ECOLOGY AND PHYTOGEOGRAPHY OF THE MOSSES OF THE BONNE BAY REGION, WESTERN NEWFOUNDLAND

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ECOLOGY AND PHYTOGEOGRAPHY OF THE MOSSES OF THE BONNE BAY REGION, WESTERN NEWFOUNDLAND

by

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A Thesis submitted in partial fulfillment
of the requirements for the degree of
Master of Science

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March 1981

St. John's Newfoundland

ABSTRACT

The moss flora of the Bonne Bay region, western Newfoundland, was investigated at 54 sites. These sites represented two physiographic regions, Coastal Plain and Highlands, and four rock types: calcareous, mafic, ultramafic, and acidic. Five lithophysiographic regions combining rock type and physiography were defined.

The 261 moss species (in 112 genera) known from Bonne Bay comprise about 60% of the known moss flora for the island of Newfoundland.

Eight species and two varieties of mosses were not previously known from Newfoundland: *Arctoa fulvella* (a genus new to Newfoundland), *Ctenidium molluscum* (a genus new to Newfoundland), *Desmatodon latifolius* var. *muticus*, *D. laureri*, *Grimmia hartmanii* var. *anomala*, *Encalypta longicolla* (a species new to eastern North America), *Molendoa sentneriana* (a genus new to Newfoundland), *Orthotrichum obtusifolium*, *Trichostomum crispulum*, and *Timmia norvegica* var. *excurrens*.

The habitats in increasing order of moss diversity were peatlands, coastal exposures, barrens, forests, and freshwater areas. The lithophysiographic regions, in order of increasing moss diversity were, Ultramafic Highlands, Acidic Highlands, Coastal Plain, Mafic Highlands, and Calcareous Highlands. A high similarity among the moss floras of the Calcareous Highlands, Mafic Highlands, and Coastal Plain was attributed to the presence of calciphilic mosses in these regions. A high similarity was also noted between the moss floras of the Mafic and Acidic Highlands. The flora of the Mafic Highlands was considered distinctive and deserving of further study.

Several species at Bonne Bay are widely disjunct from western North America, and rare in eastern North America: *Arctoa fulvella*, *Campylopus atrovirens*, *Entodon concinnus*, *Encalypta longicolla*, *Grimmia hartmanii* var. *anomala*, *Oligotrichum hercynicum*, *Pseudoleskeella catenulata*. These mosses have differing edaphic ecologies and dispersal potentials. Their Newfoundland occurrences are best explained by their having survived glaciation in ice-free areas at, or near, Bonne Bay, a hypothesis supported by recent glacial-geological evidence from the region.

ACKNOWLEDGEMENTS

Foremost, I wish to thank my supervisor, Dr. Guy R. Brassard, whose constant support, advice, and enthusiasm were invaluable toward the completion of this study.

I am indebted to members of my supervisory committee, Dr. Peter Scott, and Dr. Alan Whittick, for their criticisms and helpful suggestions.

A special thanks is due Dr. Howard Crum for his numerous verifications and comments on critical specimens. I am also grateful to Barbara Hoisington, Robert Ireland, Wolfgang Maass, Wilbur Peterson, Dale Vitt, and Richard Zander for their help with identifications in difficult groups.

The following people are also gratefully acknowledged: Bob Hooper, for logistical assistance at the Bonne Bay field station but mostly for his welcomed good humour during trying periods; Bruce Roberts, for his companionship during two field trips; the Sams and Harding families from Norris Point whose friendship and willingness to help made life at the field station a pleasurable experience; Dave Huddlestone, Elizabeth Squires, Harry Hopkins, Todd Howell, Bernard Jackson, and Greg Redmond for accompaning me on several trips; Gros Morne National Park staff for information about park trails; Roy Ficken for his assistance with the figures and photographs for the text.

I express my deepest appreciation to my friend Donna McKay for her encouragement and moral support through all phases of this study.

I would like to thank Parks Canada, Atlantic Region, for

permission to collect in Gros Morne National Park. Financial assistance for this study was provided by a Natural Sciences and Engineering Council of Canada grant (No. A-6683) to Guy R. Brassard. Additional support was provided by a Memorial University of Newfoundland Fellowship (1979-1980), and a Natural Sciences and Engineering Research Council of Canada Postgraduate Scholarship (1980-1981).

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CHAPTER I

INTRODUCTION

The Bonne Bay region of western Newfoundland is dominated by a mountainous terrain reaching elevations above 800 m, and bordered in part by a low lying coastal plain. The region possesses nearly all of the major rock types found in Newfoundland and has considerable habitat diversity. Recent geomorphological evidence has renewed the hypothesis that some land surfaces near Bonne Bay may have remained ice-free during all or part of the last (Wisconsinan) glaciation.

For these reasons, the Bonne Bay region has an especially diverse moss flora that has potential significance to the phytogeography of the region.

The objectives of this study were, (1) to describe qualitatively the ecology of the mosses of the Bonne Bay region, and, (2) to consider bryological evidence from Bonne Bay relating to possible glacial refugia in parts of western Newfoundland.

Physiography

The study area (Figs. 1 and 2) is about equidistant from the tip of the Northern Peninsula and the southwestern corner of the island. It lies between 49°20' and 49°45'N and 57°30' and 58°15'W, and it covers approximately 1800 km^2. It is centred on Bonne Bay and includes the southern portion of Gros Morne National Park.

The study area comprises two physiographic regions, a Coastal Plain and a Highlands Region (Bouchard, Hay and Rouleau 1978). The Coastal Plain, extending north from Rocky Harbour, is bounded by the Long Range Mountains to the east and the Gulf of St. Lawrence to the

Figure 1. Map of Newfoundland showing the location of the study area (blackened).

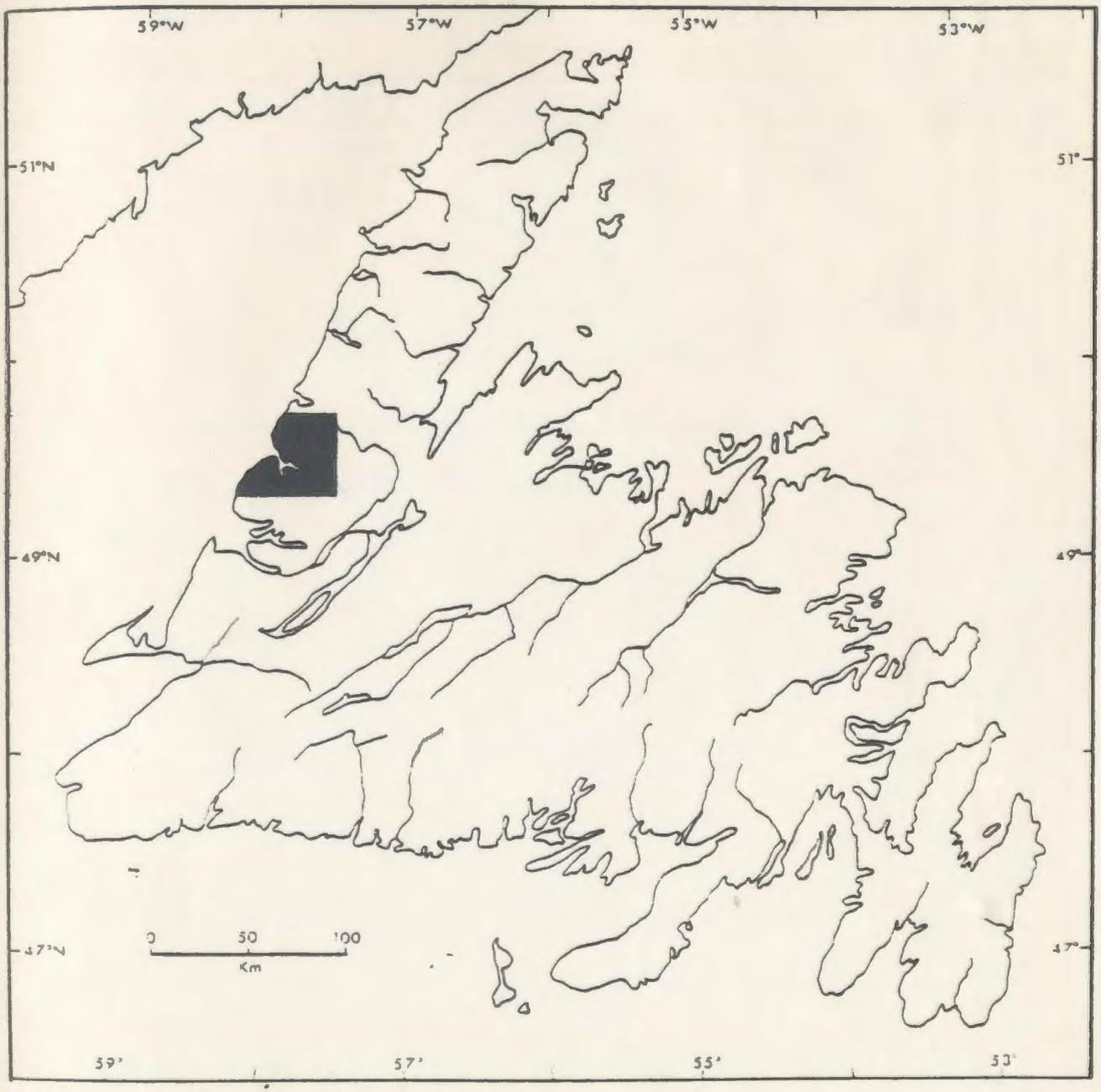
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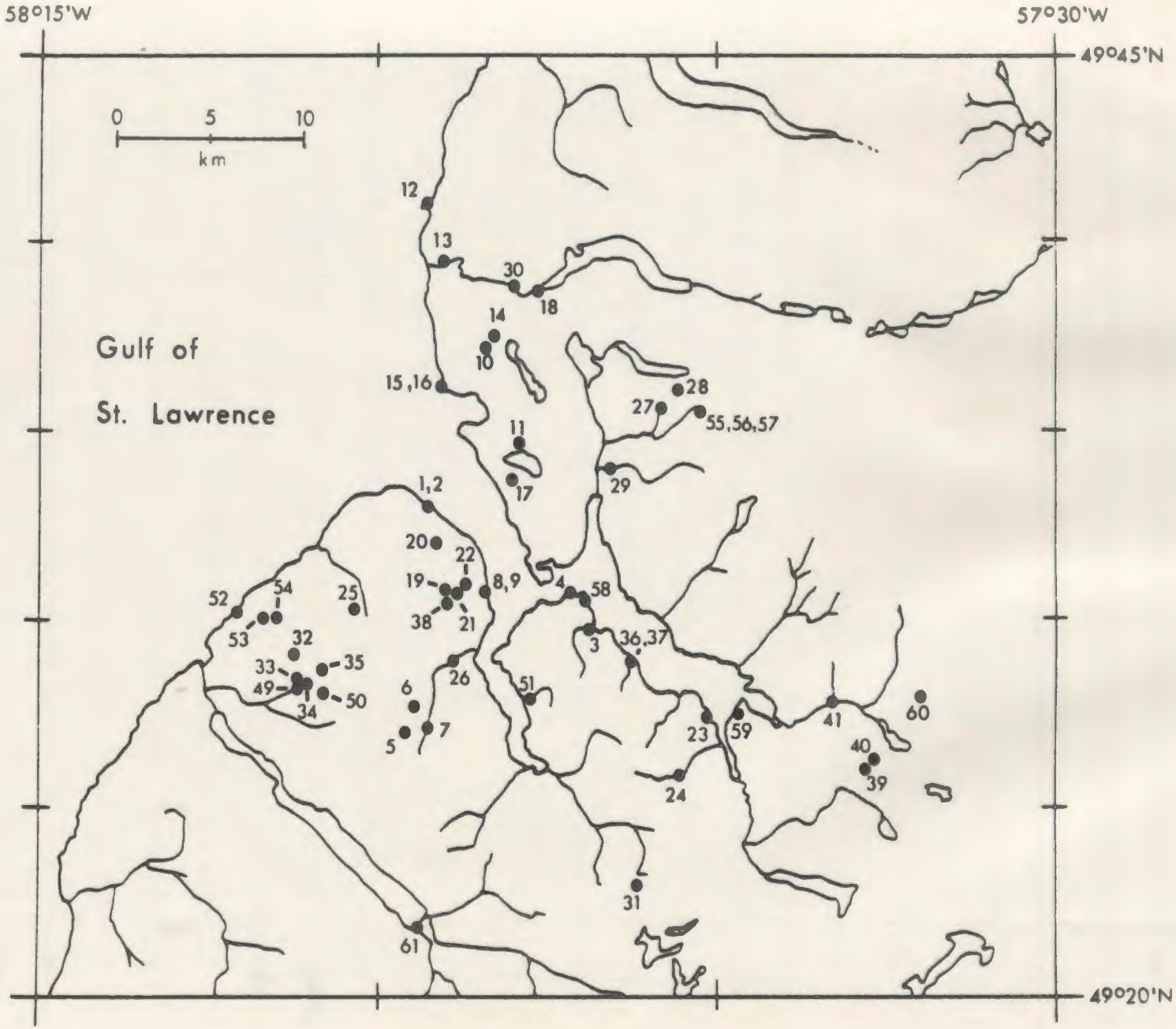
Figure 2. Map of the Bonne Bay region showing the numbers and locations of the collecting sites.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St. Lawrence
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west. It is an undulating sedimentary plain seldom exceeding 150 metres in elevation. The Coastal Plain is poorly drained, and peatlands and ponds are common. Here and there, the monotony of the Coastal Plain is broken by monadnocks (e.g. Berry Hill).

The Highlands region forms part of the Long Range Mountains, the northern end of the Appalachian Mountain chain. Oxley (1953) described the Highlands as a relatively flat peneplain which is tilted and rises gently from the east. A steep escarpment marks its contact with the Coastal Plain (Fig. 3). The plateau is dotted with numerous small lakes, and drained by rivers and creeks flowing into Bonne Bay or directly into the Gulf of St. Lawrence. Bonne Bay, an extensive fiord, is incised into the Highlands. Other former fiords, e.g. Bakers Brook Pond, are separated from the Gulf of St. Lawrence by the Coastal Plain and presently filled with fresh water.

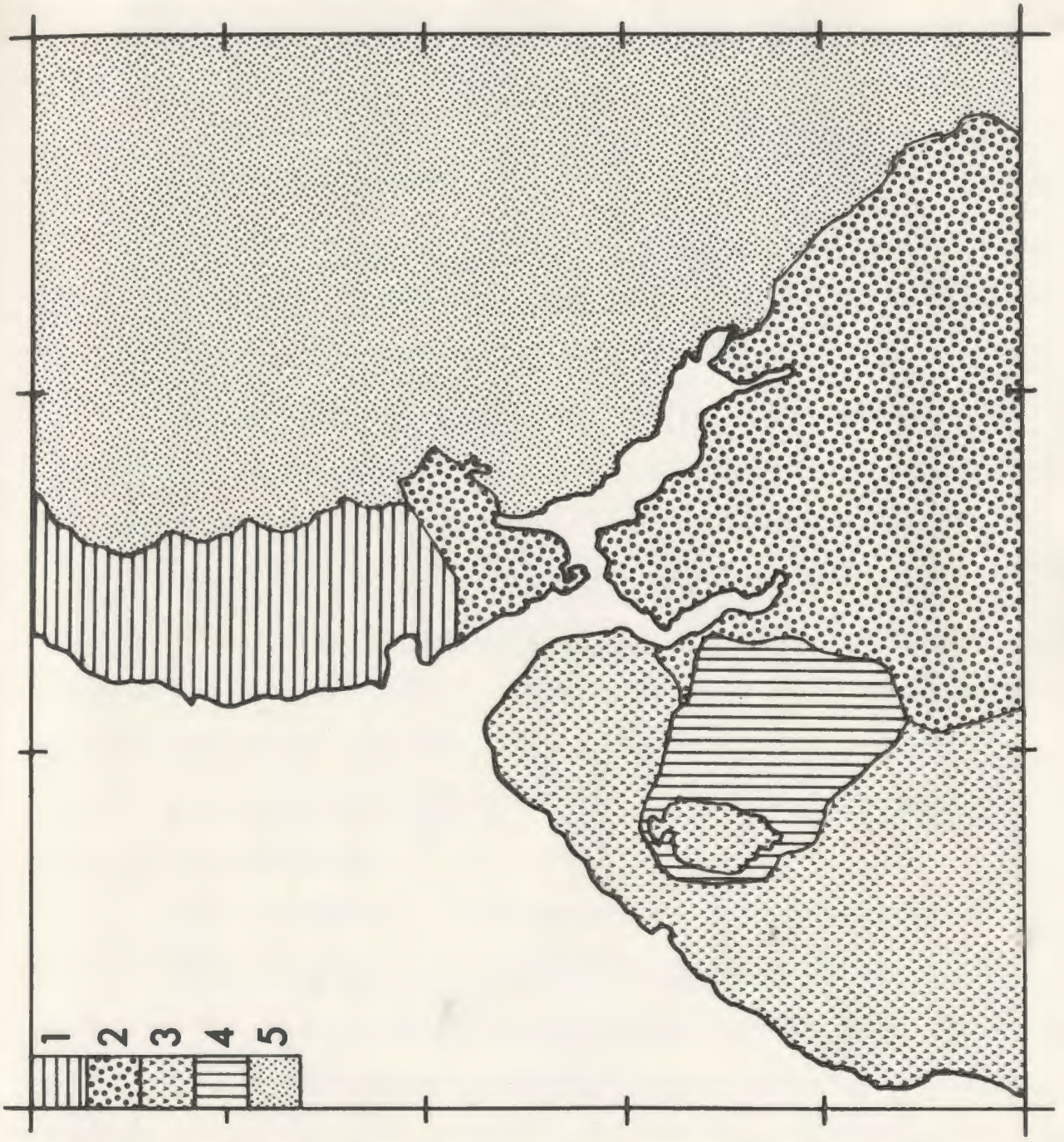
Geology

The study area lies within the northern part of the Appalachian Structural Province (Williams et al. 1972), which extends from Alabama to Newfoundland. The geological history of Bonne Bay is complex, and several rock assemblages of very different origins are represented. In this study, four rock types were recognized: calcareous, mafic, ultramafic, acidic. The distribution of these four rock types within the study area are shown in Figure 4. All types are found on the Highlands, but only calcareous rocks are present on the Coastal Plain.

Coastal Plain. Sedimentary rocks underlie the Coastal Plain and belong to three groups of Ordovician age: the Humber Arm Group, the St. George Group, and the Green Point-St. Paul's Group (Baird 1958). The Humber Arm Group forms the bedrock of the western half of the

Figure 3. The contact of the Coastal Plain and the Highlands physiographic regions. The Coastal Plain is in the foreground, while the Highlands rise abruptly in the background. This photo is taken from Parson's Pond looking southward toward the northern portion of the study area.

Figure 4. Map of the lithophysiographic regions of Bonne Bay. 1, Coastal Plain, mainly of calcareous rocks; 2, Calcareous Highlands; 3, Mafic Highlands; 4, Ultramafic Highlands; 5, Acidic Highlands.


1
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Coastal Plain and is composed of sandstones, conglomerates and shales with minor limestones. It alternates with the thinner Green Point-St. Paul's Group of thin bedded limestones, limestone breccias, shale, and siltstone. The eastern portion of the Coastal Plain is underlain by the massive limestones and dolomites of the St. George Group.

Calcareous Highland. Airphoto Analysis Associates (1975) named this region the Southern Hills, and described it as a limestone ridge and valley complex. The bedrock is the southerly continuation of the Coastal Plain rock strata, with the exception of the Green Point-St. Paul's Group which is absent.

Acidic Highland. This region includes two geologically distinct rock formations, both of which are found northeast of Bonne Bay. The Long Range Mountains are a block of metamorphosed and uplifted basement Precambrian rocks of the Grenville Geological Province (Fleming 1973). They are mainly granites, granite gneisses, and acidic banded gneisses (Baird 1958). Flanking the Long Range Mountains are the Long Range Frontal Slopes (Airphoto Analysis Associated 1975), steeply dipping Cambrian sedimentary rocks consisting of massive quartzites (Baird 1958).

Mafic Highland. This region comprises the Lookout Hills and areas west and south of the Ultramafic Highlands. The bedrock belongs to the mafic complexes of the Humber Arm Allochthon (Williams 1975). Three rock groups are included: (1) the Little Port Complex, composed of gabbro, sodic granite, and mafic dikes and flows, (2) the Old Man Cove Formation comprised of green schists, and (3) the Skinner Cove Formation composed of alkali basalt, siltstone, and limestone.

Ultramafic Highland. The Ultramafic Highlands, an uplifted, deeply dissected peneplain (Bouchard et al. 1978) are one of the most impressive features in the study area (Fig. 5). They are the northern end of the Bay of Islands Complex (Williams 1975) and comprise serpentinized ultramafic rocks which include serpentinite, dunite, peridotite, and pyroxenite (Baird 1958).

Climate

The climate of the Bonne Bay region is known primarily from a report prepared for Gros Morne National Park by Watson (1974). It is characterized by remarkably different microclimates over short distances. Bouchard et al. (1978) summarized some of the more important factors which influence the vegetation and flora in the region: a cool climate with a short growing season, a moderating influence of the ocean, a continual moisture excess, and strong prevailing winds.

Watson (1974) divided Gros Morne National Park into three climatic zones: (1) Coastal Area (which coincides with the Coastal Plain); (2) Highlands Area, corresponding to the Mafic, Ultramafic, and Acidic Highlands; (3) Bonne Bay Pond Area, corresponding to the Calcareous Highland. Table 1 and the data which follow are summarized from Watson (1974).

Table 1 shows the mean daily temperatures in the study area for the warmest and coldest months. The slightly warmer temperatures for the Bonne Bay Pond Area may be attributable to the warm Bonne Bay water or to the shelter of the Long Range Mountains from colder north-east and east winds.

Precipitation is derived from low pressure systems (Atlantic storms),

Figure 5. Photo of the Ultramafic Highlands, dominated by Table Mountain in the background. Winterhouse Brook issues from the valley near the centre of the photo (Photo by G.R. Brassard).

Table 1. Mean daily temperatures (^{o}C) for July and January, and yearly precipitation totals (cm) within the study area (data from Watson 1974)

	Coastal Area	Bonne Bay Area	*Highlands Area
Mean daily temperatures			
July	14.5	16.6	13.3
January	-5.9	-5.0	-8.9
Precipitation totals			
Rain	60-80	(-)	130-160
Snow	250-300	(-)	890-1150
Total water equivalent	85-110	(-)	219-275

*values estimated for 615 m

or as dry air masses from the Maritimes pick up moisture from the Gulf of St. Lawrence. The study area receives the most rainfall during August and the most snow during February. Table 1 gives precipitation totals for the Coastal and Highland Areas.

Potential evapotranspiration is about 46 cm/yr (Hare 1952). Since the mean annual precipitation is higher than this, the region has a moisture surplus. High precipitation and low evapotranspiration, combined with poor drainage over many parts of the Highlands and Coastal Plain, have resulted in extensive peatlands (Bouchard et al. 1978).

The growing season, when mean air temperature is greater than 6.1°C, is about 150 days (Hare 1952). It begins about 20 May in the southern portion of the study area and about 5 days later in the northern portion.

The constant winds have high mean velocities (Watson 1974). In the Coastal Area, the predominant wind is from the southwest during all months, and averages 24 km/hr from March to September. The rest of the year, mean wind velocities are usually greater than 26 km/hr. In the Bonne Bay Pond area and on the Highlands, winds are channelled by valleys. Easterlies of gale force (> 40 km/hr) are expected about three times per month from October until March. The high winds are responsible for the pruning of trees on the higher mountain ridges and also along the coast.

Vegetation

Vegetation within the study area falls into the Northern Peninsula and Newfoundland-Labrador Barrens sections of Rowe's (1972) forest classification. The most common tree species are Abies balsamea

(L.) Mill., Picea glauca (Moench) Voss, and P. mariana (Mill.) B.S.P. Pinus strobus L. is found growing scattered in upland areas.

The vegetation types in the Bonne Bay region have been described and mapped by Airphoto Analysis Associates (1975) and summarized by Bouchard et al. (1978). The following short summary is derived from these works, supplemented by my own observations.

Abies balsamea dominates extensive forests, both on the Coastal Plain and on the Highlands. On undisturbed sites, it occurs as closed-crown stands with Betula papyrifera Marsh., Picea glauca, and P. mariana. On the Coastal Plain continued logging of accessible areas maintains early successional scrub communities of Abies balsamea. Such communities are infrequent on the Highlands. Wind-shaped alpine scrub or upland tuckamoor is also dominated by A. balsamea, and resembles the tuckamoor found at lower elevations on the Coastal Plain.

Poorly drained terrain is occupied by Picea mariana-Sphagnum forests. Wetter sites support Alnus rugosa (Du Roi) Spreng. communities. These are especially common in lowland areas adjacent to larger creeks and rivers.

Peatlands are conspicuous throughout the study area. They occupy flat or nearly flat, poorly drained terrain. On the Coastal Plain, the peatlands are mostly raised bogs, having developed between raised bedrock ridges which effectively impede drainage. These peatlands are dominated by Sphagnum, Cladina, and dwarf, mainly ericaceous, shrubs. The peatlands of the Highlands are shallow and have more sedge vegetation. Patterned fens occur over much of the Ultramafic Highlands.

Heath vegetation is mainly restricted to the higher elevations of the Highlands, although Kalmia heath is found adjacent to Sphagnum

bogs at all elevations. Most common is the Empetrum heath community found on exposed upland moraines and felsenmeer knobs. It is dominated by Empetrum nigrum L., Vaccinium spp., and other arctic-alpine species such as Loiseleuria procumbens (L.) Desv. and Diapensia lapponica L.

Previous Bryophyte Collections

The earliest bryophyte collection in the study area was made by Rev. A.C. Waghorne who collected at Chimney Cove in 1896 (Macoun 1902; Tuomikoski, Koponen and Ahti 1973). More recent collections in the Bonne Bay area were made by R. Tuomikoski in 1949, D. Norris in 1966, R. Schuster in 1968 (Schuster 1969, 1974), Harry and Claire Williams in 1966, and W.S.G. Maass in 1963.

The most recent collections are those made by G.R. Brassard and his students and associates since 1972 (e.g. Brassard 1975, Brassard and Weber 1978; Fife and Brassard 1980). The most important localities they investigated are the vicinity of Glenburnie and the Trout River road, 3 to 10 km E of Trout River (in 1972, 1973, 1974) and Gros Morne mountain and the falls along Southeast Brook (in 1973).

In 1976, Allan J. Fife collected extensively in the Bonne Bay area. His localities are too numerous to list but include Berry Hill, Baker's Brook Falls, the limestone hill south of Rocky Harbour, and the Lookout Hills.

Glaciological History

In 1929, M.L. Fernald visited Bonne Bay. He had earlier published the "nunatak hypothesis" suggesting that certain areas surrounding the Gulf of St. Lawrence had been refugia during the Wisconsinan Glaciation, when much of Canada lay buried beneath ice (Fernald 1925). The nunatak hypothesis attempted to explain the presence

of arctic-alpine disjuncts and endemic vascular plant species in the Gulf region. Fernald (1925) had included some areas north and south of Bonne Bay as nunataks, and he later extended his hypothesis to include Bonne Bay, as is evident in the following remarks:

> "Passing under Western Head, at the southern entrance to Bonne Bay, we were attracted to the steeple-like pinnacles of diorite which stand like scattered spires over the slope - mute evidence that no recent continental ice-sheet has passed over the area..."
>
> (Fernald 1933, p. 92)

Fernald's nunatak hypothesis has been controversial since its publication.

Wynne-Edwards (1937) argued that the ecology of the arctic-alpine disjuncts could explain their occurrences around the Gulf of St. Lawrence. He showed that all the disjunct vascular plants were restricted to basic rocks. Because these rocks are discontinuously distributed in North America, plants restricted to them will show a similarly disjunct distribution. Rousseau (1974) and Drury (1969) have supported Wynne-Edwards' claim. Damman (1965, 1976) showed that the distribution patterns of the northern and southern elements within the Newfoundland flora can be explained adequately by existing climate and soils.

Nevertheless, others have invoked historical phytogeography to explain the distribution of arctic-alpine species. In Marie-Victorin's (1938) rainbow theory, the arctic-alpine species are considered Arcto-Tertiary plants that migrated from Arctic Canada along both sides of Hudson Bay and became extinct in the northern part of their range. These disjuncts now have two centres of distribution in North America: they are widespread in the Cordilleran region and have a minor centre

in the Gulf of St. Lawrence region.

In Marie-Victorin's (1938) sidewalk theory, a tundra environment near the edge of the retreating ice-sheet provided a corridor for migration of alpine plants from the cordillera of western North America to the Gulf of St. Lawrence (also partly supported by Crum 1972). The discovery of intermediate stations in the Lake Superior region for arctic-alpine vascular plants (Butters and Abbe 1953; Soper and Maycock 1963) and bryophytes (Steere 1937, 1938) has supported this idea.

Little mention has been made of bryophytes in the arguments for refugia in the Gulf of St. Lawrence. Bryophyte disjunctions have been used elsewhere to suggest refugia, e.g., Brassard (1971) for the Queen Elizabeth Islands, Steere (1978) for the Alaskan North Slope, and Vitt and Horton (1979) for the Nahanni and Liard ranges in the Northwest Territories.

The geological evidence for unglaciated areas at Bonne Bay is mainly the presence of highly weathered bedrock or "felsenmeer" on many mountain tops. The felsenmeer areas are distinct and have sharp boundaries to the less weathered bedrock at lower elevations. Coleman (1926) thought that these highly weathered felsenmeer surfaces would have had to remain nunataks during the Wisconsinan Glaciation. MacClintock and Twenhofel (1940) rejected Coleman's appraisal, having found abundant evidence of glacial overriding (glacial striations and erratics). They acknowledged the presence of the felsenmeer, but they minimized the time difference between the highly weathered surfaces and the less weathered bedrock.

Recent geomorphological evidence has favoured Coleman's (1926) original model. Grant (1969, 1977a) has used weathering surfaces and their associated ice-marginal features to delineate the extent of ice-cover near Bonne Bay during the Wisconsinan Glaciation. He suggests that many areas probably remained as nunataks during all of the Wisconsinan, and that others may have been ice-free during at least the late Wisconsinan. Felsenmeer surfaces have also been described for the Long Range Mountains in southwestern Newfoundland by Brookes (1977), who believes that they represent nunataks during the late Wisconsinan.

CHAPTER II

MATERIALS AND METHODS

Six field trips, totalling 59 days, were made to Bonne Bay from May 1979 to October 1980. In all, 54 sites were investigated (Fig. 2, p. 4, and Appendix A). Sites were chosen from each of the five lithophysiographic regions (Fig. 4, p. 9), and each site was considered one of the following habitat types (generally following Bouchard et al. 1978).

(1) Freshwater habitats. Following Bouchard et al. (1978) this habitat includes lake margins, and creeks and rivers. Lake margins include the lake and those portions of the shore which extend to the highest water mark. Rivers and creeks are defined by the extent of the gorge, and include the area from brink to brink.

(2) Coastal Exposures. Unforested cliffs and talus slopes at or near sea level.

(3) Barrens. Treeless areas supporting tundra communities.

(4) Peatlands. "A generic term including all types of peat covered terrain." (Wells 1976).

(5) Forested Areas. Defined by the presence of trees, but also including tuckamoor.

The selection and location of individual collecting sites was determined in part by accessibility. Thick forests or tuckamoor severely limit access to remote areas. The few National Park trails allow access to only part of the study area. Old logging trails are mostly restricted to the Coastal Plain, and roads generally follow the coastline. Collecting sites inland were, of necessity, located near

trails or roads. A small boat was used to explore sites along the coastline of Bonne Bay.

Familiarity with boreal vegetation enabled me to recognize and investigate typical habitat types. When sites with a high diversity of bryophytes were found, a special effort was made to collect these sites thoroughly.

At each site notes were made on the general physiography and vegetation. I attempted to collect all mosses present, and noted the substrate on which each grew. 1913 moss specimens were collected. Specimens were numbered, packaged, dried, and later identified at Memorial University, where full use was made of the bryophyte herbarium. Difficult or critical specimens were identified, and sent to experts for verification. The main set of voucher specimens is deposited at NFLD.

A complete list of all moss species collected from the study area by myself and others was compiled and summarized. The taxonomy used here generally follows Crum, Steere and Anderson (1973), but generic concepts in some families (notably Grimmiaceae, Mniaceae, and Polytrichaceae) follow recent taxonomic revisions (Nyholm 1954-1969; Koponen 1968; Smith 1971, respectively).

Initially, the Mafic and Acidic Highlands were considered one lithophysiographic region (part of the Alpine Plateau of Bouchard et al. 1978). It later became evident that two distinct lithophysiographic regions could be defined. Also modified was Bouchard et al.'s (1978) concept of Coastal Plain in which they included the calcareous cliffs on the East Arm of Bonne Bay. These are better considered as part of the Calcareous Highlands.

CHAPTER III

RESULTS

Ecology

The number of sites in each habitat and for each lithophysiographic region is given in Appendix B. The total number of moss species found within each lithophysiographic region and for each habitat within it are summarized in Table 2, and the percent similarities among the moss floras of the lithophysiographic regions are given in Table 3.

Phytogeography

The total moss flora of the study area comprises 261 species in 112 genera (Appendix B) which is 60% of the Newfoundland moss flora.

Annotations of noteworthy taxa

Among the taxa annotated in the following list are eight species and two varieties of mosses that were not previously known from Newfoundland, and nine species with a single previous report from Newfoundland. The first number after the species name, or after a semi-colon, refers to a site number (Fig. 2, p. 4 and Appendix A). Locations not investigated in detail as part of this study are given in full, including coordinates. Collecting numbers are underlined and are mine except where otherwise indicated.

Andreaea crassinervia. Ferry Gulch, ca. 49°35'N, 57°46'W, 2209. This is the third report from Newfoundland.

Arctoa fulvella. 50, 1948. A genus previously unreported from Newfoundland. A. fulvella was found on soil in felsenmeer tundra.

Aulacomnium androgynum. 23, 2864; Lomond area, 49°28'N, 57°45'W, 2255.

Table 2. The distribution of the Bonne Bay moss flora on the litho-physiographic regions and their habitats

Lithophysiographic region and habitat	Number of species in region	% of Bonne Bay flora	Number of species restricted to this region	Number of species in habitat
Coastal Plain	108	41.2	9	
Freshwater				34
Coastal exposure				17
Peatlands				26
Forests				57
Acidic Highlands	92	35.1	19	
Freshwater				32
Barrens				50
Peatlands				16
Forests				9
Mafic Highlands	133	51.0	11	
Freshwater				61
Coastal exposures				35
Barrens				39
Peatlands				14
Forests				32
Ultramafic Highlands	58	22.1	3	
Freshwater				9
Barrens				16
Peatlands				18
Calcareous Highlands	183	69.8	41	
Freshwater				117
Coastal exposures				70
Forests				80

Table 3. The number of moss species in common, and *percentage similarity among the moss floras on the lithophysiographic regions at Bonne Bay

	Number of Species in Common				
	Coastal Plain	Acidic Highlands	Mafic Highlands	Ultramafic Highlands	Calcareous Highlands
Coastal Plain	----	41	58	27	80
Acidic Highlands	41.0	----	52	28	48
Mafic Highlands	48.3	46.4	----	43	91
Ultramafic Highlands	32.5	37.3	42.3	----	36
Calcareous Highlands	55.2	35.0	58.0	30.0	----

Percentage Similarity

*calculated from the similarity coefficient in Odum (1972)

PC = 100(2a/b+c)

a number of species in common between two lithophysiographic regions, b the number of species present in one of the lithophysiographic regions, c the number of species present in the other lithophysiographic region

Disjunct at Bonne Bay. Known mainly from eastern Newfoundland.

Barbula convoluta. 36, 1604. This is the second report from Newfoundland, the other being from the Port au Port Peninsula (Tuomikoski et al. 1973).

Barbula reflexa. 3, Brassard 13118; 24, Brassard 13170. The only previous report of this calciphile was from Watson's Brook (Brassard and Weber 1977). Also recently collected from Cox's Cove, Bay of Islands (Belland 3941).

Bartramia ithyphylla. 24, 1185a. Primarily a coastal species in Newfoundland.

Brotherella recurvans. 8, 658, 679; 10, 728; 18, 944, 974; 54, 2085; trail into Stanleyville, 49°28'N, 57°46'W, 2239A. Southern in Newfoundland, not extending north of St. Paul's Inlet.

Bryum algovicum. 12, 786; 23, 1099. Occurring mainly on the Northern Peninsula. These specimens are southern range extensions in Newfoundland.

Bryum pallens. 24, Brassard 13122; 52, 3974. Southern range extensions in Newfoundland.

Bryum uliginosum. 6, 603. The third report for Newfoundland; previously reported under B. cernuum by Tuomikoski et al. (1973).

Callicladium haldanianum. 61, 3901, 3903. A southern species in Newfoundland, at its northern limit in Bonne Bay.

Calliergon sarmentosum. 38, 1664. A significant southern range extension within Newfoundland, previously known only from the northernmost part of the Northern Peninsula (Tuomikoski et al. 1973).

Campylium halleri. 3, 461, 531; 23, Brassard 13174; 36, 1566; 37, 1633, 1641; Lomond area, 49°28'N, 57°46'W, 2239, 2260. A calciphile, restricted to western Newfoundland.

Campylopus atrovirens. 19, 998; 38, 1678, 1688. These represent disjunct localities from the south coast, where the species is more frequent. An earlier specimen from Bonne Bay was included in Fascicle 1, Bryophyta Exciccata Terrae-Novae et Labradoricae (Brassard 1978).

Cirriphyllum piliferum. 58, 2295; 61, 3955; Lomond Junction, 49°26'N, 57°45'W, 2846. In the study area, a species of rich woods habitat.

Ctenidium molluscum. 36, 1620 (verified by H. Crum). All previous reports from Newfoundland were discounted by Tuomikoski et al. (1973). This specimen thus is the first confirmed report of this genus and species from Newfoundland.

Cyrtomnium hymenophylloides. 17, Brassard 13164; 23, Brassard 13131; 30, 1451. Previously reported only from White Bay (Brassard and Weber 1977).

Desmatodon latifolius var. muticus. 52; 2030, 2043. This is the first report of this northern variety from Newfoundland, where the species itself is rather rare (Fife and Brassard 1980).

Desmatodon laureri. 16, 866. Previously unreported from Newfoundland. Rare in North America.

Dichelyma pallescens. 61, 3930, Brassard 13466. The third report of this eastern North American endemic moss in Newfoundland (Tuomikoski et al. 1973).

Dicranum groenlandicum. 28, 2238A; 60, 2379. These localities are intermediate between stations on the Northern Peninsula and southwestern Newfoundland (Tuomikoski et al. 1973).

Didymodon rigidulus. 3, 507; 29, 1336, 1347; 52, 2028, 2029. A calciphile with an apparent west-central distribution in Newfoundland.

Ditrichum lineare. Trail into Gros Morne, 49°35'N, 57°47'W, 2244, Disjunct from eastern Newfoundland, where it is known only from the Bonavista and Avalon Peninsulas (Weber and Brassard 1976).

Encalypta longicolla. 23, 2863, Brassard 13132; brook margin near Trout River road, ca. 49°29'N, 58°03'W, 3894. These are the first reports of this species in eastern North America. Otherwise known mainly from northern British Columbia, Alaska, and the Yukon Territory (Horton 1979).

Entodon concinnus. 4, 570A; 10, Fife 2896 (No. 34 of Bryophyta Exciccata Terrae-Novae et Labradoricae); 23, Brassard 13134; 52, Brassard 13488; Gadd's Point, ca. 49°31'N, 57°53'W, 2899; Norris Point, ca. 49°31'N, 57°53'W, Brassard 13158; North of Trout River village, 49°39'N, 58°07'W, Brassard 13137; Chimney Cove (Tuomikoski et al. 1973). In eastern North America, E. concinnus is known only from western Newfoundland between latitudes 48°30'N and 50°N (Tuomikoski et al. 1973; Brassard 1975, Brassard and Weber 1977), and North Carolina (Steere 1975, 1978).

Grimmia hartmanii var. anomala. 34, 1520. This is the first report of this species in Newfoundland. G. hartmanii var. anomala is

rare in North America.

Grimmia ovalis. 23, 2257; 35, 1546; Trout River Pond, 49°26'N, 58°04'W, 3921, 3923. Poorly known in Newfoundland. Reported previously from Notre Dame Bay and the southwest coast (Brassard and Weber 1978).

Grimmia tenerrima. 6, 611, 623; 22, Fife 2186; Trout River road, ca. 49°29'N, 58°03'W, 3885, 3887; Trout River Pond, 49°26'N, 58°04'W, 3920. In Newfoundland, known only from the Bonne Bay region.

Hygrohypnum dilatatum. 2, 413, 431; 3, 518; 9, 710. Uncommon in Newfoundland, mainly on the west coast. In the Bonne Bay area, on limestone and weakly calcareous rock.

Hygrohypnum eumontanum. 41, Brassard 13184. This is the second report for Newfoundland. Previously known from Ferry Fulch, near Gros Morne mountain (Fife and Brassard 1980).

Hygrohypnum smithii. 24, 1109, 1190; 49, 1923, 1925. In eastern North America apparently restricted to the Gulf of St. Lawrence region (Fife and Brassard 1980).

Hylocomium pyrenaicum. 34, 1528; 5 km ENE of Trout River (village), 49°29'N, 58°03'W, Brassard 7560. In Newfoundland, mainly a northern boreal species.

Hypnum bambergeri. 23, Brassard 13133. A southern range extension in Newfoundland; known primarily from the limestone barrens of the northwestern part of the Northern Peninsula (Tuomikoski et al. 1973).

Isopterygiopsis muelleriana. 35, 1562, 1565. Rare in Newfoundland.

Kiaeria blyttii. 27, 1254A; 28, 1315, 1325; 38, 1675, 1686; 41, Brassard 13185; 55, 2098, 2104; Ferry Gulch, ca. 49°36'N, 57°46'W, 2211, 2213. Known also from the northeast coast near Wesleyville and, from the Northern Peninsula and Gaff Topsail (Tuomikoski et al. 1973).

Leucodon brachypus var. andrewsianus. 29, 1373, 1390. Growing on a shaded limestone cliff face. This is the third report from Newfoundland. Also known from Flat Bay Brook (Brassard 1975) and Frenchman's Cove (Tuomikoski et al. 1973).

Molendoa sendtneriana. 10, Fife 2380. A genus previously unreported from Newfoundland. Very disjunct from the nearest known localities in Arctic Canada and western North America (Zander 1977).

Myurella julacea. 3, 534; 23, Brassard 13124; 29, 1371; 37, 1634; 59, 2356; Trout River road area, 49°28'N, 57°57'W, 3943; Chimney Cove, Waghorne s.n., 16 August, 1896 (NY). These represent slight southward range extensions within Newfoundland.

Oligotrichum hercynicum. 27, 1248, 1253; 35, 1542. On soil in late snowbeds. Previously reported only once from Newfoundland and eastern North America (Tuomikoski et al. 1973).

Orthotrichum obtusifolium. 61, 3911, Brassard 13466. On Populus balsamifera. Previously unreported from Newfoundland. This species has also been recently collected in the vicinity of Deer Lake (Belland 3989, Brassard 13515).

Orthotrichum sordidum. 61, 3913, 3985. These represent only the second report from Newfoundland.

Orthotrichum stellatum. 61, 3912a. This is the third report from Newfoundland. Also known from Bartlett's River and St. John's (Tuomikoski et al. 1973)

Plagiothecium latebricola. 10, 773. Reported from Newfoundland only twice previously, on the south coast (Tuomikoski et al. 1973).

Pseudoleskea radicosa. 34, 1523, 1527. Rare in Newfoundland (Brassard and Weber 1978).

Pseudoleskeella catenulata. 3, Hooper, 3 June 1973; 23, Brassard 13141. Rare in Newfoundland; collected only once previously, on the Northern Peninsula (Fife and Brassard 1980). Apparently also rare in North America (Lewinsky 1974).

Pseudoleskeella tectorum. 3, 468; 10, 755; 23, Brassard 13142. These represent southward range extensions in Newfoundland, where the species is apparently restricted on the Northern Peninsula (Tuomikoski et al. 1973).

Pylaisiella polyantha. 56, 2187. Very rare in Newfoundland, although probably under-collected (Brassard and Weber 1978).

Pylaisiella selwynii. 61, 3910, Brassard 13467. Previously reported only from St. John's (Tuomikoski et al. 1973), although an earlier specimen is known from Deer Lake (Waghorne, 1895, NY).

Rhytidium rugosum. 20, 1012; 23, Brassard 13127. This species has a coastal distribution in Newfoundland, which correlates well with the distribution of cool summer temperatures (Damman 1976, Fig. 8).

Sciaromium lescurii. 41, 1759. Very rare in Newfoundland; previously known only from Blaketown Harbour, Avalon Peninsula, and from the south coast (Tuomikoski et al. 1973).

Seligeria tristichoides. 23, Brassard 13138. Very rare in Newfoundland, this being only the second report. It was previously known from Baker's Brook, in the study area (Fife and Brassard 1980).

Timmia norvegica var. excurrens. 10, 753. This variety was not previously reported for Newfoundland. The Newfoundland populations are considerably disjunct, the nearest other locality being on the east coast of Hudson Bay (Brassard 1979).

Tortula mucronifolia. 23, 1087; 52, 396A, 3975. These localities are intermediate to the previous two in Newfoundland (Fife and Brassard 1980).

Trichostomum crispulum. 37, 1642 (det. by R. Zander). This species is previously unreported from Newfoundland and reported only three times before in North America (Lesquereux and James 1884; Redfearn 1976; Vitt and Horton 1979). According to R. Zander (pers comm. 1980), T. crispulum is perhaps more common in Canada, existing under other names or confused with Weissia.

Zygodon viridissimus. 23, Brassard 13125; 29, 1389, 2917; 52, 3967, Brassard 13472; Gadd's Point, ca. 49°31'N, 57°53'W, Brassard 10543. Previously known only from Cow Head (Tuomikoski et al. 1973). Apparently common at Bonne Bay, on limestone and mafic rocks. Probably under-collected in western Newfoundland.

CHAPTER IV

DISCUSSION

Ecology

Habitats

The habitats at Bonne Bay show a wide variation in numbers of moss species (Table 2, p. 25). Each habitat is discussed below.

Freshwater habitats. These have the most species, with the Calcareous Highland freshwater habitats possessing the highest number of moss species of all habitats investigated. In this lithophysiographic region, the freshwater habitats examined were mostly stream gorges cut into limestone, which produces many favourable microhabitats for mosses.

The freshwater habitats on the Mafic Highlands support numerous mosses, some of which indicate nutrient-rich sites, e.g., Campylium stellatum, Calliergon trifarium, and Scorpidium scorpioides.

The Acidic Highlands and Ultramafic Highlands freshwater habitats have few species, but only one site on each lithophysiographic region was studied (e.g., Fig. 6). Observations in other parts of the study area in these regions indicate that the lists of species given for these sites (Appendix B) are typical.

Forest habitats. Forest habitats are also diverse and those of the Calcareous Highlands and Coastal Plain possess the highest number of species. The high moss diversity there is due to the inclusion within the forest habitat of densely wooded, stable limestone rock outcrops and cliffs. Many of the moss species are calciphilic, e.g., Distichium capillaceum, Ditrichum flexicaule, Encalypta streptocarpa, and Seligeria donniana.

Figure 6. Photo of the freshwater habitat at Southeast Brook Falls (site 41) (Photo by G.R. Brassard).

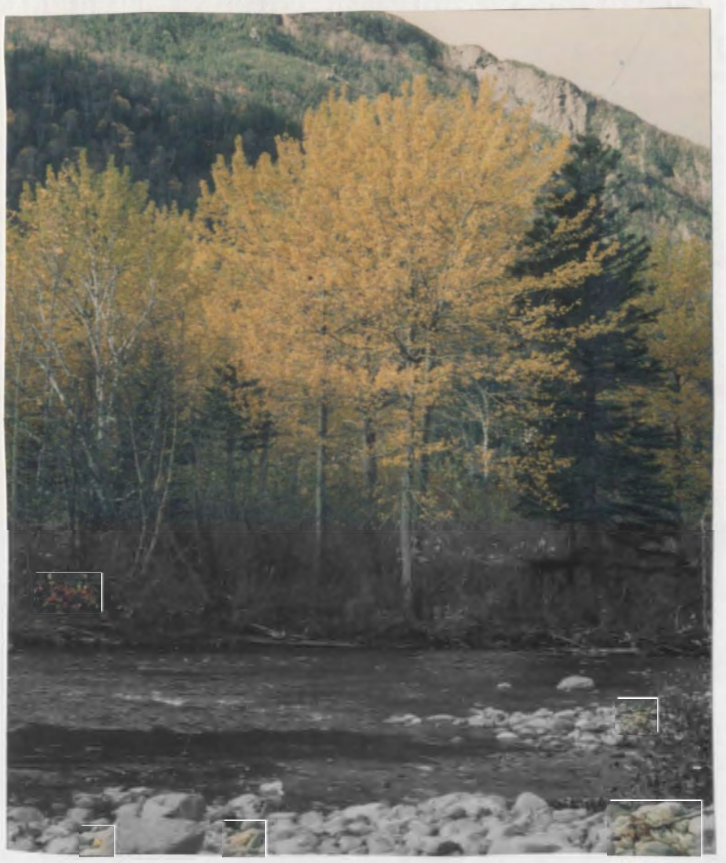
Forests on the Mafic and Acidic Highlands have fewer moss species and most are common circumboreal mosses.

Populus balsamifera forests are very rare in the study area. The only site located (site 61, Fig. 7) was found in the Calcareous Highlands. As compared with the coniferous forest sites, this stand had a high number of moss epiphytes, several (asterisks) of which are known only from this locality in the Bonne Bay region: *Neckera pennata, *Orthotrichum obtusifolium, *O. sordidum, *O. speciosum, *O. stellatum, *Pylaisiella selwynii, Ulota coarctata, U. crispa, and U. drummondii. Ground cover by mosses was poor but had patches of Brachythecium curtum, B. reflexum, and Fissidens adiantoides. The general lack of ground cover was attributed to the abundance of deciduous litter which inhibits moss growth, and to periodic flooding since this site is an alluvial delta. Also present on old stumps were Atrichum oerstedianum and Callicladium haldanianum. Dichelyma pallescens was abundant on Alnus branches partly submerged in water.

Barrens. Barrens occur on three lithophysiographic regions, the Acidic, Mafic, and Ultramafic Highlands. Here, thin soils, high winds, a short growing season, and low mean annual temperatures all contribute to a relatively impoverished moss flora. Some arctic-alpine mosses are found in this habitat, but most species are circumboreal and endure the harsh elements in protected micro-environments.

The barrens of the Acidic and Mafic Highlands regions possess similar floras containing equal numbers of species. The Ultramafic Highlands barrens, however, have fewer species. The reduced flora is dominated by Racomitrium lanuginosum, which forms extensive mats over

Figure 7. The Populus balsamifera stand at the head of Trout River Pond (Site 61) (Photo by G.R. Brassard, Oct. 1980).



rock and soil. Other moss species colonizing the barrens are restricted to wet depressions (e.g., Bryum pseudotriquetrum, Drepanocladus revolvens).

Coastal exposures. This habitat is limited to the Mafic and Calcareous Highlands, and to the Coastal Plain. High winds, salt spray, and unstable rock faces influence the colonization of mosses in coastal exposures, and the variety of the flora is directly related to the degree of exposure. Thus, the headlands and low cliffs of the Coastal Plain (Fig. 8) and parts of the Mafic Highland which face the Gulf of St. Lawrence are poor in species as compared to the headlands and cliffs along the more sheltered south shore of the East Arm of Bonne Bay.

Coastal exposures have numerous mosses which are arctic-alpine, and also calciphilic, e.g., Abietinella abietina, Desmatodon latifolius, and Entodon concinnus.

Peatlands. These habitats have the lowest number of species. Two general peatland types were recognized, raised bogs, and fens. The raised bogs have an undulating, hummocky surface comprised of light coloured lichens or by Racomitrium lanuginosum, Pleurozium schreberi, or Dicranum polysetum. Also frequent as tufts in the hummocks are Dicranum undulatum, Polytrichum strictum, and Aulacomnium palustre.

Adjacent to raised bogs or to floating vegetation around pools or lakes are sedge meadows (fens) (Bouchard et al. 1978). These are not common in the study area and do not cover appreciable areas. In contrast to raised bogs, the dominant vegetative cover consists mainly of herbaceous plants. The fens are typically eutrophic and the bryophyte species reflect this: Calliergon trifarium, Calliergonella

Figure 8. Coastal exposure at Lobster Cove Head (site 16). This habitat is fully exposed to the Gulf of St. Lawrence (Photo by D.K. M^{c}Kay).

cuspidata, Campylium stellatum, Drepanocladus revolvens, Scorpidium scorpioides, and Tomenthypnum nitens.

Some peatlands on the Highlands are dominated by Scirpus and Carex. Bog pools are often present on flat ground and these become flashets on gentle slopes. The reticulate pattern formed by the flashets and the strings between them is expecially well developed and abundant on the Ultramafic Highlands.

Distributions on the Lithophysiographic Regions

Two groups of mosses show edaphic specificity. Calciphiles, a term first used by Amann (1928), refer to mosses commonly associated with calcareous rocks, usually limestone or dolomite, and avoiding acidic rock types. Acidophiles, on the other hand, are most frequent on acidic rocks, but are rare or absent on calcareous rock.

There have been few studies comparing moss floras among rock types. Bates (1978) examined the bryoflora on mafic rocks in Great Britain similar to those found at Bonne Bay. He found this moss flora to consist mainly of acidophiles and non-calciphilic mosses.

In the Bonne Bay region, the four rock types afforded an opportunity to examine in detail the occurrences of moss species on them. A transparent overlay of the lithophysiographic regions (in pocket at back) can be used with the distribution maps of the Bonne Bay region.

In Table 2 (p.25) the moss floras on the different lithophysiographic regions are compared. About 30% of the mosses at Bonne Bay are limited to a specific region.

The Calcareous Highlands have the most diverse moss flora. This lithophysiographic region has many mosses (41) not known from the

other lithophysiographic regions. Of these, 16 are calciphilic. Myurella sibirica (Fig. 9) grows only in limestone crevices and ledges. In eastern Newfoundland this moss is reported from several localities which are not particularly calcareous (Brassard, Weber and Fife 1976; Weber 1976). Further study of this species may reveal ecotypically differentiated populations.

The Mafic Highlands also have a diverse flora. Of the 11 species that are restricted to this region, most are acidophilic or indifferent (e.g., Arctoa fulvella, Bryum salinum, Hedwigia ciliata), and two are considered calciphilic (Calliergon sarmentosum and Orthotrichum anomalum).

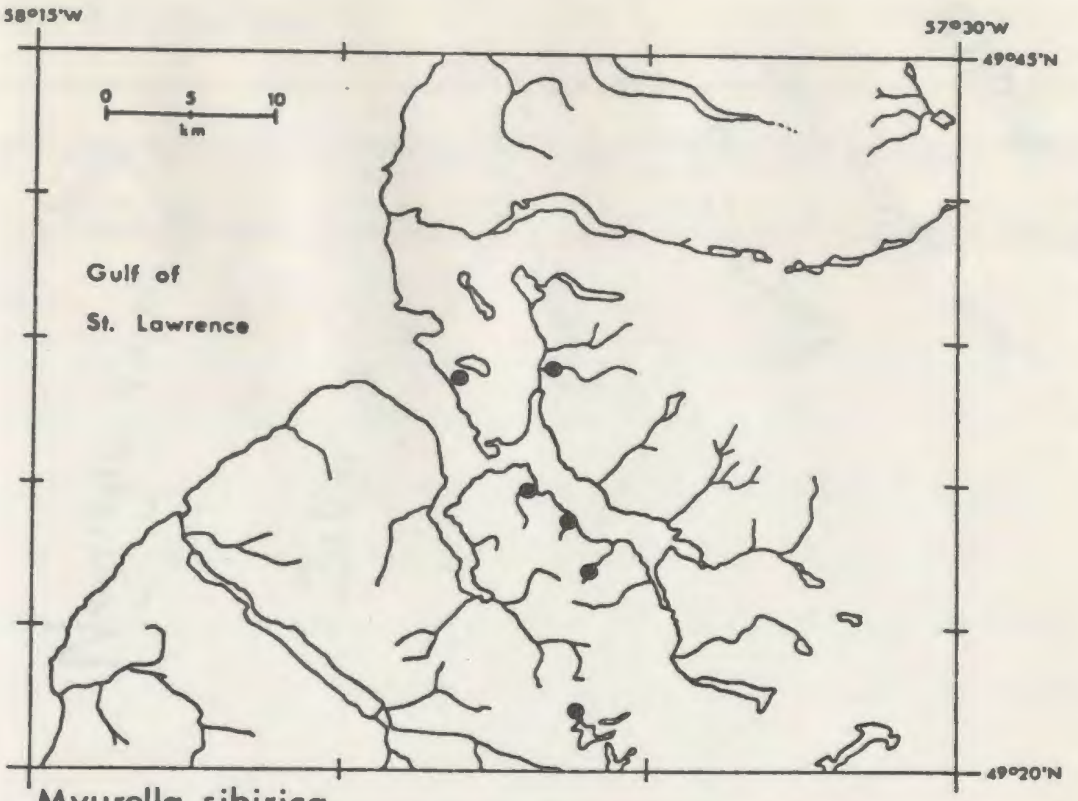
The known flora of the Coastal Plain is 108 species. Nine mosses are restricted to this lithophysiographic region, and of these, most have broad edaphic ecologies and probably also occur on the other regions. Three are calciphilic, Desmatodon cernuus, D. laureri, and Plagiobryum zierii, and are to be expected in suitable habitats on the Calcareous Highlands.

The Acidic Highlands have a known flora of 92 mosses, 19 of which were not found on any other lithophysiographic region. Dicranum elongatum (Fig. 10) and D. groenlandicum are acidophilic, arctic-alpine species (Peterson 1979) forming compact tufts in poorly drained depressions on the mountain plateaus. Other acidophiles include Andreaea crassinervia, Fontinalis dalecarlica, Hygrophypnum eumontanum, and Sciaromium lescurii.

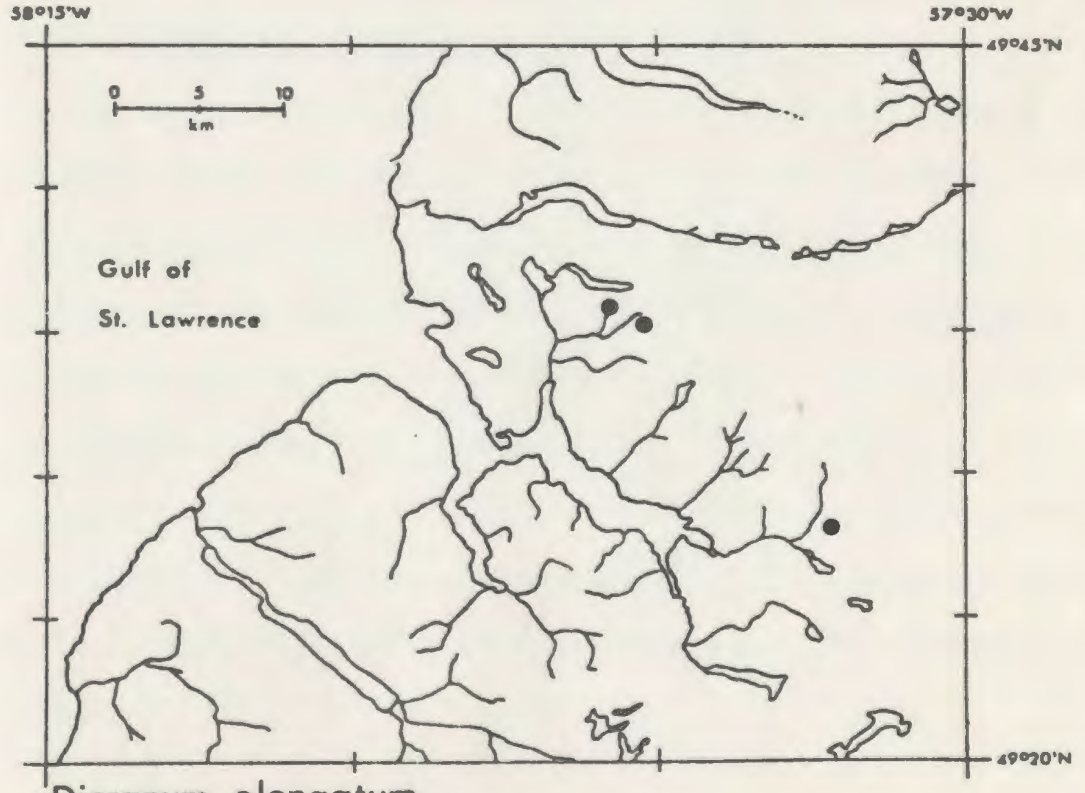
The least diverse flora is from the Ultramafic Highlands (58 mosses), undoubtedly due to the toxicity of the serpentinized bedrock. Roberts (1980) reported values of about 0.36% (by weight, oven

Figure 9. The distribution of Myurella sibirica in the Bonne Bay region.

Figure 10. The distribution of Dicranum elongatum in the Bonne Bay region.



Myurella sibirica



Dicranum elongatum

dry basis) for nickel and about 13% for magnesium for soils derived from the ultramafic rocks in the study area. The toxicity of these elements to plants is well documented by Proctor and Woodell (1975). Except for Bryum algovicum, Dicranum bonjeanii, and Tetrapolodon angustatus, all species occur on other rock types in the study area. Elsewhere in Newfoundland, however, those three mosses are not restricted to ultramafic rock types.

Similarity of moss floras among the lithophysiographic regions

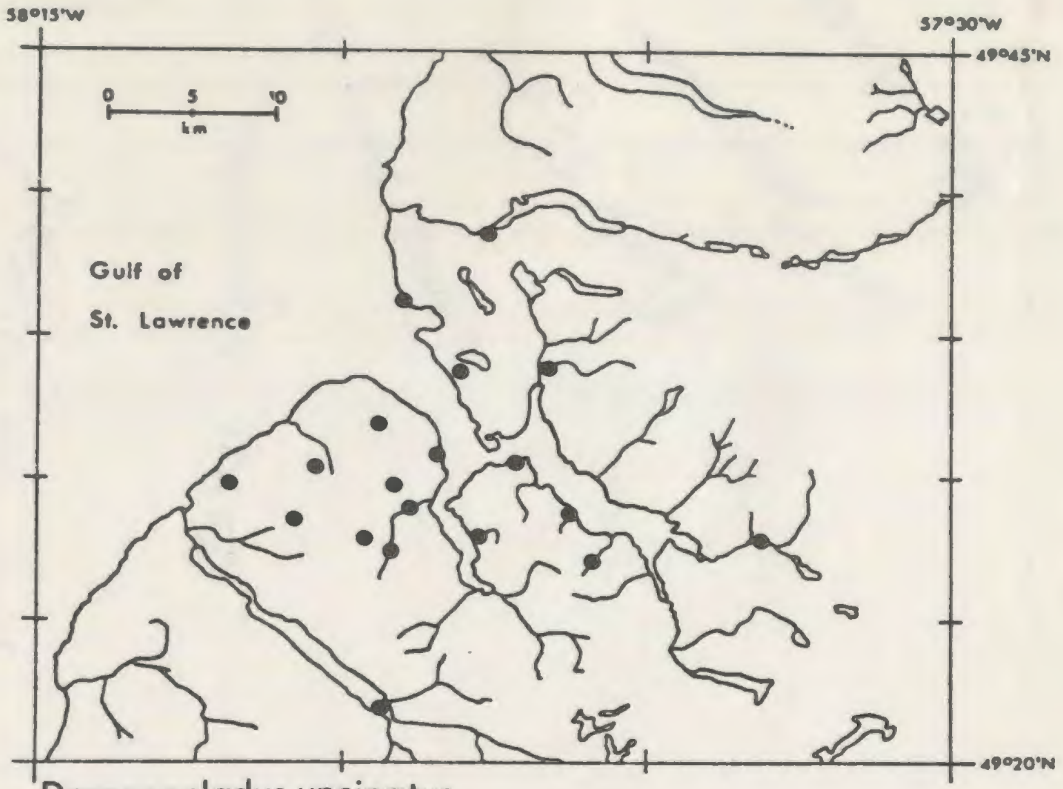
To compare the similarity of the moss floras among lithophysiographic regions, the number of species in common between them was tabulated, and a simple similarity coefficient calculated (Table 3, p. 26).

Most mosses in the Bonne Bay area grew in at least four of the five lithophysiographic regions, e.g., Drepanocladus uncinatus (Fig. 11) and Polytrichastrum alpinum (Fig. 12).

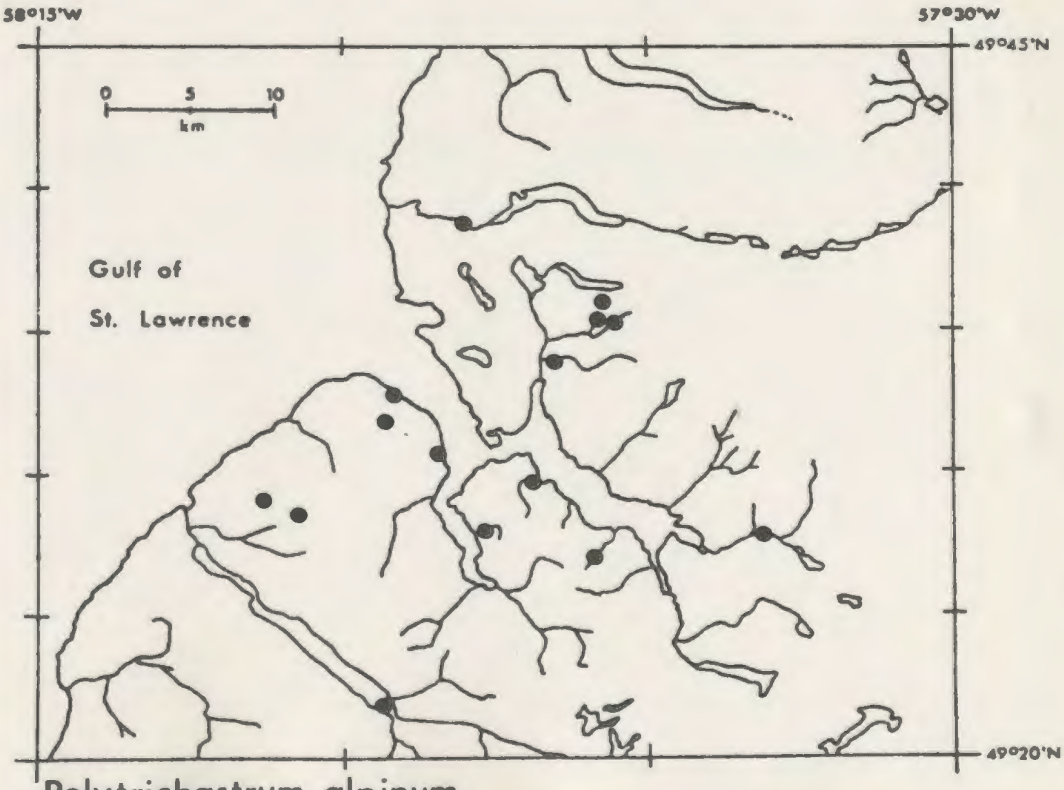
The highest percent similarities occur among the moss floras of the Coastal Plain, the Calcareous Highlands, and the Mafic Highlands (Table 3). Such high similarities are not unexpected between the Coastal Plain and Calcareous Highlands since they are underlain by similar bedrock, and have a number of species restricted to them, e.g., Seligeria donniana (Fig. 13), and Ditrichum flexicaule (Fig. 14). However, the equally high similarity of the Mafic Highlands flora to them is noteworthy. This is partly explained by the many recognized calciphiles (Nyholm 1954-1969; Lawton 1971; Crum 1976) found on the Mafic Highlands:

Figure 11. The distribution of Drepanocladus uncinatus in the Bonne Bay region.

Figure 12. The distribution of Polytrichastrum alpinum in the Bonne Bay region.



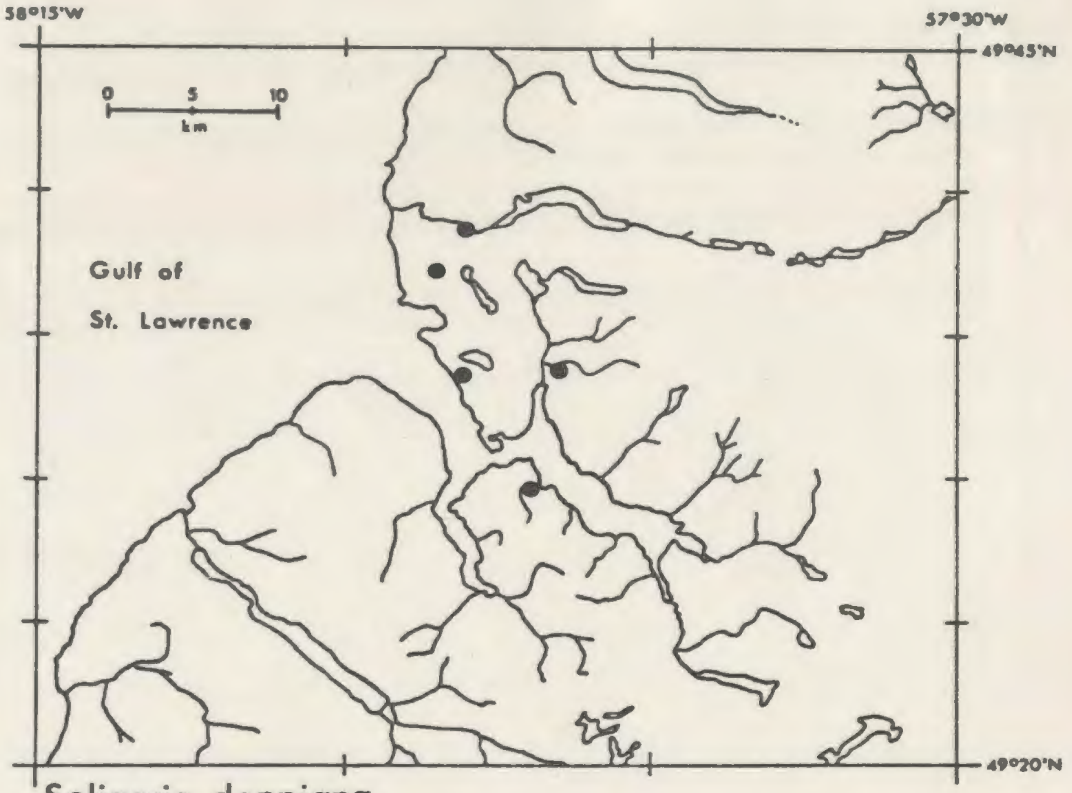
Drepanocladus uncinatus



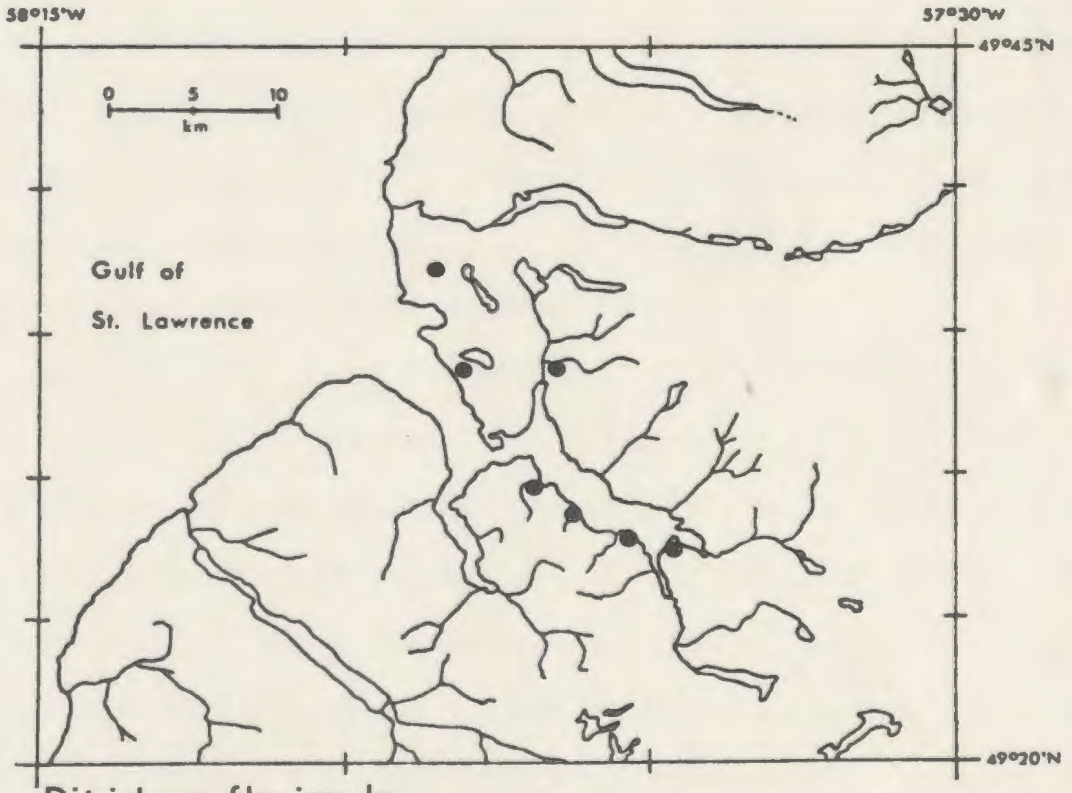
Polytrichastrum alpinum

Figure 13. The distribution of Seligeria donniana in the Bonne Bay region.

Figure 14. The distribution of Ditrichum flexicaule in the Bonne Bay region.



Seligeria donniana



Ditrichum flexicaule

Abietinella abietina

Anomodon attenuatus

A. rostratus

Barbula fallax

Bryoerythrophyllum recurvirostrum

Calliergon trifarium

Calliergonella cuspidata

Didymodon rigidulus

Encalypta rhaptocarpa

Entodon concinnus

Gymnostomum recurvirostrum

Myurella julacea

Orthotrichum anomalum

Rhynchostegiella compacta

Scorpidium scorpioides

Tortula mucronifolia

Trichostomum tenuirostre

Weissia controversa

Zygodon viridissimus

The nineteen calciphiles listed comprise about 14% of the flora on the Mafic Highlands. Elsewhere at Bonne Bay, most of them are present only on calcareous areas (Fig. 15-19).

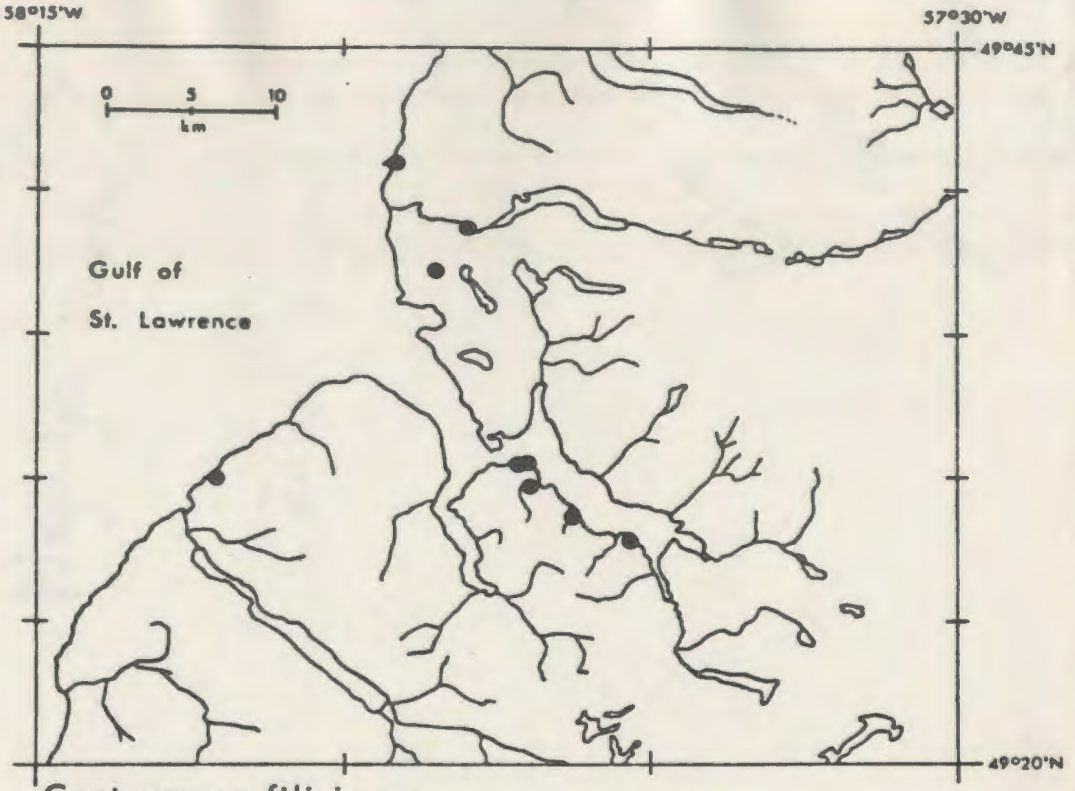
The Mafic Highlands also have a high percent similarity to the Acidic Highlands moss flora and several mosses are restricted to these two regions: Andreaea rupestris, Dicranoweisia crispula, Kiaeria blyttii (Fig. 20), Oligotrichum hercynicum, Paraleucobryum longifolium, Polytrichum juniperinum, Sphagnum majus, S. papillosum. Most of these species are generally considered acidophilic.

The Mafic Highlands, therefore, possess a distinct moss flora, consisting of a peculiar admixture of calciphiles and acidophiles. The occurrence of both ecological groups on the mafic rocks cannot be explained. Little is known of the nutrient requirements of these mosses, and detailed study is needed to define their edaphic ecologies. The diversity of rock types in the Bonne Bay region would provide a natural laboratory for the study of this and related problems.

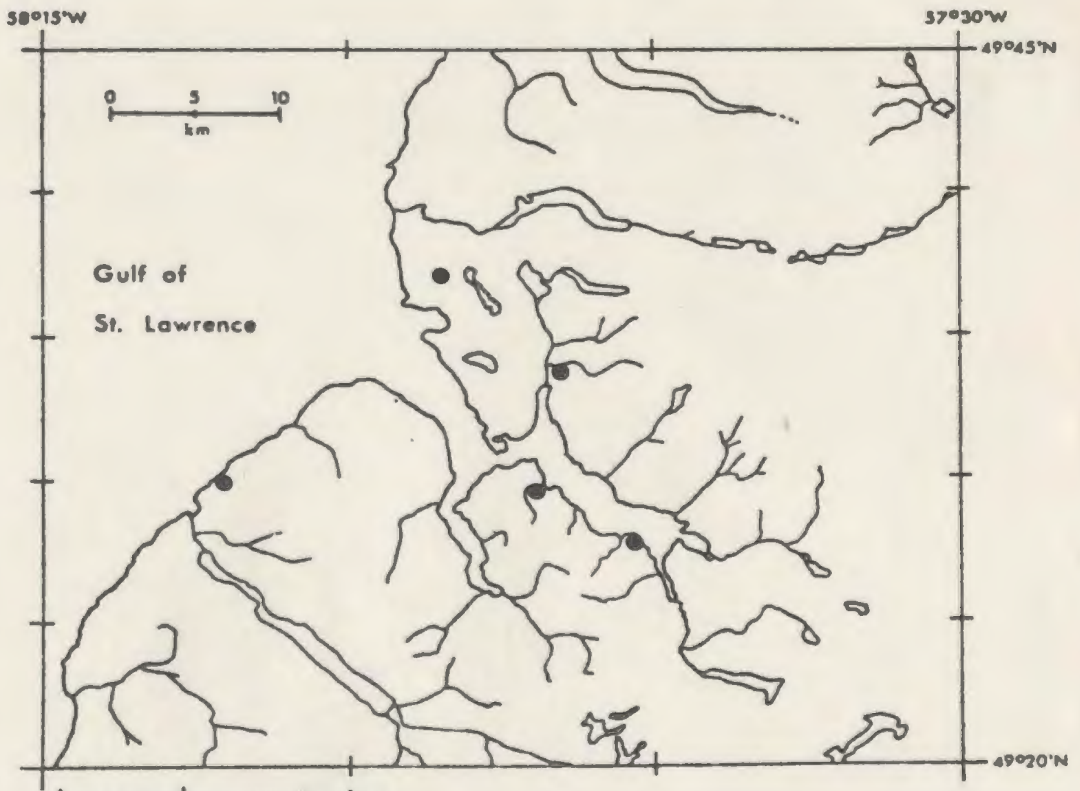
The Ultramafic Highlands have a relatively low percentage

Figure 15. The distribution of Cratoneuron filicinum in the Bonne Bay region.

Figure 16. The distribution of Anomodon rostratus in the Bonne Bay region.



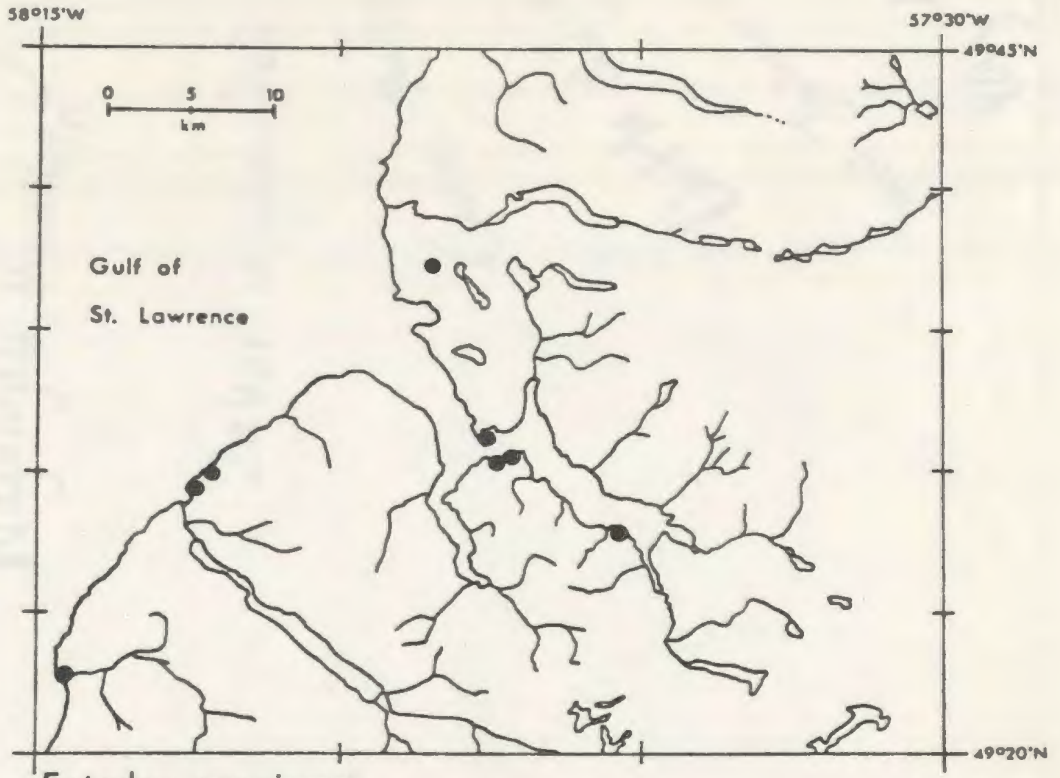
Cratoneuron filicinum



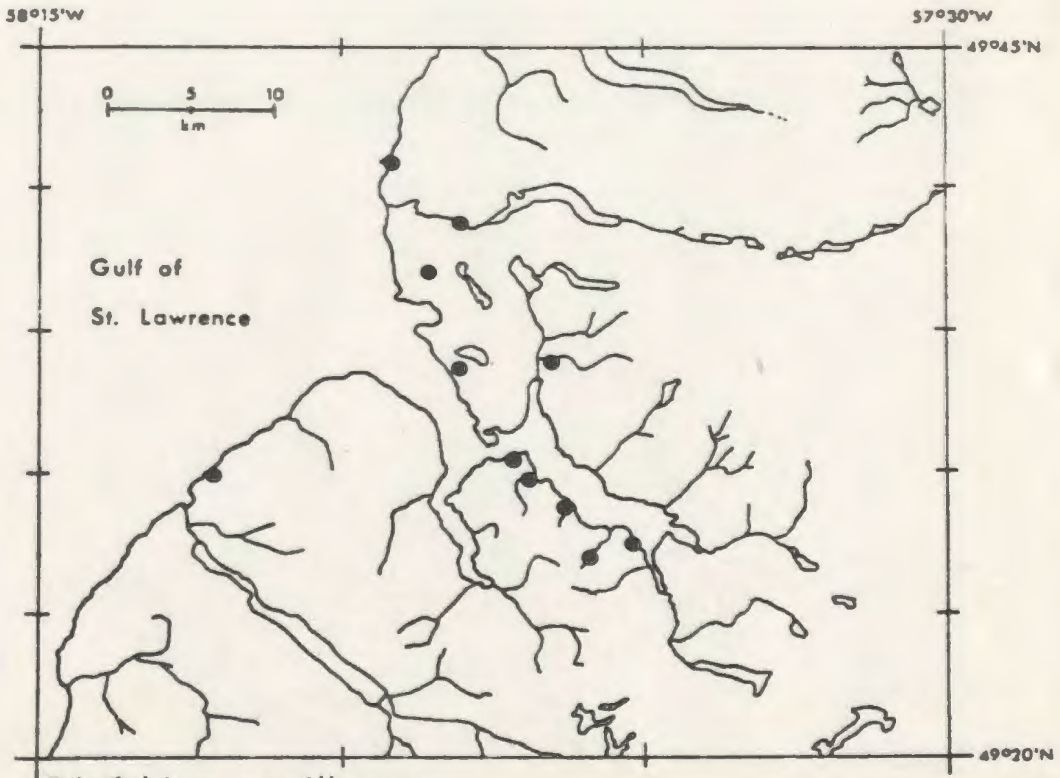
Anomodon rostratus

Figure 17. The distribution of Entodon concinnus in the Bonne Bay region.

Figure 18. The distribution of Distichium capillaceum in the Bonne Bay region.



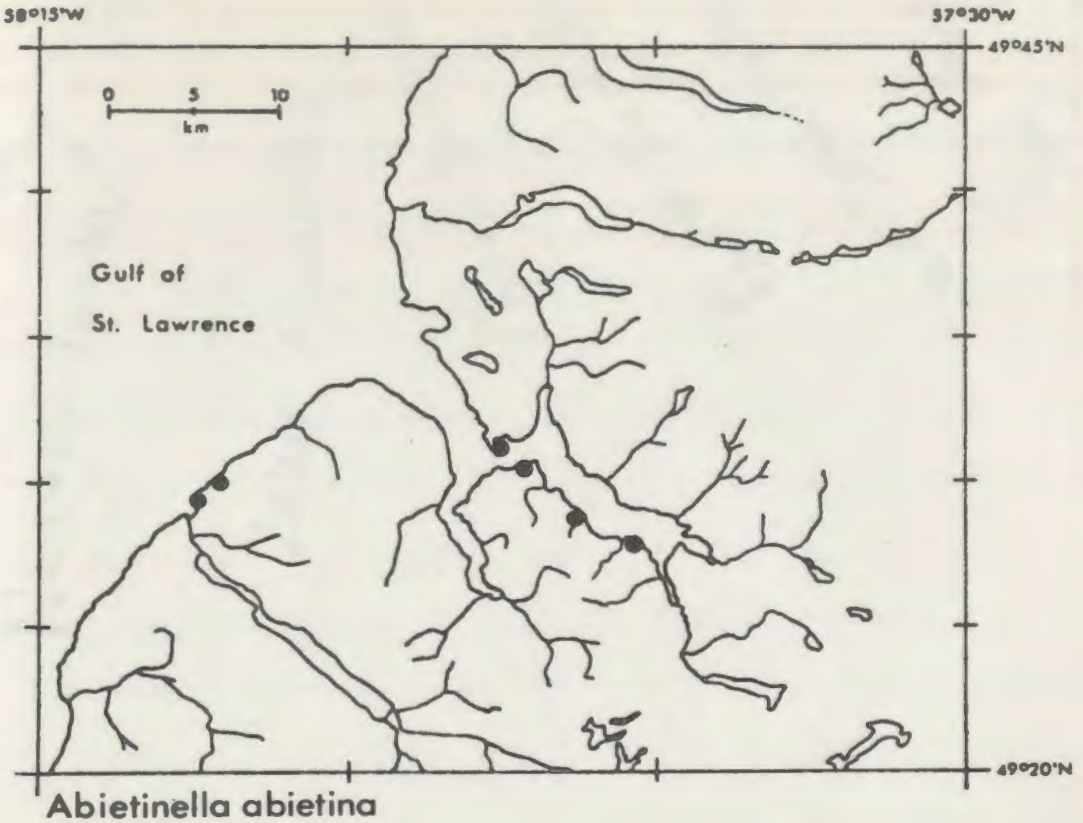
Entodon concinnus



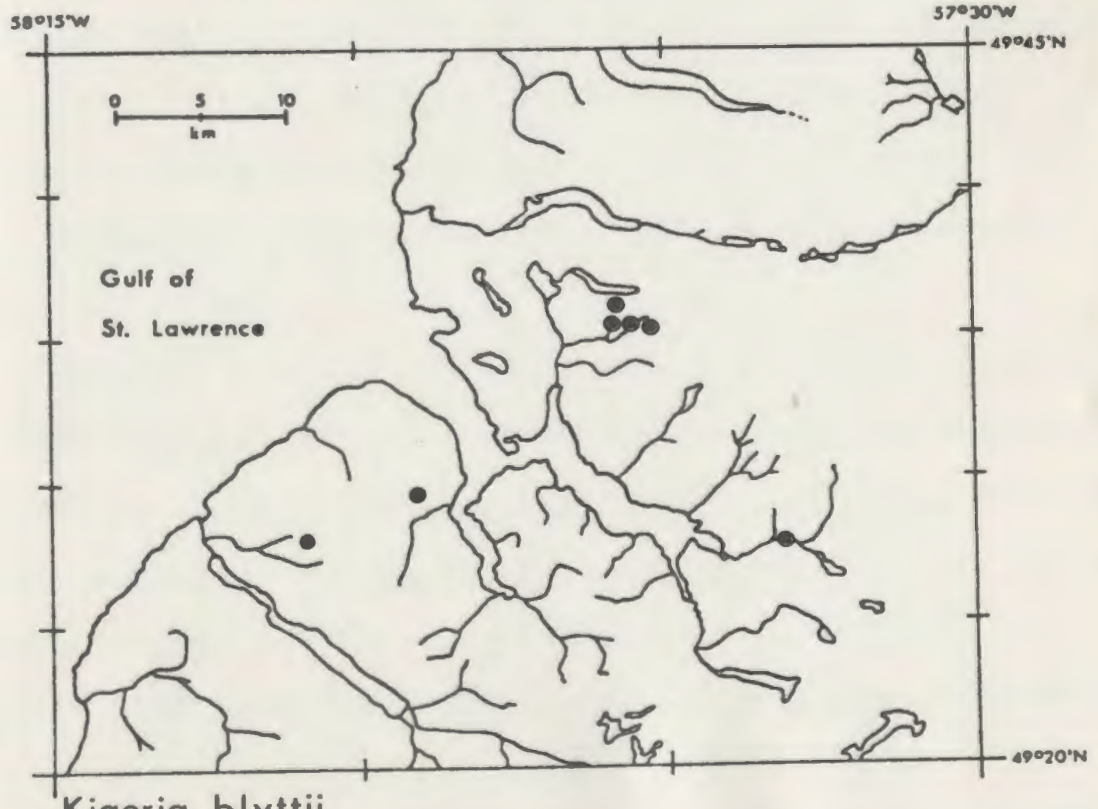
Distichium capillaceum

Figure 19. The distribution of Abietinella abietina in the Bonne Bay region.

Figure 20. The distribution of Kiaeria blyttii in the Bonne Bay region.



Abietinella abietina



Kiaeria blyttii

similarity with all other regions. There is only one species known to occur only on the mafic and ultramafic rock types, Grimmia tenerrima (Fig. 21). All other species on the Ultramafic Highlands also occur on one or several of the other three rock types. Several are calciphilic: Calliergon trifarium, Encalypta longicolla, Gymnostomum recurvirostrum (Fig. 22), Tortella fragilis, Trichostomum tenuirostre grow beside creeks or near seepage on the ultramafic rock type. Calcareous seepage may account for the presence of these calciphiles there.

Phytogeography

The Newfoundland distribution of the Bonne Bay moss flora

The distribution patterns of the mosses in insular Newfoundland were primarily discussed by Tuomikoski et al. (1973). Many new records have made it possible to refine and modify the patterns of distribution presented by these authors, and this has been done by Brassard (1981) who recognizes seven bryophyte distribution patterns in Newfoundland. The mosses from Bonne Bay are represented in six of these patterns (Table 4; Appendix B).

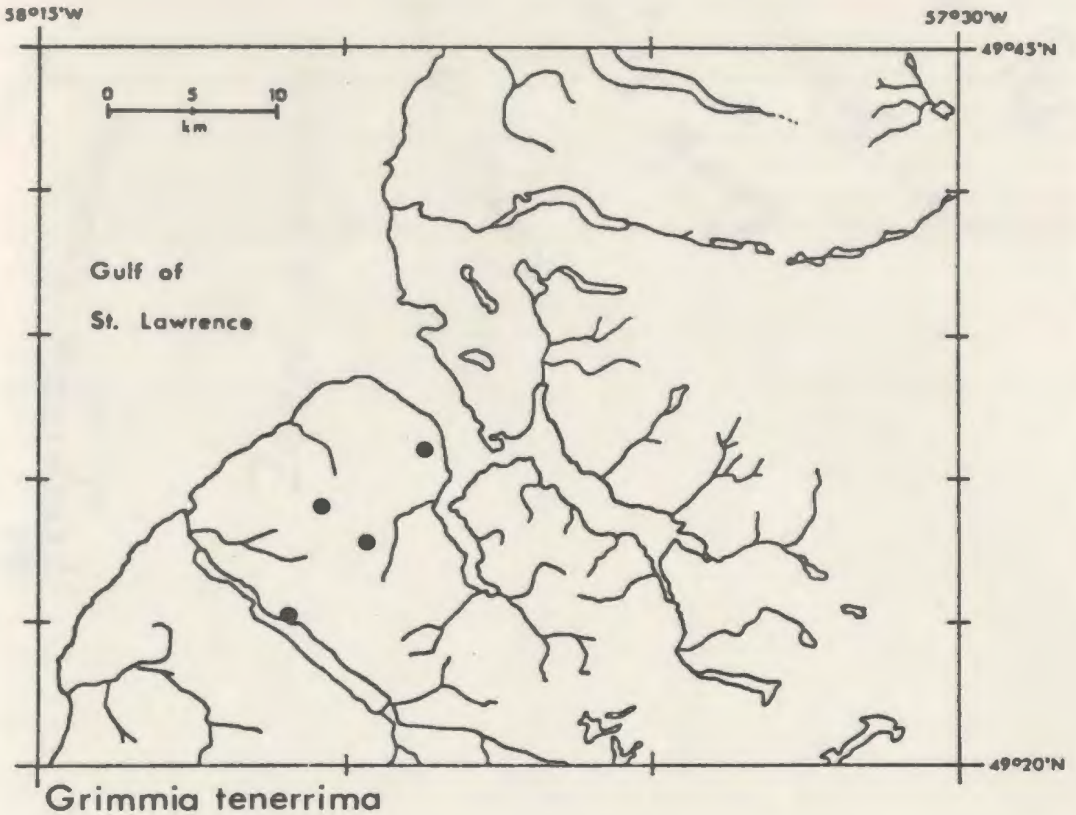
Widespread. Most mosses from Bonne Bay are widespread throughout the island.

Maritime (Figs. 23-25). Mosses with a maritime distribution in Newfoundland are restricted to rocks and thin soil within the influence of salt spray. While Desmatodon cernuus, D. heimii (Fig. 23), Distichium inclinatum, and Schistidium maritimum usually grow near the sea, others may be found farther inland.

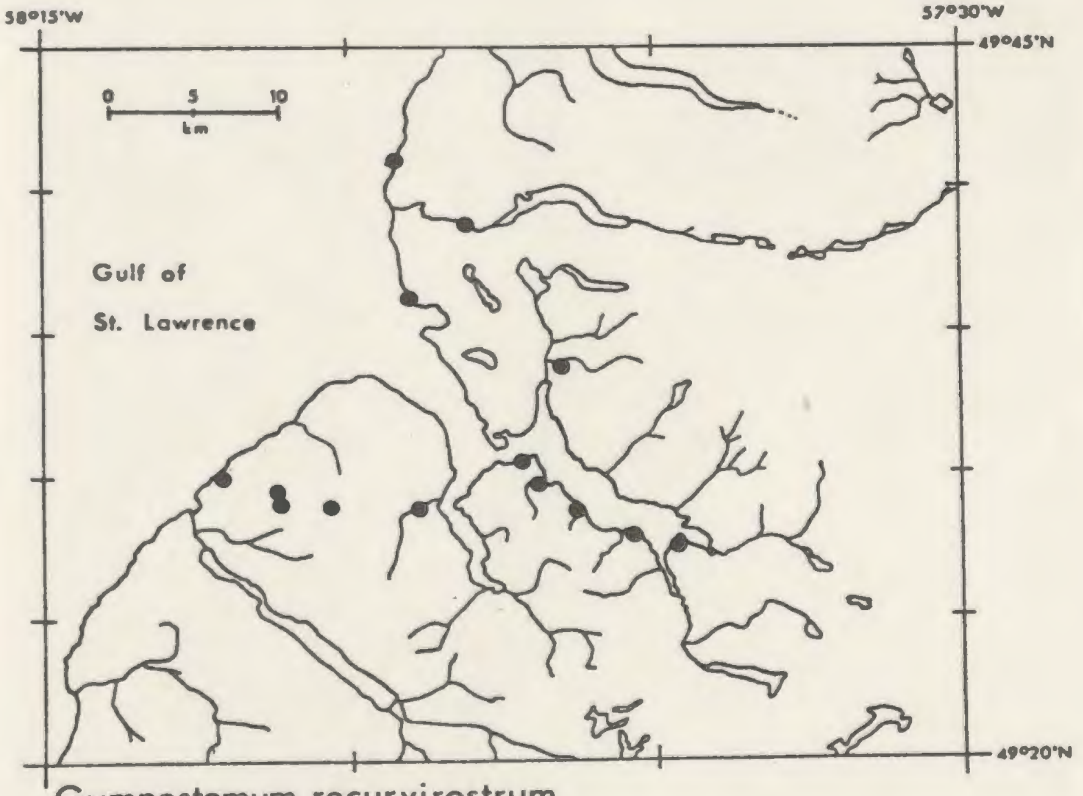
Rhytidium rugosum (Fig. 24) and Bartramia ithyphylla (Fig. 25)

Figure 21. The distribution of Grimmia tenerrima in Bonne Bay and Newfoundland.

Figure 22. The distribution of Gymnostomum recurvirostrum in the Bonne Bay region.



Grimmia tenerrima



Gymnostomum recurvirostrum

Table 4. The number of mosses in the Bonne Bay flora belonging to the seven distribution patterns of bryophytes in Newfoundland recognized by Brassard (1981)

Newfoundland distribution	Number of species Occurring at Bonne Bay	% of Bonne Bay moss flora
Widespread	144	55.2
Maritime (including coastal)	10	3.8
Northwestern	44	16.9
Northern	8	3.1
Southern	16	6.1
Southeastern	0	0.0
Disjunct	10	3.8
Unknown	29	11.1
Total	261	100.0

Figure 23. The known distribution of Desmatodon heimii in Newfoundland.

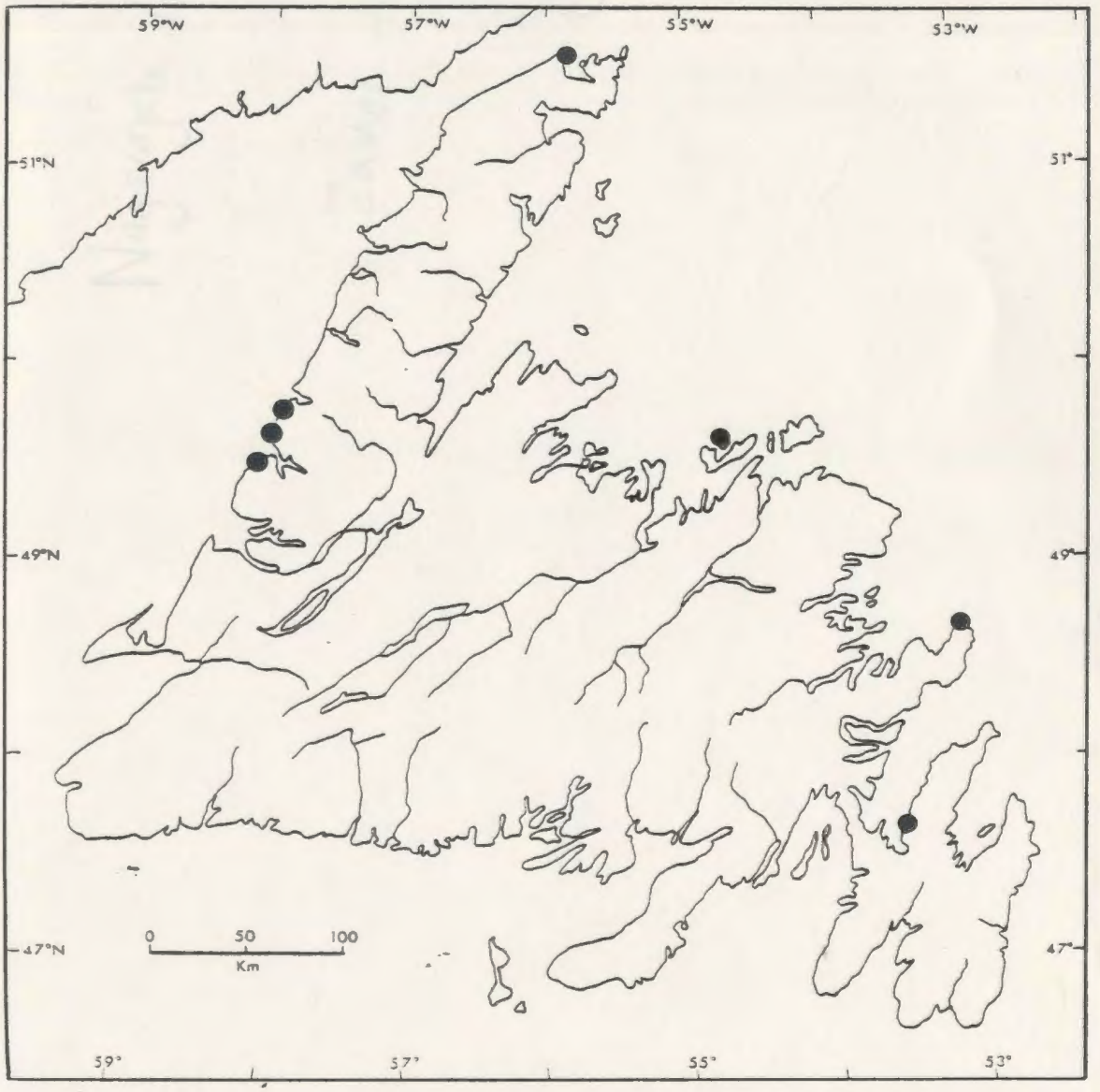

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Figure 24. The known distribution of Rhytidium rugosum in Newfoundland.

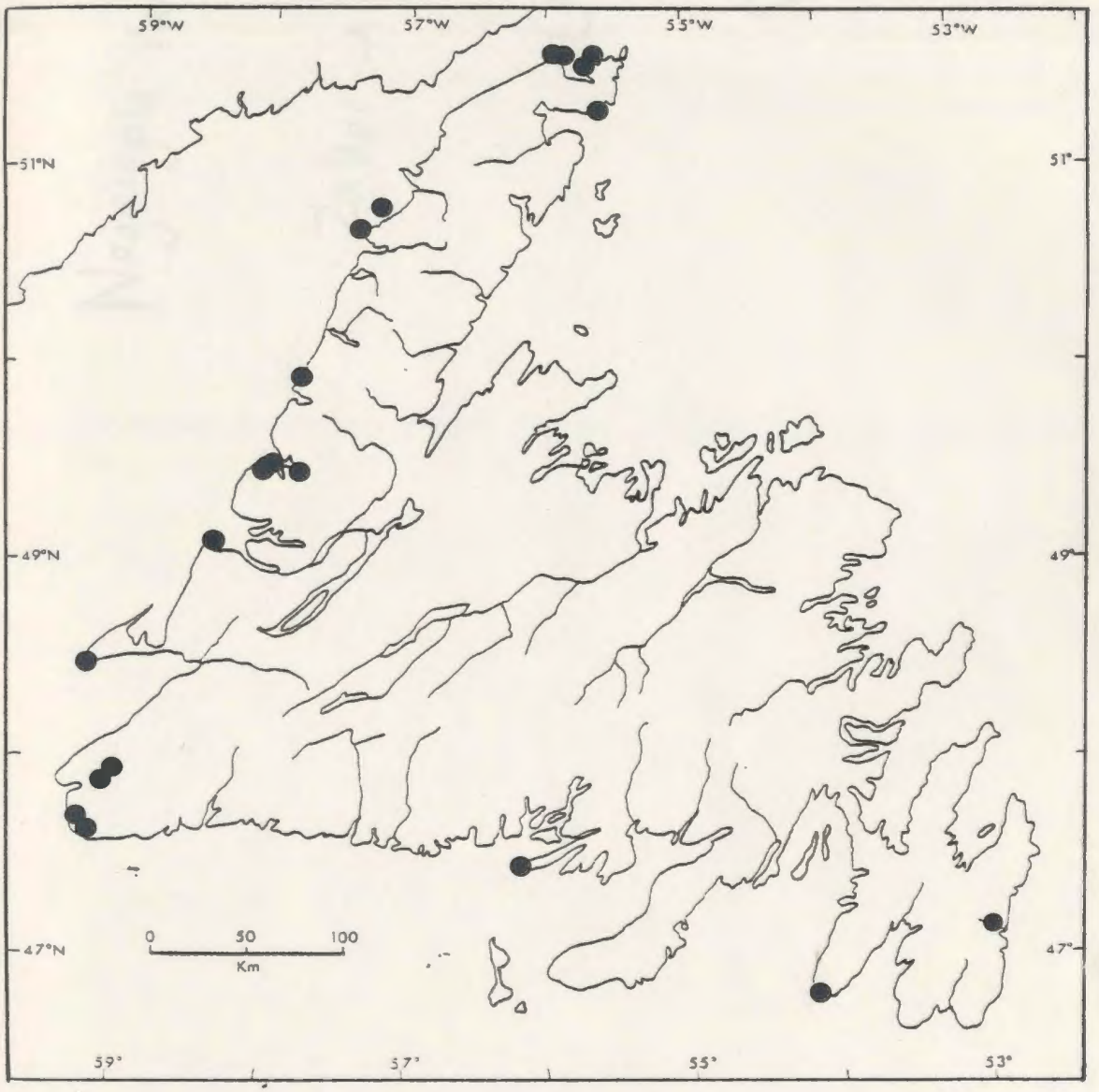
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Figure 25. The known distribution of Bartramia ithyphylla in Newfoundland.


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may be restricted to coastal environments in Newfoundland because of the cool summer temperatures there. Comparison of their distributions with Damman's (1976, Fig. 8) map of mean annual maximum temperature of 22-24°C shows a good correlation. Tortella fragilis also shows this distribution in Newfoundland.

Northwestern (Figs. 26-30). These are species which occur from the Bay of Islands northward to the tip of the Northern Peninsula and often northeastward to White Bay/Notre Dame Bay. Many species within this group occur mainly on calcareous substrates, for example Campylium halleri (Fig. 26) and Seligeria donniana (Fig. 27). S. donniana is known from all the major limestone bedrock areas in Newfoundland. Heterocladium dimorphum (Fig. 28) has a similar, but more widespread distribution, and in Newfoundland, may be considered less strongly calciphilic.

Acidophiles with a northwestern distribution are generally arctic-alpine plants (e.g., Dicranum elongatum, D. groenlandicum, Kiaeria blyttii). Kiaeria blyttii (Fig. 29) is known from both highland and coastal stations in Newfoundland. At Bonne Bay, it is found most often in exposed sites. However, it is also known from Southeast Brook Falls (Fig. 6, p.35) where it grew in the spray zone.

Noteworthy are species known only from the middle west coast of Newfoundland, roughly between the Port au Port Peninsula and Cow Head. This particular pattern of distribution has not been previously recognized. Nine species belong to it: Barbula convoluta, B. reflexa, Cirriphylum piliferum, Dicranella varia, Entodon concinnus, Leucodon brachypus var. andrewsianus, Seligeria tristichoides, Tortula

Figure 26. The known distribution of *Campylium halleri* in Newfoundland.

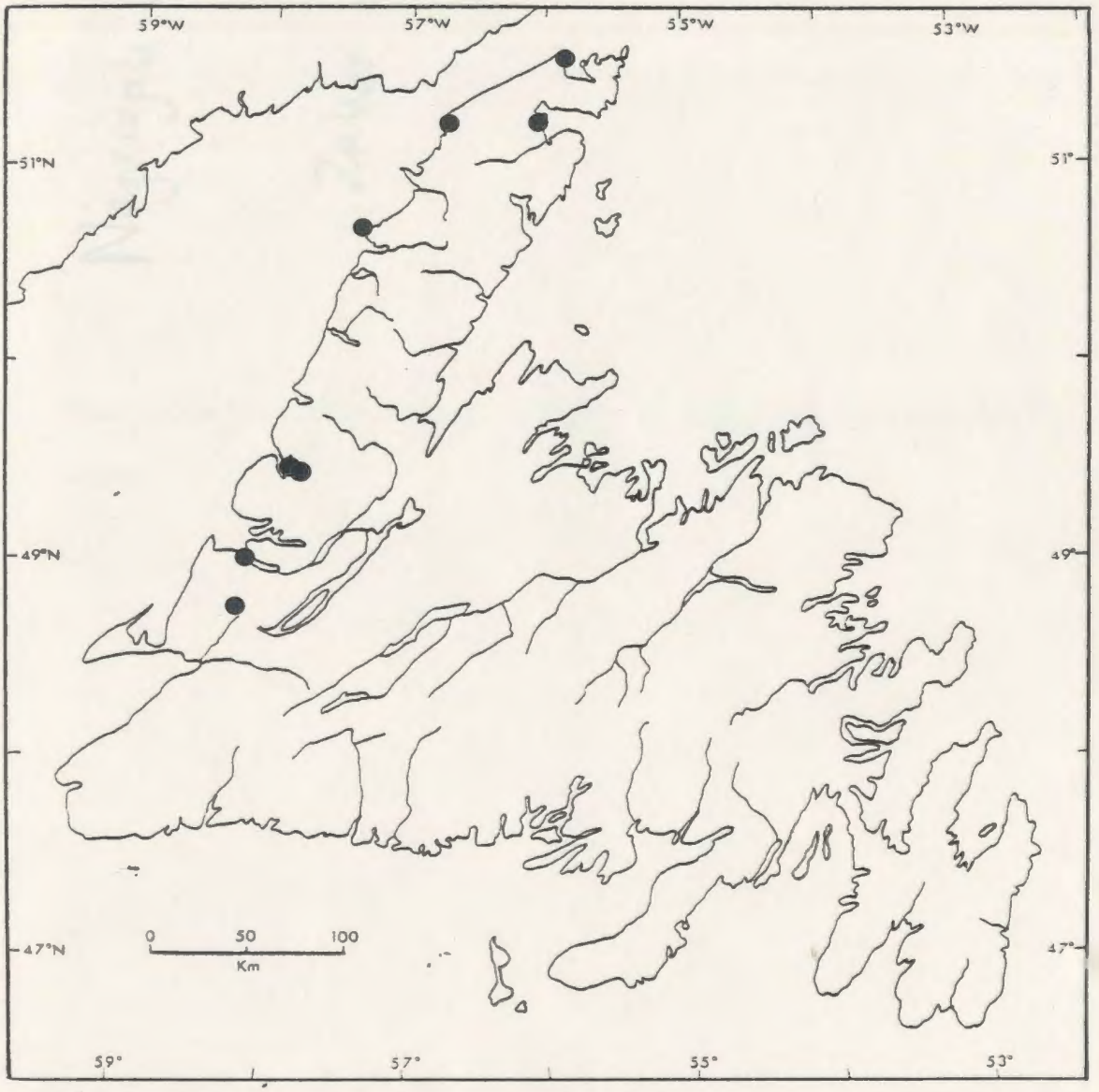
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Figure 27. The known distribution of Seligeria donniana in Newfoundland.

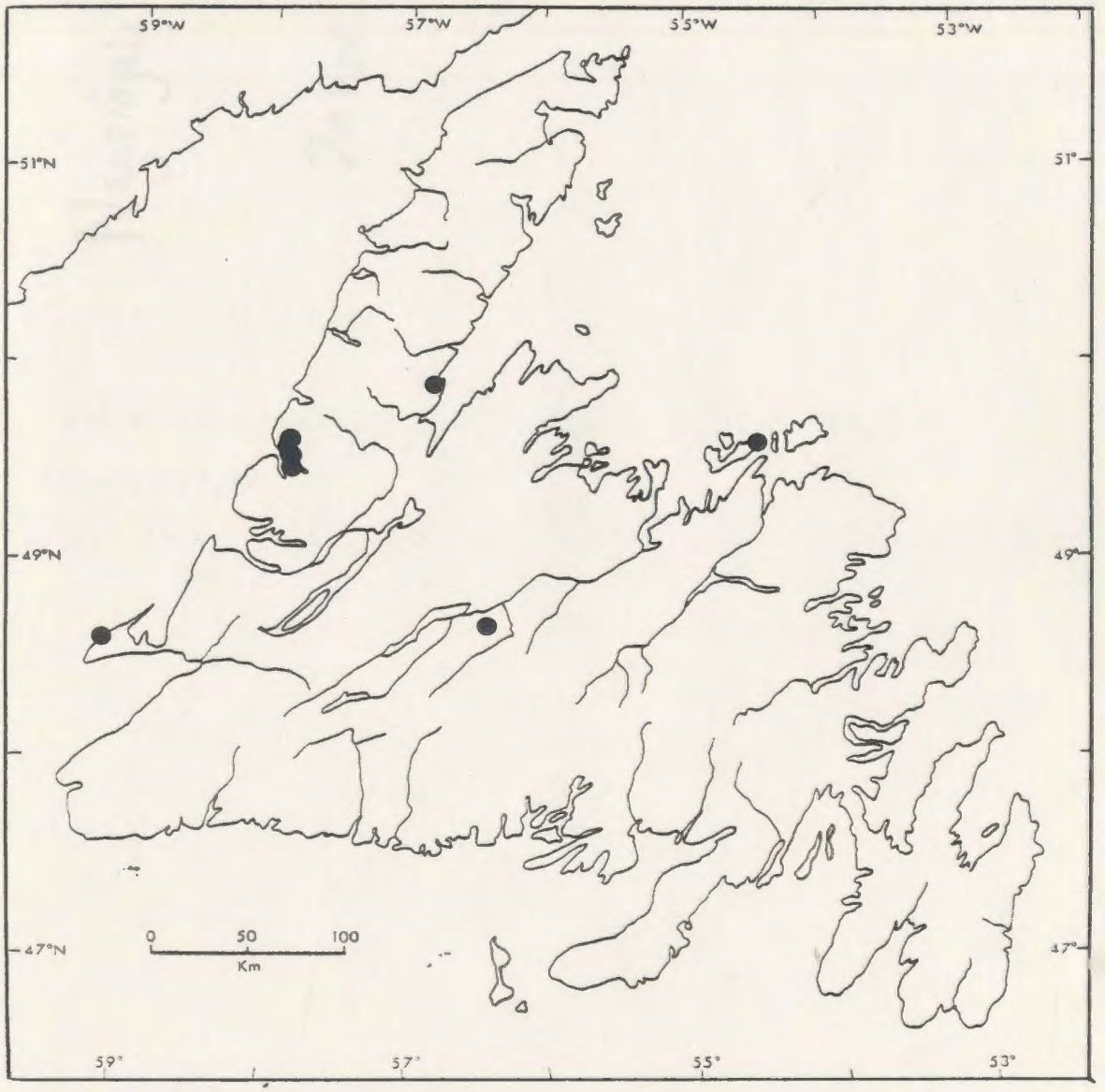
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Figure 28. The known distribution of Heterocladium dimorphum in Newfoundland.

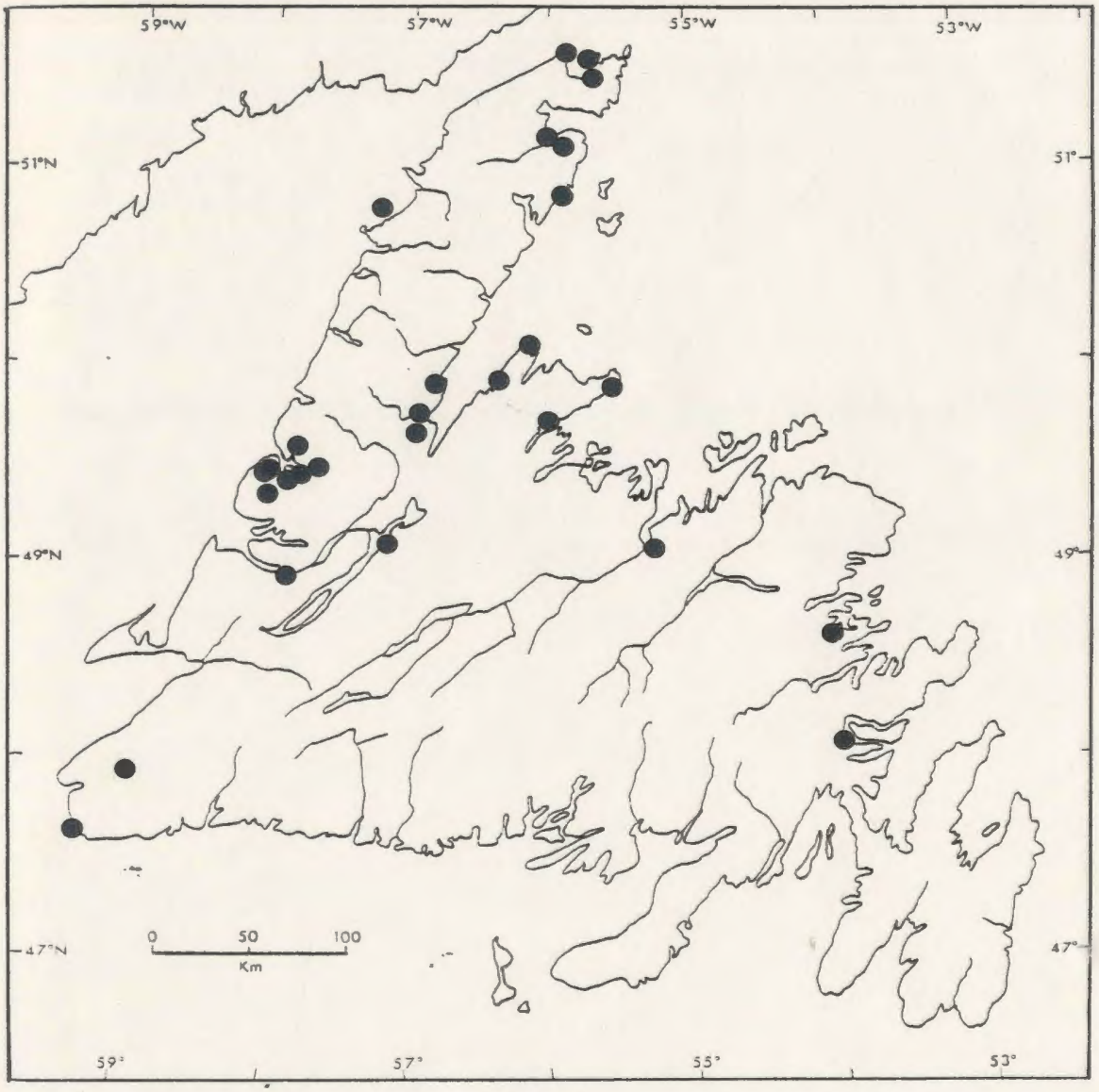
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Figure 29. The known distribution of Kiaeria blyttii in Newfoundland.

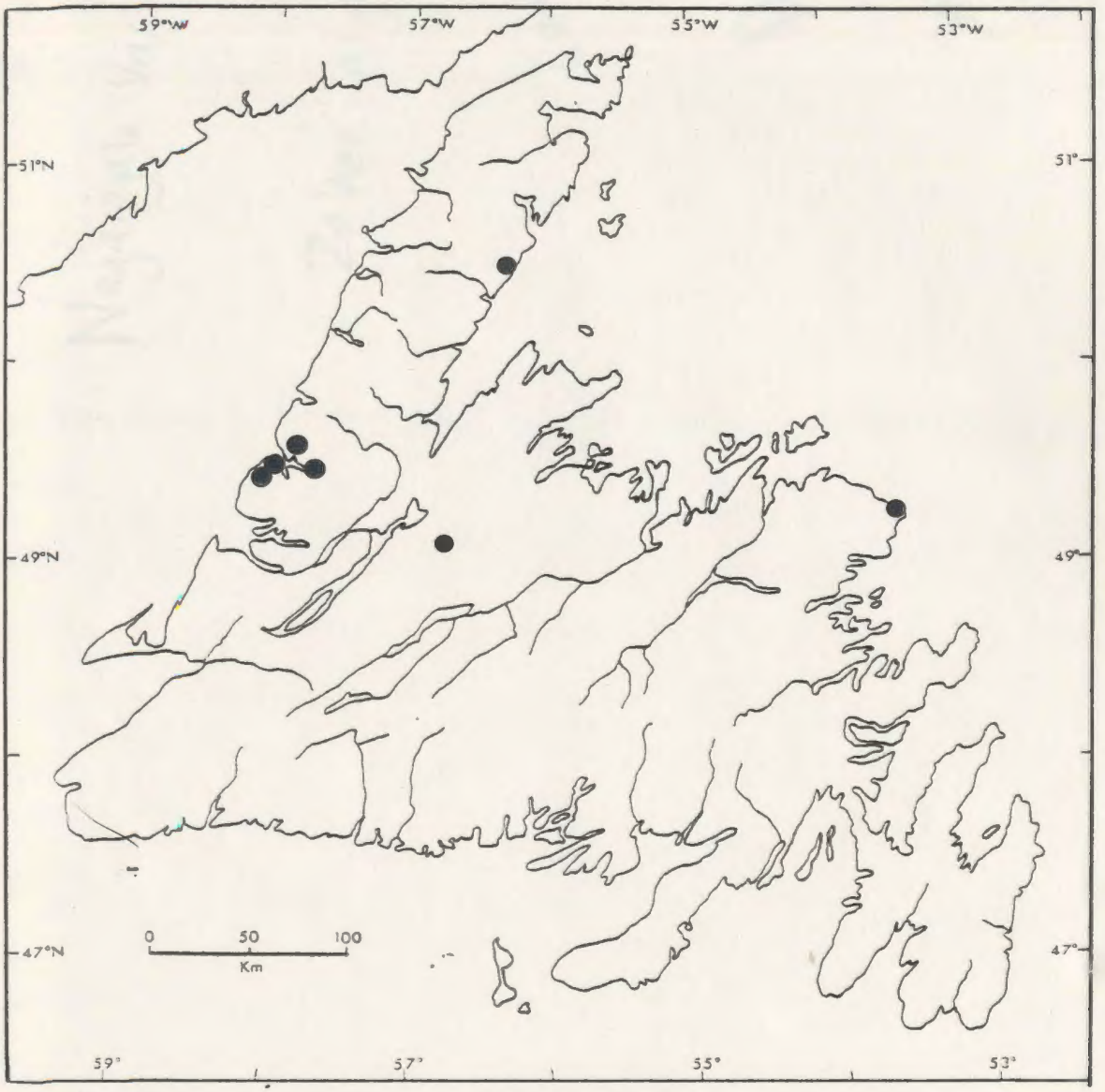
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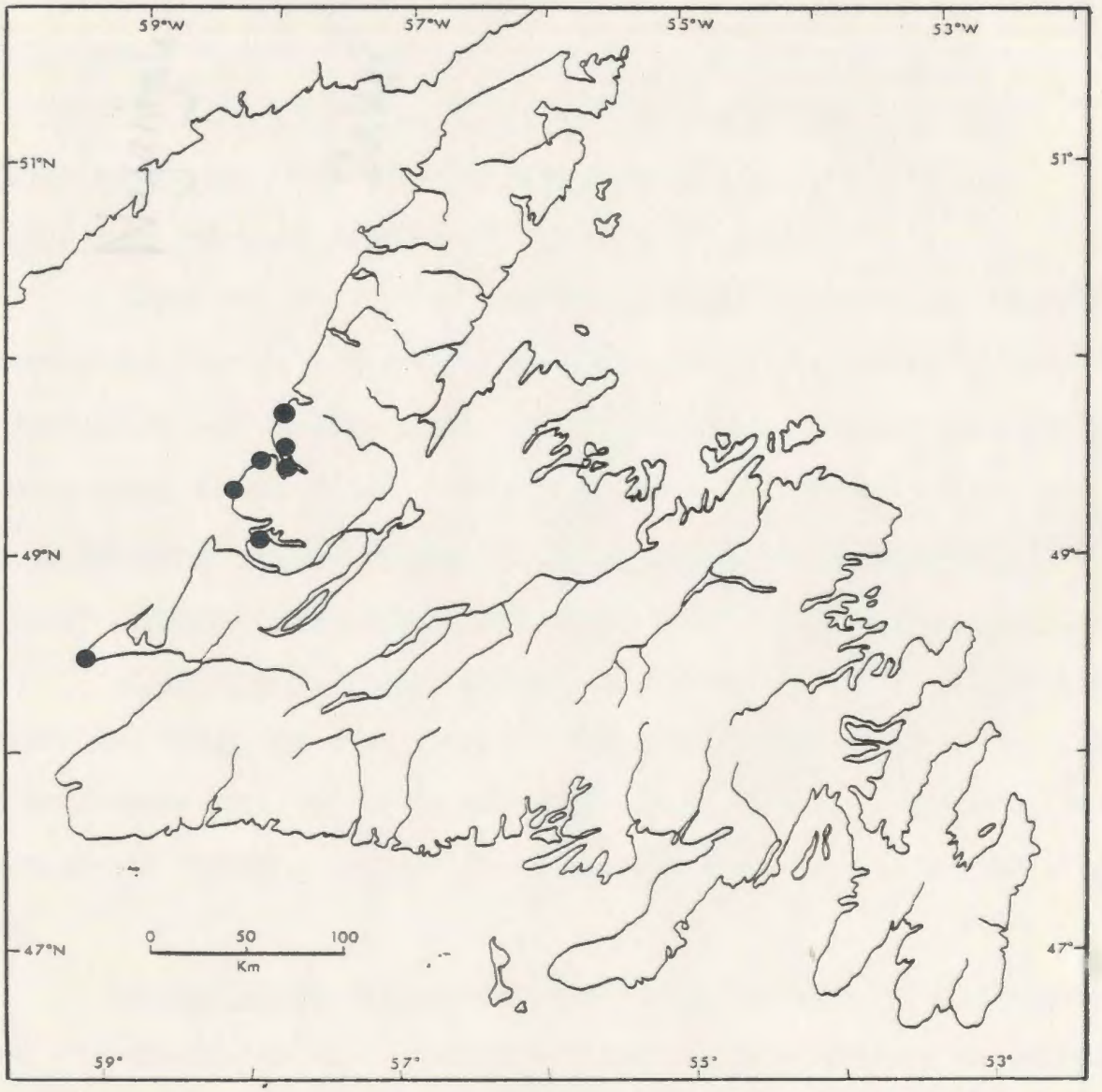
Figure 30. The known distribution of Entodon concinnus in Newfoundland.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mucronifolia, Zygodon viridissimus. Other species possibly belonging here include Encalypta longicolla, Grimmia tenerrima, and Hygrohypnum eumontanum.

The ecologies of these mosses vary. Some are acidophilic or indifferent to substrate, e.g., Dicranella varia, and Hygrophypnum eumontanum, but most are calciphilic (e.g., Barbula convoluta, B. reflexa, Cirriphylum piliferum, and Seligeria tristichoides). Entodon concinnus (Fig. 30), Tortula mucronifolia, and Zygodon viridissimus occur on calcareous and on mafic rocks.

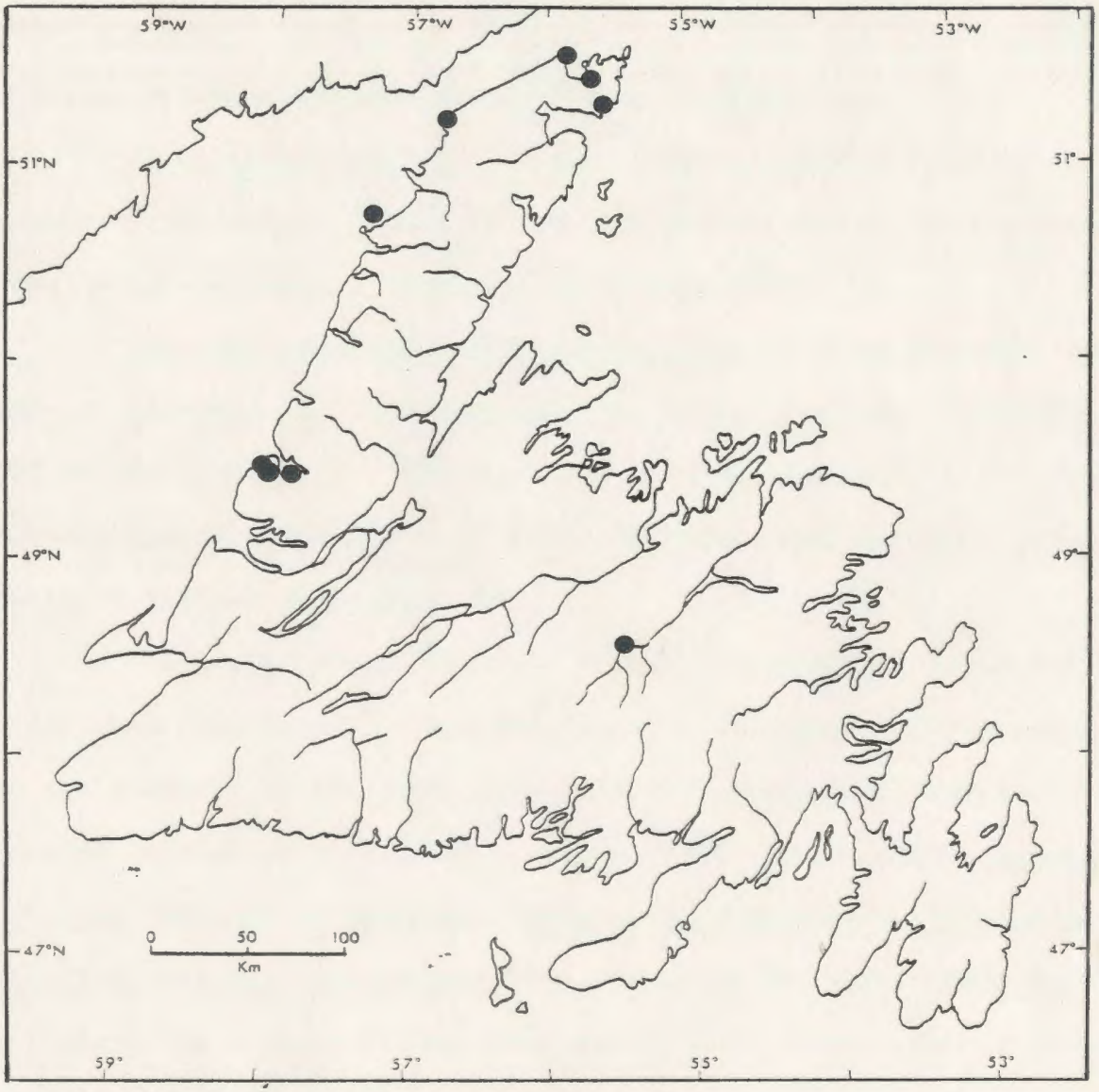
Northern (Fig. 31). Species with a northern distribution in Newfoundland reach their greatest occurrence on the Northern Peninsula and hardly extend further south than Bonne Bay. Seven mosses are known to have their southernmost stations at Bonne Bay: Bryum algovicum, Calliergon sarmentosum, Desmatodon latifolius, Hypnum bambergeri, Myurella julacea, Orthothecium strictum, and Plagiobryum zierii.

Plagiobryum zierii is rare in Newfoundland. This northern species was first reported from St. Anthony by Tuomikoski et al. (1973) and from Notre Dame Bay by Brassard and Weber (1978). Recently, Fife and Brassard (1980) recorded this moss from Bakers Brook in the study area.

Orthothecium strictum is also a calciphilic, arctic-alpine moss. Tuomikoski et al. (1973) described its Newfoundland distribution as "extremely northern". Two of the collections from Bonne Bay are from limestone coastal headlands, and the third is from Berry Hill.

In Newfoundland, Hylocomium pyrenaicum is known mainly from the Northern Peninsula (Fig. 31). It is not an arctic-alpine species and should perhaps be considered a widespread but uncommon moss in

Figure 31. The known distribution of *Hylocomium pyrenaicum* in Newfoundland.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Newfoundland.

Southern (Fig. 32). The southern pattern of distribution includes mosses most frequent on the southern portions of the island, and hardly reaching the Northern Peninsula (Tuomikoski et al. 1973). Some of the southern species are more or less restricted to the south coast. Campylopus atrovirens (Fig. 32) and Plagiothecium latebricola are frequent there and slightly disjunct in Bonne Bay.

Sciaromium lescurii is very rare in Newfoundland. It is endemic to the eastern United States and Canada, and is characteristic of the deciduous forest (Anderson and Zander 1973).

Leucodon brachypus var. andrewsianus is an Appalachian species, epiphytic elsewhere in Newfoundland, but it occurred on a limestone cliff in the study area. Ecologic shifts from epiphytic to epipetric habit are common in mosses near their northern limit of range (see especially Vaarama and Laine 1974).

Disjuncts (Figs. 33-34). Species occurring at Bonne Bay which are disjunct from other Newfoundland populations show several patterns. Some are frequent on the west coast, but are known from only a few scattered localities on the Bonavista or Avalon Peninsulas: Anomodon attenuatus, Barbula unguiculata, Homalia trichomanoides, Isopterygium pulchellum, Weissia controversa (Fig. 33). On the east coast, Barbula unguiculata has been collected only once, in St. John's, where it is probably adventive.

Isopterygium pulchellum is common in the forests of the study area. Its distribution in Newfoundland was mapped by Weber and Brassard (1976). I. pulchellum is disjunct between the Avalon Peninsula and the west coast, where it is more common. Ireland (1969) mapped its North

Figure 32. The known distribution of Campylopus atrovirens in Newfoundland.

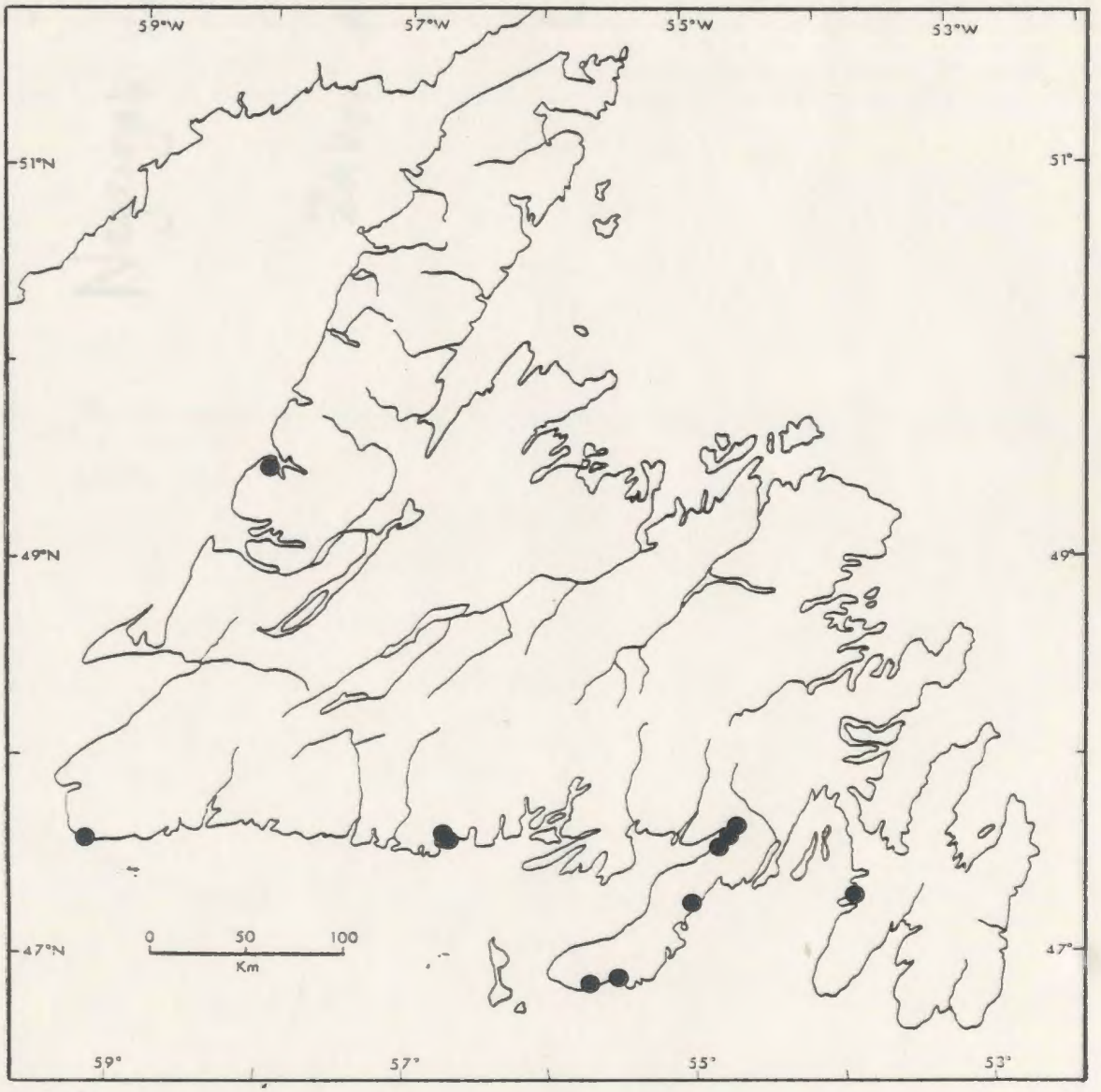
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Figure 33. The known distribution of Weissia controversa in Newfoundland.


59°W
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Figure 34. The known distribution of Aulacomnium androgynum in Newfoundland.


59°W
57°W
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47°N
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59°
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American distribution stating that this species is found "at high latitudes or in mountainous regions in shaded situations, in cliff crevices, on rocky banks, bases of trees, and decaying wood."

Aulacomnium androgynum (Fig. 34), Buxbaumia aphylla, and Ditrichum lineare are most common in eastern Newfoundland and disjunctive at Bonne Bay. Their distributions are difficult to interpret but for D. lineare at least, may reflect lack of collecting.

The North American distribution of some mosses in the Bonne Bay flora with special reference to evidence for botanical refugia.

Mosses generally exhibit the same distribution patterns as vascular plants (Steere 1965; Crum 1966, 1972). Nine floristic elements based on generalized distribution patterns are recognized here (based in part on Schofield 1969, 1972, 1980; Schofield and Crum 1972; Crum 1976). The pattern to which each species occurring at Bonne Bay belongs is included in Appendix B. Table 5 lists the phytogeographic patterns and gives the numbers of species from Bonne Bay assigned to each.

The majority (about 75%) of mosses are widespread cosmopolitan or circumboreal/circumpolar species.

Mosses with disjunct distribution patterns (2a, 3a, 3b, 3c, 4b) comprise 21.5% of the flora. Thirty nine mosses occurring at Bonne Bay belong to a group which, in North America, show a bicentric distribution, with one centre in the Western Cordillera and another in northeastern North America. These species are listed below:

Table 5. The number of mosses at Bonne Bay belonging to nine world bryogeographic distribution patterns

	Bryogeographical element	Number of species	% of Bonne Bay moss flora
1	Cosmopolitan	25	9.6
2	Circumpolar/Circumboreal	171	65.5
	2a Circumpolar/Circumboreal Disjunct	18	6.9
3	Amphiatlántic		
	3a Europe/North America	17	6.5
	3b Europe/E.N. America/W.N. America	12	4.6
	3c Europe/E.N. America	7	2.7
4	North American Endemics		
	4a Transcontinental	1	0.4
	4b E. North America/ W. North America	2	0.8
	4c Eastern North America	5	1.9
5	Unknown	3	1.1
Total		261	100.0

Arctoa fulvella

Campylopus atrovirens

Ctenidium molluscum

Dicranum majus

Diphyscium foliosum

Encalypta longicolla

Entodon concinnus

Grimmia hartmanii var. *anomala*

Herzogiella striatella

Heterocladium dimorphum

Homalia trichomanoides

Hygrohypnum smithii

Isopterygium elegans

Isopterygiopsis muelleriana

Molendoa sendtneriana

Neckera pennata

Oligotrichum hercynicum

Orthotrichum sordidum

Plagiothecium laetum

Plagiothecium cavifolium

Pseudoleskeella catenulata

Pseudoleskeella tectorum

Racomitrium heterostichum

Rhabdoweisia crispata

Rhizomnium punctatum ssp. *chlorophyllosum*

Rhytidiadelphus loreus

Schistidium maritimum

Schistostega pennata

Seligeria campylopoda

Seligeria donniana

Seligeria tristichoides

Sphagnum imbricatum

Sphagnum quinquefarium

Tetraphis geniculata

Trichostomum tenuirostre

Ulota coarctata

Ulota drummondii

Ulota phyllantha

Zygodon viridissimus

Many of the disjunct mosses listed are "forest species" (e.g., *Herzogiella striatella*, *Plagiothecium laetum* , *Tetraphis geniculata*), widespread in eastern North America, and are in Newfoundland at or near their northern limit. It is reasonable to assume that these survived the Wisconsinan Glaciation south of the ice-front and migrated northward post-glacially.

Others have distributions which suggest survival in ice-free enclaves at Bonne Bay or elsewhere in Newfoundland during the Wisconsinan Glaciation, in particular the following, some which are discussed further below:

Arctoa fulvella (Fig. 35)
Campylopus atrovirens (Fig. 36)
Encalypta longicolla (Fig. 37)
Entodon concinnus (Fig. 38)
Grimmia hartmanii
Oligotrichum hercynicum (Fig. 39)
Pseudoleskeella catenulata (Fig. 40)
Seligeria tristichoides

Encalypta longicolla (Fig. 37). Crum (1963) and Horton (1979) both suggested that, in the Rocky Mountain range, E. longicolla may have survived the Pleistocene in refugia. In eastern North America it is known only from Bonne Bay.

At Tuckers Head (Fig. 41), an exposed, NW-facing limestone headland composed of numerous small cliff sections separated by talus slopes, the habitat of Encalypta longicolla is similar to that of the northwestern North American populations (Horton 1979). Although the cliff faces appear xeric, numerous small seepages occur on them and low cloud and fog provide a frequent source of moisture. E. longicolla was found on thin soil in crevices at approximately 100 metres altitude.

Encalypta longicolla was found near Trout River, where it occurred in slight seepage in an ultramafic rock crevice on a barren, N-facing creek bank. Its presence on ultramafic rock is unusual since E. longicolla has invariably been found on highly calcareous substrates (Horton 1979).

The limited dispersal of Encalypta longicolla in western North America from a Beringian centre since glaciation was used as

Figure 35. The North American distribution of Arctoa fulvella (adapted from Vitt and Horton 1979). Stippled areas indicate regions where this species is more frequent.

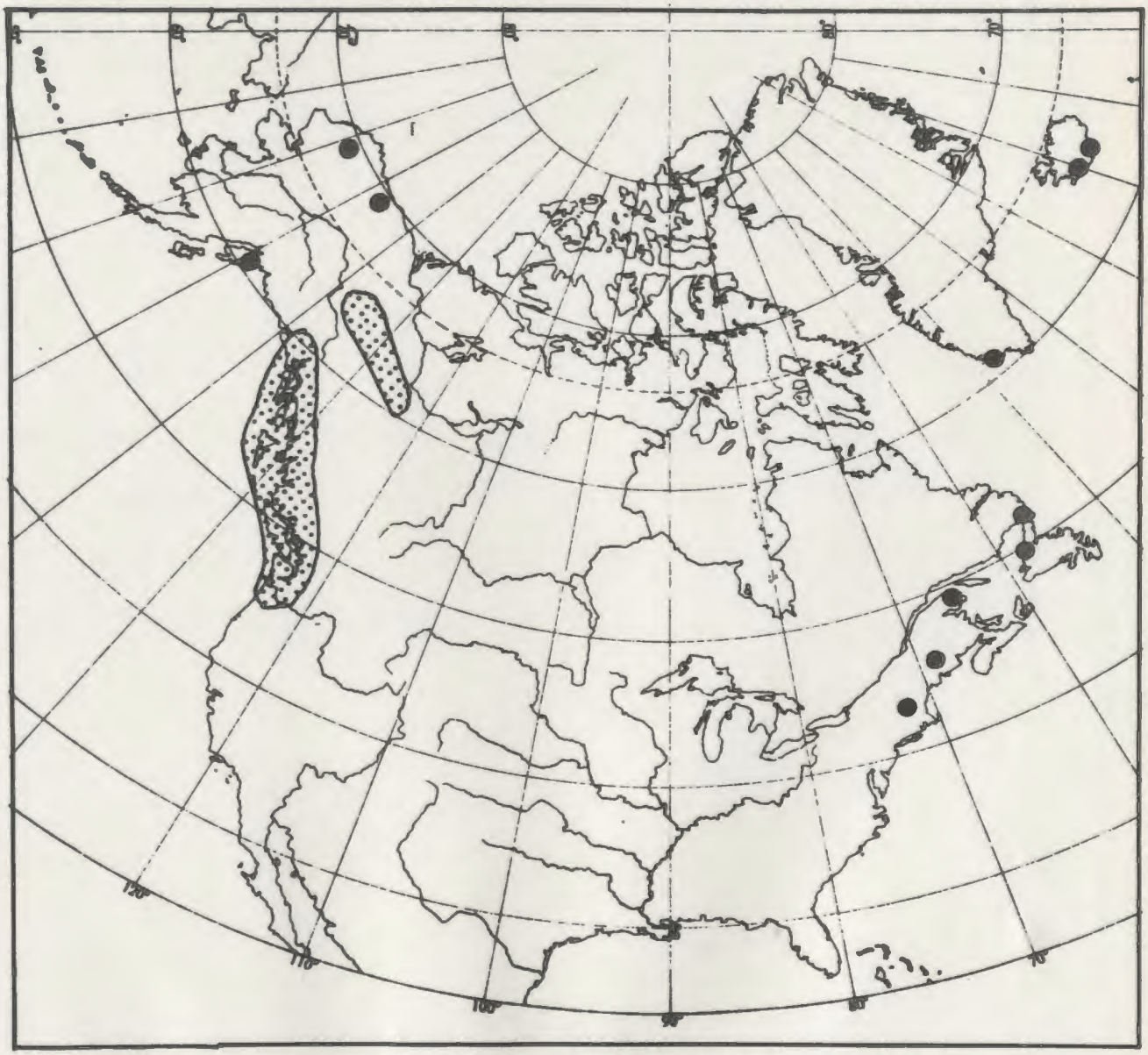

Figure 36. The North American distribution of Campylopus atrovirens (adapted from Schofield 1976 for British Columbia, and from Bohlin et al. 1980). Stippled areas indicate regions where this species is more frequent.

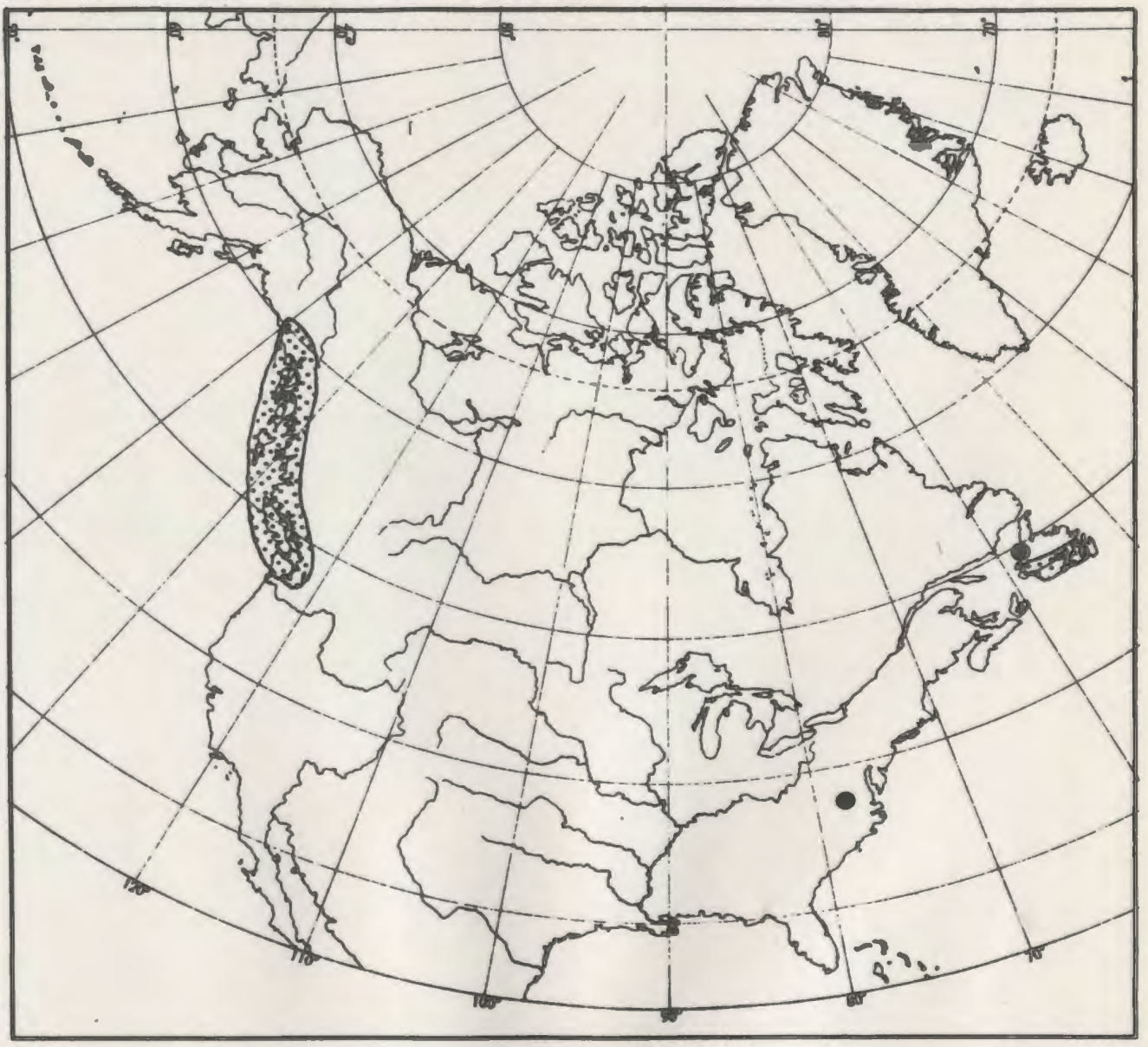

Figure 37. The North American distribution of Encalypta longicolla. Western populations based on Horton (1979). Stippled areas indicate regions where this species is more frequent.

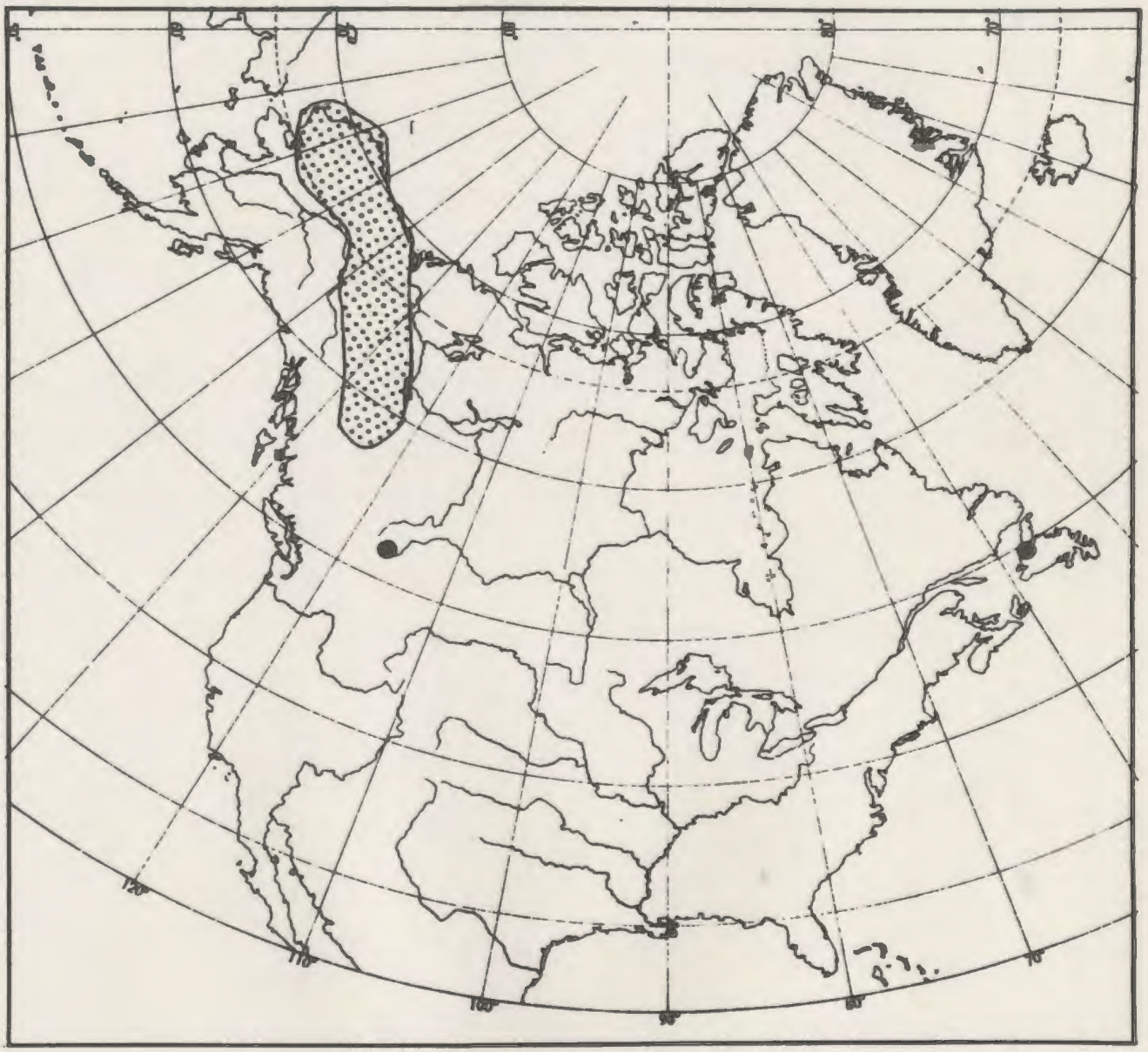

Figure 38. The North American distribution of Entodon concinnus (adapted from Steere 1978). Stippled areas indicate regions where this species in more frequent.

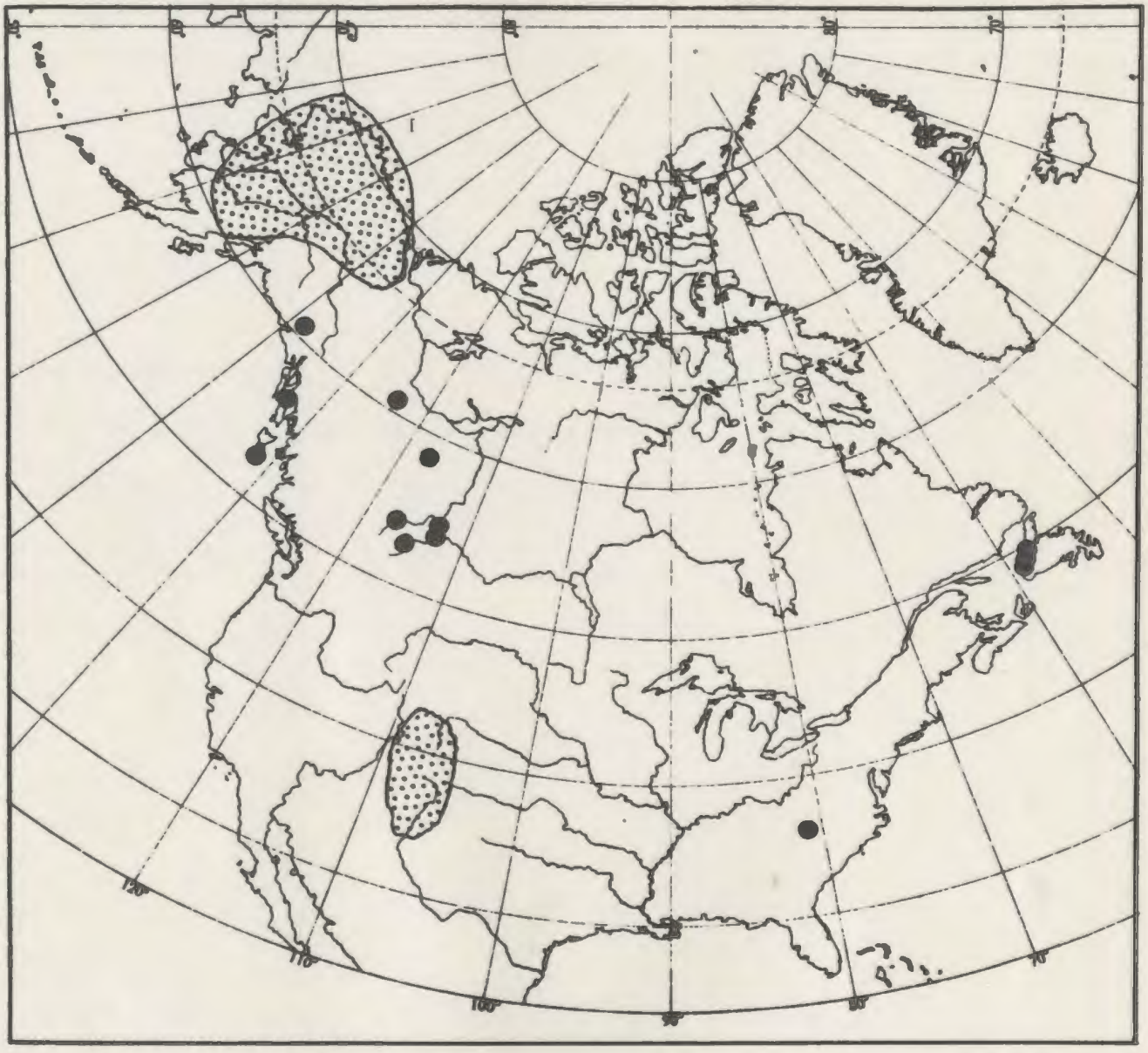

Figure 39. The North American distribution of Oligotrichum hercynicum (adapted from Schofield and Crum 1972). Stippled areas indicate regions where this species is more frequent.

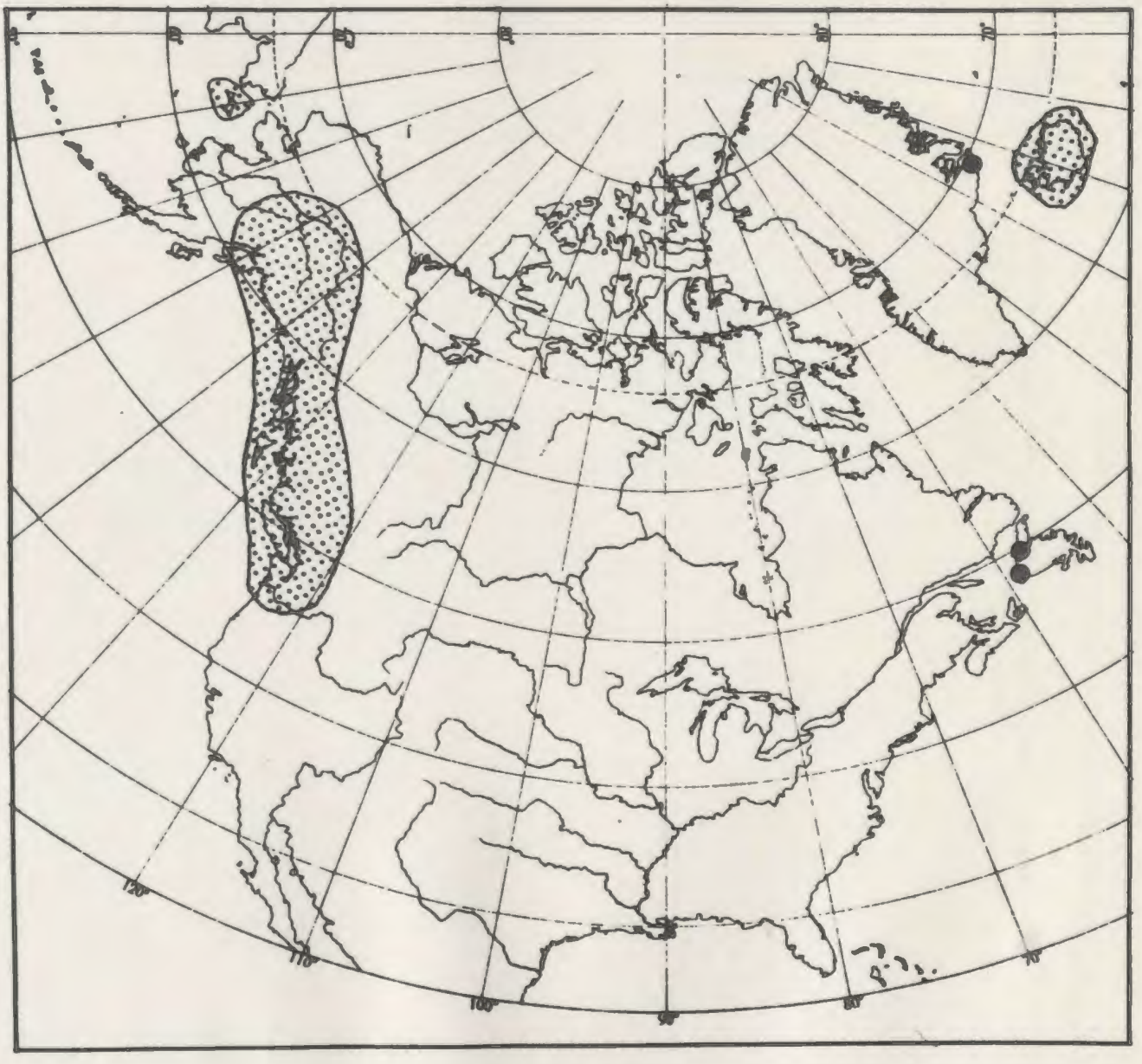
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Figure 40. The North American distribution of Pseudoleskeella catenulata (adapted from Lewinski 1974; Alaskan records from Steere 1978).

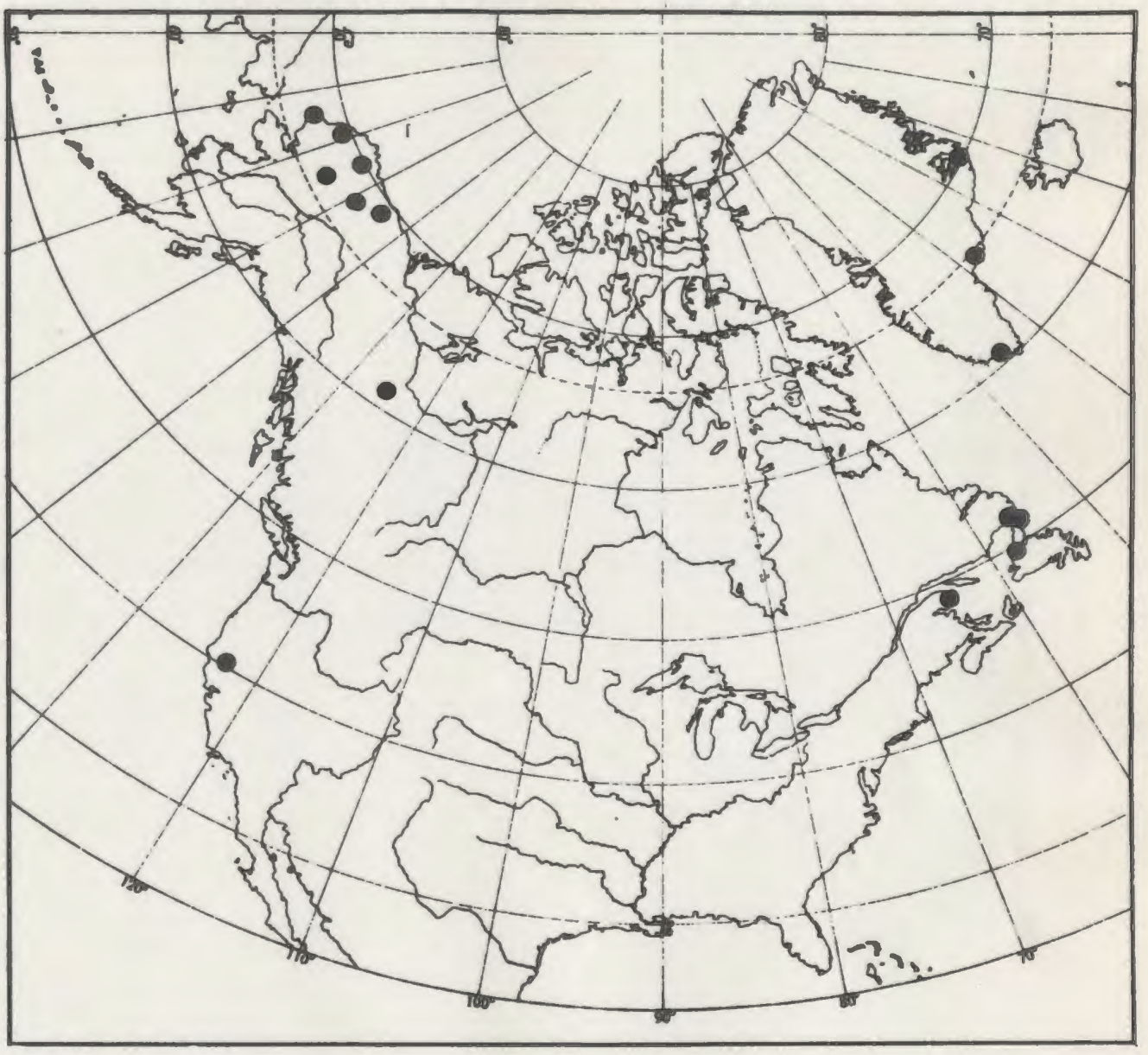
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Figure 41. The habitat of Encalypta longicolla at Tuckers Head (site 23). E. longicolla was growing in small limestone rock crevices near seepage (arrow) (Photo by B.A. Roberts).

evidence of its low dispersal capacity (Horton 1979). The spores of E. longicolla are very large (50-75 µm) compared to those of most other mosses (5-25 µm). Mogensen (1981) has shown that if moss spores of 20 µm would normally be able to disperse 1000 km, spores of 55 µm would only disperse 40 km. The disjunction of E. longicolla in Newfoundland, 6500 km from western North America, argues against post-glacial, long-distance dispersal to Bonne Bay, and the species' presence at Bonne Bay strongly suggests survival in western Newfoundland during the Wisconsinan Glaciation.

Entodon concinnus (Fig. 38). In North America, E. concinnus has four centres; two south of the maximum limit of the Wisconsinan ice-sheet, one radiating from Beringia, one in Newfoundland.

In northwestern North America, the habitat of Entodon concinnus is dry, exposed, usually calcareous sites such as sand, gravel and boulders on hillsides (Steere 1975). E. concinnus is known from a few similar sites in Newfoundland, but here also occurs in coastal meadows which may suggest possible anthropogenic introduction from Europe for the Newfoundland populations.

Campylopus atrovirens (Fig. 36). The world distribution of C. atrovirens was recently mapped by Bohlin et al. (1980). In eastern North America it is almost exclusively limited to Newfoundland.

Campylopus atrovirens is an oceanic species (Tuomikoski et al. 1973). Throughout most of its range it is mostly at low elevations on wet, acidic rock faces, but in the South and West Alps and Turkey, it grows in high exposed situations on calcium-rich substrates (Bohlin et al. 1980). In Norway, the distribution of C. atrovirens may be limited by precipitation (Störmer 1969), and in

more continental parts of Norway, this moss occurs at higher elevations than in coastal districts. The variable ecology of C. atrovirens may explain its distribution in Newfoundland, where, on the oceanic south coast, it is present mainly on wet acidic rock faces and cliffs near sea level. The Bonne Bay locality (Fig. 32, p. 84) is at 300-350 metres on wet mafic rocks, and C. atrovirens is associated with known calciphiles such as Calliergon sarmentosum, C. trifarium, and Scorpidium scopioides.

Sporophytes have seldom been reported from Campylopus atrovirens (Bohlin et al. 1980), and in Newfoundland all the populations of this species are sterile. Its occurrence in Newfoundland is difficult to explain except by survival in glacial refugia, and the other North American centres for this species (in unglaciated regions) would support this hypothesis.

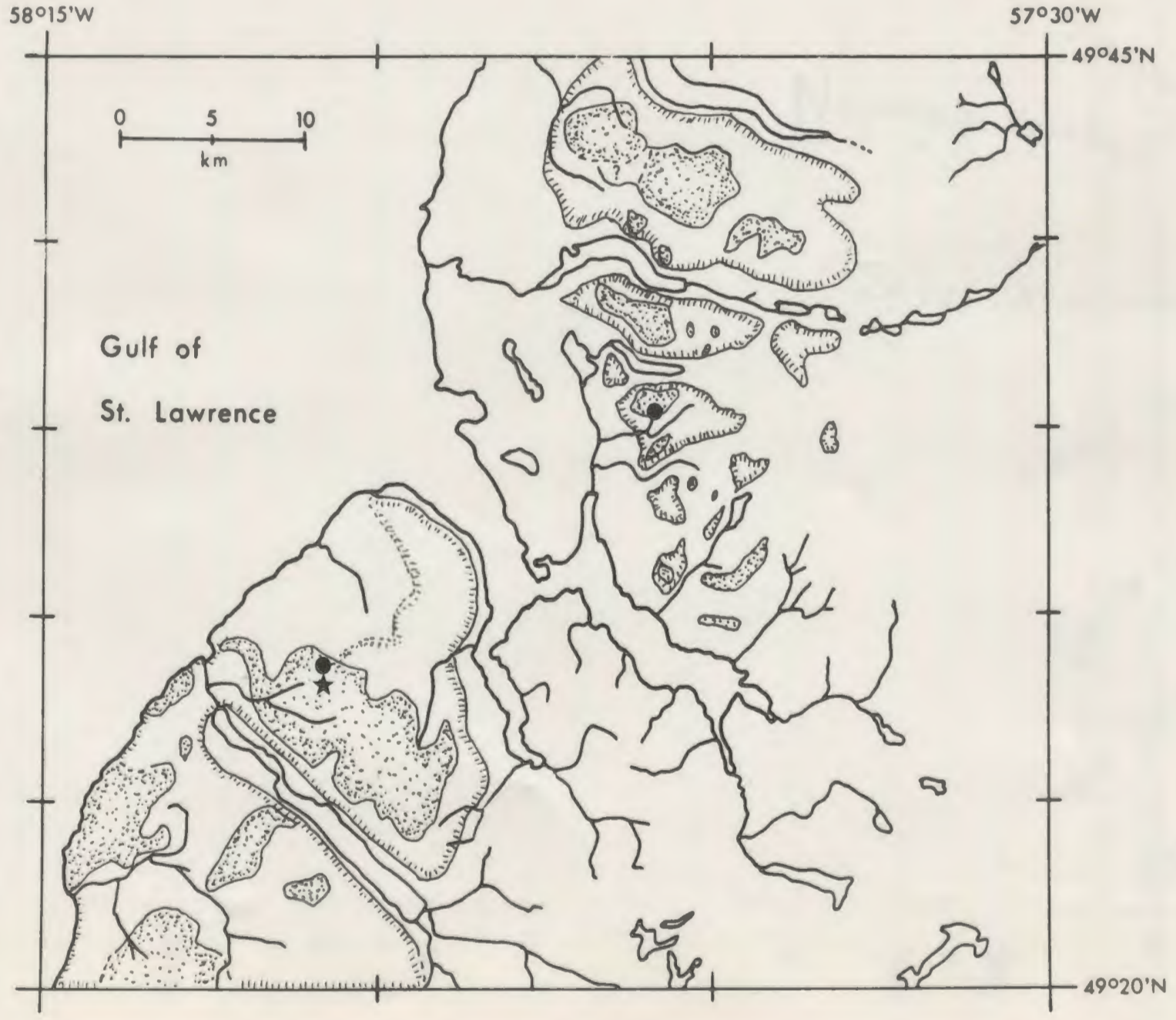
Oligotrichum hercynicum (Fig. 39). Oligotrichum hercynicum occurs in the mountains of western North America (Schofield and Crum 1972) and in southwestern Newfoundland.

On Gros Morne, it was found in a late snow area on soil derived from quartzite (Fig. 42). In the Mafic Highlands, it grew on a felsenmeer barren at 530 metres altitude. Both sites are thought to have escaped Wisconsinan Glaciation (Fig. 43).

Schofield (1969, 1980) considered Oligotrichum hercynicum circumalpine and further stated that this distribution pattern was difficult to explain except by long-distance dispersal, but added that these species "could have ranged more widely, south of the glacial boundary, across the Northern Hemisphere during or preceding the recent glaciations. Their extinction in intervening areas could be attributed

Figure 42. The habitat of Oligotrichum hercynicum on Gros Morne (site 27), taken from the top of the "Gully" looking southward. O. hercynicum was found on soil between quartzite boulders which, in this photo, are still overlain by snow (Photo by G.R. Brassard, May, 1973).

Figure 43. Wisconsinan ice limits at Bonne Bay (modified from Grant 1977a). Stippled areas are land surfaces possibly not glaciated since the last interglacial. Areas surrounded by fence lines are surfaces probably not glaciated since early or middle Wisconsinan time. Dots are known Bonne Bay localities for Oligotrichum hercynicum; star is known Bonne Bay locality for Arctoa fulvella.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57°30'W
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km
Gulf of
St. Lawrence

to the elimination of their habitat by climatic change and/or invasion of sites by other plants".

The Newfoundland populations of Oligotrichum hercynicum are sterile and this species is commonly without sporophytes elsewhere (Schofield 1976; Schofield and Crum 1972).

Arctoa fulvella (Fig. 35). In North America, Arctoa fulvella is frequent throughout the Western Cordillera, but in the east, there are known stations only in New England (Schofield 1972), Gaspé, southern Labrador, and Newfoundland.

Arctoa fulvella is an arctic-alpine species of late snowbed areas (Schofield 1976). At Bonne Bay it grew on soil among mafic boulders at about 450 metres altitude. A. fulvella is generally considered an acidophile (Grout 1937; Nyholm 1954).

In the study area, Arctoa fulvella, and Oligotrichum hercynicum are both frequent in late-snowbed areas, a habitat which undoubtedly would have been common during glaciation. In addition, both mosses were found on sites possibly unglaciated during all of the Wisconsinan Glaciation (Fig. 43). Grimmia hartmanii var. anomala also occurred on a similarly aged land surface, and Campylopus atrovirens grew on mountain tops which also escaped late Wisconsinan ice.

Grimmia hartmanii. Grimmia hartmanii is rare in eastern North America, where it occurs in Michigan (Steere 1937, 1938), Ontario (Ireland and Cain 1975), and in Nova Scotia and Newfoundland.

The distribution of Grimmia hartmanii is similar to the distribution of many of the Rocky Mountain/Gulf of St. Lawrence disjunct vascular plants which have intermediate stations near the Great Lakes (Butters and Abbe 1953, Soper and Maycock 1963). Unlike

these, which are calciphilic (see Soper and Maycock 1963), G. hartmanii is an acidophile (Vitikainen 1969).

Of the Bonne Bay mosses which might have survived the glaciation in Newfoundland refugia, only Grimmia hartmanii is presently known from intermediate localities in the Great Lakes region and may have migrated eastwards from the Cordillera along a tundra corridor such as proposed by Marie-Victorin (1938). It is, however, possible that G. hartmanii survived the Wisconsinan Glaciation in the Driftless Area in the north-central United States, such as was proposed by Schuster (1958) to explain the disjunct distribution of some hepatics.

The presence at Bonne Bay of Arctoa fulvella, Campylopus atrovirens, Encalypta longicolla, Entodon concinnus, Grimmia hartmanni, Oligotrichum hercynicum, and Pseudoleskeella catenulata (species with different edaphic ecologies and dispersal potentials) is best explained by their having survived glaciation at or near the sites where they occur today. Glacial geological studies have recently provided supporting evidence for such refugia in the study area (Grant 1969, 1977a), and have revived the concept of unglaciated areas in many critical sectors of the Gulf of St. Lawrence (Brookes 1977; Grant 1977b). However, further bryological exploration is required to establish the precise distributions and edaphic ecologies of the rare disjunct bryophytes in eastern North America before one can make conclusive statements about bryological evidence for glacial refugia in the Gulf of St. Lawrence region.

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APPENDIX A

This appendix lists the collecting localities within the Bonne Bay area.

The following abbreviations are used for the lithophysiographic regions: AH, Acidic Highlands; CH, Calcareous Highlands; CP, Coastal Plain; MH, Mafic Highlands; UH, Ultramafic Highlands.

The following abbreviations are used for the habitats: b, barrens; ce, coastal exposure; fw, freshwater habitat; fo, forest habitat; p, peatlands.

Site number	Locality	Lithophysiographic region	Habitat type	Coordinates
1	Unnamed	MH	ce	49°33'N,57°57'W
2	Unnamed	MH	fw	49°33'N,57°57'W
3	Norris Cove	CH	fw	49°30'N,57°50'W
4	Shag Cliff	CH	ce	49°31'N,57°51'W
5	Serpentine Tableland	UH	p	49°27'N,57°59'W
6	Serpentine Tableland	UH	b	49°27'N,57°58'W
7	Serpentine Tableland	UH	fw	49°26'N,57°57'W
8	Unnamed	MH	fo	49°31'N,57°55'W
9	Unnamed	MH	fw	49°31°N,57 55'W
10	Berry Hill	CP	fo	49°37'N,57°55'W
11	Unnamed	CP	p	49°34'N,57°54'W
12	Green Point	CP	ce	49°41'N,57°58'W
13	Bakers Brook	CP	p	49°39'N,57°57'W
14	Unnamed	CP	p	49°37'N,57°55'W
15	Lobster Cove Head	CP	fo	49°37'N,57°57'W

Appendix A Continued

Site number	Locality	Lithophysio-graphic region	Habitat type	Coordinates
16	Lobster Cove Head	CP	ce	49°36'N,57°57'W
17	Unnamed	CH	fo	49°34'N,57°54'W
18	Bakers Brook	CP	fo	49°38'N,57°53'W
19	Lookout Hills	MH	fw	49°31'N,57°57'W
20	Centennial Peak	MH	b	49°32'N,57°57'W
21	Lookout Hills	MH	p	49°31'N,57°56'W
22	Little Lookout	MH	b	49°31'N,57°56'W
23	Tuckers Head	CH	ce	49°28'N,57°46'W
24	Barters Brook	CH	fw	49°26'N,57°47'W
25	Unnamed	MH	fo	49°30'N,58°01'W
26	Winterhouse Brook	CH	fw	49°29'N,57°56'W
27	Gros Morne mountain	AH	b	49°35'N,57°47'W
28	Gros Morne Mountain	AH	b	49°36'N,57°47'W
29	Crow Gulch Brook	CH	fw	49°33'N,57°49'W
30	Bakers Brook Falls	CP	fw	49°38'N,57°54'W
31	Unnamed	CH	fw	49°23'N,57°48'W
32	Unnamed	MH	fw	49°29'N,58°04'W
33	Unnamed	MH	p	49°28'N,58°03'W
34	Unnamed	MH	fw	49°28'N,58°03'W
35	Unnamed	MH	b	49°28'N,58°02'W
36	Unnamed	CH	fo	49°29'N,57°49'W
37	Unnamed	CH	ce	49°29'N,57°49'W

Appendix A continued

Site number	Locality	Lithophysio-graphic region	Habitat type	Coordinates
38	Unnamed	MH	fw	49°31'N,57°57'W
39	Southeast Hills	AH	fw	49°26'N,57°38'W
40	Southeast Hills	AH	p	49°26'N,57°38'W
41	Southeast Brook	AH	fw	49°28'N,57°40'W
49	Unnamed	MH	fw	49°28'N,58°03'W
50	Unnamed	MH	b	49°28'N,58°02'W
51	Unnamed	CH	fw	49°27'N,57°53'W
52	Green Gardens	MH	ce	49°30'N,58°06'W
53	Unnamed	MH	fo	49°30'N,58°05'W
54	Unnamed	MH	fo	49°30'N,58°04'W
55	Crow Cliff	AH	b	49°35'N,57°46'W
56	Crow Cliff	AH	fo	49°35'N,57°46'W
57	Crow Cliff	AH	p	49°35'N,57°46'W
58	Unnamed	CH	fw	49°31'N,57°51'W
59	South Head	CH	ce	49°28'N,57°44'W
60	Southeast Hills	AH	b	49°28'N,57°36'W
61	Trout River Pond	CH	fo	49°22'N,57°58'W

NOTE: Sites 42-48 (inclusive) were outside of the study area.

APPENDIX B

In this appendix is included detailed ecological and distributional information of all species found in this study.

The lithophysiographic regions and the habitat collected on them are listed at the top of the page. Numbers in the columns under the habitat types is the number of sites from which a species was collected from that habitat type. Total number of sites from which a species was recorded is included under the column headed "no. of sites presence recorded".

The five columns starting from the one headed "Coastal Plain" list the presence or absence of a species from a lithophysiographic region, based on all specimens collected or seen in the herbarium at NFLD. A "+" indicates presence of that species on a lithophysiographic region.

The legend for the Newfoundland distribution types are: d, disjunct; m, maritime; n, northern; nw, northwestern; s, southern; w, widespread; u, unknown.

The legend for the world bryogeographic patterns are: 1, Cosmopolitan; 2, Circumpolar/Circumboreal; 2a, Circumpolar/Circumboreal Disjunct; 3, Amphiatlantic; 3a, Europe/North America; 3b Europe/E. North America/W. North America; 3c, Europe/E. North America; 4, North American Endemics; 4a, Transcontinental; 4b, E. North America/W. North America; 4c, E. North America; ?, unknown; $\pm$, mainly this distribution, but has outliers.

Species	Coastal Plain: Freshwater	Coastal Plain: Coastal exposure	Coastal Plain: Peatlands	Coastal Plain: Forested areas	Highlands - Acidic: Freshwater	Highlands - Acidic: Barrens	Highlands - Acidic: Peatlands	Highlands - Acidic: Forested areas	Highlands - Mafic: Freshwater	Highlands - Mafic: Coastal exposure	Highlands - Mafic: Barrens	Highlands - Mafic: Peatlands	Highlands - Mafic: Forested areas	Highlands - Ultramafic: Freshwater	Highlands - Ultramafic: Barrens	Highlands - Ultramafic: Peatlands	Highlands - Calcareous: Freshwater	Highlands - Calcareous: Coastal exposure	Highlands - Calcareous: Forested areas	no. of sites presence recorded	Coastal Plain	Highlands - Acidic	Highlands - Mafic	Highlands - Ultramafic	Highlands - Calcareous	Newfoundland distribution	Element
no. of sites investigated	1	2	3	3	2	4	2	1	7	2	4	2	4	1	1	1	7	4	3								
Abietinella abietina (Hedw.) Fleisch.									1								1	3	1	6			+		+	nv	2
Amblystegium serpens (Hedw.) B.S.G.		1							1								3	4	1	10	+		+		+	w	?1
Amphidium lapponicum (Hedw.) Schimp.	1								1								2			4	+		+	+	+	w	2
Amphidium mougeotii (B.S.G.) Schimp.	1								3	1		1					1	1		8	+		+	+	+	w	2
Andreaea crassinervia Bruch																						+				w	2
Andreaea rupestris Hedw.					1	3		1	2		4		1				2			13		+	+		+	w	1
Anomodon attenuatus (Hedw.) Hueb.									1								1			2			+		+	d	±2
Anomodon rostratus (Hedw.) Schimp.				1					1								2	1		5	+		+		+	nv	±2
Aretoa fulvella (Dicks.) B.S.G.											1									1			+			u	2a
Atrichum altecristatum (Ren. & Card.) Irel.				1													1			2	+				+	w	?
Atrichum oerstedianum (C. Muell.) Mitt.									1								1		1	3			+		+	?w	?
Aulacomnium androgynum (Hedw.) Schwaegr.																		1		1					+	d	3b
Aulacomnium palustre (Hedw.) Schwaegr.			1			2														3	+	+				w	2
Barbula convoluta Hedw.																			1	1					+	nv	2
Barbula fallax Hedw.											1						3	2		6			+		+	nv	2
Barbula reflexa (Brid.) Brid.																	2			2					+	nv	±2
Barbula unguiculata Hedw.			1														1			2	+				+	d	2
Bartramia ithyphylla Brid.																	1			1					+	c	2
Bartramia pomiformis Hedw.	1		1						1								3		1	7	+		+		+	w	2
Blindia acuta (Hedw.) B.S.G.	1				1				4								3		1	10	+	+	+	+	+	w	2
Brachythecium albicans (Hedw.) B.S.G.			1							1							1		3	6	+		+		+	u	2
Brachythecium curtum (Lindb.) Limpr.			1																1	2	+				+	w	2
Brachythecium oxycladon (Brid.) Jaeg. & Samarb.										1							1		1	3			+		+	nw	3a
Brachythecium plumosum (Hedw.) B.S.G.	1				2				4								4			11	+	+	+		+	w	2
Brachythecium populeum (Hedw.) B.S.G.									1											1				+	+	w	2
Brachythecium reflexum (Starke ex Web. & Mohr) B.S.G.			1														1		1	3	+				+	w	2
Brachythecium rivulare B.S.G.		1	1														3			5	+				+	w	2
Brachythecium rutabulum (Hedw.) B.S.G.			1														4		1	6	+				+	w	2
Brachythecium salebrosum (Web. & Mohr) B.S.G.			1										1				1	1	1	5	+		+		+	w	2
Brachythecium velutinum (Hedw.) B.S.G.			2																	2	+					u	2
Brotherella recurvans (Michx.) Fleisch.			2										2							4	+		+		+	s	4c
Bryhnia novae-angliae (Sull. & Lesq. ex Sull.) Grout																	1		1	2					+	w	3c
Bryoerythrophyllum recurvirostrum (Hedw.) Chen										1							5	2		8			+		+	?w	1
Bryum algovicum Sendtn. ex C. Muell.		1																1		2	+				+	n	2
Bryum argenteum Hedw.					1															1		+				w	1
Bryum bimum (Brid.) Turn.									1								1	1		3		+		+	+	w	?1
Bryum pallens (Brid.) Sw. ex Roehl.										1							1			2			+		+	u	2
Bryum pallescens Schleich. ex Schwaegr.			1		1												1	2	1	6	+	+			+	w	2
Bryum pseudotriquetrum (Hedw.) Gaertn., Meyer & Scherb.	1		1						1	1					1	1	1	2		9	+		+	+	+	w	2
Bryum salinum Hag. ex Limpr.										1										1			+			m	3a
Bryum stenotrichum C. Muell.										1										1			+			w	1
Bryum uliginosum (Brid.) B.S.G.															1					1				+		u	2
Buxbaumia aphylla Hedw.						1														1		+				w	2
Callicladium haldanianum (Grev.) Crum																			1	1					+	s	2
Calliergon sarmentosum (Wahlenb.) Kindb.									1											1			+			n	2
Calliergon stramineum (Brid.) Kindb.			1			2														3	+	+				w	2
Calliergon trifarium (Web.& Mohr) Kindb.			1						1											2	+		+	+		nw	2
Calliergonella cuspidata (Hedw.) Loeske	1		1							1										3	+		+		+	w	2
Campylium chrysophyllum (Brid.) J. Lange	1			1	1				1					1	1		7	2	1	16	+	+	+	+	+	w	2

Species	Freshwater	Coastal exposure	Peatlands	Forested areas	Freshwater	Barrens	Peatlands	Forested areas	Freshwater	Coastal exposure	Barrens	Peatlands	Forested areas	Freshwater	Barrens	Peatlands	Freshwater	Coastal exposure	Forested areas	no. of sites presence recorded	Coastal Plain	Highlands - Acidic	Highlands - Mafic	Highlands - Ultramafic	Highlands - Calcareous	Newfoundland distribution	Element
no. of sites investigated	1	2	3	3	2	4	2	1	7	2	4	2	4	1	1	1	7	4	3								
Campylium halleri (Hedw.) Lindb.																	1	2	1	4					+	nw	2
Campylium polygamum(B.S.G.) C. Jens.																		1		1					+	nw	2
Campylium stellatum (Hedw.) C. Jens.			2			1		1		3		1		1			1	2	1	13	+	+	+	+	+	w	2
Campylopus atrovirens De Not.										2										2			+			s	3b
Ceratodon purpureus (Hedw.) Brid.					1	2				1	1						4	1	1	11		+	+		+	w	1
Cirriphyllum piliferum (Hedw.) Grout																	1		1	2					+	nw	3c
Climacium dendroides (Hedw.) Web. & Mohr																			1	1		+	+		+	w	2
Cratoneuron commutatum (Hedw.) Roth	1				1												1	4		7	+	+		+	+	w	2
Cratoneuron filicinum (Hedw.) Spruce	1	1		1						1							2	3	1	10	+		+		+	w	2
Ctenidium molluscum (Hedw.) Mitt.																			1	1					+	u	2
Cynodontium alpestre (Wahlenb.) Milde					1	2											3	1		7		+		+	+	w	2
Cynodontium strumiferum (Hedw.) Lindb.					1												1			2		+			+	?w	2
Cyrtomnium hymenophylloides (B.S.G.) Nyh.	1																	1	1	3	+				+	nw	2
Desmatodon cernuus (Hueb.) B.S.G.		1																		1	+					?m	2
Desmatodon heimii (Hedw.) Mitt.		1									1									2	+		+			?m	2
Desmatodon latifolius (Hedw.) Brid.											1									1			+		+	n	2
Desmatodon laureri (Schultz)B.S.G.		1																		1	+					u	2
Dichelyma pallescens B.S.G.																			1	1					+	?w	4b
Dichodontium pellucidum (Hedw.) Schimp.	1			1													5		3	10	+				+	w	2
Dicranella heteromalla (Hedw.) Schimp.	1			1		1					1									4	+	+	+			w	2
Dicranella palustris (Dicks.) Crundw. ex Warb.										1										1			+			w	3a
Dicranella varia (Hedw.) Schimp.																	2			2					+	nw	2
Dicranoweisia crispula (Hedw.) Lindb. ex Milde						1				1										3		+	+		+	?w	2
Dicranum bonjeanii De Not. ex Lisa																								+		?w	2
Dicranum elongatum Schleich. ex Schwaegr.						3														3		+				nw	2
Dicranum fuscescens Turn.				3	1	4		1			1		3				2		1	16	+	+	+		+	w	2
Dicranum groenlandicum Brid.						2														2		+				nw	2
Dicranum majus Sm.				3		1			1		1		3					1	1	11	+	+	+	+	+	w	2a
Dicranum ontariense Peterson						1							1							2		+	+			s	4c
Dicranum polysetum Sw.			1			1						1	2		1					6	+	+	+	+		?w	2
Dicranum scoparium Hedw.			1			3			1		2		1		1		2		1	12	+	+	+	+	+	w	2
Dicranum undulatum Brid.			2			2	1					2				1				8	+	+	+	+		w	2
Didymodon rigidulus Hedw.											1						2			3			+		+	nw	2
Diphysium foliosum (Hedw.) Mohr												2						1		3			+		+	w	3a
Distichium capillaceum (Hedw.) B.S.G.	1	1		1							1						4	2	1	11	+		+		+	w	1
Distichium inclinatum (Hedw.) B.S.G.		1		1							1							3	1	7	+		+		+	m	2
Ditrichum flexicaule (Schwaegr.) Hampe				1													2	3	2	8	+				+	nw	2
Ditrichum lineare (Sw.) Lindb.																									+	d	3a
Drepanocladus exannulatus (B.S.G.) Warnst.						1														1		+				w	?2
Drepanocladus revolvens (Sw.) Warnst.			2		1					2					1	1	1	1		9	+	+	+	+	+	w	2
Drepanocladus uncinatus (Hedw.) Warnst.				2		1				2		2		3	1	1	5	1	3	21	+	+	+	+	+	w	2
Encalypta longicolla Bruch																		1		1					+	?nw	3b
Encalypta rhaptocarpa Schwaegr.											1							1		2			+		+	nw	2
Encalypta streptocarpa Hedw.				1													3	2	2	8	+				+	nw	2
Entodon concinnus (De Not.) Par.											1							2		3			+		+	?nw	2
Eurynchium pulchellum (Hedw.) Jenn.																	2		1	3					+	nw	2
Eurynchium riparioides (Hedw.) Rich.																	2			2					+	w	2
Fissidens adiantoides Hedw.	1			1						2							3	2	3	12	+		+		+	w	2
Fissidens osmundoides Hedw.	1									2	1	1					2			7	+		+		+	w	2
Fontinalis dalecarlica Schimp. ex B.S.G.					1															1		+				w	3c
Funaria hygrometrica Hedw.		1																		1	+					w	1

Species	Coastal Plain: Freshwater	Coastal Plain: Coastal exposure	Coastal Plain: Peatlands	Coastal Plain: Forested areas	Highlands - Acidic: Freshwater	Highlands - Acidic: Barrens	Highlands - Acidic: Peatlands	Highlands - Acidic: Forested areas	Highlands - Mafic: Freshwater	Highlands - Mafic: Coastal exposure	Highlands - Mafic: Barrens	Highlands - Mafic: Peatlands	Highlands - Mafic: Forested areas	Highlands - Ultramafic: Freshwater	Highlands - Ultramafic: Barrens	Highlands - Ultramafic: Peatlands	Highlands - Calcareous: Freshwater	Highlands - Calcareous: Coastal exposure	Highlands - Calcareous: Forested areas	no. of sites presence recorded	Coastal Plain	Highlands - Acidic	Highlands - Mafic	Highlands - Ultramafic	Highlands - Calcareous	Newfoundland distribution	Element
no. of sites investigated	1	2	3	3	2	4	2	1	7	2	4	2	4	1	1	1	7	4	3								
Grimmia hartmanii Schimp. var. anomala (Hampe ex Schimp.) Moenk.									1											1			+			u	2a
Grimmia ovalis (Hedw.) Lindb.											1							1		2			+		+	w	1
Grimmia tenerrima Ren. & Card.											1				1					2			+	+		nw	2
Grimmia trichophylla Grev.											1									1			+			w	1
Gymnostomum aeruginosum Sm.	1	1															4	2	1	9	+				+	w	2
Gymnostomum recurvirostrum Hedw.	1	2							1	1							3	4	1	13	+		+	+	+	nw	2
Hedwigia ciliata (Hedw.) P.-Beauv.																							+			w	1
Herzogiella striatella (Brid.) Iwats.				1									1				1	1	1	5	+	+	+		+	w	2
Herzogiella turfacea (Lindb.) Iwats.				1													3			4	+				+	w	2
Heterocladium dimorphum (Brid.) B.S.G.														1			1		1	3				+	+	nw	3b
Homalia trichomanioides (Hedw.) B.S.G.				1													2		1	4	+				+	d	?2
Hygrohypnum dilatatum (Wils.) Loeske									2										1	3			+		+	nw	2
Hygrohypnum eugyrium (B.S.G.) Loeske	1								1				1				3			6	+		+		+	s	2
Hygrohypnum eumontanum Crum, Steere & Anderson					1															1		+				s	3c
Hygrohypnum luridum (Hedw.) Jenn.																	2			2					+	d	2
Hygrohypnum ochraceum (Turn. ex Wils.) Loeske				1	1												2			4	+	+			+	w	2
Hygrohypnum smithii (Sw. ex Lilj.) Broth.									1								1			2			+		+	u	3b
Hylocomium pyrenaicum (Spruce) Lindb.									1											1			+	+		n	2
Hylocomium splendens (Hedw.) B.S.G.					1							1	3	1			2		1	9		+	+	+	+	w	?1
Hylocomium umbratum (Hedw.) B.S.G.					2	1							2				1		1	7		+	+	+	+	w	2a
Hypnum bambergeri Schimp.																		1		1					+	n	?2
Hypnum cupressiforme Hedw.																	1	2		3					+	w	1
Hypnum imponens Hedw.	1					2											1	3		7	+	+			+	w	2
Hypnum lindbergii Mitt.			1														2			3	+	+		+	+	w	2
Hypnum pallescens (Hedw.) P.-Beauv.				2		1	1						4				1		1	10	+	+	+		+	w	2
Hypnum plicatulum (Lindb.) Jaeg. & Sauerb.				1																1	+		+	+		nw	2
Isopterygiopsis muelleriana (Schimp.) Iwats.											1									1			+	+		nw	2a
Isopterygium elegans (Brid.) Lindb.											1						1			2			+		+	s	3b
Isopterygium pulchellum (Hedw.) Jaeg. & Sauerb.	1																2		1	4	+			+	+	d	2
Kiaeria blyttii (Schimp.) Broth.					1	3			1		1									6		+	+			nw	3a
Leptobryum pyriforme (Hedw.) Wils.																		2		2					+	w	1
Leskeella nervosa (Brid.) Loeske																	2	1	1	4					+	nw	2
Leucobryum glaucum (Hedw.) Ångstr. ex Fr.						1			2				1							4		+	+	+	+	w	2a
Leucodon brachypus Brid. var. andrewsianus Crum & Anderson																	1			1					+	nw	4c
Mnium hornum Hedw.				1						1									2	4	+		+		+	w	3a
Mnium lycopodioides Schwaegr.																						+			+	nw	2
Mnium marginatum (With.) Brid. ex P.-Beauv.				1													2			3	+				+	nw	2
Mnium thomsonii Schimp.																	1			1		+			+	nw	2
Molendoa sendtneriana (B.S.G.) Limpr.				1																1					+	u	2
Myurella julacea (Schwaegr.) B.S.G.																	2	3		5			+		+	n	2
Myurella sibirica (C. Muell.) Reim.																	4		2	6					+	w	2a
Neckera pennata Hedw.																			1	1					+	w	2
Oligotrichum hercynicum (Hedw.) DC.						1					1									1		+	+			u	2a
Oncophorus virens (Hedw.) Brid.						1			1		3						1	1		7		+	+		+	u	2
Oncophorus wahlenbergii Brid.									1											1			+	+		w	2
Orthodicranum montanum (Hedw.) Loeske				1		2		1					1				2			7	+	+	+		+	w	2
Orthothecium strictum Lor.				1														2		3	+				+	n	2
Orthotrichum anomalum Hedw.										1										1			+			u	2
Orthotrichum obtusifolium Brid.																			1	1					+	u	2
Orthotrichum sordidum Sull. & Lesq. ex Aust.																			1	1					+	u	2a

Species	Coastal Plain: Freshwater	Coastal Plain: Coastal exposure	Coastal Plain: Peatlands	Coastal Plain: Forested areas	Highlands - Acidic: Freshwater	Highlands - Acidic: Barrens	Highlands - Acidic: Peatlands	Highlands - Acidic: Forested areas	Highlands - Mafic: Freshwater	Highlands - Mafic: Coastal exposure	Highlands - Mafic: Barrens	Highlands - Mafic: Peatlands	Highlands - Mafic: Forested areas	Highlands - Ultramaf.: Freshwater	Highlands - Ultramaf.: Barrens	Highlands - Ultramaf.: Peatlands	Highlands - Calcareous: Freshwater	Highlands - Calcareous: Coastal exposure	Highlands - Calcareous: Forested areas	no. of sites presence recorded	Coastal Plain	Highlands - Acidic	Highlands - Mafic	Highlands - Ultramafic	Highlands - Calcareous	Newfoundland distribution	Element
no. of sites investigated	1	2	3	3	2	4	2	1	7	2	4	2	4	1	1	1	7	4	3								
Orthotrichum speciosum Nees ex Sturm.																			1	1					+	?w	2
Orthotrichum stellatum Brid.																			1	1					+	u	3c
Paraleucobryum longifolium (Hedw.) Loeske					2	3	1			1										7		+	+			w	2
Philonotis fontana (Hedw.) Brid.		1	1		1	1			1					1			4			10		+	+	+	+	w	2
Plagiobryum zierii (Hedw.) Lindb.	1																			1		+				n	2
Plagiomnium ciliare (K. Müll.) Kop.																							+			?nw	4a
Plagiomnium cuspidatum (Hedw.) Kop.										1							1			2			+		+	s	2
Plagiomnium medium (B.S.G.) Kop.																	1			1					+	s	2
Plagiopus oederiana (Sw.) Limpr.	1																2	1	2	6	+				+	nw	2
Plagiothecium cavifolium (Brid.) Iwats.									1											1			+		+	w	2
Plagiothecium denticulatum (Hedw.) B.S.G.					1															1		+				w	2
Plagiothecium laetum B.S.G.			2		1	1		1				1					1		2	9	+	+	+		+	w	2
Plagiothecium latebricola B.S.G.			1																	1					+	u	3a
Platydictya jungermannioides (Brid.) Crum	1		1														2	1		5	+				+	?w	2
Pleurozium schreberi (Brid.) Mitt.						2						3		1	1	1	1		1	10	?	+	+	+	+	w	2
Pogonatum dentatum (Brid.) Brid.						2														2		+		+		w	2
Pogonatum urnigerum (Hedw.) P.-Beauv.			1														1			2	+				+	w	2
Pohlia bulbifera (Warnst.) Warnst.		1			1															2	+	+				u	2
Pohlia cruda (Hedw.) Lindb.										2							3			5			+		+	w	1
Pohlia nutans (Hedw.) Lindb.					2				1	3							2		1	9		+	+		+	w	1
Polytrichastrum alpinum (Hedw.) G.L. Smith	1				1	3			2	1	1						3		1	13	+	+	+	+	+	w	2
Polytrichastrum formosum (Hedw.) G.L. Smith	1					3		1		2							1			8	+	+	+		+	s	?2
Polytrichastrum longisetum (Brid.) G.L. Smith						1														1		+				u	2
Polytrichastrum pallidisetum (Funck) G.L. Smith						1														1		+			+	s	3a
Polytrichum commune Hedw.										1									1	2			+		+	w	1
Polytrichum juniperinum Hedw.						1			1	1										3		+	+			w	1
Polytrichum piliferum Hedw.						2														2		+			+	w	1
Polytrichum strictum Brid.			1			2	1			1						1				6	+	+	+	+		w	2
Pseudoleskea patens (Lindb.) Kindb.																	1			1					+	u	3a
Pseudoleskea radicosa (Mitt.) Macoun & Kindb.									1											1			+			u	3a
Pseudoleskeella catenulata (Brid. ex Schrad.) Kindb.																	1	1		2					+	u	2a
Pseudoleskeella tectorum (Funck ex Brid.) Kindb. ex Broth.				1													1	1		3	+				+	u	2
Pterigynandrum filiforme Hedw.																	2		1	3				+	+	w	2
Ptilium crista-castrensis (Hedw.) De Not.				1										1						2	+			+	+	w	2
Pylaisiella polyantha (Hedw.) Grout.								1												1		+				d	2
Pylaisiella selwynii (Kindb.) Crum, Steere and Anderson																			1	1					+	d	2a
Rhabdoweisia crispata (With.) Lindb.	1																			1	+					w	3b
Racomitrium aciculare (Hedw.) Brid.					1				4			1					2		1	9		+	+		+	w	3a
Racomitrium canescens (Hedw.) Brid.						1														1		+			+	u	2
Racomitrium fasciculare (Hedw.) Brid.						2			2	3							1			8		+	+	+	+	w	2
Racomitrium heterostichum (Hedw.) Brid.						2			1	1	1						1			6		+	+	+	+	w	2a
Racomitrium lanuginosum (Hedw.) Brid.	1				1	3			1	2	2	1		1	1				1	14	+	+	+	+	+	w	2
Racomitrium microcarpon (Hedw.) Brid.						4			1	1										6		+	+	+		w	3a
Rhizomnium magnifolium (Horik.) Kop.																									+	?s	2
Rhizomnium punctatum (Hedw.) Kop. ssp. chlorophyllosum (Kindb.) Kop.	1		1														3		1	7	+	+			+	w	4b
Rhynchostegiella compacta (C. Muell.) Loeske									1									1		2			+		+	u	3a
Rhytidiadelphus loreus (Hedw.) Warnst.									1			3					3		1	8			+	+	+	w	3b
Rhytidiadelphus squarrosus (Hedw.) Warnst.																									+	w	2
Rhytidiadelphus subpinnatus (Lindb.) Kop.																								+	+	w	2
Rhytidiadelphus triquetrus (Hedw.) Warnst.												1					1		1	3			+		+	w	2
Rhytidium rugosum (Hedw.) Kindb.										1								1		2			+		+	m	2

Species	Freshwater	Coastal exposure	Peatlands	Forested areas	Freshwater	Barrens	Peatlands	Forested areas	Freshwater	Coastal exposure	Barrens	Peatlands	Forested areas	Freshwater	Barrens	Peatlands	Freshwater	Coastal exposure	Forested areas	no. of sites presence recorded	Coastal Plain	Highlands - Acidic	Highlands - Mafic	Highlands - Ultramafic	Highlands - Calcareous	Newfoundland distribution	Element
no. of sites investigated	1	2	3	3	2	4	2	1	7	2	4	2	4	1	1	1	7	4	3								
Schistidium agassizii Sull. et Lesq.									1								1			2			+		+	w	3a
Schistidium alpicola (Hedw.) Limpr.																	3			3					+	w	2
Schistidium apocarpum (Hedw.) B.S.G.			1							1	1						3	3	1	10	+		+		+	w	1
Schistidium gracilis (Roehl.) Limpr.									1								2	2	1	6			+	+	+	w	2
Schistidium maritimum (Turn.) B.S.G.	1								1									1		3	+		+		+	m	3b
Schistostega pennata (Hedw.) Web. & Mohr																									+	u	?2a
Sciaromium lescurii (Sull.) Broth.					1															1		+				s	4c
Scorpidium scorpioides (Hedw.) Limpr.			1		1				1								1			4	+	+	+		+	nw	2
Seligeria campylopoda Kindb. ex Macoun & Kindb.																		1		1					+	u	3c
Seligeria donniana (Sm.) C. Muell.	1		1														2		1	5	+				+	nw	2
Seligeria tristichoides Kindb.																		1		1					+	nw	3b
Sphagnum angustifolium (Russ.) C. Jens.			3												1					4	+			+		w	2
Sphagnum capillaceum (Weiss) Schrank			1		1							3								5	+	+	+			w	2
Sphagnum centrale C. Jens. ex Arnell & C. Jens.			1														1			2	+				+	w	1
Sphagnum compactum DC. ex Lam. & DC.							1		1			1				1				4		+	+	+		w	2
Sphagnum cuspidatum Ehrh. ex Hoffm.							1													1		+				w	2a
Sphagnum flavicomans (Card.) Warnst.			2																	2	+					w	4c
Sphagnum fuscum (Schimp.) Klinggr.			3				2		1			2				1				9	+	+	+	+		w	2
Sphagnum girgensohnii Russ.		1			1	2			1		1		1							7	+	+	+			w	2
Sphagnum imbricatum Hornsch. ex Russ.			1																	1	+					w	2
Sphagnum lindbergii Schimp. ex Lindb.							1													1		+				m	2
Sphagnum magellanicum Brid.			2				1					2								5	+	+	+			w	1
Sphagnum majus (Russ.) C. Jens.							1					1								2		+	+			w	2
Sphagnum palustre L.			2						1											3	+		+			w	1
Sphagnum papillosum Lindb.							2		2			1								5		+	+			w	2
Sphagnum pulchrum (Lindb. ex Braithw.) Warnst.												1				1				2			+	+		w	2
Sphagnum pylaesii Brid.						1	1		2		1					1				6		+	+	+		w	3c
Sphagnum quinquefarium (Lindb. ex Braithw.) Warnst.									2		1						1		1	5			+	+	+	s	2
Sphagnum rubellum Wils.			2			1	2					1								6	+	+	+			w	2
Sphagnum russowii Warnst.				1		1														2	+	+				w	2
Sphagnum squarrosum Crome			1	1													1			3	+	+			+	w	2
Sphagnum subfulvum Sjörs									1						1					2			+	+		w	2a
Sphagnum subsecundum Nees ex Sturm					1															1		+				w	2
Sphagnum tenellum Ehrh. ex Hoffm.	1		1				2		1			1								6	+	+	+			w	2
Sphagnum teres (Schimp.) Angstr. ex C. Hartm.	1	1																		2	+					w	2
Sphagnum warnstorfii Russ.			1			1	2	1			1	1			1		1			9	+	+	+	+	+	w	2
Splachnum ampullaceum Hedw.							1													1		+				w	2
Tetraphis geniculata Girg. ex Milde	1		1																1	3	+				+	w	2a
Tetraphis pellucida Hedw.			2										1				3		1	7	+		+		+	w	2
Tetraplodon angustatus (Hedw.) B.S.G.															1					1				+		u	3a
Tetraplodon mnioides(Hedw.) B.S.G.					1															1		+				w	2
Thuidium delicatulum (Hedw.) B.S.G.			1						2				1				4	1	2	11	+		+		+	w	2
Thuidium recognitum (Hedw.) Lindb.																		1	1	2					+	nw	2
Timmia austriaca Hedw.																						+				nw	2
Timmia norvegica Zett.			1																1	2	+				+	nw	2
Tomenthypnum nitens (Hedw.) Loeske			1															1		2	+				+	nw	2
Tortella fragilis (Drumm.) Limpr.									1		1								1	3			+	+	+	m	2
Tortella tortuosa (Hedw.) Limpr.	1		1						4		2						5	3	2	18	+		+	+	+	w	2
Tortula mucronifolia Schwaegr.											1							1		2			+		+	nw	2
Tortula ruralis (Hedw.) Gaertn., Meyer & Scherb.											1									1			+		+	w	2
Trematodon ambiguus (Hedw.) Hornsch.																	1	1		2					+	w	2a
Trichostomum crispulum Bruch																		1		1					+	u	u
Trichostomum tenuirostre (Hook. & Tayl.) Lindb.													1		1			1		3			+	+	+	?w	?2
Ulota coarctata (P.-Beauv.) Hamm.			1														1	1	1	4	+				+	w	3a
Ulota crispa (Hedw.) Brid.			2															1	3	6	+				+	w	2
Ulota drummondii (Hook. & Grev. ex Grev.) Brid.			1										1					1	2	5	+		+		+	s	2
Ulota hutchinsiae (Sm.) Hamm.																	1			1					+	s	2a
Ulota phyllantha Brid.	1				1					1										3	+	+	+		+	m	3b
Weissia controversa Hedw.									1									1		2			+	+	+	d	1
Zygodon viridissimus (Dicks.) Brid.										1							1	1		3			+		+	nw	2a

Legend. 1, Coastal Plain; 2, Calcareous Highlands; 3, Mafic Highlands; 4, Ultramafic Highlands; 5, Acidic Highlands.