THE BRYOPHYTES OF CATARACTS PROVINCIAL PARK, NEWFOUNDLAND

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THE BRYOPHYTES OF CATARACTS PROVINCIAL PARK, NEWFOUNDLAND

A Thesis

Presented to

The Department of Biology

Memorial University of Newfoundland

In Partial Fulfillment

of the Requirements for the Degree

Master of Science

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by

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January, 1976

ABSTRACT

The bryogeographical knowledge of insular Newfoundland has been significantly augmented through the intense investigation of the bryoflora of Cataracts Provincial Park, Avalon Peninsula, and its vicinity.

The area investigated included forested areas, bog, heath, and a deep, angular, and narrow river gorge and waterfalls which provide numerous microhabitats particularly suitable for growth of bryophytes. Each bryophyte habitat is fully described, and an annotated list of species gives data on occurrence, frequency, and fertility. Within an area of approximately 13 hectares, 121 species of mosses and 63 species of liverworts were collected, representing one third of the total known bryophyte flora of the island of Newfoundland. The mosses Bryum creberrimum and Ditrichum lineare and the liverwort Cephaloziella hampeana are reported for the first time from insular Newfoundland. The ranges of a number of Newfoundland bryophytes, including several species previously thought to be more or less restricted to the predominantly calcareous regions of the west coast such as Hygrohypnum luridum or Lophozia gillmani, have been extended to include the Avalon Peninsula.

A small southern element, represented by Sematophyllum marylandicum, and a northern element, represented by Lophozia bantriensis, are present within the Park but most of the moss and liverwort species there are typical circumboreal species.

ACKNOWLEDGEMENTS

Foremost I would like to thank my supervisor Dr. Guy R. Brassard whose constant interest, enthusiasm, and advice guided me throughout the course of this study.

I wish to sincerely thank Mr. Harry Williams of Millbrook, Ontario for his critical examination of nearly all liverwort collections made within the study area.

I also wish to thank Dr. Howard A. Crum and Dr. Robert R. Ireland for their repeated assistance concerning identifications and other enquiries.

I gratefully acknowledge the willing assistance given by Dr. H. Ando, Dr. D. Jamieson, Dr. T. Koponen, Dr. G. L. Smith, Dr. W. C. Steere, Dr. R. Stotler, and Dr. D. H. Vitt in identification, revision, or confirmation of specimens in difficult genera.

The research was carried out with the aid of a National Research Council of Canada Grant (A-6683) to Dr. G. R. Brassard and a Provincial Government Graduate Fellowship.

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CHAPTER I

INTRODUCTION

The purpose of this study was to investigate in detail the bryoflora of Cataracts Provincial Park, Newfoundland. Preliminary observations had indicated that this locality had particularly rich and diverse moss and liverwort floras.

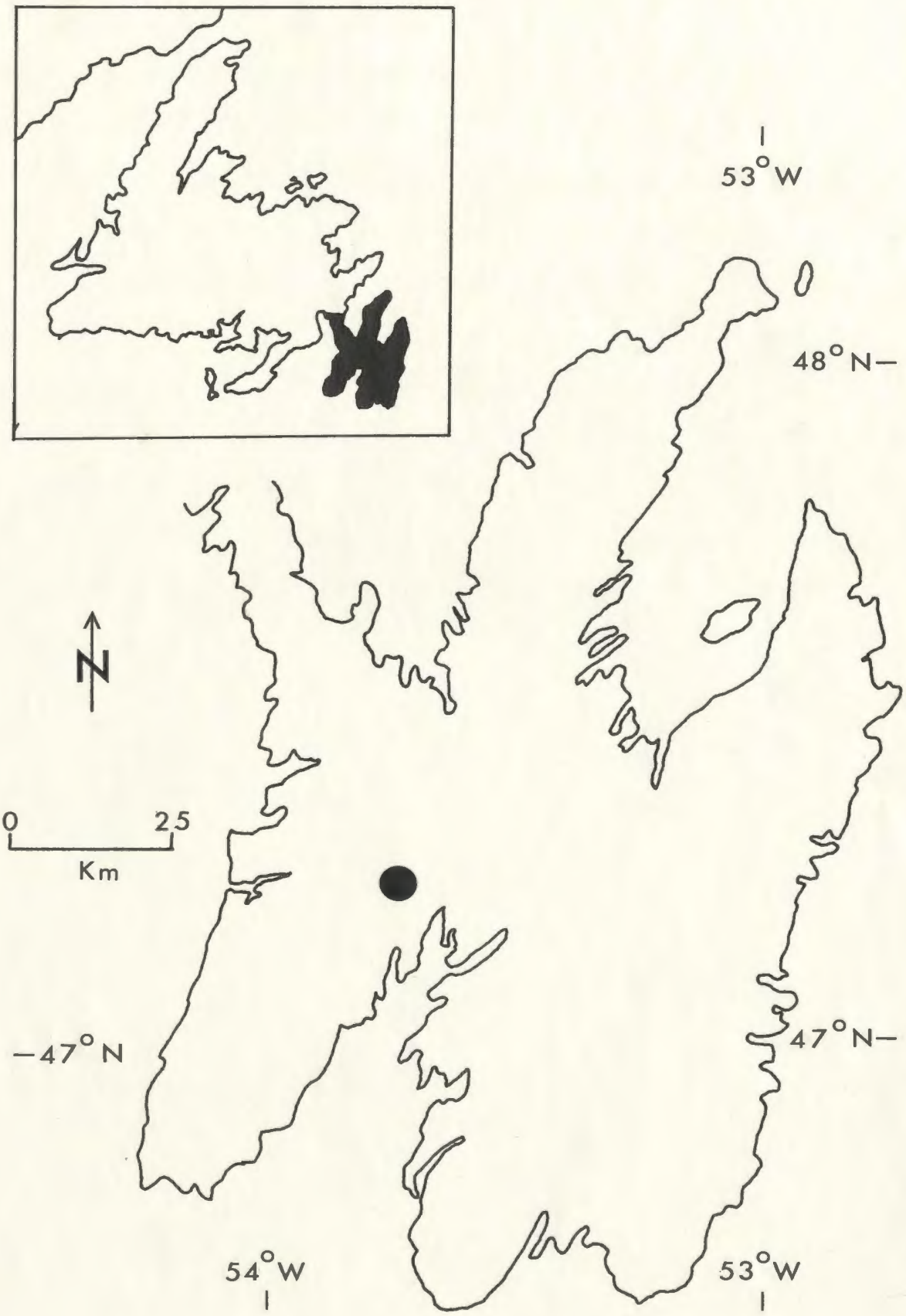
The study area includes Cataracts Provincial Park and its immediate surroundings (47° 15'N, 53° 38'W). This provincial park is located in the south-central part of the Avalon Peninsula, 7 km west-northwest of Colinet (Fig. 1). The park is 7 km inland from North Harbour (St. Mary's Bay) along Cataracts Brook, a tributary of the North Harbour River, and has an area of approximately 13 hectares.

The earliest major bryophyte collection in Newfoundland was made by Bachelot de la Pylaie in 1816 and 1819-1820 and was identified by Bridel (1826, 1827). The Reverend Arthur C. Waghorne collected numerous bryophytes in the 1880's and 1890's, especially in the Trinity Bay area, and these were primarily identified by the Swedish bryologist N. C. Kindberg (Macoun, 1902; Macoun and Kindberg, 1892). Bayard Long in 1924-1926 (Bartram, 1928) and Wickes (1943) also collected in parts of the island of Newfoundland.

The most recent large published collection was made by R. Tuomikoski in 1949 (Buch and Tuomikoski, 1955; Tuomikoski, Koponen, and Ahti, 1973). Important but less extensive collections by a number of bryologists (T. Ahti, G. R. Brassard, T. Koponen, W. Maass, D. H. Norris,

Figure 1

The Avalon Peninsula of Newfoundland, showing the location of Cataracts Provincial Park (black dot). The inset shows the island of Newfoundland and the region enlarged in the main map (blackened area).


53°W
48°N
N
0
25
Km
47°N
54°W
53°W

R. M. Schuster, H. Williams), and by various Canadian Forestry Service personnel and others have all contributed to a greater knowledge of the Newfoundland bryoflora.

New or additional bryophyte records from Newfoundland (Brassard, 1975; Brassard, 1976; Brassard, Weber and Fife, 1976; Brassard and Williams, in preparation; Hancock and Brassard, 1973) continue to augment earlier floristic data on bryophytes of the island.

Except for a few specimens collected by G. R. Brassard and J. A. Hancock, there had been no previous bryological investigations of Cataracts Provincial Park.

To date there are 398 species of mosses (including 41 species of Sphagnum--A. W. Damman, pers. comm.) and 136 species of liverworts known from Newfoundland.

CHAPTER II

DESCRIPTION OF THE AREA

Geology

The Avalon Peninsula, which lies within the Appalachian System (Henderson, 1972), is generally underlain by metamorphosed Precambrian sedimentary rocks lacking limestone (MacCartney, 1967). The Cataracts Provincial Park area falls into the upper part of the Snow Pond Formation of the Precambrian Hodgewater group described by MacCartney (1967) as "dark grey wavy-bedded siltstone and grey arkose; green arkose commonly cross bedded; rare grey pebble conglomerate; restricted red arkose at the top."

The axes of major folds and faults all trend northeasterly (Henderson, 1972).

The St. Mary's Bay area is an area of recessional moraines, and Henderson (1972) has put the Cataracts Provincial Park area into the category of continuous ground moraine cover (stony till about 1 m thick). Rowe (1972) described the soils of the Avalon Peninsula as nutrient-poor humo-ferric podzols of youthful appearance.

Topography and Vegetation

The raison d'être of Cataracts Provincial Park, opened in 1959, is its scenery. Cataracts Brook crosses the Park in a generally northeast-southwest direction. Newfoundland Route 8 crosses the Park in an east-west direction (Figs. 2, 3). From road level at the main bridge, the river gorge is approximately 16 m deep and 22 m wide.

Figure 2

Diagrammatic surface view of study area. Large slashed lines perpendicular to river indicate extent of the gorge. Arrows indicate direction of water flow. Stippled areas along river indicate sediment accumulation. Zig-zag lines indicate main seepage tracks. Dashed lines indicate trails. Scale is approximate.

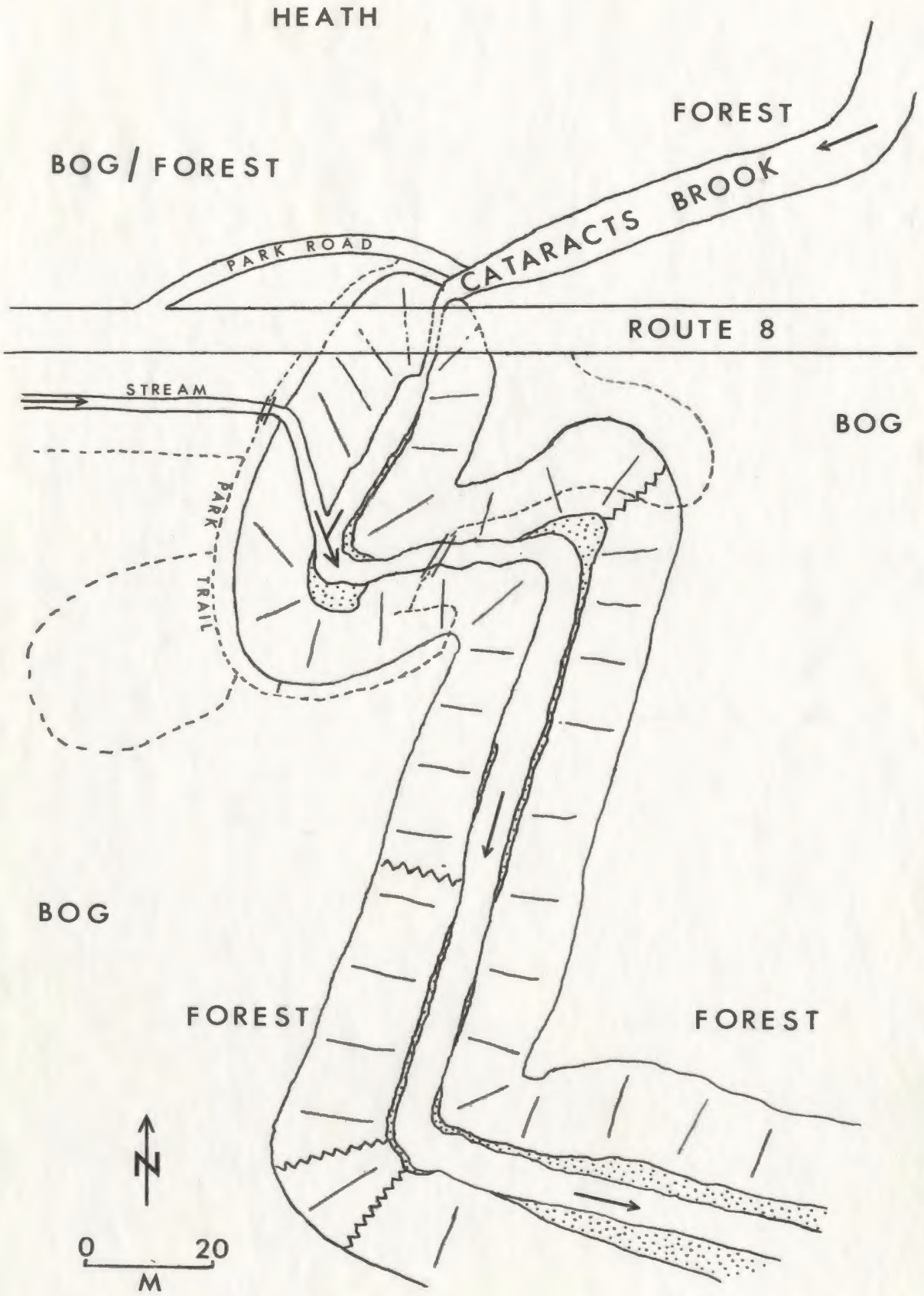

HEATH
FOREST
BOG / FOREST
CATARACTS BROOK
PARK ROAD
ROUTE 8
STREAM
BOG
PARK TRAIL
BOG
FOREST
FOREST
N
0
20
M

Figure 3

Aerial photograph of Cataracts Provincial Park and its vicinity. Approximate boundary of the Park is outlined in black.


N

The gorge walls are steeply sloping (more than 45°) to vertical (Figs. 4, 5). As one moves downstream the gorge walls decrease in height and the gorge itself increases in width.

The main falls of the river, which are just north of the bridge, are approximately 14 m high. The second falls (Figs. 6, 7), entering the main river just south of the bridge, are approximately 16 m high and have about one sixth of the water flow of the main river.

Thick carpets of moss, notably Sphagnum, especially along the wooded slopes, absorb much of the frequent precipitation and thus arrest erosion. Only in a few areas are washout tracks found, those being the result of spring runoff.

Outside the gorge the land is gently rolling with extensive forest dominated by Abies balsamea (L.) Mill. and Picea mariana (Mill.) BSP. Acer spicatum Lam. and Betula lutea Michx. f. are also present but are not very common. The common shrubs (mainly Amelanchier spp., Nemopanthus mucronata (L.) Trel., Taxus canadensis Marsh., and Viburnum cassinoides L. and herbs (mainly Clintonia borealis (Ait.) Raf., Cornus canadensis L., Dryopteris spinulosa (O. F. Muell.) Watt, Linnaea borealis L., Osmunda cinnamomea L., and Trientalis borealis Raf.) are typical boreal forest species.

Wet shrubby bogs dominated by Abies balsamea, Larix laricina (Du Roi) K. Koch, Picea mariana, and Sphagnum spp., and open bog dominated by Eriophorum spp., Scirpus cespitosus L. and Sphagnum spp. are also present. Heathland, dominated by Cladonia spp., Kalmia angustifolia L., and Vaccinium angustifolium Ait., occurs less frequently.

Figure 4

The gorge looking south under the bridge of Route 8 and showing the steep walls of the river gorge of Cataracts Brook (February, 1975).

Figure 5

The more southerly section of the river gorge. Note ice accumulation near the center of the photograph (arrow)(February, 1975).

Figure 6

The waterfalls (about 16 m high) entering Cataracts Brook immediately south of Route 8. Compare to Fig. 7. (February, 1975).

Figure 7

The waterfalls (about 16 m high) entering Cataracts Brook (flowing to the left). The dark green fringe on either side of the waterfalls is Hygrohypnum ochraceum. Photo by G. R. Brassard (8 September, 1975).

Fires have not been recorded within the Park, however, patches of burnt-over areas on the surrounding hills are quite evident. Wilton and Evans (1974) documented fires in the Colinet area in 1926, 1928, and 1957.

Climate

The sea dominates the climate of Newfoundland. The proximity of the cold Labrador current keeps the spring and summer relatively cool, but the winter milder than the adjacent continent. This warmth is derived from the open seas of the southern coast (Hare, 1952).

The whole island of Newfoundland has abundant, evenly distributed precipitation (Hare, 1952). Table 1 gives mean monthly temperature and monthly precipitation data recorded at Colinet (47°11'N, 53°35'W) from 1963-1972 (Department of Transport, 1963-1970; Environment Canada, 1971, 1972). The mean annual precipitation for 1963-1972 was 138 cm.

Cloud and fog cover are generally extensive over the Avalon Peninsula, but the south central portion is generally sunnier than other places.

The local topography of Cataracts Provincial Park is variable, particularly within the gorge, and this creates a number of different microclimates. Although no actual data were recorded it was easily observed that temperatures tended to be lower within the gorge than above it. Snowfall is heavy, with snow and ice lingering until May, especially on north-facing areas within the gorge (Fig. 8). Spray from the two falls combined with the numerous seepage tracks also increases humidity. A light cool breeze funnelled along the river in the gorge is often felt.

TABLE 1

MEAN MONTHLY TEMPERATURES (°C) AND PRECIPITATION (CM)
RECORDED AT COLINET 1963-1972

(DEPARTMENT OF TRANSPORT, 1963-1970; ENVIRONMENT CANADA, 1971-1972)

Month	Temperature	Precipitation
January	- 3.7	13.6
February	- 2.6	12.8
March	- 2.8	9.5
April	2.1	10.3
May	5.9	10.8
June	9.9	9.8
July	14.1	10.5
August	15.3	15.0
September	11.4	10.0
October	7.6	13.0
November	3.6	13.8
December	- 1.2	12.6

Figure 8

Photograph showing heavy ice accumulation along gorge walls (close-up of area of arrow in Fig. 5)(February, 1975).

CHAPTER III

MATERIALS AND METHODS

Thirteen field trips, totalling 23 days in all, were made to Cataracts Provincial Park from May 1974 to November 1975. Attempts were made to find and investigate all different types of bryophyte habitats within the study area.

Many small bryophytes can easily be overlooked. Sporophytes, which usually make the plants more obvious, occur at different seasons for different species. Thus the various habitats were scrutinized closely, often on hands and knees, and often revisited at several different times of the year.

Appropriate habitat data, collection dates, and notes on fertility are included on voucher specimen labels. Nearly 500 bryophyte specimens from the study area were collected by myself, 54 by G. R. Brassard, and 11 by J. A. Hancock.

The specimens were identified using the Memorial University of Newfoundland Bryophyte Herbarium (NFLD) as a source of material for comparison. Problematic species were tentatively identified and sent to various specialists for confirmation or revision. Almost all liverworts were verified, revised, or identified by Mr. Harry Williams.

The annotated lists of all moss and liverwort species found within the study area are given in Appendix A. Voucher specimens are all deposited in the Memorial University Bryophyte Herbarium (NFLD) unless otherwise specified. Distribution maps are based on specimens examined and reliable literature reports.

CHAPTER IV

BRYOPHYTE ECOLOGY OF CATARACTS PROVINCIAL PARK

Epiphytes

Barkman (1958) defines an epiphyte as an organism living on a plant, or in the dead outer tissues of a plant, without drawing water or food from its support plant. Moss and liverwort epiphytes were not very common within the study area, but did occur on Abies balsamea, Acer spicatum, Alnus crispa (Ait.) Pursh, and Picea mariana. Epiphytes encountered included Dicranum fuscescens, Frullania asagrayana, Hypnum pallescens, Ptilidium pulcherrimum, Ulota coarctata, U. crispa, and U. drummondii. Only the three species of Ulota were found exclusively as epiphytes. These species were found in the wooded areas and along the river on tree trunks and branches from heights of approximately 1-3 m from ground level. Drepanocladus uncinatus, some Brachythecium and Hypnum species, and Oncophorus wahlenbergii were found creeping up the tree trunks but were generally confined to the tree base.

Although not particularly evident within the study area, vertical zonation of epiphytic bryophytes is a common phenomenon (Hale, 1952).

Forest Floor

Studies have shown that certain forest communities have a characteristic bryophyte ground layer with two or three species predominant (Higinbotham and Higinbotham, 1954). Within the fir-spruce woods at Cataracts Provincial Park, terrestrial bryophytes are very

abundant. The dominant humicolous bryophytes include Dicranum majus, Hylocomium splendens, and Pleurozium schreberi.

On the wetter wooded slopes, various Sphagnum species become dominant. Only in a few isolated sites is the tree canopy so heavy that no bryophytes are found beneath it. This primarily results from reduced light (Tamm, 1953), but increased leaf litter (Johnsen, 1959) must also be considered, although the latter is less important in a predominantly evergreen forest.

Rotting Wood

Fallen trees in various stages of decomposition provide habitats for many bryophytes, particularly leafy liverworts. Fairly distinct successional trends and associated vegetational changes occur in the decay of fallen trees (Muhle, 1973). Table 2 lists, in four broad successional categories, those bryophytes found on decaying logs within the study area. The primary factor determining the type of bryophyte community on decaying wood is the degree of decay. Bacterial and fungal action along with the physical action of water are important factors in the decomposition of fallen trees.

Epiphytic vegetation on a freshly fallen tree is soon sloughed off along with the bark, exposing bare areas of wood for colonization by pioneering species such as Jamesoniella autumnalis or Lophocolea heterophylla. As the wood continues to break down and the substrate changes, the logs are invaded by more competitive species such as Anastrophyllum hellerianum, Cephalozia catenulata, or Lophozia porphyroleuca. As a decayed log becomes more closely incorporated into the surrounding humus Brotherella recurvans, Tetraphis geniculata, and T. pellucida

TABLE 2

STAGES OF DECOMPOSITION OF FALLEN TREES AT CATARACTS PROVINCIAL PARK WITH CHARACTERISTIC BRYOPHYTE SPECIES

Stage I (earliest)	
Dicranum fuscescens	*Ulota coarctata*
Frullania asagrayana	*Ulota crispa*
Hypnum pallescens	*Ulota drummondii*
Ptilidium pulcherrimum	
Stage II	
Harpanthus scutatus	*Nowellia curvifolia*
Jamesoniella autumnalis	*Ptilidium pulcherrimum*
Lophocolea heterophylla	
Stage III	
Anastrophyllum hellerianum	*Dicranum fuscescens*
Anastrophyllum michauxii	*Lophozia porphyroleuca*
Blepharostoma trichophyllum	*Plagiothecium laetum*
Cephalozia bicuspidata	*Riccardia latifrons*
Cephalozia catenulata	*Scapania umbrosa*
Cephalozia leucantha	*Tritomaria exsecta*
Stage IV (latest)	
Bazzania trilobata	*Lophozia incisa*
Blepharostoma trichophyllum	*Oncophorus wahlenbergii*
Brotherella recurvans	*Ptilium crista-castrensis*
Dicranum fuscescens	*Tetraphis geniculata*
Herzogiella striatella	*Tetraphis pellucida*

become established.

Gorge

The river gorge within the study area was divided into four zones (Fig. 9), each zone having characteristic or different dominant bryophyte species. Appendix B lists the species' occurrence in each zone.

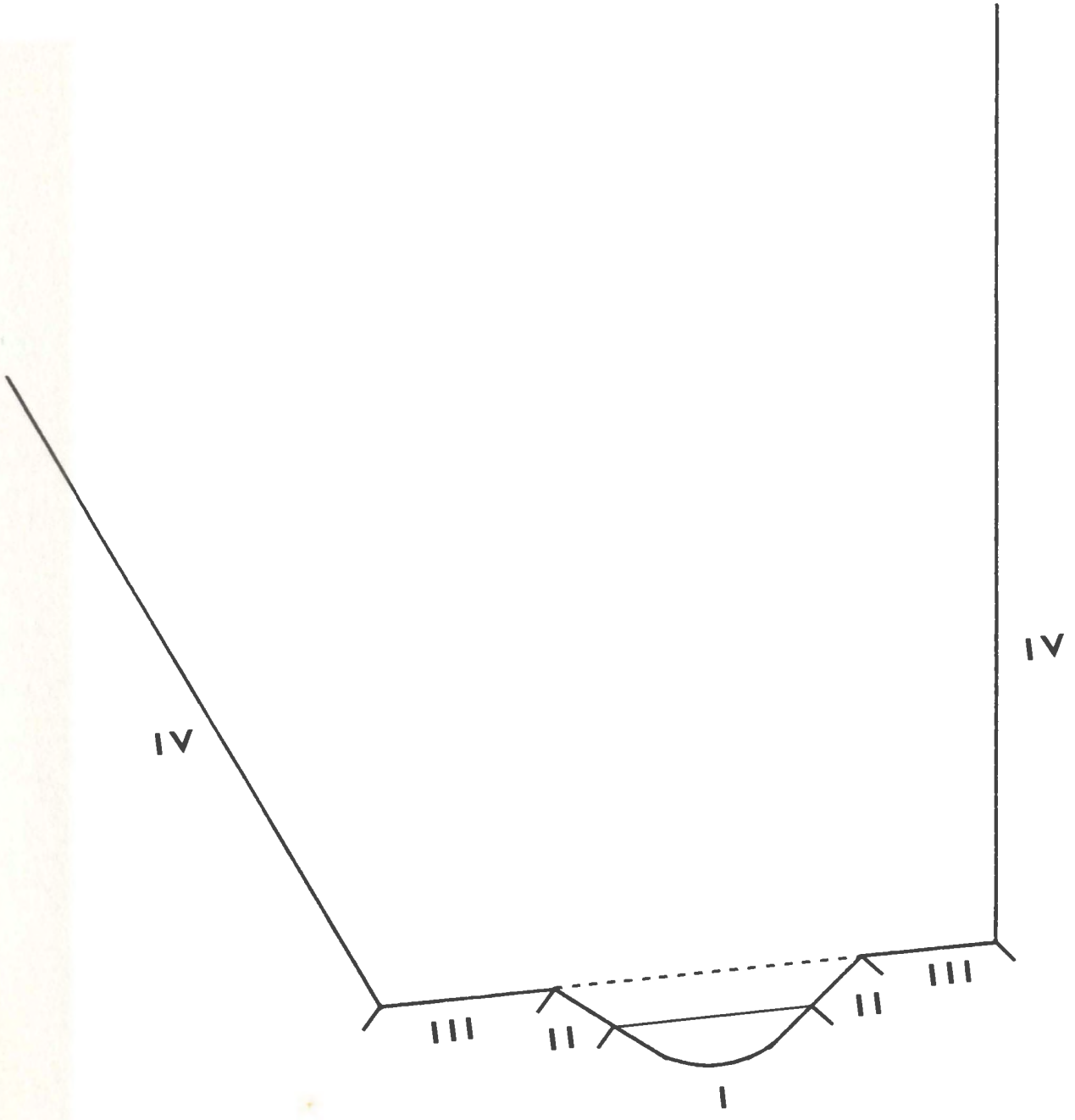
Zone I. Aquatic zone. The characteristic bryophytes of this zone, Fontinalis dalecarlica and Scapania undulata, are essentially confined to submerged or emergent rocks. Fontinalis antipyretica var. gigantea and Riccardia sinuata were found submerged on the mud of a rivulet running into the gorge. The faster water flow of the main river may have some bearing on the absence of these species in the gorge.

Zone II. Inundation zone. This is a narrow strip along the river that is periodically submerged or exposed depending on rising or falling water level. This zone is not particularly well defined. It contains species found also in zones I and III. However, this is the zone where species such as Marsupella emarginata, Rhacomitrium aciculare, Scapania undulata, S. nemorosa, and Plagiochila asplenioides grow optimally. Upstream, above the gorge, the gemmiferous Pohlia bulbifera and P. annotina var. decipiens occur in this zone.

Zone III. Riverbank. This zone is characterized by a layer of fine to coarse sandy soil over the bedrock and in crevices. Thuidium delicatulum, Climacium dendroides, and Atrichum oerstedianum appear to be more or less confined to this zone.

Figure 9

Diagrammatic cross-section of the river gorge at Cataracts Provincial Park. Numbered zones are demarcated by slash marks: I - aquatic zone, II - inundation zones, III - riverbank, IV - gorge faces and slopes. The solid line across Zone I indicates low water level; the broken line across Zone II indicates high water level.


IV
IV
III
II
I
II
III

Zone IV. Gorge slope and faces. This zone is the largest and most complex, and contains extremely diverse habitats which are designated by IVa, IVb, etc.

Exposed xeric rock faces (IVa)(Fig. 10) are characterized by Andreaea rupestris, Rhacomitrium heterostichum, R. fasciculare, and Schistidium apocarpum.

On shaded to open mesic rock faces and crevices (IVb) the species composition is typically made up of Amphidium lapponicum, Diplophyllum albicans, Bartramia pomiformis, and Tortella tortuosa.

The flora of dripping rock faces and other seepage areas (IVc) is rich and diverse, with species common to zones I and II. Dicranella palustris, Hygrohypnum luridum, H. ochraceum, Philonotis fontana, Preissia quadrata, Riccardia multifida, and Scapania nemorosa characterize this type of habitat within the gorge. Along the gorge slopes, pH readings indicated a downward movement of bases, a phenomenon that has also been noted by others (Glenn and Welch, 1931; Montgomery, 1931). Riccardia multifida and R. pinguis, both indicators of nutrient-rich sites (Schuster, 1953), were found to occur most abundantly at Cataracts Provincial Park toward the base of the slopes.

Soil- or humus- filled crevices (IVd) along the open slopes are numerous and dominated by the mosses Bryum creberrimum, B. pallescens, Diphyscium foliosum (Fig. 11), and Rhabdoweisia crispata.

Where the humus layer is thicker and more continuous (IVe), and conditions humid, liverworts are common: Calypogeia spp., Lophozia attenuata, Mylia taylori, and Tritomaria spp.

A more typical forest bryoflora occurs on the wooded gorge slopes

Figure 10

Xeric rock face within river gorge typically inhabited by *Andreaea rupestris*, *Rhacomitrium fasiculare* and *R. heterostichum*. Photo by G. R. Brassard (8 September, 1975).

Figure 11

Photograph of Diphyscium foliosum found growing over humus in rock crevices. Photo by G. R. Brassard (2 November, 1974).


PENTAX

where the humus layer is generally deep (IVf). Hylocomium brevirostre, H. splendens, Pleurozium schreberi, Rhytidiadelphus loreus, and Sphagnum spp., form luxuriant closed carpets in many areas.

Bog

Within the open boggy areas (pH 3-4) of the Park, Sphagnum spp. predominate. Other typical bog bryophytes encountered include: Calypogeia sphagnicola, Dicranum leioneuron, Gymnocolea inflata, Microlepidozia setacea, Mylia anomala, and Odontoschisma sphagni. The typical hummock-hollow pattern of many Newfoundland bogs is not particularly well developed within the study area.

Heath

The heathland found within Cataracts Provincial Park (Fig. 12) is dominated by Kalmia angustifolia, Vaccinium spp., and lichens. Bryophytes do not contribute much to plant cover in these heaths. Typical heath bryophytes found there include Buxbaumia aphylla, Dicranum spurium, Mylia anomala, and Polytrichum piliferum. Other species such as Cladopodiella francisci, Lophozia bicrenata, and Odontoschisma denudatum were encountered only in the heaths.

Miscellaneous Habitats

Because the Park has facilities for public use, certain sites were altered by man. Picnic areas and various trails, bridges, and stairs were constructed, leaving bare soil patches open to pioneering species: Ceratodon purpureus, Ditrichum lineare, D. pusillum, Nardia scalaris, Pogonatum urnigerum, Pohlia nutans, Polytrichum commune,

Figure 12

The northern part of Cataracts Provincial Park. Heath dominates the foreground. The river valley above the gorge runs through the central wooded area in the photograph. Bog dominates the background area. Photo by G. R. Brassard (8 September, 1975).

and Polytrichum juniperinum. Pogonatum pensilvanicum, often found growing along roadbanks in eastern North America (Crum, 1973), is found in this habitat in Cataracts Provincial Park.

The construction of the cement bridge across Cataracts Brook perhaps accounts for the presence of Bryoerythrophyllum recurvirostrum; this calciphile was found growing on the cement ledges of the bridge over a layer of road dust and immediately under the bridge in an area of run-off from the bridge. There are very few reports of indigenous occurrences of this species for the Avalon Peninsula (Tuomikoski et al., 1973).

CHAPTER V

BRYOFLORISTICS AND PHYTOGEOGRAPHY

Bryophyte patterns of geographic distribution often, but not always, parallel rather closely those of vascular plants (Steere, 1965). Although numerous bryophyte collections have been made throughout Newfoundland, a great deal more intensive investigation must be undertaken before definitive conclusions can be reached regarding insular bryofloristic affinities. Large areas of the Long Range Mountains, and the Central Highlands, remain virtually unexplored, and are bound to yield significant bryogeographical data.

The Avalon Peninsula is the most intensively investigated part of Newfoundland, yet we have only a general knowledge of the distribution of mosses and liverworts there, with additions continually being found.

There have been several previous approaches to floristic analysis in Newfoundland. Damman (1965), discussed northern and southern vascular elements in the Newfoundland flora, relating these to climate and soils. Buch and Tuomikoski (1955) analyzed the distribution patterns of Newfoundland liverworts based on the total range of the species, especially in eastern North America and Europe. Tuomikoski, Koponen, and Ahti (1973) similarly discussed the phytogeography of the mosses of the island, and listed four main distribution types based on areas of highest frequency: (1) species distributed more or less throughout the island (at most avoiding exposed extremely barren areas),

(2) species showing greater or lesser preference for the Northern Peninsula, (3) southern species not or hardly reaching the Northern Peninsula, and (4) inland species.

The Newfoundland bryoflora is, as one would expect, largely composed of wide-ranging circumboreal species.

Liverworts (Hepaticae)

Most of the 63 species of liverworts found at Cataracts Provincial Park (Appendix A) occur throughout the island. However, a number of liverworts generally considered calciphilic (Buch and Tuomikoski, 1955) were found within the study area: Conocephalum conicum (Fig. 13), Lophozia bantriensis (Fig. 14), and Lophozia gillmani (Fig. 15).

In temperate North America Conocephalum conicum occurs most abundantly on calcareous or subcalcareous shales and sandstones (Schuster, 1953), and in Newfoundland C. conicum is dependent on rich, often calcareous sites (Buch and Tuomikoski, 1955). At Cataracts Provincial Park this species was found growing within the gorge over an east-facing siltstone face near the river. C. conicum is not common in the southeast of Newfoundland and until recently there were no reports of this species in the eastern half of the island.

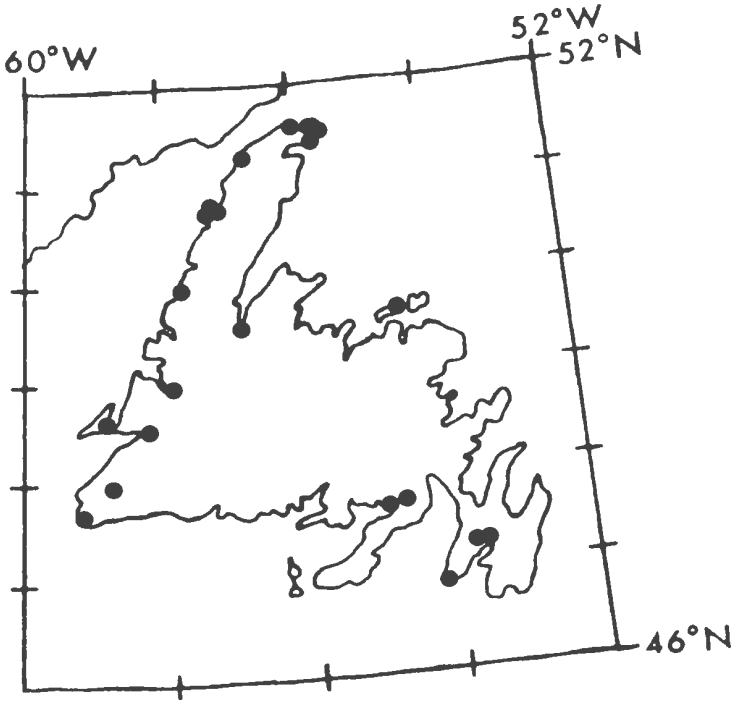
Lophozia bantriensis, found at Cataracts Provincial Park along a moose trail in a moist depression, was previously reported only from the western part of the Northern Peninsula. According to Schuster (1969), this species is a distinct calciphile, very rare in eastern North America, and essentially high subarctic and arctic in range.

Figure 13

Distribution of *Conocephalum conicum* in Newfoundland.

Figure 14

Distribution of *Lophozia bantriensis* in Newfoundland.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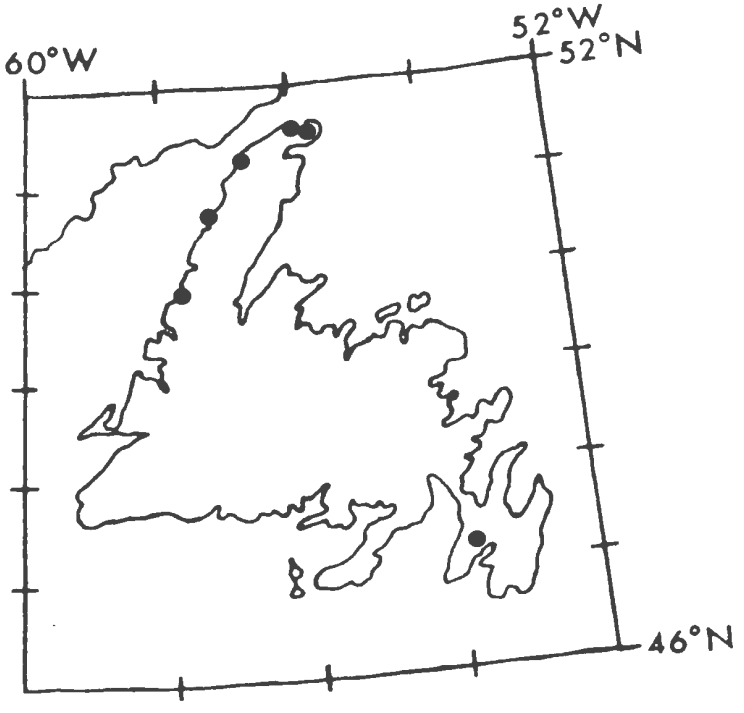
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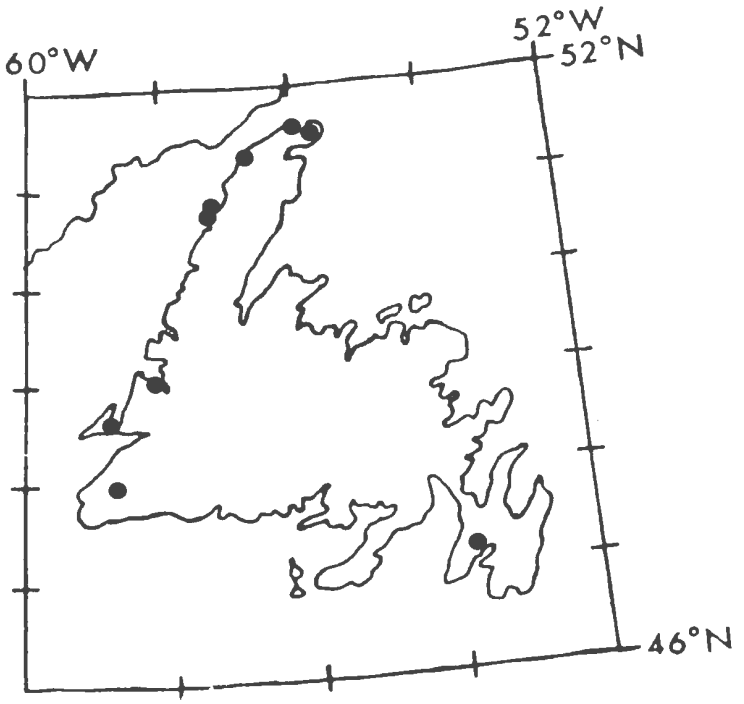
Figure 15

Distribution of Lophozia gillmani in Newfoundland.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L. bantriensis was the only distinctly northern liverwort species found at Cataracts Provincial Park.

Lophozia gillmani, found in the Park on mesic sites in Amphidium cushions is reported to be an obligate calciphile (Schuster, 1969). Buch and Tuomikoski (1955) considered Lophozia gillmani as a continental species confined to the western parts of the island rich in calcareous habitats. The presence of L. gillmani within the study area increases its range in Newfoundland considerably and suggests that this species may not be as continental or calciphilic as previously suspected.

Several other liverwort species found at Cataracts Provincial Park e.g. Preissia quadrata (Fig. 16), Riccardia multifida (Fig. 17), and R. pinguis (Fig. 18) are also considered calciphilic (Schuster, 1953). Although no substrate analyses were undertaken, it was observed that all three of these species were found most abundantly in the richer sites within the Park, that is, towards the base of slopes in seepage.

Since there are no calcareous outcrops in the vicinity of Cataracts Provincial Park, use of the terms distinct calciphile or obligate calciphile in reference to some of the above-mentioned species could be misleading. Water analysis of Cataracts Brook and one of its tributaries (Table 3) indicates a low calcium content, especially when compared to sites in western Newfoundland.

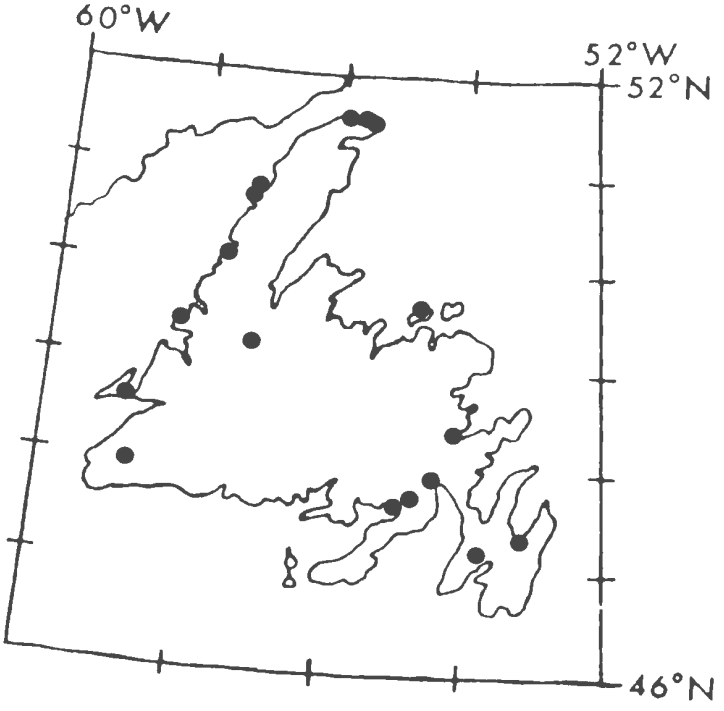
The oceanic influence on the Newfoundland hepatic flora is not very pronounced. Those species recorded at Cataracts Provincial Park, and considered suboceanic by Buch and Tuomikoski (1955), are Cladopodiella francisci, Diplophyllum albicans, Microlepidozia setacea,

Figure 16

Distribution of *Preissia quadrata* in Newfoundland.

Figure 17

Distribution of *Riccardia multifida* in Newfoundland.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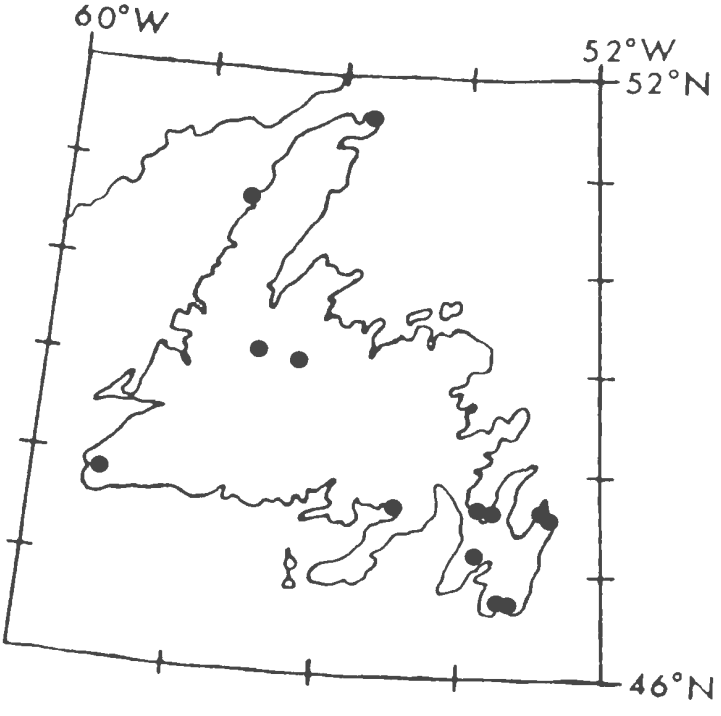
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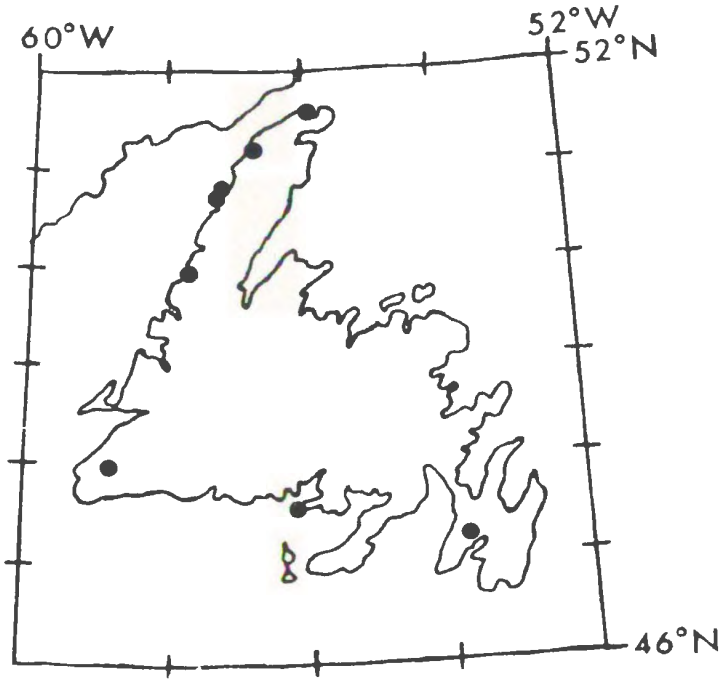


Figure 18

Distribution of Riccardia pinguis in Newfoundland.

TABLE 3

COMPARATIVE WATER ANALYSES OF SOME NEWFOUNDLAND STREAMS

(Western Newfoundland data from Mitchell, 1975)

Parameter	Western Newfoundland			Eastern Newfoundland	
	Horseback Brook	Boom Siding	Watsons Brook	Cataracts Brook	Tributary of Cataracts Brook
Alkalinity (in mg/l $CaCO_3$)	7.0	13.3	110.4	4.8	6.8
Hardness (in mg/l $CaCO_3$)	28.1	20.0	143.7	13.5	14.4
pH	7.8	7.2	7.7	6.7	6.6
Calcium (in mg/l $CaCO_3$)	8.1	6.3	48.8	3.5	3.1

Mylia taylori, Nardia scalaris, Odontoschisma denudatum, and O. sphagni.

A number of liverwort species in the study area have been recorded only once or twice for the island and any attempt to categorize their geographic affinities would be premature. These include Calypogeia sphagnicola, Cladopodiella francisci, Hygrobiella laxifolia, Lophozia bicrenata, Nardia insecta, Riccardia sinuata and Tritomaria exsecta.

Mosses (Musci)

The total number of mosses known to occur in insular Newfoundland is 398. It would appear from recent data (Brassard, 1975; Brassard, 1976; Brassard et al., 1976) that this number will increase appreciably as more and more bryological investigations are made. The numbers of moss species known from the maritime provinces are: New Brunswick, 381; Nova Scotia, 456; Prince Edward Island, 178 (R. Ireland pers. comm.). A total of 121 species of mosses were found within the study area.

The collections of Bryum creberrimum and Ditrichum lineare at Cataracts Provincial Park represent the first reports of these species for Newfoundland, although both species occur in nearby mainland localities, e.g. New Brunswick and Labrador.

The following species collected within the study area have been previously reported from Newfoundland from only one or two localities, and most are here reported for the first time from the Avalon Peninsula: Bryum pallescens, Cynodontium alpestre, C. strumiferum, Pogonatum pensilvanicum, Pohlia lescuriana, and Tetraplodon angustatus. The statement by Tuomikoski et al. (1973) that the occurrence of T. angustatus in southeast Newfoundland seems improbable on phytogeographical

grounds must be disregarded in view of its presence at Cataracts Provincial Park.

Of the species that Tuomikoski et al. (1973) considered southern or coastal, Rhabdoweisia crispata and Sematophyllum marylandicum occur at Cataracts Provincial Park. The southern or coastal nature of the distributions of these two species is evident (Figs. 19, 20). Anderson and Zander (1973) reported S. marylandicum as endemic to the Appalachian-Ozarkian area and Rhabdoweisia crispata as having strong Appalachian affinities.

According to Ketchledge (1956) Diphyscium foliosum, Hylocomium brevirostre, and Isothecium eumyosuroides also belong to the Appalachian element. Presently available data indicate that Diphyscium foliosum (Fig. 21) and Isothecium eumyosuroides (Fig. 22) are restricted, or nearly so, to the southeastern part of Newfoundland.

Other species collected at Cataracts Provincial Park that are apparently most frequent in the southern part of the island include Brotherella recurvans, Brachythecium rutabulum, Dicranella heteromalla, Hygrohypnum eugyrium, Hypnum imponens, Leucobryum glaucum, and Pohlia annotina var. decipiens.

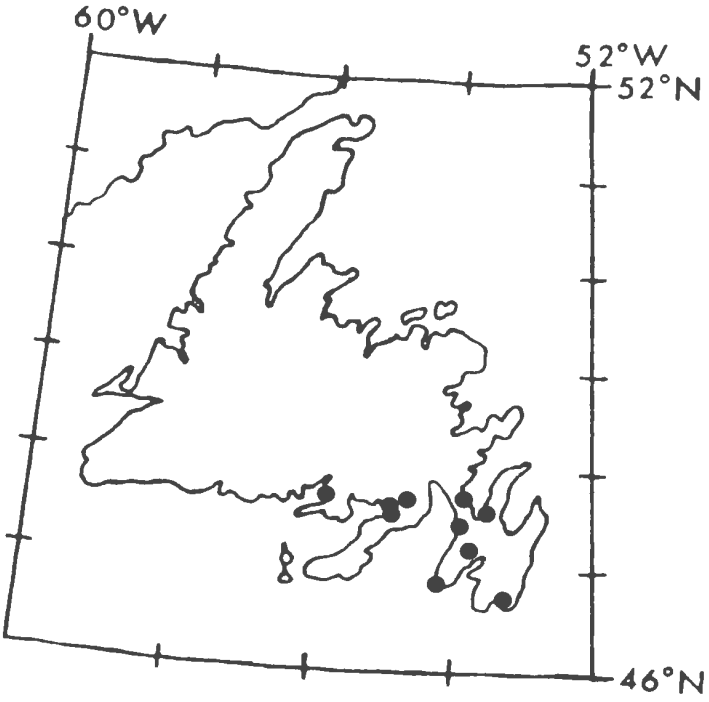
Although Tuomikoski et al. (1973) included Atrichum undulatum, which also occurs within the study area, in the above-mentioned group, it would best be omitted since all Newfoundland specimens deposited at NFLD, which included many of Tuomikoski's collections, were revised in 1975 by R. R. Ireland to A. altecristatum (2 specimens) or A. oerstedianum (13 specimens). Thus it would appear that the distributional data reported by Tuomikoski et al. (1973) for A. undulatum applies

Figure 19

Distribution of *Rhabdoweisia crispata* in Newfoundland.

Figure 20

Distribution of *Sematophyllum marylandicum* in Newfoundland.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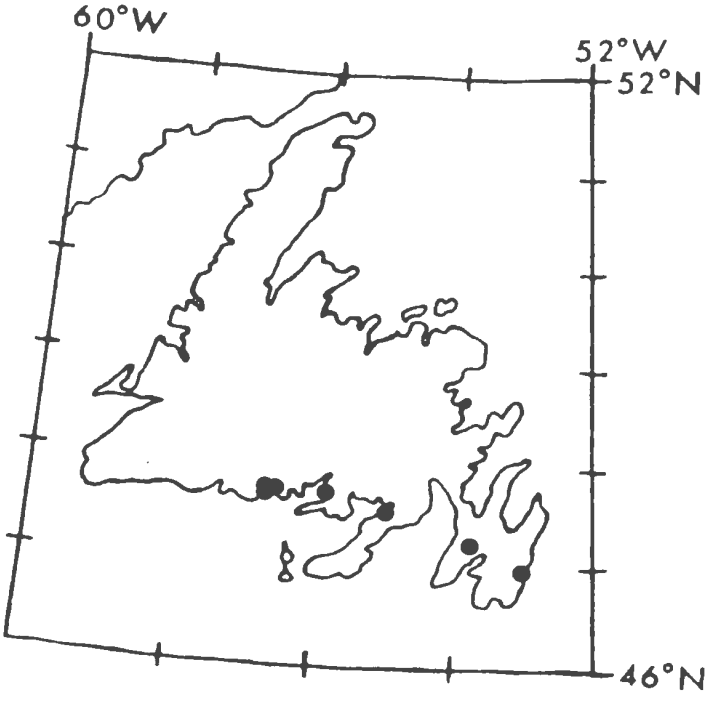
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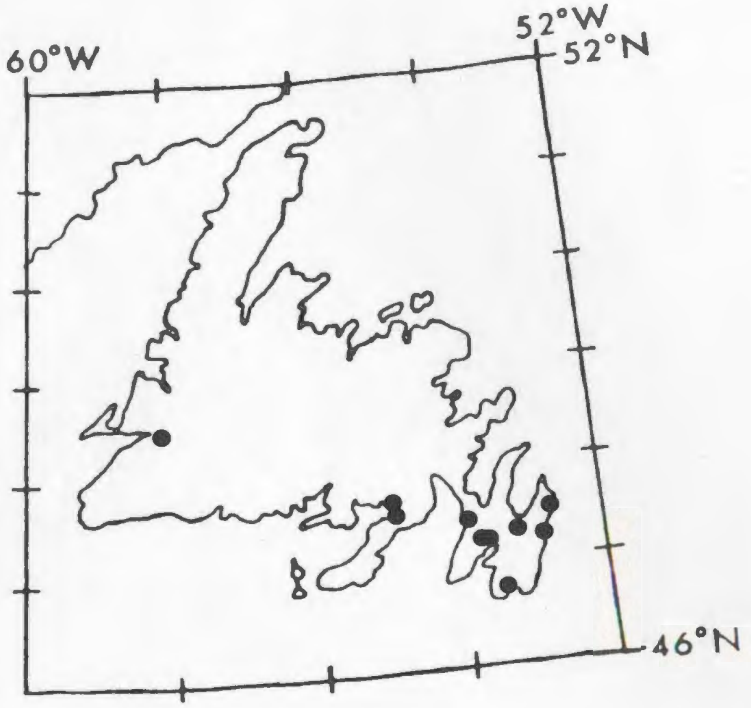
Figure 21

Distribution of *Diphyscium foliosum* in Newfoundland.

Figure 22

Distribution of *Isothecium eumyosuroides* in Newfoundland.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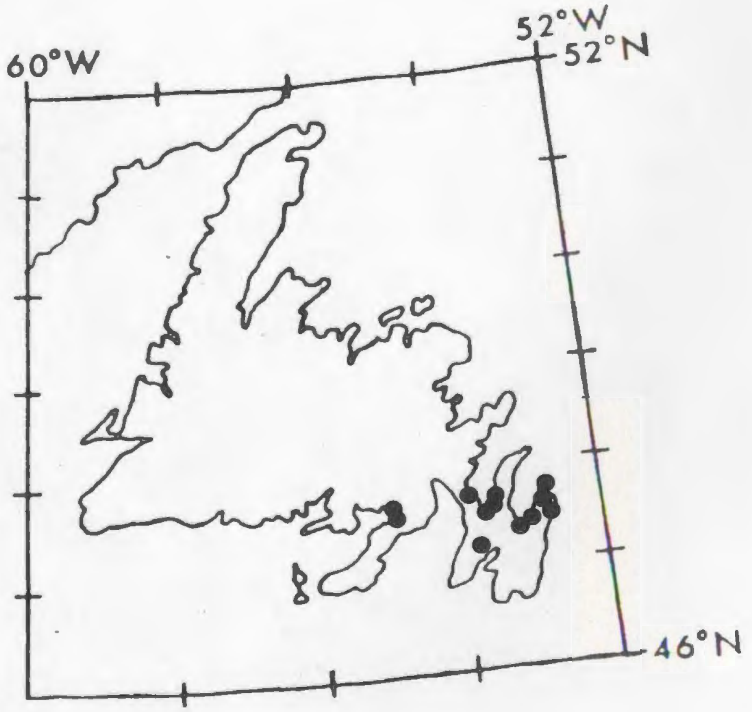
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more appropriately to A. oerstedianum (Fig. 23). A. undulatum var. undulatum appears to be rarer or at least less frequently collected than A. oerstedianum in Newfoundland, as suggested by Ireland (1969) for North America as a whole.

Tuomikoski et al. (1973) reported Polytrichastrum ohioense from a number of Newfoundland localities. According to G. L. Smith (pers. comm.) P. ohioense is a distinct taxon restricted to the eastern deciduous forests of North America. Smith has revised all of Tuomikoski's specimens deposited at NFLD to P. pallidisetum. P. ohioense should be excluded from the Newfoundland bryoflora and P. pallidisetum added. The specimen of P. pallidisetum from Cataracts Provincial Park extends its range southeastward in Newfoundland to the Avalon Peninsula (Fig. 24).

Tuomikoski et al. (1973) considered Pterigynandrum filiforme (Fig. 25) an inland or continental species. This species has recently been collected in several eastern and coastal localities, indicating a more general distribution in Newfoundland, even in the coastal parts (Brassard et al., 1976).

The only occurrences of a number of interesting calciphilic mosses on the Avalon Peninsula are at the Cataracts Provincial Park: Distichium capillaceum (Fig. 26), Hygrohypnum luridum (Fig. 27), and Isopterygium pulchellum (Fig. 28). The specimen of I. pulchellum confirms the species' presence in southeast Newfoundland, which was previously doubted by Tuomikoski et al. (1973).

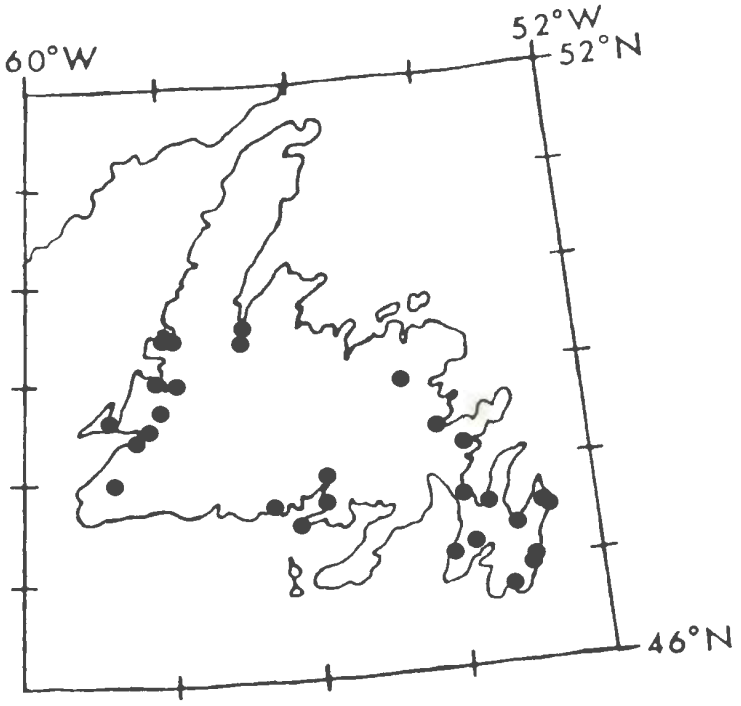
Myurella sibirica (Fig. 29), another calciphile, has recently been recorded from a number of stations in eastern Newfoundland (Brassard

Figure 23

Distribution of *Atrichum oerstedianum* in Newfoundland.

Figure 24

Distribution of *Polytrichastrum pallidisetum* in Newfoundland.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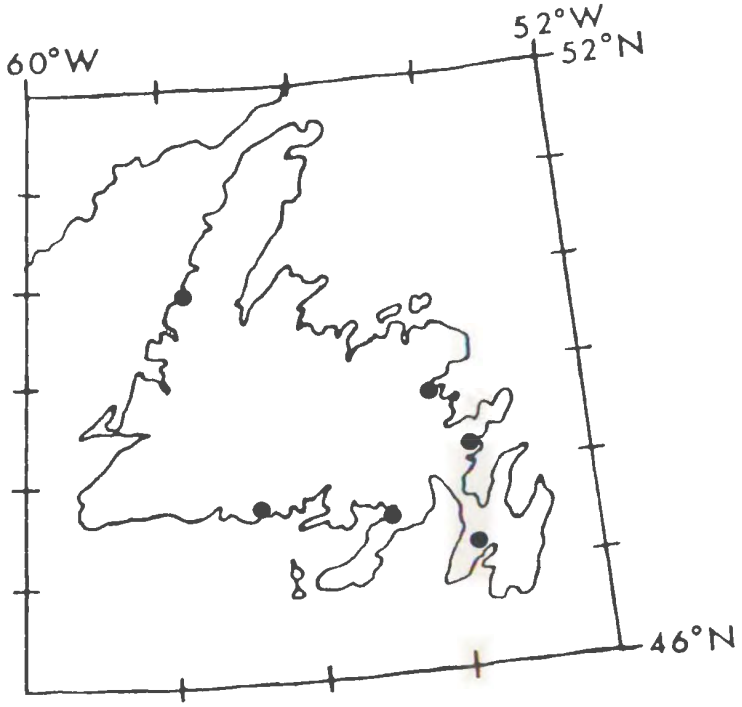
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Figure 25

Distribution of *Pterigynandrum filiforme* in Newfoundland.

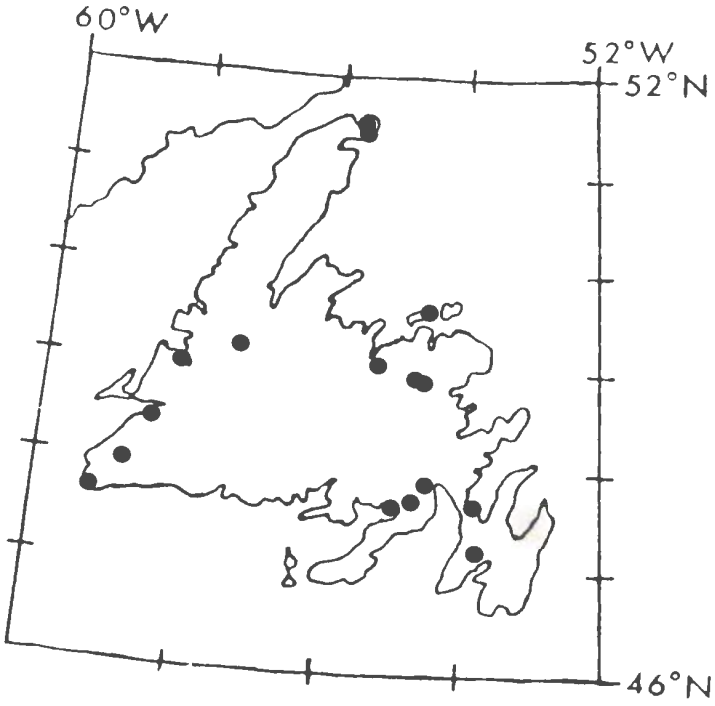
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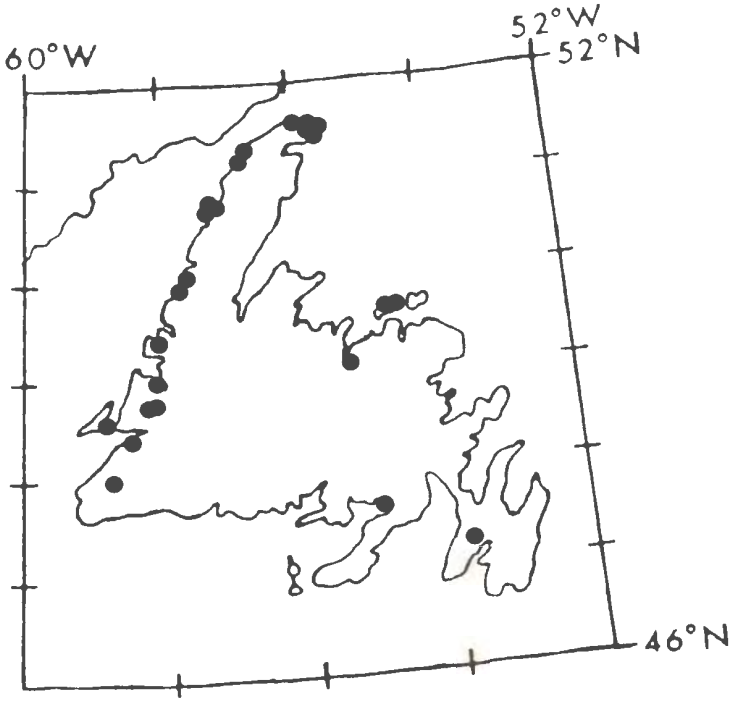
Figure 26

Distribution of *Distichium capillaceum* in Newfoundland.

Figure 27

Distribution of *Hygrohypnum luridum* in Newfoundland.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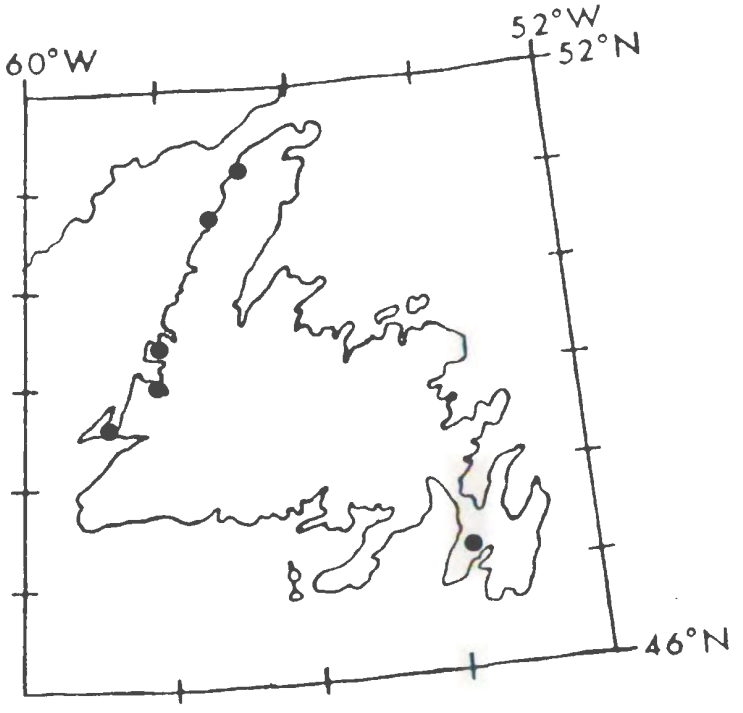
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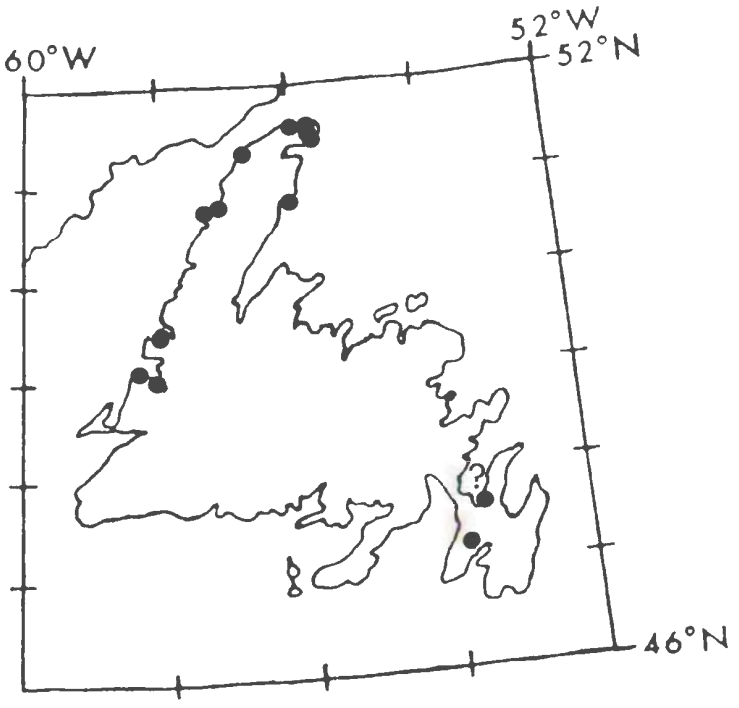
Figure 28

Distribution of *Isopterygium pulchellum* in Newfoundland.

Figure 29

Distribution of *Myurella sibirica* in Newfoundland.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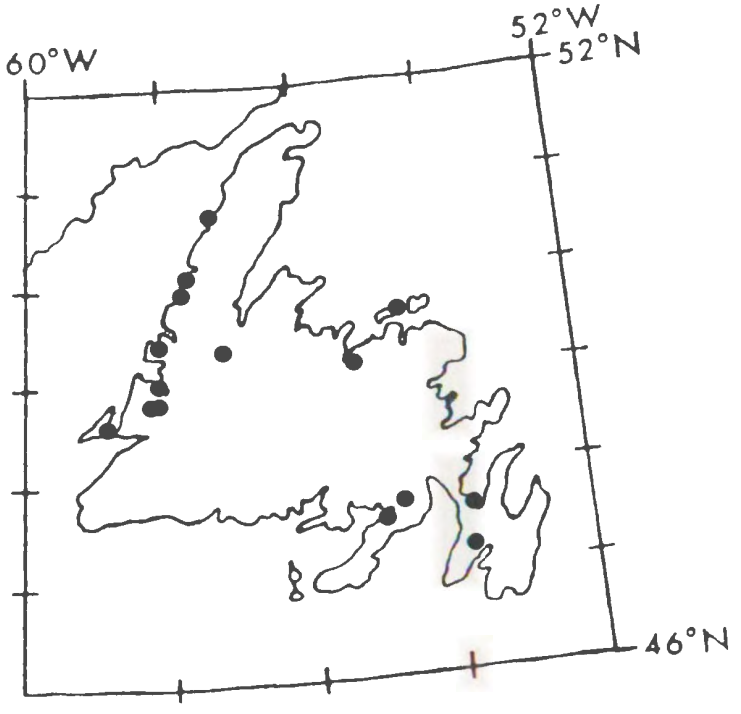
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et al., 1976). It appears to avoid the exposed parts of the south coast, being most common, however, in the rich areas of western Newfoundland.

The calciphile Bryoerythrophyllum recurvirostrum also occurs within the study area. It was collected on and beneath the cement road bridge. This species is rare on the Avalon Peninsula.

Calliergonella cuspidata, according to Tuomikoski et al. (1973), has its highest frequency on the Northern Peninsula (Fig. 30). This is the first report of this species for the Avalon Peninsula.

Dicranella palustris was previously reported only from a few localities on the west coast of Newfoundland. This species has been collected within the study area, as well as at a number of other eastern sites. Its distribution is more widespread in Newfoundland than previous records indicated (Fig. 31).

Seventy-five percent of the moss flora of Cataracts Provincial Park is composed of widespread circumboreal species, e.g. Amphidium lapponicum, Aulacomnium palustre, Blindia acuta, Brachythecium plumosum, Climacium dendroides, Dicranum scoparium, D. polysetum, Hygrohypnum ochraceum, Hylocomium splendens, Pleurozium schreberi, Ptilium cristacastrensis, Rhytidiadelphus triquetrus. As one would expect these species are widespread throughout the Island and in Labrador.

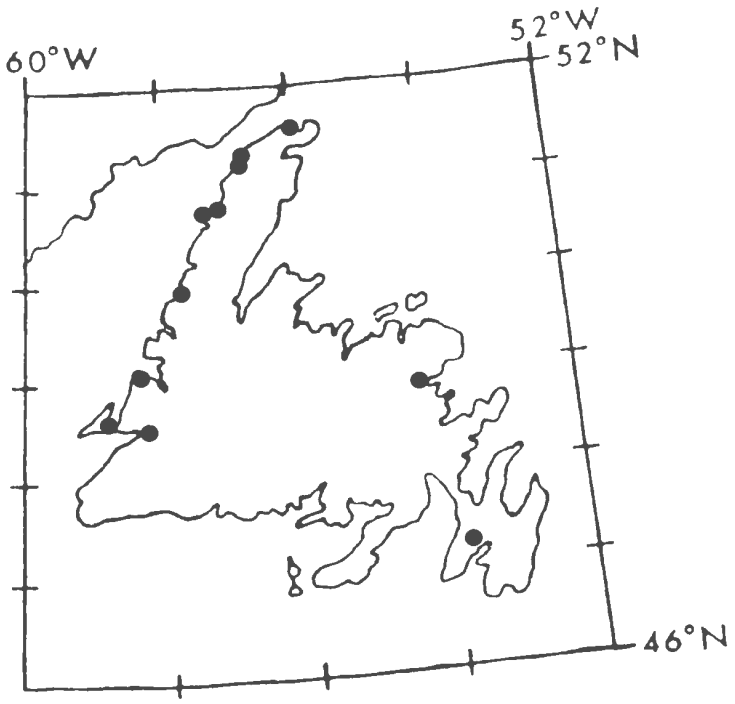
Twelve species of Sphagnum were found within the study area (Appendix A). Forty-one species of Sphagnum are known to occur in Newfoundland. The species composition and distribution of the Sphagnaceae of Newfoundland have yet to be dealt with in a unified manner. Pertinent information remains scattered in a number of publications. In his studies on the taxonomy and distribution of

Figure 30

Distribution of Calliergonella cuspidata in Newfoundland.

Figure 31

Distribution of Dicranella palustris in Newfoundland.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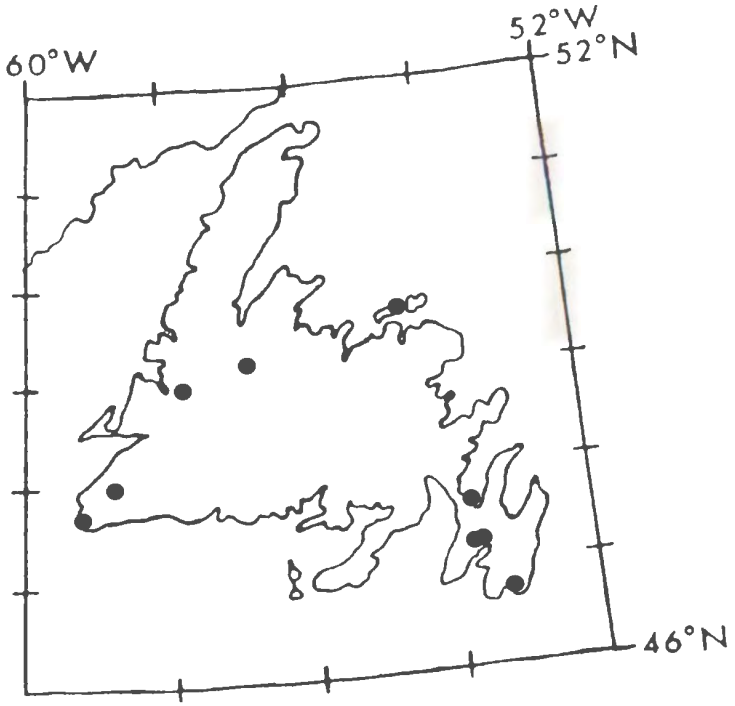
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certain Sphagnum species in eastern North America, Maass (1966a, 1966b, 1967a, 1967b, 1967c) included Newfoundland in his discussions. The Newfoundland Forest Research Centre has published information reports on Sphagnum species found in Newfoundland (Pollett, 1973; Pollett and Meades, 1970), and also on the distribution of species growing in peatlands (Robertson, Pollett, and Olsen, 1973). A southern element in the bryoflora of Newfoundland, with particular reference to certain Sphagnum species was noted by Damman (1965).

All Sphagnum species observed at Cataracts Provincial Park are typical circumboreal species.

General Discussion

The richness and diversity of the bryoflora of Cataracts Provincial Park are probably greater than at any other site on the Avalon Peninsula. Bryologically, Cataracts Provincial Park is the most intensively investigated site on the Avalon Peninsula, perhaps even on the whole of insular Newfoundland. The 121 species of mosses and 63 species of liverworts found within the study area represent 70% of the total moss flora of the Avalon Peninsula and 35% of the total known bryoflora of insular Newfoundland. This high diversity of bryophytes at Cataracts Provincial Park is truly surprising when considering its small size of approximately 13 hectares.

The Cataracts Provincial Park area does not possess any phytogeographically significant bryophytes. As was reported for the waterfalls of central Labrador (Brassard, 1972), most of the species found at Cataracts Provincial Park are widely distributed circumboreal

species. Those species occurring within the study area which are reported here for the island for this first time also occur in nearby mainland localities and are likely to occur elsewhere in Newfoundland as well.

Range extensions within the island itself were encountered, these being mainly for species that previously had been reported only from western Newfoundland: Cynodontium alpestre, Hygrobiella laxifolia, Pohlia lescuriana, Solenostoma gracillimum, Tetraplodon angustatus. The presence of calciphiles (such as Distichium capillaceum, Hygrohypnum luridum, Lophozia bantriensis, L. gillmani, Myurella sibirica) within the study area and other recently investigated eastern localities illustrates that these species and others are not restricted to the calcareous regions of western Newfoundland as previously reported (Buch and Tuomikoski, 1955; Tuomikoski et al., 1973).

A southern moss element found at Cataracts Provincial Park, represented by Sematophyllum marylandicum, is here near its northeastern limit in North America. Conversely, a northern liverwort, Lophozia bantriensis is at its southeastern North American limit at Cataracts Provincial Park.

One would expect few phytogeographically significant bryophytes to be found in Newfoundland because of its recent glacial history. There are, however, two types of disjunction represented in the Newfoundland bryoflora,(1) amphi-atlantic disjuncts (notably those restricted in North America to Newfoundland: Homalothecium sericeum, Lejeunea lamacerina, Orthotrichum gymnostomum, Seligeria brevifolia, and Thuidium tamariscinum, and (2) cordilleran disjuncts (including

Bazzania denudata, Dryptodon patens, and Frullania bolanderi). However, none of the above species, whose known world-wide distribution is rather puzzling, was found within Cataracts Provincial Park.

It is evident that the great majority of bryophyte species at Cataracts Provincial Park are concentrated there because of the numerous favourable microhabitats. Four major macrohabitats are represented within the study area: forest, bog, heath, and river gorge, each with its own characteristic species. But it is the narrow and deep river gorge that makes this locality so unique for the Avalon Peninsula. The varying characteristics of slope, humidity, substrate, light, exposure, and temperatures found in various combinations within the gorge create numerous microhabitats ideal for bryophytes. Along certain areas of the gorge slopes and faces very few vascular plants are able to become established because of the nature of the substrate. Rocky crevices or pockets with very little soil or humus accumulation and bare rock faces are readily colonized by bryophytes. Here species are found that are essentially restricted to shaded cliffs or river gorges: Amphidium lapponicum, A. mougeotii, Bartramia pomiformis, Blindia acuta, Cynodontium alpestre, Diplophyllum albicans, Isothecium eumyosuroides, Lejeunea cavifolia, Polytrichastrum alpinum, Radula complanata, Rhabdoweisia crispata, Tortella tortuosa.

In the spray zones of waterfalls in central Labrador some calciphilic bryophytes are regularly present, apparently because the increased precipitation and nutrients from the river spray tend to offset any disadvantages of the acidic substrate (Brassard, 1972). It would appear that a constant nutrient supply from waterfall spray,

seepage tracks, and perhaps even sea salts, account for the presence of the calciphilic bryophytes found at Cataracts Provincial Park. Although the spray is not that noticeable within the gorge, the deep, narrow, and angular gorge (Fig. 3) tends to concentrate spray on the immediate walls and slopes, very little of it being carried very far.

The high and constant humidity and low temperatures within the gorge are very favourable for the growth of bryophytes, especially liverworts. Water relations are especially important to bryophytes at critical phases of their life cycles, that is, fertilization and spore germination. Many mosses and liverworts within the study area were found with sporophytes. Although most of these produce sporophytes regularly under suitable conditions, several species such as Pleurozium schreberi and Rhytidiadelphus loreus, do so only irregularly. Yet these species were observed with sporophytes at several sites at Cataracts Provincial Park.

This study has shown that Cataracts Provincial Park has one of the most diverse bryofloras in Newfoundland. The range of many bryophyte species within the island of Newfoundland has been increased through this study. Only by detailed examination of other selected areas throughout the island will the more precise nature of the species distribution patterns of Newfoundland mosses and liverworts become clarified.

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APPENDIX A

The following lists of liverworts and mosses are arranged in alphabetical order within the two classes. Nomenclature for the Musci generally follows Crum, Steere, and Anderson (1973) except for Grimmiaceae (Nyholm, 1956), Mniaceae (Koponen, 1968; 1974), and Polytrichaceae (Smith, 1971). Species concepts for the mosses generally follow Crum et al. (1973).

All collection numbers are mine except those above 7300 which belong to G. R. Brassard and those in the 200's which belong to J. A. Hancock. Collection numbers (underlined) are listed following the name of each taxon and numbers followed by an asterisk indicate a specimen with sporophytes. The general area(s) where a taxon was collected (or observed) is then coded as: B(bog), F(forested area), G(gorge), H(heath), or M(miscellaneous areas, for example, roadsides, disturbed areas). The degree of commonness, based on personal field observations, is signified by the letters: vc (very common), c(common), o(occasional), r(rare), and vr(very rare). Substrate relations are denoted by the letters: h(humus), k(rock), s(soil), and w(wood). Semicolons separate symbols for area, commonness, and substrate.

Voucher specimens are deposited in NFLD.

HEPATICAE

Anastrophyllum hellerianum (Nees) Schust. 795. F, G; o; w.

Anastrophyllum michauxii (Web.) Buch. 832b, 1121.* F, G; o; w.

Anastrophyllum minutum (Cr.) Schust. 609, 860. G; c; h, k.

Bazzania trilobata (L.) S. F. Gray. 630a, 1149.* F, G; vc; h, w.

Blepharostoma trichophyllum (L.) Dumort. 630b, 947. F, G; c; h, w.

Calypogeia muelleriana (Schiffn.) K. Müll. 677, 699, 769. F, G; o; h, s.

Calypogeia neesiana (Mass. & Carest.) K. Müll. emend. Buch. 693, 772, 773. G, H; o; h, s.

Calypogeia sphagnicola (Arn. & Perss.) Warnst. & Loeske. 759b. B; r; h.

Cephalozia bicuspidata (L.) Dumort. 524a, 589, 619, 689, 696, 723, 751, 812, 826. F, G, H; vc; h, k, s, w.

Cephalozia catenulata (Hüben.) Lindb. 818b, 863a, 871. F, G; c; w.

Cephalozia leucantha Spr. 863b. F, G; o; w.

Cephaloziella divaricata (Sm.) Schiffn. 792. M; r; s.

Cephaloziella hampeana (Nees) Schiffn. 708. G; r; h, k.

Chiloscyphus pallescens (Ehrh.) Dumort. 870. F; r; h.

Cladopodiella francisci (Hook.) Buch. 724c. H; vr; s.

Conocephalum conicum (L.) Dumort. 569.* G; r; h, k.

Diplophyllum albicans (L.) Dumort. 90, 92, 505, 552,* 588,* 7400. F. G; vc; h, k.

Frullania asagrayana Mont. 514,* 557,* 622. F, G; vc; w.

Gymnocolea inflata (Huds.) Dumort. 756, 796,* 805. B, F; o; h.

Harpanthus scutatus (Web. & Mohr.) Spr. 524b, 688a. F, G; c; h, w.

Hygrobiella laxifolia (Hook.) Spr. 691. G; r; s.

Jamesoniella autumnalis (DeCand.) Steph. 743b, 817.* F, G; c; w.

Jungermannia lanceolata L. 872.* F; r; h, w.

Lejeunea cavifolia (Ehrh.) Lindb. 510, 709, 858. G; o. k.

Lepidozia reptans (L.) Dumort. 523b, 620, 675. F, G, H; c; h, w.

Lophocolea heterophylla (Schrad.) Dumort. 743a. F; o; w.

Lophozia alpestris (Schleich.) Evans. 683. G; r; k.

Lophozia attenuata (Mart.) Dumort. 836b. G; o; h.

Lophozia bantriensis (Hook.) Steph. 762. F; vr; h.

Lophozia bicrenata (Schmid.) Dumort. 722b. H; vr; h.

Lophozia gillmani (Aust.) Schust. 680, 820. G; o; h.

Lophozia incisa (Schrad.) Dumort. 748, 816, 1092. F, G; o; h, w.

Lophozia longidens (Lindb.) Macoun. 833. G; r; w.

Lophozia porphyroleuca (Nees) Schiffn. 747b, 832a. F; o; w.

Lophozia ventricosa (Dicks.) Dumort. 672, 707, 710, 720, 839, 1116, F, G, H, M; vc; h, s. w.

Marsupella emarginata (Ehrh.) Dumort. 503, 532,* 581.* G, M; c; k, s.

Microlepidozia setacea (Web.) Joerg. 724a, 758b. B, H; c; h.

Mylia anomala (Hook.) S. F. Gray. 758a, 759a, 1092. B, H; c; h.

Mylia taylori (Hook.) S. F. Gray. 672. G; r; h.

Nardia insecta (Lindb. 715. M; vr; s.

Nardia scalaris (Schrad.) S. F. Gray. 570,* 585, 607, 678. G, M; o; s.

Nowellia curvifolia (Dicks.) Mitt. 558, 617, 652, 740.* F, G; vc; w.

Odontoschisma denudatum (Nees) Dumort. 722. H; vr; s.

Odontoschisma sphagni (Dicks.) Dumort. 724b, 755. B, H; r; h.

Pellia epiphylla (L.) Corda. 584.* 697, 698. G, M; o; k, s.

Pellia neesiana (Gottsche) Limpr. 681, 732, 798. G, M; o; k, s.

Plagiochila asplenioides (L.) Dumort. 501, 704. G, M; c; k, s.

Preissia quadrata (Scop.) Nees. 770.* G; r; h, k.

Ptilidium ciliare (L.) Nees. 673. F, G, H; c; h.

Ptilidium pulcherrimum (Web.) Hampe. 523a, 618.* F, G; c; w.

Radula complanata (L.) Dumort. 536, 736.* G; r; k.

Riccardia latifrons (Lindb.) Lindb. 728, 739, 747a, 831. F, G; c; w.

Riccardia multifida (L.) S. F. Gray. 1122, 1145. F, G; r; h, k, s.

Riccardia pinguis (L.) S. F. Gray. 690, 937, 1125, 1146. F, G; r; h, s.

Riccardia sinuata (Dicks.) Trevis. 734a, 734b. F; r; k, s.

Scapania curta (Mart.) Dumort. 701, 1113. G, M; r; s.

Scapania nemorosa (L.) Dumort. 91, 516a, 546, 590,* 676, 685, 692, 695, 727, 735, 768, 802a. F, G, M; vc; h, s, w.

Scapania umbrosa (Schrad.) Dumort. 671, 674, 688b, 818a. F, G; c; h, w.

Scapania undulata (L.) Dumort. 571,* 591, 659,* 736. F, G, M; c; k, s, w.

Solenostoma gracillimum (Smith) Schust. 802b, 835. M; r; s.

Solenostoma hyalinum (Hook.) Mitt. 549,* 948. G, M; r; k, s.

Tritomaria exsecta (Schmid.) Schiffn. 684. F, g; r; w.

Tritomaria exsectiformis (Breid.) Schiffn. 686, 687. F, G; o; h, k.

MUSCI

Amphidium lapponicum (Hedw.) B. S. G. 189,* 537, 562,* 623,* 1120,* 7357.* G; c; h.

Amphidium mougeotii (B.S.G.) Schimp. 954. G; r; h.

Andreaea rupestris Hedw. 250, 553,* 613, 626,* 760.* G, M; c; k.

Atrichum oerstedianum (C. Muell.) Mitt. 544, 648, 1098,* 7386,* 9513.* G, M; c; s.

Atrichum undulatum (Hedw.) P.-Beauv. var. undulatum. 661.* M; r; s.

Aulacomnium palustre (Hedw.) Schwaegr. 729,* 804. B, F; c; h.

Bartramia pomiformis Hedw. 97,* 520,* 555.* G; c; h, s.

Blindia acuta (Hedw.) B.S.G. 539,* 608,* 810.* G; o; k, s.

Brachythecium curtum (Lindb.) Limpr. 824.* F; o; s.

Brachythecium plumosum (Hedw.) B.S.G. 509,* 516a,* 525,* 535,* 637,* 703,* 7370,* 7390.* F, G; c; h, k, s.

Brachythecium rivulare B.S.G. 855, 861, 930, 930a, 944, 7372. F, G; o; k, s.

Brachythecium rutabulum (Hedw.) B.S.G. 100,* 797,* 800,* 9517. F, M; o; h, k, s.

Brotherella recurvans (Michx.) Fleisch. 1106. F; r; h, w.

Bryhnia novae-angliae (Sull.) Grout. 851, 862, 869, 943, 7375, 9515, 10437.F, G; vc; h, s.

Bryoerythrophyllum recurvirostrum (Hedw.) Chen. 538, 840, 9516b. G, M; r; s.

Bryum creberrimum Tayl. 547,* 799,* 940.* G, M; o; s.

Bryum pallescens Schwaegr. 605,* 711,* 7383.* G, M; o; s.

Buxbaumia aphylla Hedw. 614,* 665.* H, M; r; h.

Calliergon stramineum (Brid.) Kindb. 1101, 1117. F; r; h.

Calliergonella cuspidata (Hedw.) Loeske. 778. G; vr; s.

Campylium chrysophyllum (Brid.) J. Lange. 938b, 1091,* 1095. G; r; k, s.

Ceratodon purpureus (Hedw.) Brid. 792,* 801.* M; o; s.

Climacium dendroides (Hedw.) Web. & Mohr. 583, 819, 7371a, 7371b. G, M; o; s.

Cynodontium alpestre (Wahlenb.) Milde. 843*(MICH), 928.* G; r; h.

Cynodontium strumiferum (Hedw.) Lindb. 627,* 953,* 1105,* 1128.* G; o; h.

Dicranella heteromalla (Hedw.) Schimp. 93,* 96,* 521,* 550,* 592,* 600,* 601,* 639,* 713,* 725,* 749,* 842,* 7362.* F, G, H; vc; h, s.

Dicranella palustris (Dicks.) Warb. 811, 948, 7379. G; r; h, s.

Dicranum fuscescens Turn. 594,* 830.* F, G; o; w.

Dicranum leioneuron Kindb. 828. B; r; h.

Dicranum majus Smith. 261, 596, 603,* 744.* F, G; vc, h.

Dicranum montanum Hedw. 995. G; r; k.

Dicranum polysetum Sw. 868. M; r; h.

Dicranum scoparium Hedw. 515, 641,* 7377.* F, G; c; h.

Dicranum spurium Hedw. 866, 952. H; r; h.

Dicranum undulatum Brid. 664,* 719, 726,* 788.* H; o; h.

Diphyscium foliosum (Hedw.) Mohr. 500,* 615,* 700,* 828.* G, M; o; h, s.

Distichium capillaceum (Hedw.) B.S.G. 104,* 579.* G; r; h.

Ditrichum lineare (Sw.) Lindb. 750,* 835.* M; o; s.

Ditrichum pusillum (Hedw.) Hampe. 803.* M; o; s.

Drepanocladus exannulatus (B.S.G.) Warnst. 876. M; r; s.

Drepanocladus fluitans (Hedw.) Warnst. 717,* 844. B, F; o; s.

Drepanocladus uncinatus (Hedw.) Warnst. 103,* 527,* 599,* 705,* 7381,* 9511. F, G; c; s, w.

Eurhynchium riparioides (Hedw.) Rich. 938. G; vr; k.

Fissidens adiantoides Hedw. 502,* 533,* 7398. G; o; h, s.

Fissidens osmundoides Hedw. 90, 577, 682, 859, 7376. G; o; h, s.

Fontinalis antipyretica Hedw. var.gigantea (Sull.) Sull. 657. M; r; s.

Fontinalis dalecarlica B.S.G. 643, 656,* 945, 7393. F, G; o; k.

Funaria hygrometrica Hedw. 838.* G; vr; k.

Herzogiella striatella (Brid.) Iwats. 511,* 560,* 706,* 714,* 775,* 846, 1103.* F, G; c; h, s, w.

Hygrohypnum eugyrium (B.S.G.) Loeske. 852,* 9523. G; r; k.

Hygrohypnum luridum (Hedw.) Jenn. 526, 534,* 857. G; r; h, k, s.

Hygrohypnum ochraceum (Wils.) Loeske. 259, 508, 541, 580, 587a,* 809, 931. F, G; c; k, s.

Hylocomium brevirostre (Brid.) B.S.G. 606, 853, 9512. F, G; c; h, s.

Hylocomium splendens (Hedw.) B.S.G. 506, 597.* F, G, H; vc; h.

Hylocomium umbratum (Hedw.) B.S.G. 951, 1147. F, G; r; s.

Hypnum cupressiforme Hedw. 531, 624. F, G; o; k, w.

Hypnum curvifolium Hedw. 7371a, 7373. G; o; h, s.

Hypnum imponens Hedw. 249, 512,* 556,* 625,* 7364, 7405. F, G; c; h, w.

Hypnum lindbergii Mitt. 776, 7388. F, G; r; s.

Hypnum pallescens (Hedw.) P.-Beauv. 629,* 742,* 934,* 1151.* F, G; o; w.

Isopterygium elegans (Brid.) Lindb. 551, 1148. F, G; r; s.

Isopterygium pulchellum (Hedw.) Jaeg. & Sauerb. 813.* G; r; s.

Isothecium eumyosuroides Dix. 188, 246, 849, 929, 936. G; o; k.

Leucobryum glaucum (Hedw.) Fr. 632. F, G; vr; h.

Mnium hornum Hedw. 252,* 543,* 7365,* 7385.* G, M; c; h, s.

Myurella sibirica (C. Muell.) Reim. 192, 830b, 936, 939, 7368. G; o; h, s.

Oncophorus wahlenbergii Brid. 513,* 731,* 794,* 825,* 847.* F, G; c; h, w.

Paraleucobryum longifolium (Hedw.) Loeske. 7399. G; vr; k.

Philonotis fontana (Hedw.) Brid. 554,* 567,* 712,* 771,* 7378a, 7378b. G, M; c; h, s.

Plagiothecium cavifolium (Brid.) Iwats. 636. F, G; r; k.

Plagiothecium laetum B.S.G. 628,* 834,* 864.* F, G; o; h, w.

Pleurozium schreberi (Brid.) Mitt. 519. F, G, H; vc; s.

Pogonatum dentatum (Brid.) Brid. 716. G; r; s.

Pogonatum pensilvanicum (Hedw.) P.-Beauv. 94,* 660,* 1097.* G, M; r; s.

Pogonatum urnigerum (Hedw.) P.-Beauv. 774,* 780,* 850,* 1150,* 7303, 7304. G, M; o; s.

Pohlia annotina (Hedw.) Lindb. var. decipiens Loeske. 941, 942, 1093, 1115, 1129, 1130, 10435. G, M; o; s.

Pohlia bulbifera (Warnst.) Warnst. 1114. M; vr; s.

Pohlia cruda (Hedw.) Lindb. 190, 194,* 7358. G; o; s.

Pohlia lescuriana (Sull.) Grout. 1104.* G; vr; s.

Pohlia nutans (Hedw.) Lindb. 572,* 635,* 702,* 790,* 823,* 890.* F, G, H; c; h, s. w.

Polytrichastrum alpinum (Hedw.) G. L. Smith. 101,* 251, 565,* 593,* 634,* 7363. G; c; h, s.

Polytrichastrum formosum (Hedw.) G. L. Smith. 522, 586,* 595,* 611,* 1123,* 7365. F, G; c; h, s.

Polytrichastrum pallidisetum (Funck) G. L. Smith. 814.* F; r; s.

Polytrichum commune Hedw. 647, 669,* 761,* 789, 845.* F, G; c; h, s.

Polytrichum juniperinum Hedw. 582,* 633, 663,* 718.* G, H, M; c; h, s.

Polytrichum piliferum Hedw. 865.* H; r; h.

Polytrichum strictum Brid. 791.* M; r; h.

Pterigynandrum filiforme Hedw. 935, 1119. G; r; k.

Ptilium crista-castrensis (Hedw.) De Not. 616, 779. F, G, H; c; h, w.

Rhabdoweisia crispata (With.) Lindb. 573,* 638.* G; o; s.

Rhacomitrium aciculare (Hedw.) Brid. 530,* 874, 7402.* G, M; c; k.

Rhacomitrium fasiculare (Hedw.) Brid. 98,* 528,* 561,* 645,* 7370a,* 7384, 7389,* 7395.* G, M; c; k.

Rhacomitrium heterostichum (Hedw.) Brid. 193,* 529,* 559. G, M; c; k.

Rhacomitrium lanuginosum (Hedw.) Brid. 621, 836a. G; r; h, k.

Rhizomnium punctatum (Hedw.) Kop. ssp. chlorophyllosum (Kindb.) Kop. 99,* 191,* 254,* 504,* 568,* 587b,* 694, 854,* 7366.* G, M; c; h, s.

Rhytidiadelphus loreus (Hedw.) Warnst. 507, 598,* 646, 653, 837,* 1127. F, G; c; h, s.

Rhytidiadelphus subpinnatus (Hedw.) Kop. 873, 7387. G, M; r; s.

Rhytidiadelphus triquetrus (Hedw.) Warnst. 654, 827. F; o; s.

Schistidium alpicola (Hedw.) Limpr. 936.* M; o; k.

Schistidium apocarpum (Hedw.) B.S.G. 841,* 1094,* 7389.* G; r; k.

Sematophyllum marylandicum (C. Muell.) Britt. 649, 946. G; r; k.

Sphagnum capillaceum (Weiss) Shrank. 610, 667, 670, 821, 877. F, G, H; c; s.

Sphagnum compactum Lam. & D.C. 867. H; r; h.

Sphagnum fuscum (Schimp.) Klinggr. 752. B; o; h.

Sphagnum girgensohnii Russ. 517, 651. F, G; o; h.

Sphagnum magellanicum Brid. 668, 784, 785, 786. B, M; c; h.

Sphagnum palustre L. 563, 574, 655, 730, 807.* F, G, B; c; h.

Sphagnum pulchrum (Braithw.) Warnst. 650, 782, 783, 1096. B, M; o; h.

Sphagnum quinquefarium (Braithw.) Warnst. 793.* F; o; h.

Sphagnum russowii Warnst. 806,* 888. F, G; o; h.

Sphagnum squarrosum Crome. 576, 822.* F, G; r; h, s.

Sphagnum subsecundum Strum. [includes var. rufescens (Nees,Hornsch. & Sturm.) Hueb.]. 542, 575, 662, 889. F, G, o; h, s.

Sphagnum tenellum Hoffm. 666, 753,* 754. B, H; o; h.

Tetraphis geniculata Milde. 518,* 745,* 1126.* F, G; c; h, w.

Tetraphis pellucida Hedw. 631,* 640,* 741,* 1118.* F, G; c; w.

Tetraplodon angustatus (Hedw.) B.S.G. 950.* F; vr; h.

Thuidium delicatulum (Hedw.) Mitt. 540, 564, 733, 808, 7382, 7401. G, M; o; h, s.

Tortella tortuosa (Hedw.) Limpr. 95, 612, 815, 7359. G; o; h.

Ulota coarctata (P.-Beauv.) Hamm. 1100.* F; vr; w.

Ulota crispa (Hedw.) Brid. 578,* 602,* 604,* 737,* 848,* 947,* 7404,* 9514.* F, G; c; w.

Ulota drummondii (Grev.) Brid. 658,* 737,* 1099.* F; vr; w.

APPENDIX B

Characteristic or dominant bryophytes within the four designated zones of the gorge at Cataracts Provincial Park.

Aquatic Zone (I)

Fontinalis dalecarlica
Hygrohypnum ochraceum
Rhacomitrium aciculare
Scapania undulata
Schistidium alpicola

Inundation Zone (II)

Hygrohypnum eurygium
Hygrohypnum ochraceum
Marsupella emarginata
Paraleucobryum longifolium
Pellia epiphylla
Plagiochila asplenioides
Rhacomitrium aciculare
Scapania nemorosa
Scapania undulata
Schistidium alpicola

Riverbank (III)

Atrichum oerstedianum
Brachythecium plumosum
Climacium dendroides
Dicranella palustris
Drepanocladus uncinatus
Marsupella emarginata
Mnium hornum
Pleurozium schreberi
Plagiochila asplenioides
Pogonatum urnigerum
Rhizomnium punctatum
Rhytidiadelphus loreus
Scapania nemorosa
Solenostoma hyalinum
Thuidium delicatulum

Gorge (IV)

Xeric rock faces and slopes (IVa):

Andreaea rupestris

Pterigynandrum filiforme

Rhacomitrium fasciculare

Rhacomitrium heterostichum

Schistidium apocarpum

Shaded mesic rock faces and crevices (IVb):

Amphidium lapponicum

Amphidium mougoetii

Bartramia pomiformis

Campylium chrysophyllum

Diplophyllum albicans

Lejeunea cavifolia

Lophozia gillmani

Radula complanata

Tortella tortuosa

Dripping rock faces, slopes, and other seepage areas (IVc):

Conocephalum conicum

Dicranella palustris

Eurhynchium riparioides

Fontinalis dalecarlica

Hygrohypnum luridum

Hygrohypnum ochraceum

Philonotis fontana

Preissia quadrata

Rhacomitrium aciculare

Riccardia multifida

Riccardia pinguis

Sematophyllum marylandicum

Scapania nemorosa

Open humus--or soil-filled crevices (IVd):

Bryum creberrimum

Bryum pallescens

Cynodontium alpestre

Cynodontium strumiferum

Diphyscium foliosum

Rhabdowesia crispata

Humus patches (IVe):

Calypogeia muelleriana

Calypogeia neesiana

Cephalozia bicuspidata

Lophozia attenuata

Lophozia incisa

Mylia taylori

Tritomaria exsecta

Tritomaria exsectiformis

Wooded gorge slopes (IVf):

Bazzania trilobata

Bryhnia novae-angliae

Hylocomium brevirostre

Hylocomium splendens

Hylocomium umbratum

Pleurozium schreberi

Rhytidiadelphus loreus