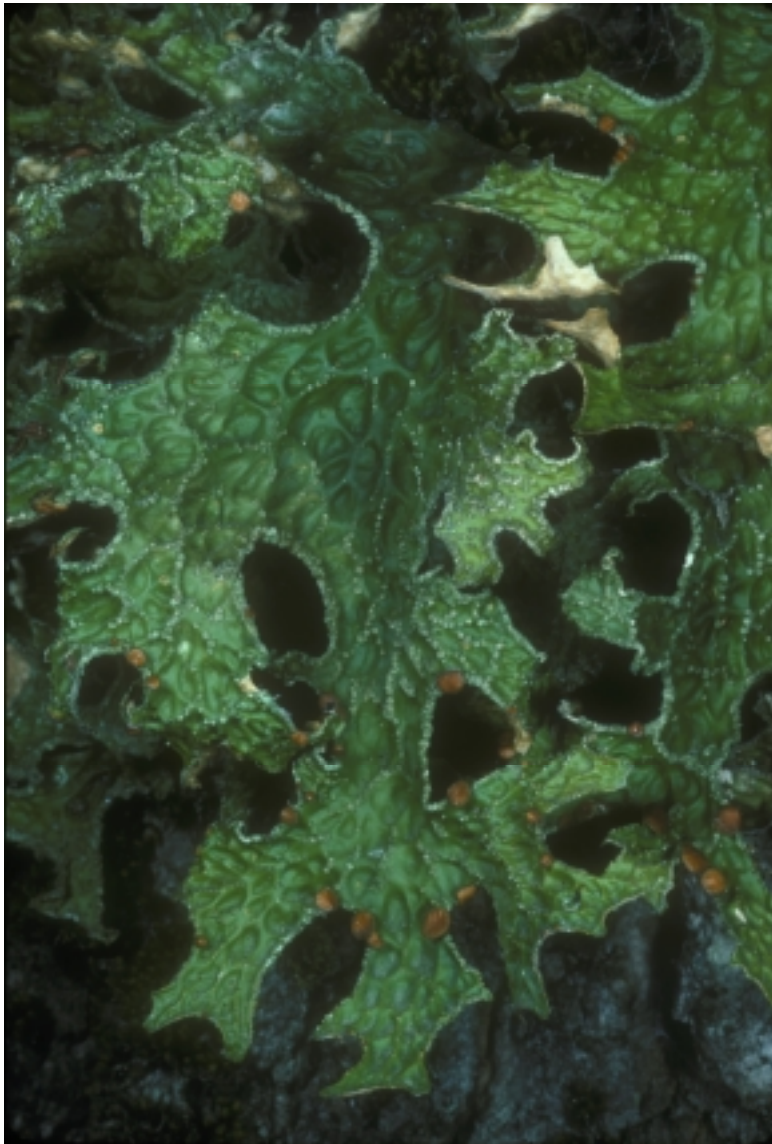


IDENTIFYING LICHENS OF NOVA SCOTIA

A REFERENCE GUIDEBOOK



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Ecological Monitoring and Assessment Network
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About this Reference Manual

The relationship of lichens as indicators of air pollution has been documented in hundreds of studies, from Britain to Scandinavia to Italy, and more recently, North America. By examining the species composition and abundance in an area, researchers can inexpensively determine the air quality in an area.

The Air Branch and Protected Areas Branch of the Nova Scotia Environment and Labour have established a province-wide network of permanent lichen monitoring sites. These sites have been set up in order to monitor air pollution in a relevant, measurable, efficient, inexpensive manner: by tracking changes in lichen diversity.

The suite of lichens in this manual was selected for the purposes of the provincial study. They were chosen based on their tolerance of air pollution, from intolerant to moderate to tolerant. The study focused on lichens found on the following maple trees:

Red maple (*Acer rubrum*)

Sugar maple (*A. saccharum*)

Silver maple (*A. saccharinum*)

Norway maple (*A. norvegicum*).

The lichens in this manual are only a few of the many species occurring in the lichen rich province of Nova Scotia. The high diversity is partly due to the maritime climate, which provides humid air and a diversity of habitats in which lichens can thrive. There are species of rare lichen found in Nova Scotia, including many species of pollution sensitive cyanolichens (those species with cyanobacteria as their photosynthetic symbiont). Historical (e.g., Ward, P. 1968. Lichens and air pollution in Halifax. *The Linnaea*. 2(13-18)) and more recent studies have shown that Nova Scotia's lichens – particularly the cyanolichens - are impacted by air pollution, as is the case for the endangered Boreal felt lichen (*Erioderma pedicellatum*). This particular species used to be more abundant in the province, with about 40 known locations in the 1970's, but has been so severely impacted by pollution that there are only nine locations known today. Because of this drastic decline, the Boreal felt lichen has been designated as Endangered in the province.

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***Cladonia* spp.**

Cladonia, pixie cups, powderhorn lichens

Description: Species in the genus *Cladonia* are two-part lichens. Development begins with a scaly (squamulose) primary thallus. The squamules making up the primary thallus (and therefore called primary squamules) vary greatly in size, the way the margins are subdivided and lobed, and production of soredia, but with rare exceptions, they are attached at one edge and have a white lower surface lacking a cortex or rhizines. Erect stalks (podetia) usually develop from the surface or edge of the squamules, but in specimens found on tree trunks, especially close to cities, podetia often do not develop, and so the entire lichen thallus is made up of nothing but masses of scale-like squamules. The podetia are always hollow, but they can be unbranched or highly branched; they can end in a cuplike structure or be blunt or pointed at the tip; they can be covered with squamules, soredia, or flat to rounded granules, or they can be quite smooth. Podetia normally have an outer cortex, an algal layer, and a stiff, cartilaginous, translucent to blackened, supporting layer called a stereome that lines the hollow interior. The podetia sometimes produce brown or bright red marginless apothecia at the tips, or on the cup margins. Photobiont green (*Trebouxia* or *Pseudotrebouxia*).

Chemistry: *Cladonia* species contain a wide variety of compounds. Some compounds that give positive spot tests (turning red, yellow or orange with bleaching solution, K or PD) can be useful for distinguishing the species. Perform spot tests on the lower surface of the squamules, sorediate patches, cup margins, or the thickest areas of medulla.

Habitat: On soil, peat, wood, bark, or rock, often mixed with mosses.

Comments: The primary squamules, in the absence of podetia, can resemble other squamulose or minutely foliose lichens, especially species of *Physcia*, which also have a white lower surface. *Cladonia* squamules, however, never produce rhizines, and they tend to be more overlapping and scale-like.



Cladonia chlorophaea

Collema subflaccidum

Tree jelly lichen

Description: Thallus dark olive to almost black, becoming jelly-like and translucent when wet; lobes large, rounded, mostly 2-6 mm across, with a smooth to folded or puckered surface, and with globular isidia that sometimes become cylindrical or even branched on old lobes. Apothecia rarely seen.

Chemistry: All spot tests negative; contains no lichen substances.

Habitat: On bark of hardwood and sometimes coniferous trees, especially in old forests; also on shaded or mossy rocks.

Comments: *Collema furfuraceum*, a somewhat larger jelly lichen (lobes 5-10 mm across), also occurs in Nova Scotia. It differs from *C. subflaccidum* in having distinct pustules and ridges, with the isidia (which are mainly cylindrical, not globular) mostly confined to the summits of the ridges and blisters. Rare specimens of *C. subflaccidum* have low, poorly defined blisters, but the isidia are globular and are distributed uniformly over the center of the thallus, not just on the ridges.



Hypogymnia physodes

Monk's-hood lichen, hooded tube lichen

Description: Thallus extremely variable, usually pale greenish grey and smooth; lobes hollow and tube-like, long or short, ascending or, less frequently, appressed, usually fanning out at the tips; lobe tips mostly 1-2.5 mm wide but can broaden to 5 mm; lower surface black, lacking any kind of rhizines; underside of lobe tips bursting open into lip-shaped soralia containing coarsely granular soredia; medullary ceiling usually white. Apothecia rare.

Chemistry: Medulla PD+ red, K+ slowly turning brownish red, KC+ pink, C- (physodalic, protocetraric, physodic, physodalic and 3-hydroxyphysodic acid.)

Habitat: On bark and wood, primarily of conifers; rarely on moss or soil.

Comments: This is one of the most common tree lichens in the conifer forests of North America. It is usually easy to identify because of its hood-like soralia at the lobe tips. Unfortunately, one often finds thalli that are almost devoid of soredia, but a diligent search usually uncovers one or two sorediate lobes. *Hypogymnia vittata*, which occurs in the Maritime Provinces, is a more slender, longer, more irregularly branched species also having lip- or hood-shaped soralia. It has a dark medullary ceiling, black margins, and a PD- medulla. It is much rarer than *H. physodes*. *Hypogymnia krogiae* is similar but usually lacks any kind of soralia and, instead, has round holes in the lobe tips. It also typically forms flattened rosettes on the bark, only rarely growing on twigs. [A rare sorediate form of *H. krogiae* also has lip-shaped soralia but still shows the holes in the non-sorediate lobe tips, and it has a slightly different chemistry from that of *H. physodes* (lacking 3-hydroxyphysodic acid and therefore not turning red-brown with K.)]



Lecanora conizaeoides

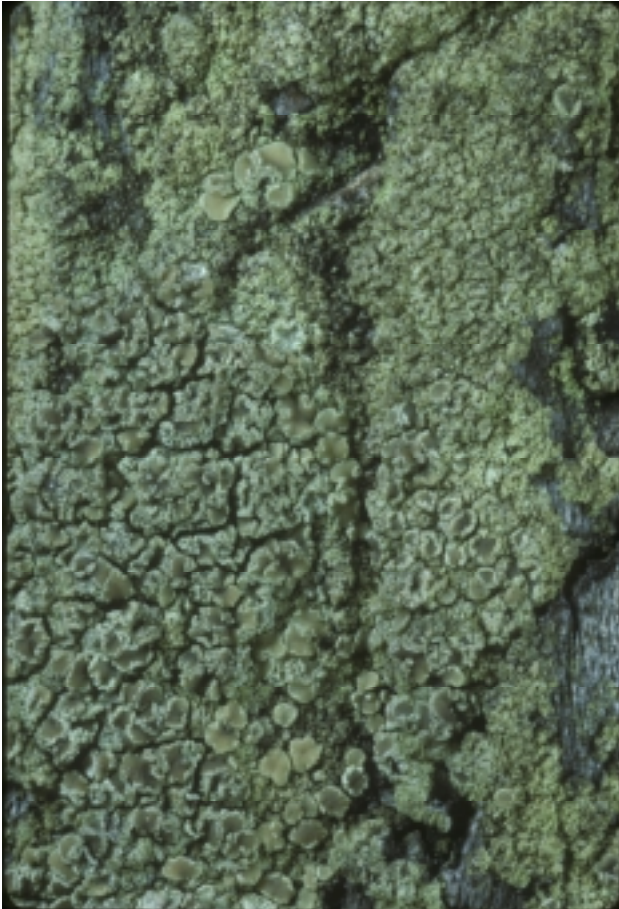
City rim lichen

Description. Thallus crustose, coarsely granular, the granules 0.07-0.3 mm in diameter, dissolving into soredia; thallus sometimes becoming almost entirely sorediate (leprose) but broken up into angular patches; pale, yellowish grey, sometimes overgrown with epiphytic algae giving it a darker, greenish tone. Apothecia frequently present, lecanorine (with a thallus-colored rim); disk flat, very pale orange to light pinkish brown, occasionally lightly pruinose; apothecial margin prominent, bumpy (verruculose) to granular, or sometimes remaining smooth, often wavy in outline (flexuose); spores colorless, 1-celled, ellipsoid, 10-12 x 5.5-7.0 μm .

Chemistry. Thallus cortex, medulla and soredia PD+ red, K- (although sometimes appearing to be K+ yellow), C-, KC- (fumarprotocetraric acid).

Habitat. On a variety of trees, especially elm, beech, maple and hickory, less frequently on conifers.

Comments. This is one of the most pollution-tolerant lichens known. In fact, in coastal regions, it tends to be more associated with cities than with rural landscapes and can be considered as an indicator of moderate levels of sulphur dioxide pollution. (Very high levels will kill even this lichen.)



Leptogium cyanescens

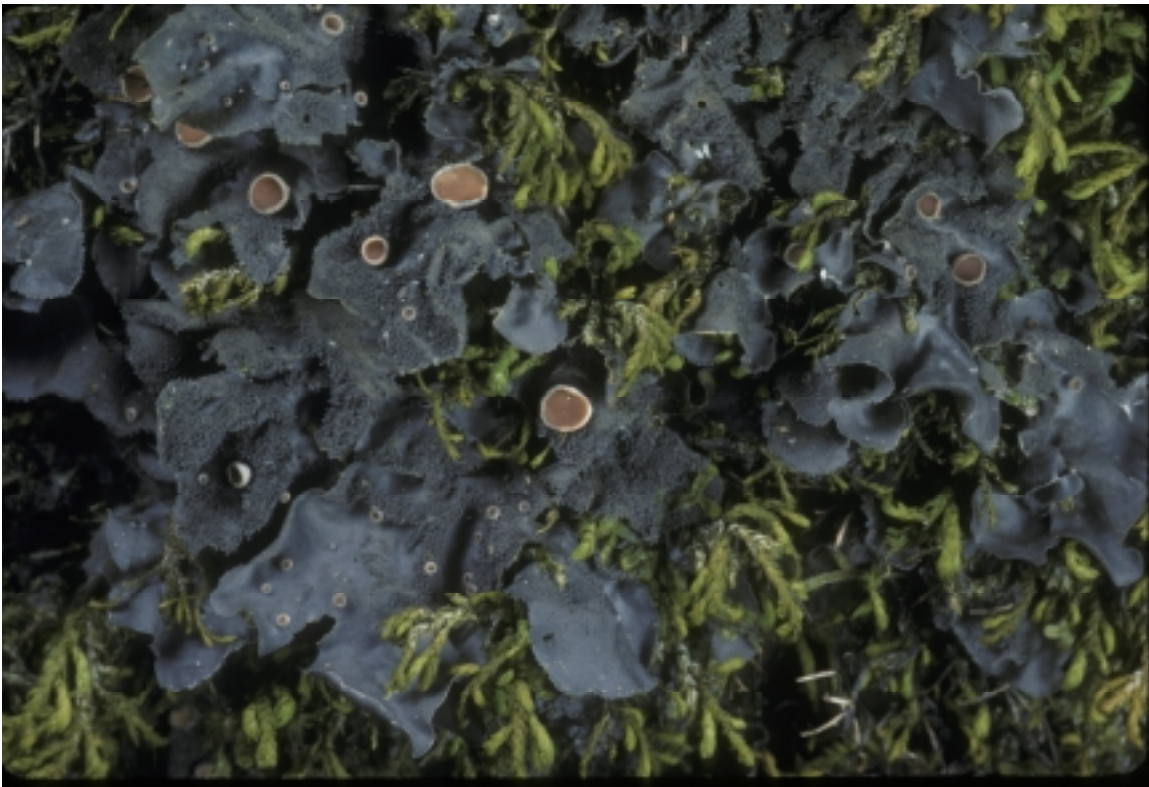
Blue jellyskin, blue oilskin

Description: Thallus blue-grey, with thin, smooth, spreading or folded lobes 2-4 mm across; lobe margins rounded or somewhat toothed or minutely lobed (lobulate); isidia cylindrical (often branched) to flattened and lobule-like, usually abundant on the lobe margins and upper surface; lower surface of lobes much like the upper surface, occasionally producing tufts of attachment hairs.

Chemistry: All spot tests negative; contains no lichen substances.

Habitat: On bark of all kinds, especially on tree bases, and on logs or mossy shaded rocks.

Comments: This is the most common *Leptogium* in Nova Scotia. Misidentifications are usually due to the varying quantity of isidia produced on the lobes, or to the slight roughness of the surface of older lobes being interpreted as wrinkles. *Leptogium corticola* is a species that can be mistaken for *L. cyanescens* in Nova Scotia, but it is very rare. It usually produces abundant, red-brown apothecia, and it lacks any kind of isidia or lobules. Another isidiate jellyskin lichen in the province is *L. laceroides*, with lobes 1-3 mm wide often with finely divided margins, but is most recognizable by its white, fuzzy (tomentose) lower surface, and its browner colour. Like *L. corticola*, it is fairly rare. See also the description of *Collema subflaccidum*.



Lobaria pulmonaria

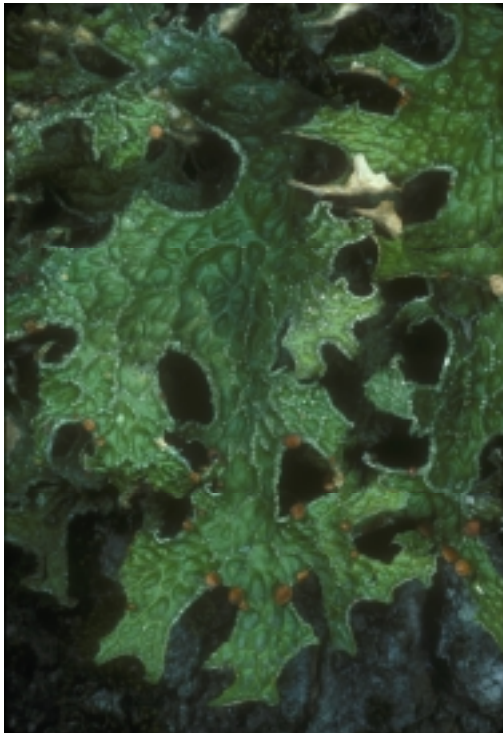
Lungwort, lung lichen

Description: Thallus pale brown to olive-brown when dry and quite green when wet, containing green algae, with a strongly ridged and pitted surface that gives the lichen the appearance of lung tissue; lobes 8-30 mm broad, up to 7 cm long, branching in Y-shaped dichotomies or trichotomies; soredia developing on the lobe margins and along the thallus ridges, often with isidia emerging among the soredia; lower surface pale brown, with a pale tomentum interspersed with bare areas. Tiny, wart-like cephalodia, 0.5-1.5 mm in diameter common or sparse on the lower surface: cut one open to see the dark, blue-green cyanobacteria inside, quite different from the grass-green layer in the main part of the thallus. Apothecia infrequent, mostly on or near the lobe margins or along ridges on the upper surface.

Chemistry: Medulla PD+ orange, K+ yellow to red, KC-, C- (stictic and norstictic acids), or PD+ yellow, K+ red, KC-, C- (norstictic acid alone).

Habitat: On trees, mossy rocks, and wood in mature forests, usually in the shade.

Comments: *Lobaria pulmonaria* is the largest lichen of those being surveyed and is the most widely distributed and common *Lobaria* in North America. In the forests of the Maritimes, nothing else resembles *L. pulmonaria*. The only other lungwort in the northeast is *L. quercizans*, which has smaller lobes (5-20 mm across), a smooth to wrinkled, greenish grey thallus, often with large, red-brown apothecia, and lacks any soredia or isidia. Like *L. pulmonaria*, its lower surface is tan and fuzzy with tomentum, and it also has cephalodia, but its medulla reacts C+ pink (gyrophoric acid). All species of *Lobaria* are good indicators of rich, unpolluted forests.



Lobaria quercizans

Smooth lungwort

Description: Thallus uniformly greenish grey, smooth on the younger portions but becoming strongly wrinkled in older parts of the thallus; lobes 5-20 mm broad; soredia and isidia absent; lower surface pale brown, with a pale tomentum over much of the surface. Photobiont green, with infrequent, internal, gall-like cephalodia (containing cyanobacteria) that show up on the lower surface as small bumps. Large, red-brown apothecia, up to 4.5 mm across, without marginal lobules, are often produced on the thallus surface.

Chemistry: Upper cortex K+ yellow; medulla PD-, K+ orange, KC+ red, C+ pink (gyrophoric acid).

Habitat: On bark of deciduous trees, especially sugar maple, sometimes on mossy rock.

Comments: This is a large, grey lungwort, unusual for the genus in having a smooth surface rather than reticulate ridges and depressions. It looks like a large shield lichen (e.g., *Parmelia* or *Parmotrema*) but has a pale brown, fuzzy tomentose lower surface and produces cephalodia. Most true shield lichens have a shiny black to dark brown lower surface. *Punctelia* species, which can have a pale brown lower surface, have smaller lobes and the upper surface is spotted with tiny white dots (pseudocyphellae).



Lobaria scrobiculata

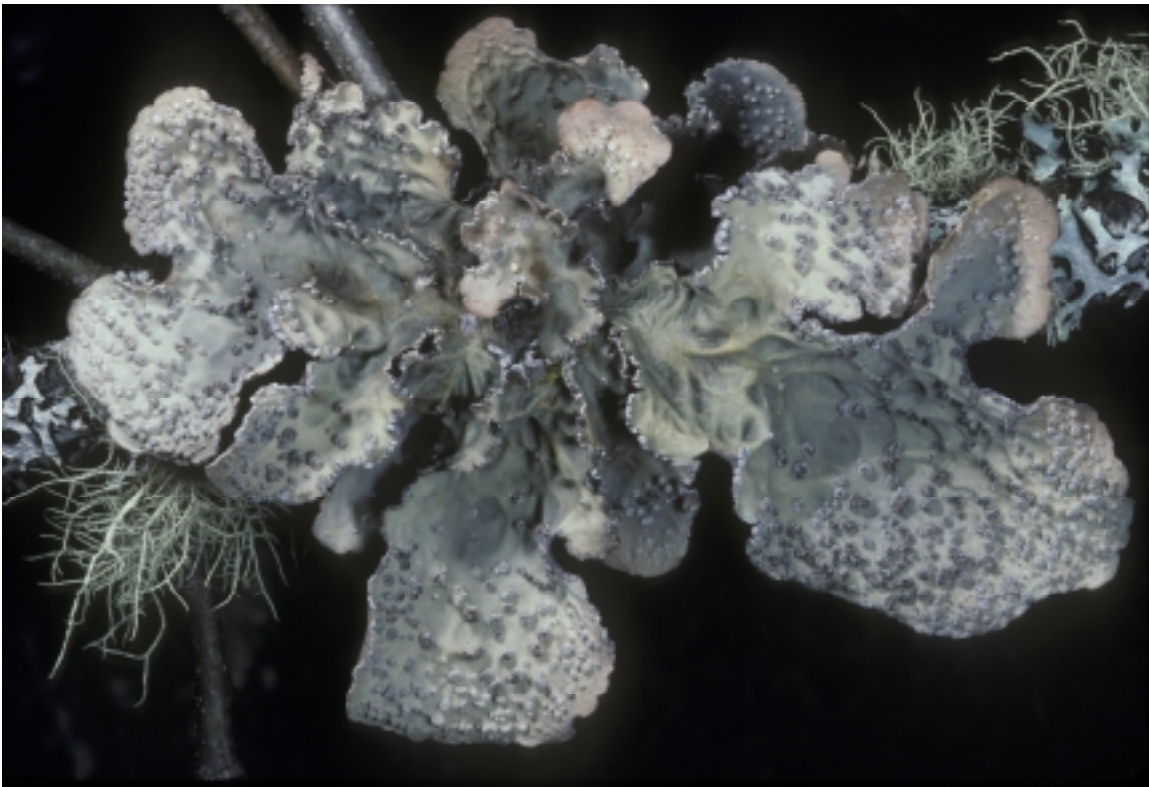
Textured lungwort

Description: Thallus yellowish green to pale green or olive, sometimes yellowish grey, often brownish at the lobe margins, containing cyanobacteria (algal layer dark blue-green rather than grassy green); lobes 10-20 mm across, usually with depressions and ridges (scrobiculate), but sometimes smooth; blue-grey granular soredia produced on the lobe margins and in round to irregular soralia on the upper surface; lower surface pale brown, with a pale tomentum over much of the surface.

Chemistry: Cortex K-, KC+ yellow (often vague); medulla and soralia PD+ orange, K+ yellow to orange, KC- or KC+ pink, C- (stictic, constictic, and norstictic acids, scrobiculin, and usnic acid).

Habitat: On a variety of trees or mossy rocks, especially in moist regions.

Comments: This is the most common lungwort containing cyanobacteria rather than green algae as a photobiont.



Melanelia subaurifera

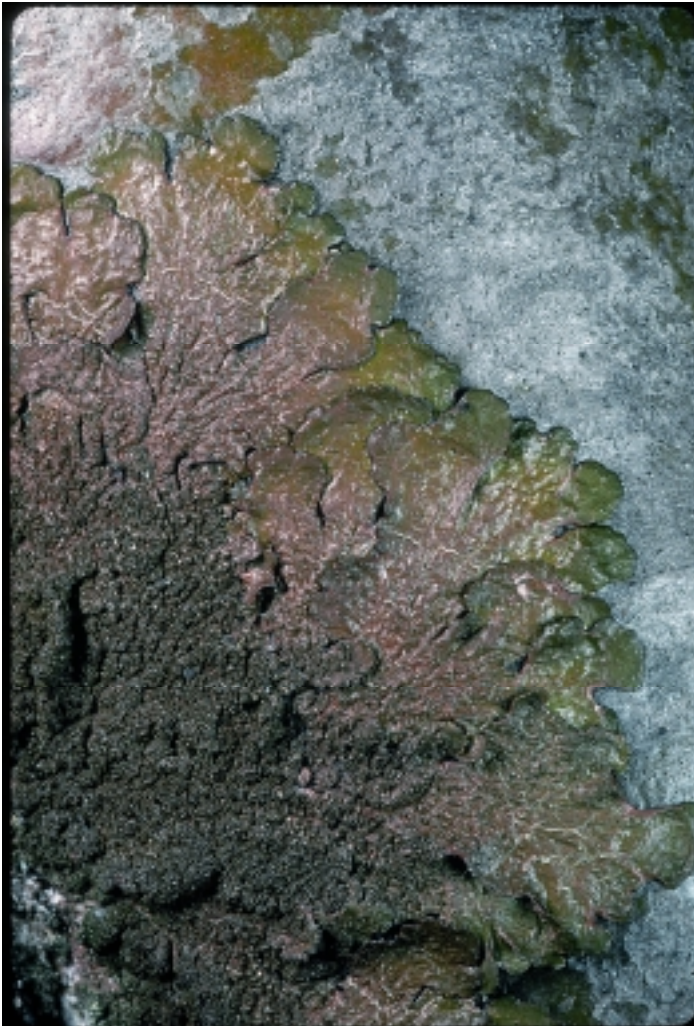
Abraded camouflage lichen

Description: Thallus olive to chocolate brown, dull, or shiny especially at the edge, lacking a frost-like white pruina; lobes rounded, 1-4(-6) mm wide, flat, sorediate or isidiate, usually both, with short, cylindrical, unbranched isidia (mostly less than 0.2 mm long) breaking down into granular soredia on the thallus surface, leaving yellowish patches where they are rubbed off. Apothecia uncommon.

Chemistry: Medulla PD-, K-, KC+ red, C+ red (lecanoric acid).

Habitat: On bark of all kinds, sometimes wood, rarely rock.

Comments: *Melanelia subaurifera* is the most common and widespread of the camouflage lichens in eastern North America and is the only bark-dwelling species of that genus in Nova Scotia producing soredia when the isidia disintegrate. Specimens that remain mostly isidiate rather than sorediate can resemble *M. fuliginosa*, a species that is also C+ red, but never becomes sorediate and has longer, usually branched isidia (up to 0.8 mm long).



Parmelia squarrosa

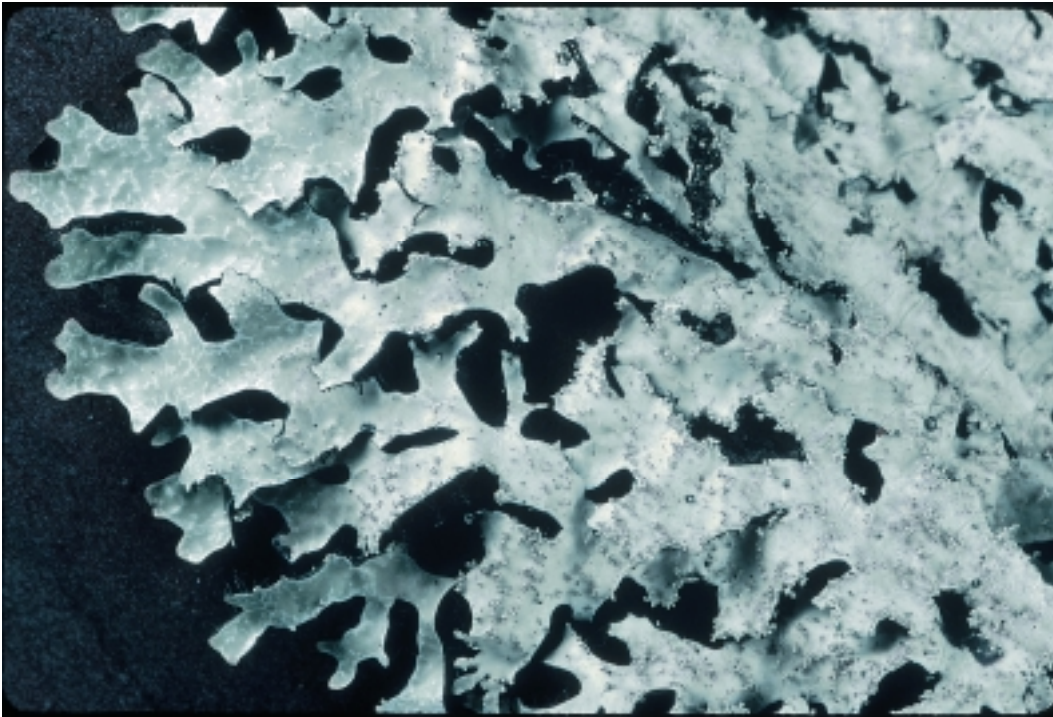
Bottlebrush shield lichen

Description: Thallus pale grey, with lobes 1-5 mm wide, often overlapping, with conspicuous reticulate ridges and white markings; isidia mostly cylindrical and shiny, but sometimes becoming somewhat flattened or fat and dull, marginal as well as on the lobe surface; rhizines slender, unbranched when young, then branched like a bottle-brush (squarrose). Apothecia rather common, with brown disks.

Chemistry: Cortex PD-, K+ yellow (atranorin), KC-, C-. Medulla PD+ yellow, K+ yellow turning blood red (salazinic acid), KC-, C-.

Habitat: On bark or mossy rock, mostly in shaded, humid habitats.

Comments: Although the rhizines on young lobes of *P. squarrosa* can be unbranched, they are never thick and forked as in *P. saxatilis*, a similar lichen with isidia on the upper surface. *Parmelia saxatilis* can also grow on bark, but it is more commonly found on rock.



Parmelia sulcata

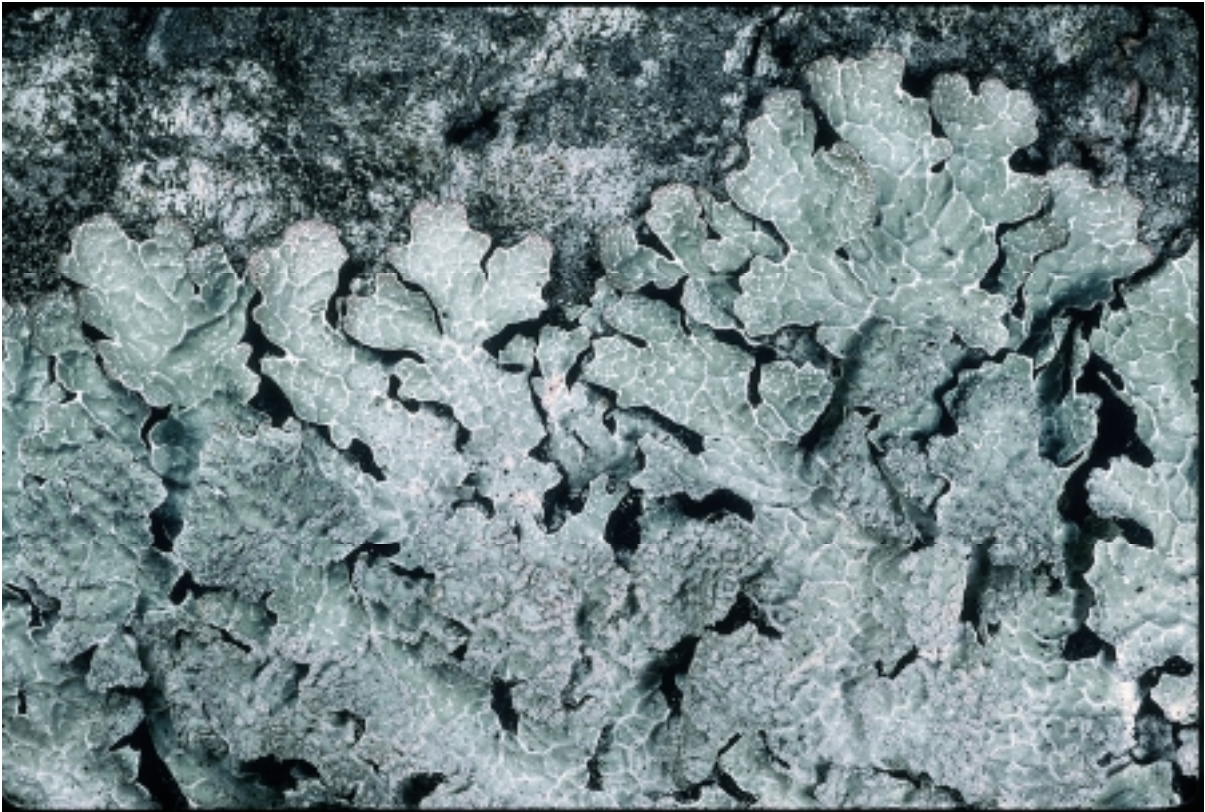
Hammered shield lichen

Description: Thallus blue-grey and often browned at the edges, or almost entirely brownish when in exposed habitats; lobes 2-5 mm wide, with a network of sharp ridges and depressions and irregular whitish markings; powdery soredia along the ridges and lobe margins where the cortex develops cracks; rhizines densely branched like a bottle-brush (squarrose) when fully developed, but on young lobes, they are slender and unbranched. Apothecia rare.

Chemistry: Cortex PD-, K+ yellow (atranorin), KC-, C-. Medulla PD+ yellow, K+ yellow turning blood red (salazinic acid), KC-, C-.

Habitat: Mostly on bark, but also on mossy rocks, wood, and even soil in both shade and sun.

Comments: This is an extremely widespread, even weedy species in northern North America, including the Maritime Provinces. As it is one of the first lichens to invade trees and old wooden structures in suburban areas, *P. sulcata* is the lichen most familiar to casual observers. It is, unfortunately, also quite variable. For example, soredia can be abundant or hardly produced at all. If soredia are lacking, it can be confused with *P. fertilis*, a rather rare, small, more abundantly fertile species with less conspicuous ridges and white markings.



Physcia adscendens

Hooded rosette lichen

Description: Thallus pale grey to pale greenish grey, mottled with white, forming small clusters of ascending lobes, many of which expand at the tip to produce inflated and hollow, helmet-shaped soralia, which are formed from a separation of the upper and lower cortices and contain greenish, granular soredia; lobes mostly under 1 mm broad except for the helmets, which can be up to 2 mm across; long, white, mostly unbranched hair-like cilia (some with darkened tips) grow from lobe margins and tips; lower surface white. Apothecia not common.

Chemistry: Cortex PD-, K+ yellow (atranorin), KC-, C-. Medulla PD-, K-, KC-, C-.

Habitat: On bark, twigs, and wood of a variety of trees, less frequently on rock, in well-lit or slightly shaded sites.

Comments: This is the only clearly "hooded" *Physcia*. *Physcia tenella*, a common bark-dwelling lichen along the coast, has long cilia at the lobe tips and margins and lip-shaped soralia on the lobe tips, but it does not form hollow hoods or helmets.



Physcia millegrana

Mealy rosette lichen

Description: Thallus pale grey, mottled with white; lobes thin, appressed to somewhat ascending, 0.3-1(-2) mm broad, margins (especially the tips) finely divided and finally dissolving into granular soredia; lower surface white, with pale rhizines. Apothecia very common, under 1 mm in diameter, dark brown, often lightly pruinose.

Chemistry: Cortex PD-, K+ yellow (atranorin), KC-, C-. Medulla PD-, K-, KC-, C-.

Habitat: On bark, especially deciduous trees, as well as wood and occasionally granitic rock.

Comments: This is among the most common bark-dwelling lichens in eastern North America, even occurring close to urban areas on cultivated as well as wild deciduous trees. In Nova Scotia, no other bark-dwelling sorediate species of *Physcia* produces coarsely granular soredia all along the lobe margins and has finely divided lobes.



Platismatia glauca

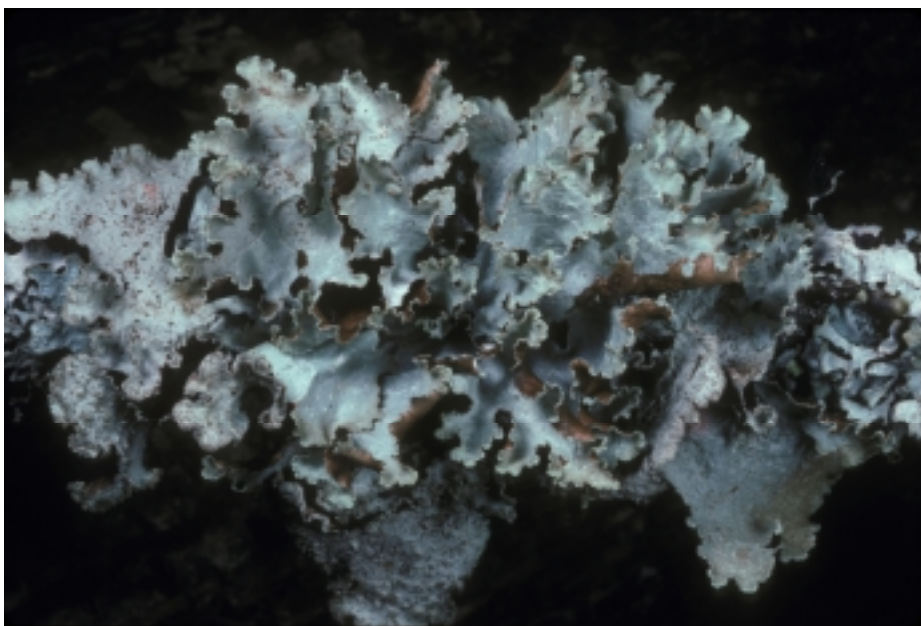
Varied rag lichen, ragbag

Description: Thallus pale greenish grey, often browning at the edges, uniform, with almost no white spots formed by pseudocyphellae and maculae; lobes (3-) 5-20 mm wide, ascending and irregular, margins often divided into small rounded to angular lobes; lobe margins and, occasionally, the surface with an abundance of either a mixture of granular soredia and isidia, only isidia, only soredia, or large, branched almost fruticose outgrowths; lower surface brown and shiny at the edge, black in the centre, but with scattered to continuous patches of ivory-white close to the edge; rhizines sparse, black. Apothecia and pycnidia very rare.

Chemistry: Cortex, PD-, K+ yellow, KC-, C- (atranorin); medulla, all reactions negative.

Habitat: Extremely common in conifer forests, especially on branches.

Comments: The only other large grey foliose lichens in Nova Scotia with a black lower surface and no rhizines (at least close to the lobe margins) belong to the genus *Parmotrema*, the ruffle lichens, or *Cetrelia*, the sea-storm lichens. *Cetrelia* species have tiny white dots (pseudocyphellae) on the upper lobe surface and in the more common species (*C. chicitae* and *C. olivetorum*), the medulla reacts C+ pink or KC+ pink, and soredia are produced on the lobe margins. Both species of *Parmotrema* found in Nova Scotia have abundant black rhizines on the older parts of the lower surface and black marginal cilia (sometimes sparse), and both react K+ deep yellow or orange in the medulla. *Parmotrema chinense* has powdery soredia along the lobe margins, and *P. crinitum* produces isidia on the upper surface of the lobes. *Platismatia glauca* varies from purely sorediate to almost entirely isidiate, with all intermediates, but it has no white spots on the upper surface or any marginal cilia. The lobes can be quite broad, or they can be relatively narrow.



Pseudocyphellaria crocata s. lat. (including *P. perpetua*)

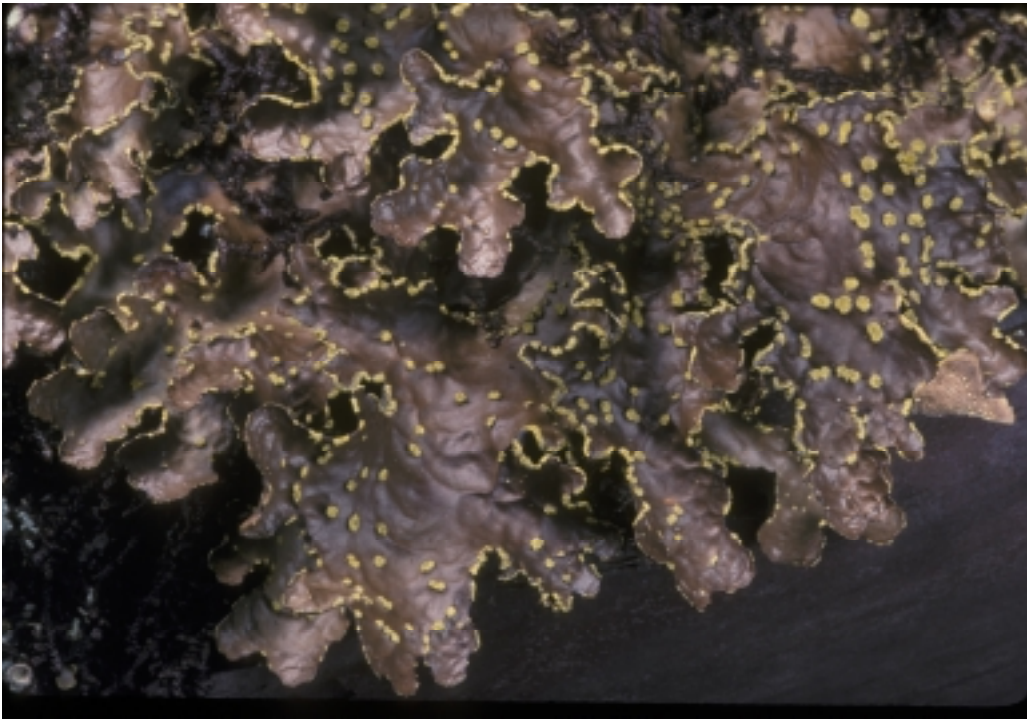
Yellow specklebelly

Description: Thallus pale to dark chocolate brown, rarely grey-brown, with bright yellow soralia (often flecked with black) on the lobe margins, on low ridges and in shallow depressions; medulla mostly white, but bright yellow in part, especially in and under the soralia and close to the pseudocyphellae and algal layer; lobes 5-20 mm broad; lower surface with pale to dark brown tomentum interspersed with round, bright yellow dots (pseudocyphellae), sometimes large and conspicuous and sometimes very sparse. Photobiont blue-green. Apothecia rarely seen.

Chemistry: Medulla PD+ orange, K+ yellow, KC-, C- (stictic acid, and calycin, a yellow pigment).

Habitat: On bark, shrubs, and sometimes mossy rock in humid sites.

Comments: *Pseudocyphellaria crocata* and its sister species, *P. perpetua*, are morphologically variable and so their delimitation is still not clear. That is why we call this taxon "*Pseudocyphellaria crocata* s. lat.," i.e., in the broad sense, including both taxa. Even if a specimen has very few yellow dots on the lower surface, the combination of brilliant yellow soredia, bright yellow medulla below the soralia (and sometimes throughout the thallus) and blue-green photobiont is unique in Nova Scotia. *Pseudocyphellaria crocata* and *P. perpetua* are distinguished in the Pacific Northwest by the largely white medulla and scattered soralia in the former, and the mainly yellow medulla and marginal soralia in the latter. Intermediates are common in eastern populations, however, and, because the two seem to have a similar response to pollution, they do not have to be distinguished for the purposes of pollution monitoring.



Punctelia rudecta

Rough speckled shield lichen

Description: Thallus dark greenish grey to almost blue-grey, lobes mostly 3-8 mm broad, more or less covered with cylindrical to branched, or sometimes flattened isidia; white spots (pseudocyphellae) usually prominent on lobe tips; lower surface pale tan, with pale rhizines. Apothecia infrequent.

Chemistry: Cortex K+ yellow (atranorin); medulla PD-, K-, KC+ red, C+ red (lecanoric acid).

Habitat: On bark of all kinds or shaded rocks.

Comments: This is one of the most common eastern isidiate foliose lichens. The combination of prominent white dots, isidia and a pale brown lower surface makes it quite distinctive. Specimens with very few isidia can be mistaken for *P. bolliana* (medulla C-, usually with abundant lobules on the thallus surface and edges).



Ramalina dilacerata

Punctured ramalina

Description: Thallus with flattened branches, pale, short and densely shrubby, with relatively thin cortex and loose medulla; branches 1-2 (-3) cm long, 0.4-1.3 mm wide, rather smooth, always more or less hollow with many perforations into the medulla, without pseudocyphellae or soredia. Apothecia abundant, marginal, or mainly at or close to the branch tips, with pale yellow, pruinose disks.

Chemistry: Medulla PD-, K-, KC-, C- (divaricatic acid).

Habitat: On twigs and branches of various trees in the open, typically in open, humid, coastal forests.

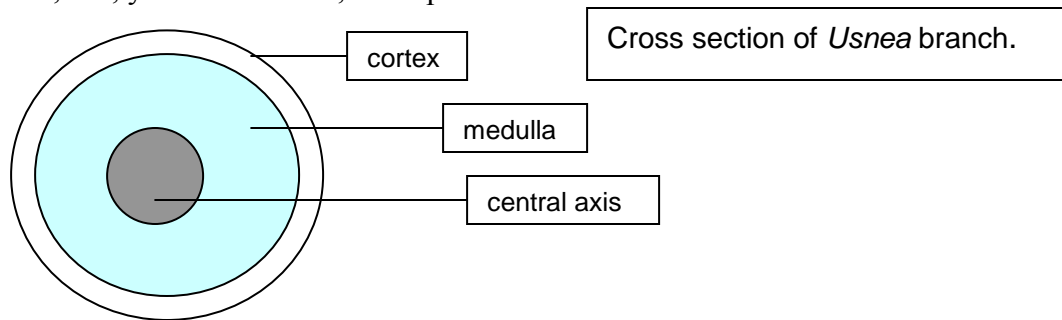
Comments: The thickness of the cortex varies: some thalli are thin and almost translucent, and others are tough and shiny. *Ramalina americana* has a similar aspect but is not hollow or perforate and usually has raised white dots or dashes (pseudocyphellae) on the branch surface. The most similar fruticose lichens other than *Ramalina* are *Evernia mesomorpha* and *E. prunastri*. Both produce soredia on their branches and are much duller and softer in texture. *Evernia prunastri* is distinctly flattened (unlike *E. mesomorpha*), and the lower side of the branches tends to be very pale, almost white.



Usnea spp.

Beard lichens, old man's beard

Description: Pendent or shrubby, filamentous, fruticose lichens; yellowish green or darkening, occasionally reddish because of pigment in the cortex; branches round or angular in cross section and characterized by a central, cartilaginous cord (axis) of supporting tissue; cortex thick, thin, or falling away; medulla thin or thick, loose and cottony (lax) or dense, white or pigmented yellow to dark red; axis slender or relatively broad, solid in all Canadian species; surface of branches smooth, or uneven due to various kinds of bumps or warts. Soredia, isidia, or isidia-like branchlets produced by many, but not all, species; isidia frequently developing within soralia and mixed with the soredia, or occurring directly on the branch surface. Photobiont green (*Trebouxia*?). Apothecia occur on a few species close to the branch tips, and have a thallus-like margin, with broad, flat, yellow to brown, often pruinose disks.



Chemistry: Cortex KC+ dark yellow (usnic acid) in all species; medulla with a varied chemistry including many compounds that can react with PD or K, or fluoresce in long wave UV light. Examples are barbatic, diffractaic, squamatic, salazinic, norstictic, and stictic acids.

Habitat: On trees and shrubs, and a few species on rock.

Comments: *Alectoria*, *Ramalina*, and *Evernia* are also yellowish green, hairlike, bushy, or pendent lichen genera, but none of these have the central cord that characterizes *Usnea*. *Alectoria sarmentosa*, in particular, is often mistaken for a species of *Usnea*. Naming specimens of *Usnea* is often difficult because of the morphological and chemical variation that occurs in many species. Indeed, *Usnea*

taxonomy is still in a state of flux, and much remains to be done before we have a clear understanding of species limits. For the purposes of pollution monitoring, we will consider all species of *Usnea* to have a similar sensitivity. Although this may not be the case, they all are considered to be very intolerant to air pollution.

KEY TO NOVA SCOTIA LICHENS FOR POLLUTION MONITORING

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1. Thallus crustose, forming a superficial crust over the bark without lobes of any kind, often granular or sorediate; apothecial disks very pale orange or pinkish brown; margins resembling thallus in colour and texture (lecanorine), at first smooth, but often becoming granular or sorediate *Lecanora conizaeoides*

[Note: Many species of crustose lichens will be encountered in the surveys, but because the pollution tolerance of most crusts is unknown, only *Lecanora conizaeoides* is being tracked.]

1. Thallus squamulose, foliose or fruticose: lobed or at least partly free from the substrate, not crust-like 2

2. Thallus fruticose, stalked, shrubby or pendent, attached to the substrate by one or only a few points 3

2. Thallus squamulose or foliose, more or less flat and lobed, with lobes or scales having distinguishable upper and lower surfaces and usually attached to the substrate by many parts of the lower surface 5

3. Thallus much-branched, pendent to shrubby, generally well above the tree base on the trunk, branches and twigs 4

3. Thallus stalked, unbranched or with few branches, not shrubby; generally on tree bases *Cladonia* spp. (fertile)

4. Branches more or less flattened or angular, at least close to tips, lacking a central cord
..... *Ramalina dilacerata*
4. Branches entirely round in cross section, with a central, somewhat elastic cord
..... *Usnea spp.*
5. Thallus becoming very dark green to almost black and translucent (when held up to the light) or jelly-like when wet; slate grey to brownish grey or dark olive to almost black when dry 6
5. Thallus not becoming black or jelly-like when wet, remaining opaque; greenish grey or olive to brown when dry 7
6. Thallus very dark olive to olive brown or black when dry, covered with mostly globular granules (isidia); on tree bases or trunks..... *Collema subflaccidum*
6. Thallus slate-grey when dry; tiny cylindrical to flattened outgrowths (isidia) covering parts of upper lobe surface; most commonly found on tree bases
..... *Leptogium cyanescens*
7. Lobes extremely small and/or finely divided, mostly less than 1.0 mm in width; lower surface entirely white..... 8
7. Lobes medium to large, with lobes usually more than 1.5 mm in width; lower surface beige to black, at most mottled with white blotches 10

8. Hair-like rhizines absent from lower surface; lobes typically overlapping and appearing scale-like (squamulose) *Cladonia* spp. (sterile)
8. Hair-like rhizines commonly produced on lower surface and sometimes lobe margins; lobes overlapping or spreading out 9
9. Lobe tips ending in hood-like expansions that contain powdery soredia; lobe tips often bearing colourless hair-like cilia *Physcia adscendens*
9. Lobe tips flat, without any hood-like expansions; granules and soredia produced along the lobe margins *Physcia millegrana*
10. Thallus lobes hollow and tube-like, bursting at the tip into a hood- or lip-shaped expansion containing soredia; rhizines entirely lacking from lower surface
..... *Hypogymnia physodes*
10. Thallus lobes thin and solid, never tube-like or producing soredia-containing hoods at the lobe tips; rhizines common and abundant on lower surface, **or** replaced with a fuzzy tomentum, **or** absent 11
11. Lobes (1-)2-8 mm in width; medium-sized foliose lichens, generally closely attached over most of the lower surface by hair-like rhizines 12
11. Lobes (3-)5-30 mm in width; large foliose lichens, often with many lobes ascending and loosely attached; rhizines rare, or replaced by tomentum 15

12. Thallus uniformly olive or brown, never grey; young lobes more or less smooth; upper surface with large patches of powdery soredia or cylindrical isidia, sometimes both; lower surface and rhizines pale brown; medulla turns red with C and is negative with K *Melanelia subaurifera*

12. Thallus grey or, when growing in bright sunlight, sometimes brownish at the lobe margins, never olive; lower surface and rhizines pale brown or black; medulla is C + red or C -, and K+ red or K- 13

13. Thallus with conspicuous round white dots on the lobes; upper surface smooth or wrinkled, but without a network of ridges and depressions, more or less covered with cylindrical to somewhat flattened isidia; lobes 3-8 mm across; lower surface and rhizines light brown; medulla turning C+ red but negative with K *Punctelia rudecta*

13. Thallus with irregular (not round) white spots or blotches on lobes; upper surface with a network of depressions and ridges appearing like hammered metal, with or without isidia or soredia; lobes 1-5 mm across; lower surface black in centre to very dark brown at the edge; rhizines black; medulla C- but K+ yellow quickly turning to blood red 14

14. Thallus with cylindrical to branched isidia produced on the lobe surface and especially the lobe margins *Parmelia squarrosa*

14. Thallus with powdery soredia produced on ridges on the lobe surface and on the lobe margins (sometimes sparse on young thalli)..... *Parmelia sulcata*

15. Thallus with bright yellow patches of soredia produced on the lobe margins and lobe surface; lower surface with yellow dots (pseudocyphellae)
..... *Pseudocyphellaria crocata* s. lat.
15. Thallus with or without soredia, but without any bright yellow pigments; lower thallus surface without yellow dots 16
16. Lower surface mostly black or dark brown, smooth and shiny, lacking a fuzzy tomentum, with white blotches especially near lobe margins; rhizines very rare; thallus producing soredia, isidia or mixtures of the two mainly along or close to the lobe margins
..... *Platismatia glauca*
16. Lower surface pale brown, smooth or with a fuzzy tomentum; soredia and isidia present or absent 17
17. Thallus lacking any soredia or isidia, but commonly producing abundant brown-disked apothecia on the thallus surface; thallus grey to greenish grey when dry; medulla C+ red *Lobaria quercizans*
17. Thallus with soredia and/or isidia at least on the lobe margins and sometimes on the upper surface of the lobes; apothecia uncommon or rare 18
18. Soredia are blue-grey, isidia absent; thallus dark grey to blue-grey when wet, grey to yellowish green when dry, containing cyanobacteria (algal layer is dark blue-grey or blue-green, never grass-green); ridges and depressions irregular and not abundant
..... *Lobaria scrobiculata*

18. Soredia are olive, brown or green, not blue-grey, often mixed with isidia; thallus green when wet, olive to brownish when dry, containing green algae (algal layer is grass green); surface covered with a regular network of depressions and ridges

..... *Lobaria pulmonaria*

TABLE OF SPECIES TOLERANCE TO POLLUTION

Pollution Intolerant Lichens	
<i>Cladonia</i> species	<i>Lobaria quercizans</i>
<i>Leptogium</i> species	<i>Lobaria scrobiculata</i>
<i>Lobaria pulmonaria</i>	<i>Pseudocyphellaria crocata</i>
Intermediate Pollution Tolerant Lichens	
<i>Hypogymnia physodes</i>	<i>Ramalina dilacerata</i>
<i>Parmelia squarrosa</i>	<i>Usnea</i> species
<i>Platismatia glauca</i>	
Pollution Tolerant Lichens	
<i>Melanelia subaurifera</i>	<i>Physcia adscendens</i>
<i>Parmelia sulcata</i>	<i>Physcia millegrana</i>

GLOSSARY

Adnate: Tightly attached to the surface.

Alga (Algae): Green photosynthetic organism containing chloroplast and nuclei and belonging to the kingdom Protocista.

Algal layer: Layer of algal cells in a stratified lichen thallus. Sometimes used synonymously with “photobiont layer” (a layer of either green algae or cyanobacteria).

Anastomose: To form a net-like, interconnected growth.

Apothecium (Apothecia): A disk-or cup-shaped ascoma, usually with an exposed hymenium.

Appressed: Flattened and closely adnate.

Ascending: Lifting from the surface and becoming free from it, at least in part.

Ascohymenial: Pertaining to a type of ascoma having a hymenium with true paraphyses rather than pseudoparaphyses or paraphysoids.

Ascolocular: Pertaining to a type of ascoma in which the asci arise within a uniform mass of fungal tissue and are separated in maturity, not by true paraphyses but by abundantly branched pseudoparaphyses or paraphysoids.

Ascoma (Ascomata): The fruiting body of an Ascomycete; the structure that bears the asci, which in turn contain the ascospores. Apothecia and perithecia are types of ascomata.

Ascomycete: A fungus that produces its sexual spores within an ascus.

Ascospore: A spore produced in an ascus.

Ascus (Asci): The sac-like structure in Ascomycetes in which the ascospores are formed. The sexual fusion of nuclei and reduction division occur within the ascus.

Blue-green algae: Cyanobacteria.

Bryophytes: Mosses, liverworts (hepatics), and hornworts.

Campylidium (Campylidia): Helmet-shaped conidia-bearing structure found in many tropical, foliicolous lichens.

Cartilaginous: Tough, pliable cartilage- or sinew-like tissue. The term usually refers to supporting tissue.

Cephalodium (Cephalodia): A small gall-like growth that contains cyanobacteria and occurs within the tissues or on the surface of some lichens with green algal photobionts.

Chloroplast: The structure in a green cell that contains chlorophyll, the substance responsible for photosynthesis.

Cilia: Hair-like appendages on the margins of the thallus or apothecia of many foliose and fruticose lichens.

Conidium (Conidia): An asexual spore usually formed in large numbers within special structures such as pycnidia and campylidia. Conidia sometimes serve as male sexual cells (spermatia).

Continuous: Unbroken, or broken only by cracks.

Cortex: The outer protective layers of a lichen thallus or apothecium, completely fungal in composition (except for some dead algal cells), often composed of hyphae with thick, gelatinized walls.

Corticate (Cortical): Having a cortex; pertaining to a cortex.

Corticolous: Growing on bark.

Crenulate: Having a scalloped margin with rounded teeth or lobes.

Crisped: Having a ruffled, wavy, or twisted margin, as in many species of *Cetrelia* and *Parmotrema*.

Crustose: A thallus type that is generally in contact with the substratum at all points and lacks a lower cortex; cannot be removed intact from its substrate without removing a portion of the substrate as well.

Cyanobacteria: Photosynthetic, chlorophyll-containing organisms related to bacteria (in the kingdom Monera), without organized nuclei or chloroplasts; sometimes called blue-green algae.

Cyanolichen: A lichen with cyanobacteria as the photobiont.

Dichotomous: Branching into two equal parts, as in the letter “Y.”

Dorsiventral: With distinguishable upper and lower surfaces.

Ellipsoid: Oval in outline; more or less football-shaped.

Family: A taxonomic category consisting of closely related genera.

Farinose soredia: Very fine, powdery soredia.

Filamentous: Hair-like.

Flexuose: Wavy.

Foliicolous: Growing on leaves of vascular plants (especially in the tropics).

Foliose: Pertaining to a more or less “leafy” lichen thallus, distinctly dorsiventral, and varying in its attachment to the substrate from completely adnate to umbilicate.

Fruiting body: the sexual reproductive structure of a lichen fungus (e.g. apothecium, perithecium, mushroom); in most lichens, the ascoma.

Fruticose: Pertaining to a lichen thallus that is stalked, pendent, or shrubby, and normally with no clearly distinguishable upper and lower surfaces.

Genus (Genera): A group of closely related species, presumably with the same ancestor; constitutes the first word of the two-word name of every organism.

Granular (Granulose): 1) Having granules or granule-like particles. 2) Pertaining to soredia that are large enough to be easily distinguished under a dissecting microscope; see farinose.

Granule: A spherical or nearly spherical corticate particle.

Haustorium (Haustoria): A special branch of a mycobiont that penetrates or otherwise attaches itself to the photobiont cell for the purpose of food absorption.

Herbarium: A collection of dried plants (or lichens).

Holdfast: The relatively thick and, in many cases, only attachment point of some lichens, especially *Usnea*.

Hymenium: The spore-bearing layer of an ascoma, consisting of asci and paraphyses, paraphysoids, or pseudoparaphyses.

Hypha (Hyphae): The filamentous elements of a fungus, often modified and resembling round or angular cells.

Inflated: Swollen and hollow.

Isidium (Isidia): A minute thalline outgrowth that is corticate and contains photobiont cells. Isidia are easily detached from the thallus and serve as vegetative reproductive units.

Laminal: On the upper surface of a thallus (e.g. laminal soralium).

Lax: Loose, not compact; usually referring to the medulla.

Lecanorine: Pertaining to an apothecium having a margin containing a photobiont, and usually resembling the thallus in colour and texture.

Leprose: Composed entirely of soredia, referring to a thallus surface or the thallus itself.

Lichen: An association of a fungus and a photosynthetic symbiont (photobiont) resulting in a stable vegetative body with a specific structure, in which the fungus encloses the photobiont.

Lichenized: Pertaining to a fungus, alga, or cyanobacterium living within a lichen association.

Lignicolous: Growing on bare wood (lignum), as on a log or a wooden fence.

Lobe: A rounded or somewhat elongated division or projection of a thallus margin; measured at its widest point.

Lobulate: Having many lobules.

Lobule: A small, often scale-like lobe growing from a foliose thallus either along its margin or from the surface, sometimes also appearing along apothecial margins, generally of the same colour and character as the parent thallus. Lobules that are constricted at the base and function as propagules are often called phyllidia.

Macrolichen: A foliose or fruticose lichen.

Maculate: Spotted or blotched by *maculae*, which are pale round or reticulate areas caused by gaps in the photobiont layer below the cortex.

Marginal: Along the thallus margins.

Mealy: Coarsely granular, like cornmeal.

Medulla: The internal layer in a thallus or lecanorine apothecium, generally composed of loosely packed fungal hyphae.

Microlichen: A crustose or squamulose lichen.

- Morphology:** Physical characteristics, including external shape and internal anatomy.
- Mutualism:** A type of symbiosis in which both components benefit from the association.
- Mycobiont:** The fungal symbiont or partner in a lichen.
- Paraphysis (Paraphyses):** A sterile fungal filament, sometimes branched, attached at the base and free at the summit, associated with asci in the hymenium.
- Paraphysoids:** Sterile hymenial tissue between the asci, abundantly branched with frequent anastomoses.
- Pendent:** Hanging straight down and usually soft and pliable; grades into *almost pendent* forms that are bushy and relatively stiff at the base but pendent over most of their length.
- Perithecium (Perithecia):** A flask-shaped ascoma opening by a pore at the summit; [fig. 17] may be prominent, but is more often partially or completely embedded in the thallus tissue; used here to include all similarly shaped ascomata regardless of their developmental origin (i.e., ascohymenial or ascolocular).
- Photobiont:** The photosynthetic component (symbiont) in a lichen thallus, either algae in the strict sense (e.g., green algae) or cyanobacteria (blue-green algae).
- Podetium (Podetia):** A stalk formed by a vertical extension of lower apothecial tissues (usually the hymenium and stipe) and secondarily invested with an algal layer and sometimes a cortex, as in most specimens of *Cladonia*. The fertile tissue or apothecial disks can be present or commonly absent; podetia can be either short and unbranched or quite tall and abundantly branched.
- Primary squamules:** Small, scale-like lobes forming the basal or primary thallus of *Cladonia* species.
- Primary thallus:** A squamulose or crustose thallus from which fruticose stalks or podetia arise as secondary components. Examples are found in *Cladonia*.
- Propagule:** A reproductive unit, either sexual (such as an ascospore) or vegetative (like a soredium or isidium).
- Pruina:** Powdery, frost-like deposit (usually white or gray, rarely yellow or reddish), typically composed of calcium oxalate or pigment crystals, dead cortical tissue, or some mixture of them; often occurs on a thallus or apothecial surface.
- Pruinose:** Having a frosted appearance caused by a deposit of pruina.

Pseudocyphella (Pseudocyphellae): A tiny white dot or pore caused by a break in the cortex and the extension of medullary hyphae to the surface.

Pseudoparaphyses: Branched, anastomosing hyphae between the asci in perithecium-like ascolocular ascomata, growing from the roof of the ascoma toward the base.

Pustule: A more or less hollow wart of verruca, small and knobby or broad and blister-like.

Pustulate: Having many pustules.

Pycnidium (Pycnidia): A small globular or flask-shaped body in which conidia are formed, embedded in a thallus or entirely superficial, often closely resembling a perithecium.

Reticulate: Net-like and interconnected.

Rhizine: A purely hyphal extension of the lower cortex that generally serves to attach a foliose thallus to its substrate; of various lengths, thicknesses, colours, and degrees of branching.

Saxicolous: Growing on rock, stone, pebbles, concrete, or brick.

Sensu lato (s. lat.): Meaning “in a broad sense;” usually used in reference to species or genera that are somewhat heterogeneous and may include other taxa (e.g., *Pseudocyphellaria crocata* and *P. perpetua*).

Sessile: Sitting on the surface, without a stalk of any kind.

Soralium (Soralia): An area of a thallus in which the cortex has broken down or cracked and soredia are produced; can be in many forms; sometimes contains isidia as well as soredia, as in *Lobaria pulmonaria*.

Soredium (Soredia): A vegetative propagule of a lichen consisting of a few algal cells entwined and surrounded by fungal filaments, and without a cortex; generally produced in localized masses called *soralia*, or covering large, diffuse areas on a thallus.

Sp.: Abbreviation of “species,” generally used where the species is unknown or unspecified.

Species: The basic evolutionary unit of an organism; named with two words, the first being the genus to which the species belongs, and the second the species’ own name or “epithet.” With respect to lichens, the name of a species refers to its fungal component. Lichen species are defined by discontinuities in various morphological, chemical, ecological, and geographic characteristics and, more and more frequently in

recent years, by analysis of the actual genetic material (DNA) of the fungal component.

Spore: A single- or multicelled reproductive body capable of giving rise to a new organism; as used here, refers specifically to an ascospore.

Spp.: Several unspecified species.

Squamule: A small, scale-like lobe or areole, lifting from the surface, at least at the edges, and sometimes strongly ascending and almost foliose (as in some species of *Cladonia*).

Squamulose: Composed of or characterized by having squamules.

Squarrose: With short, stiff, perpendicular branches; having the general appearance of a bottlebrush, as in certain types of rhizines.

Stereome: A tough, cartilaginous cylinder forming the supporting tissue for species of *Cladonia*.

Stratified; Layered; in reference to lichen thalli having distinguishable layers of tissue including a cortex, photobiont layer, medulla, and often, a lower cortex.

Substrate: The surface upon which a lichen grows; a nutritional relationship is *not* implied and rarely occurs in lichens.

Superficial: Used here with reference to apothecia and other structures that sit on the surface of the thallus (i.e., sessile, not immersed or stalked).

Symbiosis: A long-term, usually physical association between at least two dissimilar organisms. Mutualism and parasitism are types of symbiosis in which one or both organisms are changed in some way, either beneficially or detrimentally. In commensalism, neither of the associated organisms is affected.

Taxon (Taxa): A unit in a classification scheme; most commonly used with reference to a genus, species, or subdivision of a species (subspecies, variety, or form).

Taxonomy: The study of taxa, especially with respect to their identification and classification, and the correct application of their names.

Terricolous: Growing on soil, sand, or peat.

Thalline: Pertaining to the lichen thallus; similar to the thallus in appearance or structure.

Thallus (Thalli): In lichens, the vegetative body consisting of both algal and fungal components.

Tomentose: Having tomentum; with a downy or woolly appearance.

Tomentum: A covering of fine hair or fuzz usually caused by a superficial growth of colourless hyphae.

Trichotomous[†]: Branching almost equally in three parts.

Verrucose: With a rough, warty surface.

Verruculose: Minutely verrucose.

Wood: Lignum; trunks, logs, and stumps having no bark.

All terms (except where indicated) as defined in Brodo, I.M., S.D. Sharnoff, and S. Sharnoff. 2001. Lichens of North America. New Haven: Yale University Press. Used with permission.

[†] Source: Galloway, D.J. Australian Biological Resources Study. Accessed from: <http://www.anbg.gov.au/glossary/webpubl/lichglos.htm>.