

# NEW OBSERVATIONS ON THE DISTRIBUTION AND ECOLOGY OF CAVERNULARIA HULTENII IN EASTERN NORTH AMERICA<sup>1</sup>

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In eastern North America, the distribution of *Cavernularia hultenii* has been found to extend from southern Labrador to southwesternmost Nova Scotia. The lichen communities in which *C. hultenii* occurs in Newfoundland and Nova Scotia have been characterized. The diversity of habitats is significantly greater in Newfoundland as the result of a generally cooler and more humid climate to which *C. hultenii* favorably responds. Because of the presence of high humidity niches in the forests of the interior, *C. hultenii* is not exclusively coastal in Newfoundland, whereas in Nova Scotia all known occurrences lie within a narrow coastal strip along the Eastern Shore.

En Amérique du Nord orientale, l'aire de distribution de *Cavernularia hultenii* s'étend du sud du Labrador à l'extrémité sud-ouest de la Nouvelle-Ecosse. On définit dans le présent article les communautés de lichens où l'on rencontre *C. hultenii* à la Terre-Neuve et en Nouvelle-Ecosse. A la Terre-Neuve, la diversité des habitats est significativement plus grande à cause d'un climat généralement plus frais et plus humide auquel *C. hultenii* répond favorablement. A cause de la présence de niches écologiques très humides dans la partie intérieure de cette province, *C. hultenii* n'est pas une espèce exclusivement côtière à la Terre-Neuve, alors qu'en Nouvelle-Ecosse, on ne la retrouve que dans une étroite bande côtière le long de la côte est de la province.

## Introduction

*Cavernularia hultenii* Degel. is a minute and easily overlooked foliose lichen (Figs 1-3) that grows on the twigs of a variety of trees and shrubs and has a strictly oceanic distribution in parts of the boreal-temperate zone adjacent to the Atlantic and Pacific coasts. Following Ahti's discovery of this highly interesting representative of the large family Parmeliaceae in Newfoundland (Ahti 1959), its world distribution was plotted (Ahti & Henssen 1965). Further occurrences in eastern North America were to be expected, and the present paper deals with the distribution and ecology of *C. hultenii* in this part of the world.

## Observations

During recent lichenological expeditions to Newfoundland the writer's attention was drawn to *C. hultenii* which was found in nine different situations:

1. On the lowest, very sheltered branches of both *Picea mariana* (Mill.) B.S.P. and *Abies balsamea* (L.) Mill. in ombrotrophic bogs, where they form low and typically prostrate thickets of the Krummholz type that have obviously retarded the growth of *Sphagnum* so that wind-sheltered niches are formed. This habitat was observed in a raised bog south of Pt. Verde as well as in the heathlands between St. Brides and Cape St. Mary's lighthouse which have been studied previously by Ahti (see Ahti 1974).

2. On the branches of *Abies*, forming mixed Krummholz stands with *Picea mariana* in *Diapensia* - *Empetrum* - *Loiseleuria* - *Racomitrium* heath without *Sphagnum*. Seen once on Brunette Island at about 75 m altitude.

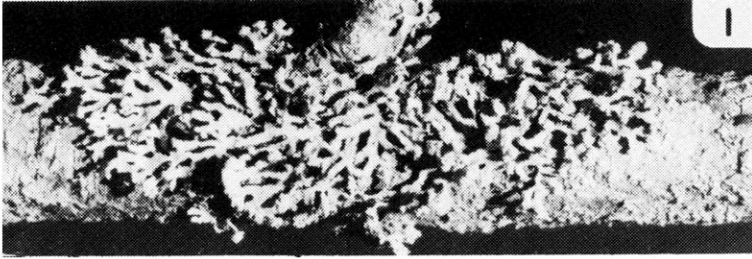


Fig 1. Thallus of *Cavernularia hultenii* on twig of *Abies*. Note the finely divided thallus with the capitata soralia. x 4.

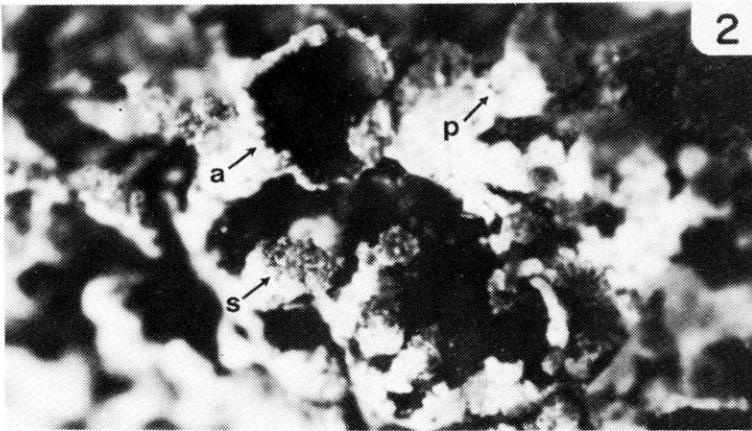


Fig 2. Close-up of *Cavernularia hultenii*, showing an apothecium (a) and the irregularly crenate lobes with soralia (s) and pycnidia (p). x 25. Specimen is from the Queen Charlotte Islands, B.C.

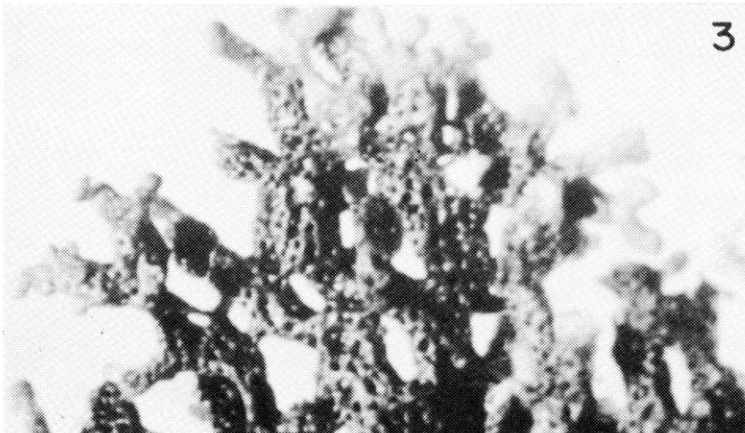


Fig 3. Underside of the thallus of *Cavernularia hultenii*, displaying the characteristic pits or cavernulae, x 15.

3. On the twigs of *Abies* and/or *Picea mariana* in medium-height thickets (see Ahti & Henssen 1965), usually with a spongy ground cover of hepatics (*Bazzania*) and mosses including *Sphagnum*. Often adjacent to maritime heathlands or intergrading into these.

4. On the twigs of younger specimens of *Abies* and/or *Picea mariana* in an otherwise tall and often dense mixed coniferous forest (see Table I in Maass 1980). Typically on slopes.

5. On the branches of mature *Abies* and/or *Picea mariana* or even on deciduous trees including *Alnus* in rather tall but half-open mixed forests. Typically on northerly slopes along swampy brooklets, e.g., on Brunette Island.

6. On the branches of mature *Picea mariana* (and less commonly on those of *Abies*) in half-open successional sphagnous heathland forests of the interior, characterized by an understory of *Kalmia angustifolia* L., *Ledum groenlandicum* Oeder and *Chamaedaphne calyculata* (L.) Moench and by an abundance of *Alectoria sarmentosa* (Ach.) Ach. and *Bryoria* on the trees.

7. On the trunks of *Abies* in mature fir forests which have a closed canopy but little or no *Sphagnum* growing on the ground (Hoisington & Maass 1982).

8. On the branches of *Abies* and *Picea glauca* (Moench) Voss or *P. mariana* (developed either as upright trees or as *Krummholz*) in sea cliff habitats, usually between 20-70 m altitude and without any *Sphagnum* on the ground (Hoisington & Maass 1982).

9. At the edges of river gorges (Hoisington & Maass 1982).

Subsequently *C. hultenii* was also found in Nova Scotia. As the overall distribution of *C. hultenii* in Newfoundland is going to be discussed in a review article on the biogeography of the lichens of that province (Ahti 1982), an in-

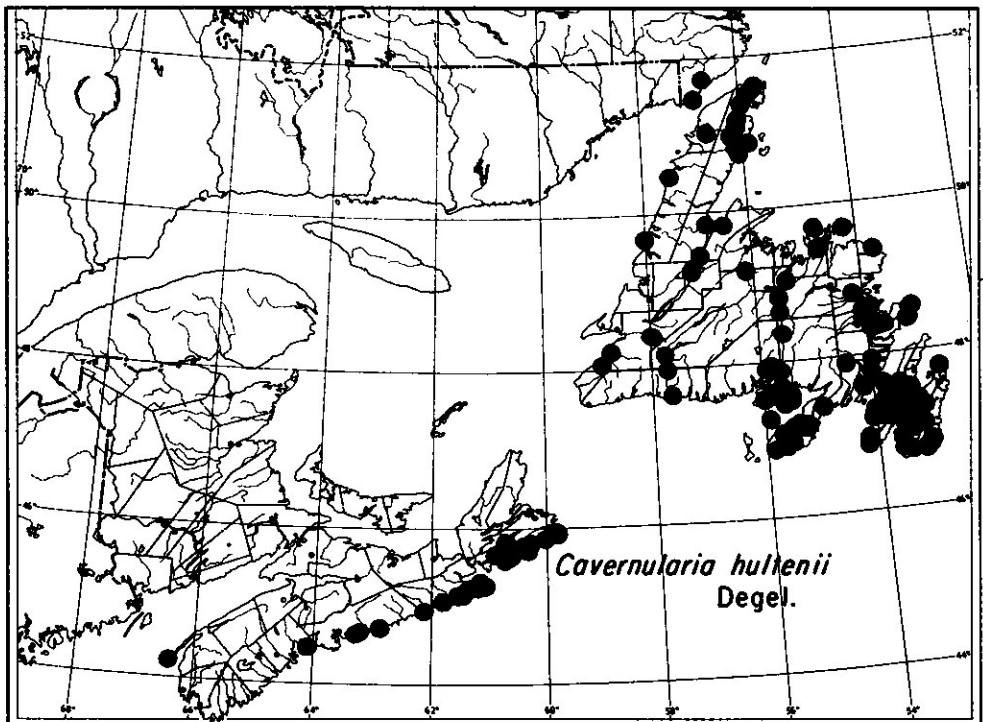


Fig 4. The distribution of *Cavernularia hultenii* in eastern North America.

terpretation of the distribution will be offered here with an emphasis on the Nova Scotian occurrences of *C. hultenii*. This lichen is now known to have a rather continuous distribution in eastern North America from Brier Island, N.S. (44°14'N), to the Pinware River System, Labrador (51°40'N). Within Nova Scotia, it is confined to a very narrow coastal strip of forested land along the Atlantic Ocean (Fig 4). The somewhat isolated Brier Island locality is well known for some southern range extensions of high boreal to subarctic plants including *Betula michauxii* Spach, *Huperzia selago* (L.) Bernh, and *Selaginella selaginoides* (L.) Link (Roland & Smith 1969). However, the actual southern limit of *Cavernularia* in eastern North America may well lie somewhere in the coastal plain between Maine and New Jersey or in the high rainfall areas of the adjacent Appalachian Mountains. The occurrence of *C. hultenii* in mountainous forests is well documented for the Scandinavian Shield (Degelius 1952), and in western North America the lichen follows the coastline at intervals from Alaska as far south as California (Ahti & Henssen 1965). Within Nova Scotia, the frequency of the lichen definitely declines from north to south. The best-explored area is western Halifax County where *C. hultenii* has not yet been found despite the presence of numerous seemingly suitable forest and bog sites. Apart from reasons of incomplete collecting, some of the discontinuous distribution of *C. hultenii* may be explained by pollution from local sources. For instance, the apparent absence of *C. hultenii* from the extensively surveyed western parts of Richmond as well as eastern Cape Breton counties may have resulted from various industrial activities in the Port Hawkesbury, Point Tupper, and Sydney-Glace Bay areas; all of the local fog forest lichen communities that have remained there are unusually depauperate. In addition, the coastal habitats in the Halifax-Dartmouth area may have suffered from urban pollution and those near Liverpool from SO<sub>2</sub> pollution by a pulp and paper mill or small mining operations of the past or present. In spite of surveys of numerous unspoiled localities in Prince Edward Island and on the Cape Breton Highlands *C. hultenii* has not been found there, nor on the coasts of the Northumberland Strait or the Bay of Fundy, including the Fundy National Park (S. Gowan, in verb.), Grand Manan Island, Campobello Island (see Maass 1980) and the adjacent Quoddy Head State Park, Maine. Along the Northumberland Strait, the remaining coastal forests appear too dry (perhaps because of the drier summers there), whereas those of the slightly more humid southern coastal areas of New Brunswick have been severely modified by the presence of pulp and paper mills and other industries. A combination of forest fires and lumbering seems largely responsible for the apparent changes in the forest lichen vegetation on Campobello Island (Maass 1980). Thus, it is possible that *C. hultenii* was once a component of the lichen flora in southern New Brunswick.

In a study of the habitats of *C. hultenii* in northernmost Newfoundland and southern Labrador (Hoisington & Maass 1982) it was concluded that this lichen behaves as a drought-sensitive species. Therefore, it is not surprising that in the Maritime Provinces, *C. hultenii* generally is limited to hyperoceanic sites (i.e., those right next to the outermost coastline of Nova Scotia along the Atlantic Ocean). *Cavernularia* is extremely tolerant of marine aerosols and may even depend on them for either nutritional reasons or because of the decreased acidity of coniferous bark substrates along the coast.

Although *C. hultenii* is most often found on *Abies* (in eastern North America, see Hoisington & Maass 1982), *Picea* (in all parts of the range) and *Betula* (in Scandinavia, see Degelius 1952), it has been observed on a large variety of other substrates. The phorophytes of *C. hultenii* include the lichens *Lobaria pulmonaria* (L.) Hffm. (Hoisington & Maass 1982), *Cetraria ciliaris* Ach. emend. W. Culb. & *C. Culb.* and *Nephroma bellum* (Spreng.) Tuck. (Hoisington & Maass 1982), the



conifers *Abies balsamea* (Ahti & Henssen 1965) including var. *phanerolepis* Fern., *Juniperus* (Degelius 1952), *Larix laricina* (Du Roi) K. Koch, *Picea abies* (L.) Karsten (Ahlner 1948), *P. glauca* (Hoisington & Maass 1982), *P. mariana* (Hoisington & Maass 1982), *P. rubens* Sarg., *P. sitchensis* (Bong.) Carr (Degelius 1937) and *Pinus contorta* Dougl. (Ahti & Henssen 1965), and the angiosperm trees or shrubs *Alnus incana* (L.) Moench (Ahlner 1948), *A. rugosa* (Du Roi) Spreng., *Betula pubescens* Ehrh. including subsp. *tortuosa* (Ledeb.) Nyman (Degelius 1952), *B. papyrifera* Marsh (Hoisington & Maass 1982), *Ledum groenlandicum*, *Myrica californica* Cham. (Ahti & Henssen 1965), *Nemopanthus mucronata* (L.) Trel. (Ahti & Henssen 1965), *Sorbus aucuparia* L. (Ahlner 1948), *Vaccinium ovatum* Pursh (Ahti & Henssen 1965) and *Viburnum cassinoides* L. This very low substrate specificity allows the lichen to be used as an indicator of microclimatic habitat conditions (Hoisington & Maass 1982).

Abundant populations of *C. hultenii* have been found in Nova Scotia only near Fort Louisbourg (an area previously visited by Lamb 1954), Fourchu, Clam Harbour Beach and Miseners (Meismers) Head. At the Fort Louisbourg site, a couple of specimens of *C. hultenii* were found to contain galls resembling those found in Labrador (Hoisington & Maass 1982). Although galls have not been reported previously from *Cavernularia* (see review by Grummann 1960), they were collected on *C. hultenii* at least once before (in Sweden, Jämtland, Åre parish, 3 km south of Enafors, on twigs of spruce in a spruce forest, altitude 550-600 m, 16 August 1948 R. Santesson No. 48456, FH). Their description will be provided in a separate study (Maass and Rice 1983).

In Nova Scotia, *C. hultenii* has been seen in the following general types of habitats:

1. In bogs on prostrate to stunted specimens of *Abies*, *Larix* and *Picea mariana* (only near Fort Louisbourg).
2. In medium-height thickets of *Abies* and/or *Larix* and/or *Picea mariana*.
3. On the branches of medium-height specimens or thickets of *Abies* within the mature coastal *Picea mariana* forests along the boundary of wetlands. These forests usually have a mossy ground cover including *Bazzania* and *Sphagnum* and may contain *Cavernularia* wherever they provide a sufficient shelter from the immediate impact of coastal storms.
4. On the branches of more mature but slightly exposed *Abies*, *Picea mariana* or *P. rubens* (very rarely on the trunks or over epiphytic lichens) in mixed coniferous forests covering wet slopes adjacent to peatlands or rivers. Usually over mossy ground including *Bazzania* and *Sphagnum*. Rarely on low-lying branches of *Picea* in the fen border of these forests.
5. In sea cliff habitats on the branches of *Picea glauca*, *P. mariana* and *Abies*, over rather dry ground without any *Bazzania* or *Sphagnum*.

Although basically all of these habitats have been encountered in Newfoundland, a more detailed description of their lichen communities will be given below. The drier heathland, rather dry heathland successional forest, mature fir forest and gorge habitats described from Newfoundland under Nos. 2, 6, 7 and 9 are unknown from Nova Scotia. These habitats may be well depend on the cooler summer climate of the north with its much higher frequency of foggy weather and generally greater relative humidity. In addition, the heathland successional forest of the interior of Newfoundland (habitat No. 6) becomes suitable as a high humidity niche for *Cavernularia* by the very abundant growth of *Alectoria* and *Bryoria* on the coniferous branches. These highly branched fruticose lichens, whose occurrence in the interior is more or less restricted to peatlands in the vicinity of water courses, apparently enhance the humidity of this microhabitat

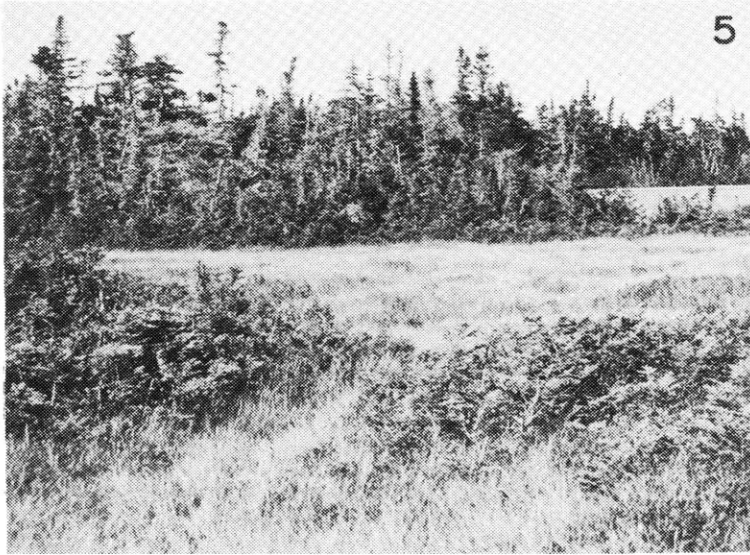


Fig 5. Two typical bog habitats of *Cavernularia hulthenii* near access road to Fort Louisbourg, N.S., including *Abies balsamea*, *Larix decidua* and *Picea mariana* as phorophytes. The lichen was found inside the medium-tall thickets of conifers in the background as well as on the lowest protected branches of the dwarf conifers that straddle the drier *Sphagnum* ridges in the foreground.



Fig 6. Habitat of *Cavernularia hulthenii* in mature forest of *Picea glauca*, *P. mariana* and *Abies balsamea* around a lagoon behind shingle beach, Miseners Head, N.S. View is in westerly direction.



Fig 7. Overmature forest of *Picea mariana* and *Abies balsamea* with regeneration growth at Clam Harbour Beach, N.S. View is in easterly direction across a flooded fen. *Cavernularia* was found in very dense to half-open, medium-height thickets of *Abies*, as well as on *Alnus incana* and *A. rugosa*.



Fig 8. Habitat of *Cavernularia hultenii* on *Picea glauca* and *P. rubens* in the sunny but somewhat sheltered borders of a narrow coastal fen at Point Michaud, N.S. View is in westerly direction.

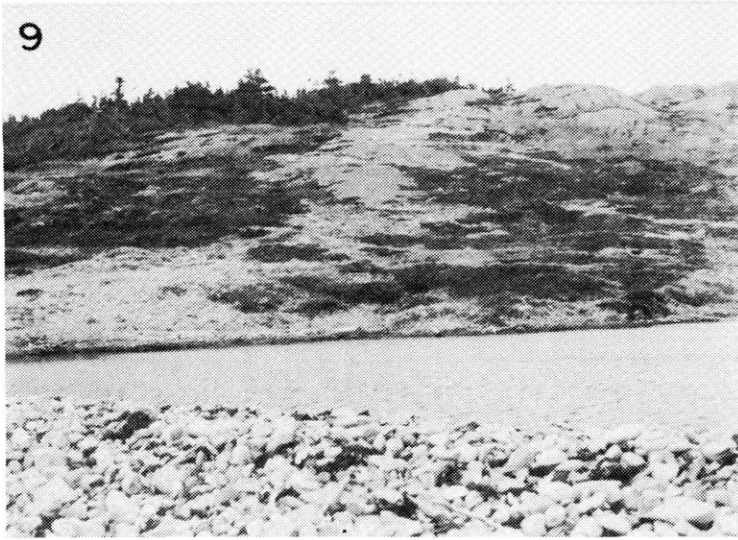


Fig 9. Coastal cliff habitat of *Cavernularia hultenii* at Baleine, N.S., with stunted forest of *Picea mariana*, *P. glauca* and *Abies balsamea* at about 20 m altitude.



Fig 10. Coastal cliff habitat of *Cavernularia hultenii* at Main-à-Dieu, N.S., showing windswept thickets of *Picea glauca* at 5-10 m altitude.

by acting as a buffer. In many of the coastal habitats of *C. hultenii* as well, a lush growth of *Alectoria* and *Bryoria* has been noted.

A number of typical Nova Scotian forest habitats (corresponding to Nos. 1-5) can be seen in Figures 5 to 10. These include free-standing low to medium-height thickets as well as mature and overmature forest sites. Except for the sunny border of these forests, their lichen vegetation is fairly uniform and more strongly controlled by low light levels and high humidity than by the occurrence of specific phorophytes.

In these shaded habitats, *C. hultenii* is often found with *Bacidia chlorantha* (Tuck.) Fink, *Bryoria* (usually juvenile stages of various species), *Hypogymnia physodes* (L.) Nyl., *H. tubulosa* (Schaer.) Hav., *H. vittata* (Ach.) Gas., *Parmelia squarrosa* Hale, *Platismatia glauca* (L.) W. Culb. & C. Culb., *Ramalina thrausta* (Ach.) Nyl. and *Usnea* sp. (usually juvenile stages of various species). In more exposed sites, winds and high light intensities would seem to suppress the development of *C. hultenii* not only in presenting unfavourable conditions per se but in favouring a very luxuriant and competitive growth of many of the lichen species with which *C. hultenii* is normally associated. On the exposed branches of *Abies* and *Picea* (*P. mariana* and *P. glauca*) along the borders of forests, these species generally tend to form denser communities to the exclusion of *Cavernularia*, because they have a wider ecological amplitude and are better adapted to conditions of periodic drought, bright sunlight, and summer heat. This photophilic lichen community on conifers is best developed on coastal beaches and headlands (over sea cliffs) and is made up of the following members: *Bryoria furcellata* (Fr.) Brodo & D. Hawksw., *B. salazinicola* Brodo & D. Hawksw., *B. trichodes* (Michx.) Brodo & D. Hawksw. subsp. *trichodes*, *B. trichodes* subsp. *americana* (Mot.) Brodo & D. Hawksw., *Caloplaca holocarpa* (Hoffm.) Wade, *C. ferruginea* (Huds.) Th.Fr., *Cetraria ciliaris*, *C. halei* W. Culb., & *C. Culb.*, *Evernia mesomorpha* Nyl., *Hypogymnia physodes*, *H. tubulosa*, *Parmelia squarrosa*, *Platismatia glauca*, *P. tuckermanii* (Oakes) W. Culb. & C. Culb., *Ramalina minuscula* Nyl., *R. roesleri* (Hochst. ex Schaer.) Hue, *R. thrausta*, *Usnea filipendula* Stirt., *U. fulvovirens* (Räs.) Räs., *U. subfloridana* Stirt., and *Xanthoria polycarpa* (Ehrh.) Oliv. The occurrence of *C. hultenii* in this photophilic community was only observed once near Point Michaud, where the habitat consisted of the large low-lying branches of *Picea glauca* and *P. rubens* over *Sphagnum* in the fen border of adjacent coniferous forests (Fig 8). *Cavernularia* was mainly found on the northerly exposed trees where the lichen association of the branches was enriched by large foliose members of the Lobariaceae [*Lobaria pulmonaria*, *L. scrobiculata* (Scop.) DC. and (more rarely) *Pseudocyphellaria crocata* (L.) Vain.], indicating an unusually high humidity in this habitat (Maass et al. 1982). However, it also occurred on the southerly exposed trees on the opposite side of the narrow fen.

In its normal forest habitats, *C. hultenii* has been seen on slopes of westerly, northerly, and easterly exposures although preferentially near the wet bottom of these slopes such as near Clam Harbour Beach (Fig 7). In this respect it is much less demanding than the exceedingly rare *Erioderma pedicellatum* (Hue) P.M. Jørg. which may occasionally be found in association with *C. hultenii* [in the Lunenburg County locality, east of Clam Harbour and near North Fourchu, (Maass 1980; 1982), as well as in Newfoundland (unpublished data)].

Two typical bog habitats from near Fort Louisbourg are seen in Figure 5. One of these is formed by the prostrate thickets of *Abies*, *Picea*, and *Larix* on the hummocks of *Sphagnum* [predominantly *S. fuscum* (Schimp.) Klinggr., *S. flavicomans* (Card.) Warnst., *S. imbricatum* Russ., and *S. magellanicum* Brid.], as previously observed on the Avalon Peninsula in Newfoundland. The other habitat occurs in the



drier parts of this extensive area of ombrotrophic bogs and poor fens and is confined to the inside of taller, medium-height thickets composed of the same species of conifers. These exposed islands of scraggy forest over peatland have probably formed as a successional stage from the low-lying thickets. In these taller thickets, *Cavernularia* seems to be restricted to the innermost branches at breast height but occurs on *Abies*, *Picea mariana*, and *Larix laricina*. Here it is found in association with *Bryoria trichodes* subsp. *trichodes*, *B. trichodes* subsp. *americana*, *Cetraria ciliaris*, *C. halei*, *Hypogymnia physodes*, *Parmelia squarrosa*, *P. sulcata* Tayl., *Platismatia glauca*, *P. norvegica* (Lynge) W. Culb. & C. Culb.1, *P. tuckermanii*, *Ramalina roesleri*, *R. thrausta* and *Usnea* sp. In the prostrate thickets, however, *C. hultenii* occurs together with *Hypogymnia physodes*, *Platismatia glauca* and species indicative of a snow cover during winter such as *Cetraria pinastri* (Scop.) S. Gray, *Parmeliopsis ambigua* (Wulf.) Nyl. and *P. hyperopta* (Ach.) Arn.

Seacliff forest habitats were only seen in northern Nova Scotia (habitat No. 5, Figs 9-10). They were less exposed than the sea cliff habitats encountered in northern Newfoundland and Labrador (Hoisington & Maass 1982).

The Nova Scotian *Cavernularia* habitats No. 3 and No. 4 are floristically very similar and may merely reflect different developmental stages of the forest. However, they have been kept separate to emphasize the medium-height thickets of conifers as an important environment for *Cavernularia* both inside and outside of the mature forests. Such thickets cover extensive peatlands both in southern Newfoundland (Ahti & Henssen 1965) and near the Atlantic coast of Nova Scotia. The thickness of the underlying peat, its rate of decomposition, and the exposure of the site all seem to determine the growth pattern of the conifers and the rate of succession from Krummholz stands (see habitat No. 1) to mature mixed coniferous forests.

The important conclusion to be made from the preceding discussion is that *C. hultenii* would have been able to occupy its present territory in eastern North America relatively early during the post-Pleistocene period of reforestation. It is even possible that it may have survived the late Wisconsinan glaciation on dwarf shrubs in one of the ice-free refugia of western Newfoundland and the Labrador coast proposed by Grant (1977). One of the important dwarf shrubs to consider here as a phorophyte is *Ledum groenlandicum*, on which *C. hultenii* was found near Clam Harbour Beach (in association with *Bryoria trichodes*, *Hypogymnia physodes*, *M. tubulosa*, *Lecanora symmictera* Nyl., *Parmelia squarrosa*, *Protoblastemia cinnabarina* (Somm.) Räs., and *Usnea trichodea* Ach. For this reason, even though there is no forest today in Greenland to support typically arboricolous lichens, *C. hultenii* may still be expected to occur in Greenland as part of the former land bridge which must have facilitated dispersal between the European and American continents. The most probable sites are sea cliffs with *Ledum groenlandicum* in southwestern Greenland. This area is well known for its rich peatland vegetation with numerous more southerly elements, including the amphiatlantic *Sphagnum pylaesii* Brid. (Lange 1976).

In habitats of *C. hultenii* that have been disrupted by diseases or development, some of the lichen thalli may become exposed to excessive light and assume a yellowish brown instead of the green color that they normally display.

In Nova Scotia, thalli of *C. hultenii* have been found only sporadically on the trunks of conifers (altogether 3 on *Abies*, near Clam Harbour Beach and *Ecum Secum*, and 1 very depauperate thallus over old exuded resin on *Picea mariana*,

<sup>1</sup>A rare lichen not previously reported from Nova Scotia.



near Miseners Head). However, in the dense and very mature fir forests of northern Newfoundland they grow exclusively on the trunks, forming a unique habitat (No. 6), especially on the east side of the Great Northern Peninsula. Here they are sometimes associated with *Lobaria scrobiculata* and other cyanophilic lichens.

An early stage of colonization by *C. hultenii* was observed on a second-year shoot of *Abies*, where the lichen consisted of a single narrow lobe which was freely anchored to 2 adjacent green needles. Under the microscope, many lichen thallal initials of uncertain identity could be seen on the upper and lower sides of the needles and it is at least possible that *Cavernularia* may frequently grow as a foliicolous lichen during its early stages of colonization.

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Dr. Tom Nash III kindly provided me with the apotheciate thallus of *C. hultenii* shown in Figure 2.

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### References

- Ahlner, S. 1948. Utbredningstyper bland nordiska barrträds-lavar. *Acta Phyto-geogr. Suec.* 22.
- Ahti, T. 1959. Studies on the caribou lichen stands of Newfoundland. *Ann. Bot. Soc. Zool. Bot. Fenn. 'Vanamo'* 30: 1-44.
- Ahti, T., and Henssen, A. 1965. New localities for *Cavernularia hultenii* in eastern and western North America. *Bryologist*, 68: 85-89.
- Ahti, T. 1974. Notes on the lichens of Newfoundland. 3. Lichenological exploration. *Ann. Bot. Fenn.* 11: 89-93.
- Ahti, T. 1982. The lichens of Newfoundland. In *Biogeography and Ecology of the Island of Newfoundland*, (ed. G.R. South), Dr. W. Junk, The Hague (in press)
- Degelius, G. 1952. On the lichen *Cavernularia hultenii* Degel. and the problem of the glacial survival of spruce in Scandinavia. *Sven. Bot. Tidskr.* 46: 53-61.
- Grant, D.R. 1977. Glacial style and ice limits, the quarternary stratigraphic record, and changes of land and ocean level in the Atlantic Provinces, Canada. *Geogr. Phys. Quat.* 31: 247-260.
- Grumann, V.G. 1960. Die Cecidien auf Lichenen. *Bot. Jahrb. Syst. Pflanzen-gesch. Pflanzengeogr.* 80: 101-144.
- Hoisington, B.L., and Maass, W.S.G. 1982. *Cavernularia hultenii* in northernmost Newfoundland and southern Labrador. *Bryologist* 85 (in press).
- Lamb, I.M. 1954. Lichens of Cape Breton Island, Nova Scotia. *Nat. Mus. Can. Bull.* 132: 239-313.
- Lange, B. 1976. *Sphagnum pylaessii* in Greenland. *Bryologist* 79: 47-54.
- Maass, W.S.G. 1980. *Erioderma pedicellatum* in North America: A case study of a rare and endangered lichen. *Proc. N.S. Inst. Sci.* 30 (1): 69-87.
- Maass, W.S.G. 1982. New observations on the occurrence of *Erioderma* in North America. (in preparation).

- Maass, W.S.G., and Rice, E.** 1983. Observations on the morphology and chemistry of *Cavernularia*. (in preparation).
- Maass, W.S.G., Hoisington, B.L., Walker, I., and Ahti, T.** 1982. Occurrences of members of the Lobariaceae on conifers as ecological indicators. (in preparation).
- Roland, A.E., and Smith, E.C.** 1969. *The Flora of Nova Scotia*. The Nova Scotia Museum, Halifax. (Reprinted from *Proc. N.S. Inst. Sci.* 26: 3-238; 277-743.)

### Appendices

All of the collections reported under Appendices 1 and 2 were made between September 1979 and 1981 by Wolfgang S.G. Maass, Barbara L. Hoisington, or both. For an assessment of the chemical ecology of a lichen over a larger geographical area, it may be important to note whether the lichen has been found on twigs or trunks and on *Abies* or *Picea* or on specific deciduous trees or shrubs (Maass et al., unpubl.). Thus, trunk occurrences of *Cavernularia* on *Abies* and *Picea* are symbolized by A and P, and twig occurrences on the same phorophytes by a and p respectively. Other exceptional phorophytes are indicated by genus or full binomial.

Representative specimens have been deposited at CANL and NSPM, and with the appropriate National Park authorities.

#### 1. New localities for *C. hultenii* in Newfoundland.

*St. George's Bay Area:* Codroy Pond, A; 8 km NE of Robinson's R., A.

*Road to Burgeo:* 2.4 km NW of Burgeo Motel, 30 m alt., p; 12.9 km S of bridge over Pond River, a; 3.8 km N from bridge over narrows of Peter Stride's Pond near tributary of Victoria River, a, p; Southwest Brook area 30.5 km E from Trans-Canada Highway (TCH), a; Southwest Brook area 23.3 km E from TCH, p.

*White Bay Area:* on TCH just W of Boot Brook near Sandy Lake, A; Hampden River 1.6 km S of jct. of Hwys. 420 and 421, A, a, p; 16.5 km E of Western Arm on Hwy. 411, A.

*Interior:* On TCH about 23 km N of Badger, A, p; along Hwy. 360, 29 km N of Miguel's Brook, p; along Hwy. 360, 0.5 km S of the crossing over Miguel's Brook, p; along Hwy. 360, 34.3 km S of the crossing over the Northwest Gander River, a, p.

*Bay d'Espoir Area:* Between St. Veronica and Long Pond (Jeddore L.) 2 km W from road to the Power Commission, A, a; St. Veronica, 0.7 km E of turnoff to airport between Hwy. 361 and Bay d'Espoir, p; St. Albans, between Swanger Cove and St. Josephs about 3 km from bridge near St. Albans, ca. 60 m alt., a; 3.1 km W from St. Albans, A; near road to Morrisville 6.7 km from Hwy. 361 jct., A, a; 1.4 km N from access road to Jipujijikuei Kuespem Provincial Park, 180 m alt., a; 2.5 km S from access road to Jipujijikuei Kuespem Provincial Park, p.

*Hermitage Bay Area:* On Hwy. 364, 1.3 km NE of bridge in Sandyville, p; 4.7 km SW of jct. of Hwys. 360 and 364 on road to Hermitage Bay, p; 2.5 km NE of jct. of Hwys. 360 and 364, 45 m alt., a; 2.9 km SW of jct. of Hwys. 360 and 362, a, p.

*Fortune Bay—Belle Bay Area:* Brunette Island, on S side of central valley, 75 m alt., in *Diapensia - Empetrum - Loiseleuria - Racomitrium* heath with islands of Krummholz, a, and between 15-60 m alt. on steep northerly slopes SSE and NE of the biggest lake, most abundantly on the trunks of *Abies*, A, in dense fir forest, in more open places on *Bryoria*-laden twigs of *Abies*, a, or on *Alnus*; on Hwy. 363, 3.5 km W of turn to Boxey Harbour, a; 2.6 km N of jct. of Hwys. 363 and 362, a; 14.3 km N of jct. of Hwys. 363 and 362, a; 6.1 km S of the turnoff to Pool's Cove on Hwy. 362, a.

**Notre Dame Bay - Bonavista Bay Area:** Bishops Falls, on TCH about 4.5 km E from Hwy. 360 jct., A; North Twillingate Island, Seabreeze Park, in woods below the lighthouse, a; Chapel Island 2.6 and 3.6 km WNW of turnoff to Boyd's Cove North near Hwy. 340, A; Fogo Island, recreational park near the motel near jct. of Hwys. 333 and 334, A; 2.5 km N of turnoff to Deadman's Bay on Hwy. 330, p; Middle Brook, about 1 km W from turnoff to dump on S side of Hwy. 320, a; Terra Nova National Park, on Hwy. 310 about 1 km E from turn to Burnt Point, p; Terra Nova National Park, along TCH 5.2 km S of Hwy. 310, a; Terra Nova National Park, on Hwy. 301, 2.7 km W from TCH, A; Terra Nova National Park, 2.3 km S of jct. of Hwys. 301 and TCH, A, p.

**Bonavista Peninsula:** On Hwy. 230, 1 km NNW of Paradise, p; on Hwy. 230, 10.5 km NE of turn to Champney's East, A, a; on Hwy. 230, 4.2 km NE of the road to Champney's East, p; Rattle Falls Natural Scenic Attraction on Hwy. 230, 2.1 km E from Hwy. 235 jct., p; on Hwy. 230, 8.9 km W of turnoff to Charleston, a, p; on Hwy. 230 near Morley's Siding, 0.2 km SW of Hwy. 233 jct., a, p, P, and on *Viburnum cassinoides*.

**Burin Peninsula:** Between Garnish and Winterland below Hwy. 213 adjacent to a lake, a; SW of Frenchmans's Cove, 1.4 km from Hwy. 210, p, a, A (*Abies balsamea* var. *phanerolepis*); 1.6 km W of turnoff to Molliers NW of Hwy. 210, a; near Lord's Cove in deep scrubby fen vegetation on slope above Hwy. 220, a; 4.1 km ENE of Lawn above Hwy. 220, a; Winterland, 0.4 km S of turnoff to the airport on W side of Hwy. 222, A; 0.7 km W from turnoff to Creston North, near the second ridge SW from Hwy. 210, a; on road to Baine Harbour 1 km from Hwy. 210 jct., A.

**Placentia Bay North Area and Isthmus:** Merasheen Island, NE part, a, p; headlands of Sandy Harbour River, E side of Long Pond, a; Goobies, 0.7 km S of the jct. of Hwy. 210 with TCH, a, A, p; Jacks Pond Provincial Park, a, A, p, and on *Larix*; near TCH 1.1 km NW and 1.2 km S of Hwy. 203 jct., a, p; and 0.5 km NW of entrance to Bellevue Beach Provincial Park, a.

**Avalon Peninsula:** 2.5 and 4 km N from Cape St. Mary's, a; St. Brides, near Hwy. 100, 1.6 km W from turnoff to Cape St. Mary's, a; Point Verde, open raised bog, 1 km S of Green Point, p; on road from Southeast Placentia to Colinet (Hwy. 91) 1.7 km W of the turnoff to Dunville, a, p; near Hwy. 91, 0.7 km E of the turnoff to Dunville, above tributary of the Southeast River, 100 m alt., a, p, P; near Hwy. 91, 4.7 km E of the turnoff to Dunville, 105 m alt., p; on Hwy. 102, 1.7 km NNE of Dunville, ca. 90 m alt., p; between Fox Harbour and Ship Harbour 1.3 km SW from Ship Harbour Brook, ca. 90 m alt., a, A, p; along Hwy. 102, 10.6 km NE from Fox Harbour, p, and on *Alnus* and *Larix*; Ship Harbour, near Atlantic Charter Historic Site, p; Fitzgerald's Pond Provincial Park, ca. 135 m alt., p; on Hwy. 101, 1.2 km S of railway crossing, ca. 200 m alt., a; on Hwy. 101, 0.8 km N of railway crossing, ca. 150 m alt., a; Ship Harbour Big Pond on Hwy. 101, 5.4 km N from jct. with Hwy. 100, 160-170 m alt., a, p; on Hwy. 101, 6.8 km S from Hwy. 202 jct., A; on Hwy. 101, 4.1 km S from Hwy. 202 jct., a, p; on Hwy. 101, 3.4 km S from Hwy. 202 jct., a, p; on Hwy. 101, 1.8 km S from Hwy. 202 jct., p; on Hwy. 202, 4.4 km NE of Hwy. 101 jct. near Long Harbour, p; near TCH 1 km SE of Hwy. 202 jct., a, A, p; on Hwy. 100, 7.2 km from TCH jct., a, A, p, and on *Viburnum cassinoides*; near Hwy. 81, 5.3 km S of railway crossing in Whitbourne (just N of Markland), a, p, and on *Nemopanthus*; near Hwy. 81, 11.4 km S of railway crossing in Whitbourne, a, p; Rocky River near Hwy. 81, 10 km N from Hwy. 91 jct. in Colinet, a; on Hwy. 81, 0.3 km S from bridge across Rocky River, 50-60 m alt., p; near Hwy. 91, 1.6 km W of Hwy. 92 jct., near East Branch of the North Harbour River on a wet ridge between Cataracts Brook and North Harbour River, ca. 45 m alt., a, p, and on

*Nemopanthus*; near Hwy. 91, 2.7 km W of Cataracts Provincial Park, ca. 105 m alt., a, p; Haricot, 1.5 km E from river, a; S of Hwy. 91, 6.1 km E of bridge across Colinet River, ca. 100 m alt., a; on Hwy. 91, 1.9 km W of St. Catherines, about 95 m alt., a; St. Josephs, on Hwy. 90, 1.4 km SE of Hwy. 94 jct., p; Holyrood Provincial Park, a, p; Daniels Point, on Hwy. 10, 2.1 km SW from bridge over Northwest Brook, about 30 m alt., p; between Hwy. 10 and Chance Cove Provincial Park, a; on Hwy. 10, 9.6 km SSW from Cappahayden, p; on Hwy. 13, 9.3 km NW from Hwy. 10 jct., a, p; Salmonier Nature Park, a; on Hwy. 90, 8.4 km S from TCH, a, A, p; near TCH 4.5 km E from Hwy. 90 jct., p; on S side of TCH 1.4 km W of Hwy. 71 jct., a, p; South River system in Conception Bay area, on the road from Clarke's Beach to Snow's Pond, 6.3 km from Hwy. 70 jct. (SW of Halls Town). p; and on Hwy. 73, 2.2 km E from Hwy. 80 jct., p.

## 2. Collecting data for *C. hultenii* in Nova Scotia.

**Cape Breton Co.:** Main-à-Dieu, in coniferous thickets on top of sea cliffs, and at edge of fen behind the cliffs, p; Baleine, near the highest coastal rock outcrop, a, p; Fort Louisbourg, between the circumferential road and White Point, a, p, and on *Larix*; 0.1 and 0.8 km W of Landing Cove Brook, a, p; along brook 0.9 km W of Kennington Cove Brook, p; and 4.6 km S of Gabarus Lake (from junction of road to Victoria Bridge), a.

**Richmond Co.:** Irish Cove, on Hwy. 4, 1.6 km from Cape Breton County line, edge of steep coniferous forest, on trunk of *Picea glauca* over *Cetraria ciliaris*; North Fourchu, 2.4 km from Fourchu Harbour road jct., a; Fourchu, 0.6 km W from Fourchu Harbour road jct., a, p; 1.5 km NW of North Framboise, a, p; near W end of St. Esprit Lake, a; between Fergusons Lake and L'Archeveque 0.6 km W of turnoff to East Side Grand River, a, p; 2.8 km NE of Point Michaud picnic park, a, p; and near Point Michaud picnic park, p; on Hwy. 4, 5.8 km E from St. Peters Canal, p; and on Hwy. 4, 3.4 km W from St. Peters Canal, p.

**Guysborough Co.:** 2.5 km SE of Little Dover church, a; between Half Island Cove and Fox Island Main, 2.7 km E of Hwy. 316 jct., a; Cole Harbour on S side of Hwy. 316, 0.8 km E from turnoff to village, a, p; Larrys River, 2 km S from turnoff to Lundy, a; Tor Bay, near end of road, 4 km from Hwy. 316 jct., p; New Harbour, 0.5 km S of Hwy. 316 jct., a; Coddles Harbour, 1.8 km E of East Brook, a; Port Bickerton, 0.9 km S of main road jct., p; and just E of Ecum Secum on the narrow peninsula, a, A.

**Halifax Co.:** Clam Harbour, near bog on road to Owls Head Harbour, a, p, and on *Larix*; SE of Clam Harbour Beach, a, A, and on *Alnus incana*, *A. rugosa* and *Ledum groenlandicum*; Lower East Chezzetcook, Miseners Head, a, p, P; and causeway opposite Three Fathom Harbour, a.

**Lunenburg Co.:** Aspotogan Peninsula, New Harbour, a, p.

**Digby Co.:** Brier Island, below road S from Western Light Road, p, and on slope between Gull Rock Road and valley fen, a.