcata Taylor	Saxicolous, corticolous on snag, corticolous on exposed Ulmus.	*McMullin 17884*, *17932*, V; *17987*, X (CANL). *Maloles 203*, IV; *302*, IX (OAC).	S5
Peltigera canina (L.) Willd.	Terricolous on thin soil over bedrock, lignicolous on a log with bryophytes	*Maloles 261* IV; *250*, X (OAC).	S5
Peltigera elisabethae Gyeln.	Lignicolous on deciduous log	*Maloles 239*, IV (OAC).	S5
Peltigera evansiana Gyeln.	Terricolous, saxicolous on rock	*McMullin 17966*, *17984*, II (CANL). *Maloles 240*, I; *238*, VI (OAC).	S4
Peltigera praetextata (Flörke ex Sommerf.) Zopf	Terricolous on moss covered rock, saxicolous on a boulder, lignicolous on fallen log.	*McMullin 17972*, II (CANL). *Maloles 274* IV; *214*, VI (OAC).	S5
Peltigera rufescens (Weiss) Humb.	Terricolous	*McMullin 17880*, V (CANL).	S5
Pertusaria macounii (I.M. Lamb) Dibben	Corticolous on *Fagus grandifolia*	*McMullin 17997*, X (CANL).	S4
†*Phaeocalicium curtisii* (Tuck.) Tibell	Corticolous on *Rhus typhina* branches	*McMullin 17945*, V (CANL).	S5

APPENDIX. CONTINUED.

Species Name	Substrate	Collection Information	S-rank
†*Phaeocalicium polyporaeum* (Nyl.) Tibell	On polypore of a deciduous tree	*Maloles 227*, VI (OAC).	S2S3
†*Phaeocalicium populneum* (Brond. ex Duby) A.F.W. Schmidt	Corticolous on *Populus balsamifera* branches	*Maloles 200*, IV (OAC).	SU
Phaeophyscia adiastola (Essl.) Essl.	Bryicolous	*McMullin 17971*, II (CANL).	S4
Phaeophyscia pusilloides (Zahlbr.) Essl.	Corticolous on *Fraxinus*, corticolous on deciduous snag	*McMullin 17973*, II; *17947*, V (CANL). *Maloles 204*, IV (OAC).	S5
Phaeophyscia rubropulchra (Degel.) Moberg	Corticolous on *Acer saccharum*, corticolous on deciduous snag	*McMullin 17899*, II; *17986*, X (CANL). *Maloles 260*, IV; *306*, VII (OAC).	S5
Physcia adscendens H. Olivier	Corticolous on *Acer*, corticolous on *Malus*, corticolous on exposed *Ulmus*	*McMullin 17850*, *17920*, *17931*, V (CANL). *Maloles 272*, IV; *192*, X (OAC).	S5
Physcia aipolia (Ehrh. Ex Humb.) Fürnr.	Corticolous on *Fraxinus*, corticolous on snag	*McMullin 17897*, *17954*, *17962*, II; *17946*, V (CANL). *Maloles 278*, IV (OAC).	S5
Physcia dubia (Hoffm.) Lettau	Saxicolous	*McMullin 17853*, V (CANL).	S5
Physcia millegrana Degel.	Corticolous on *Acer*, corticolous on *Malus*, corticolous on *Fraxinus*	*McMullin 17963*, II; *17859*, *17919*, V (CANL). *Maloles 232*, X (OAC). *Maloles 301*, VIII (OAC).	S5
Physcia stellaris (L.) Nyl.	Corticolous on *Quercus rubra*.	*McMullin 17851*, V (CANL).	S5
Physciella chloantha (Ach.) Essl.	Corticolous on *Acer*, corticolous on *Fraxinus*	*McMullin, 17860*, *17941*, *17942*, V (CANL).	S4
Physconia detersa (Nyl.) Poelt	Corticolous on deciduous snag, corticolous on *Fraxinus nigra*	*McMullin 17898*, II (CANL). *Maloles 210*, IV (OAC).	S5

APPENDIX. CONTINUED.

Species Name	Substrate	Collection Information	S-rank
Physconia enteroxantha (Nyl.) Poelt	Corticolous on *Acer*, corticolous on *Fraxinus*, saxicolous on rock	*McMullin 17955*, II; *17856*, *17881*, V (CANL).	S4
Physconia perisidiosa (Erichsen) Moberg	Corticolous on *Fraxinus nigra*	*Maloles 216*, IV (OAC).	S4
Placidium squamulosum (Ach.) Breuss	Terricolous	*McMullin 17876*, V (CANL).	S3?
Placynthium nigrum (Huds.) Gray	Saxicolous	*McMullin 17970*, II; *17888*, V (CANL). *Maloles 443*, I (CANL).	S5
Polycauliona polycarpa (Hoffm.) Frödén, Arup, & Søchting Syn. *Xanthoria polycarpa*	Corticolous on *Acer*	*McMullin 17864*, V (CANL)	S4
Porpidia crustulata (Ach.) Hertel & Knoph	Saxicolous	*McMullin 17935*, V (CANL).	S5
Porpidia macrocarpa (DC.) Hertel & A.J. Schwab	Saxicolous on a boulder	*McMullin 17974*, II (CANL).	S4
Protoblastenia rupestris (Scop.) J. Steiner	Saxicolous	*McMullin 17975*, II; *17952*, V (CANL).	S5
Protoparmelia hypotremella Herk, Spier & V. Wirth	With *Sphinctrina anglica* on dead branch of a live *Thuja occidentalis*	*McMullin 17904*, V (CANL). *Maloles 270*, X (OAC).	SNR
Protoparmeliopsis muralis (Schreb.) M. Choisy Syn. *Lecanora muralis*	Saxicolous	*McMullin 17869*, *17873*, V (CANL).	S5
Pseudoschismatomma rufescens (Pers.) Ertz & Tehler	Corticolous on *Betula alleghaniensis*	*Maloles 445*, X (CANL).	SNR

APPENDIX. CONTINUED.

Species Name	Substrate	Collection Information	S-rank
Punctelia rudecta (Ach.) Krog	Saxicolous, corticolous on *Acer*, corticolous on *Thuja occidentalis*, corticolous on *Picea glauca* branch	*McMullin 17862*, *17885*, *17900*, V (CANL). *Maloles 215*, IV; *221*, VI (OAC).	S5
Ramalina intermedia (Delise ex Nyl.) Nyl.	Corticolous on *Abies balsamea*	*Maloles 444*, IV (OAC).	S5
Rinodina freyi H. Magn.	Corticolous on *Quercus rubra*	*McMullin 17950*, V (CANL).	SNR
Rufoplaca arenaria (Pers.) Arup, Søchting & Frödén Syn. *Caloplaca arenaria.*	Saxicolous on non-calcareous rock	*McMullin 17875*, V (CANL).	S5
Rusavskia elegans (Link) S.Y. Kondr. & Kärnefelt Syn. *Xanthoria elegans*	Saxicolous	*McMullin 17872*, V (CANL).	S5
Sarcogyne regularis Körb.	Saxicolous	*McMullin 17871*, V (CANL). *Maloles 299*, IX (OAC).	S5
†*Sarea resinae* (Fr.) Kuntze	Resinicolous on *Pinus strobus*	*Maloles 298*, V (OAC).	S5
Scoliciosporum chlorococcum (Graewe ex Stenh.) Vězda	Corticolous on a fallen branch of a deciduous snag.	*McMullin 17914*, V (CANL).	S5
Scoliciosporum umbrinum (Ach.) Arnold	Corticolous on *Quercus rubra*	*McMullin 17951*, V (CANL).	S4
Scytinium lichenoides (L.) Otálora, P.M. Jørg. & Wedin Syn. *Leptogium lichenoides*	Saxicolous with bryophytes	*McMullin 17990*, X (CANL).	S5
**Sphinctrina anglica* Nyl.	Lichenicolous on *Protoparmelia hypotremella*, on dead branch of a live *Thuja occidentalis*	*McMullin 17903*, V (CANL). *Maloles 223*, III (OAC).	S3

APPENDIX. CONTINUED.

Species Name	Substrate	Collection Information	S-rank
†*Stenocybe pullatula* (Ach.) Stein	Corticolous on *Alnus incana* branches	*McMullin 17985*, V (CANL). *Maloles 280*, IV (OAC).	SU
Stereocaulon saxatile H. Magn.	Saxicolous on calcareous rock	*Maloles 230*, VI (OAC).	S5
Trapelia placodioides Coppins & P. James	Saxicolous	*McMullin 17993*, XI (CANL).	S5
Usnea hirta (L.) Weber ex F.H. Wigg.	Corticolous on *Abies balsamea*	*Maloles 263*, IV (OAC).	S5
Verrucaria calkinsiana Servít	Saxicolous	*McMullin 17879*, V (CANL).	S5
Xanthomendoza fallax (Hepp ex Arnold) Søchting, Kärnefelt & S.Y. Kondr.	Corticolous on *Acer*, corticolous on *Fraxinus*	*McMullin 17961*, II; *17857*, V (CANL). *Maloles 202*, IV (OAC).	S5
Xanthoparmelia cumberlandia (Gyeln.) Hale	Saxicolous	*McMullin 17870*, V (CANL). *Maloles 259*, X (OAC).	S5
Xanthoria parietina (L.) Th. Fr.	Corticolous on *Acer*	*McMullin 17854*, V (CANL). *Maloles 199*, IV (OAC).	SNR