

Bryophytes of British Columbia: Rare Species and Priorities for Inventory

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Province of British Columbia
Ministry of Forests Research Program

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Citation:

Ryan, M.W. Bryophytes of British Columbia: rare species and priorities for inventory. Res. Br., B.C. Min. For., and Wildl. Br., B.C. Min. Environ, Lands and Parks. Victoria, B.C. Work. Pap. 12/1996.

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FOREWORD

British Columbia, Canada's most westerly province, has a bounty of biological diversity. Its mountains, lakes and rivers, rainforests, wetlands and arid grasslands, and long, rugged coast provide habitats for more species of living organisms than are found anywhere else in Canada. However, this very diversity means that there is much to be discovered about these organisms—their distribution, abundance, habitat requirements, and interrelationships with their environments. Increasing our knowledge of this biodiversity will help us with the complex task of sustainably managing our land and waters.

In 1992 the Provincial Government initiated a co-operative biodiversity research program with funding from the Corporate Resource Inventory Initiative; the British Columbia Ministries of Forests (Research Branch); Environment, Lands and Parks (Wildlife and Habitat Protection branches); and Tourism and Culture, (Royal British Columbia Museum); and the Forest Resource Development Agreement (FRDA II). One goal of this research program is to extend information to scientists, resource managers, and the public through biodiversity publications. These publications are intended to increase awareness and understanding of biodiversity, promote the concepts and importance of conserving biodiversity, and communicate provincial government initiatives related to biodiversity. We hope that they will be used as tools for the conservation of British Columbia's rich, living legacy.

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ACKNOWLEDGEMENTS

This report would not have been possible without the generous support and advice of Dr. Wilf Schofield. I cannot stress too much the importance of his contribution to this report and to bryological research in general. Other people who provided help, information, or assistance include Dr. Judy Godfrey, Dr. Geoff Godfrey, Dr. René Belland and Olivia Lee at the University of British Columbia, Bruce Bennett at the Royal British Columbia Museum, and Brenda Costanzo at the University of Victoria. Bryan Thompson helped record much of the habitat and location information for specimens located at the University of British Columbia.

Funding for the production and publication of this report was provided by the Canada–British Columbia Forest Research Development Agreement (FRDA) and delivered through the Corporate Resource Inventory Initiative and the Ministry of Forests IRM research program. Trudy Chatwin co-ordinated the project on behalf of the Wildlife Branch of the Ministry of Environment, Lands and Parks while Andrew Harcombe, Gail Harcombe, Ted Lea, and Don Eastman contributed in various ways to the production of these reports. Fran Aitkins edited the report, Paul Harris typeset it, and Ted Wagstaff proofread it.

Thanks are also extended to Evelyn Hamilton, Heather Strongitharm, Susan Barker, and Alison Nicholson for their work in co-ordinating, funding, and producing these reports in the Ministry of Forests Research Branch.

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INTRODUCTION

In recent years, widespread changes in the environment (e.g., acid rain, depletion of the ozone layer, global warming), and increasing rates of resource extraction (such as forest harvesting, conversion of wildlands to agriculture, and residential development) have raised serious ethical and utilitarian concerns over the disappearance of species, whole ecosystems, and the genetic diversity of animal and plant populations. Articles focusing on the maintenance of biodiversity at the ecosystem, species, and genetic levels are prevalent in both the scientific and popular literature (e.g., Harris 1984; Wilson 1988; Westman 1990; Hansen et al. 1991; Chapin et al. 1992; Kimmens 1992; Pielou 1992; Pimental et al. 1992; Wilson 1992; Fenger et al. 1993). Despite the documentation of the flora and fauna for many parts of the world, particularly in temperate regions, there are still large gaps in our knowledge. Of particular concern is the lack of basic information, such as regional species checklists, for many groups of organisms including bryophytes (mosses, liverworts, and hornworts), lichens, and fungi. Unfortunately, these organisms are more at risk than their larger counterparts, the vascular plants, because they are not maintained in botanical gardens and, once their habitats disappear, these organisms become extinct.

Fortunately, many areas of British Columbia have not been altered to the same extent as other regions in North America, such as California, where almost half the crustose lichens collected in the early part of the century have not been found since, because so much of the land has been irrevocably changed by residential and agricultural development and air pollution (Hale and Cole 1988). However, documentation of the bryophytes of British Columbia is so inadequate that we do not know how much these groups have been affected by human activities.

Although our knowledge is probably greater for bryophytes than for lichens and macrofungi, much that we know is fragmentary and incomplete. Many areas of the province have not been adequately inventoried, and the existing information is widely scattered in published and unpublished reports, and on specimen labels in herbaria. Even in those areas where bryophytes are protected from direct habitat destruction (e.g., ecological reserves and parks), there has been little or no documentation of the bryophytes, so it remains unclear which elements of the bryoflora are currently protected.

The most recent checklist of mosses in Canada lists a total of 965 species (Ireland et al. 1987), of which more than three-quarters occur in British Columbia. These include 30 genera and 160 species that are found nowhere else in Canada (Schofield 1990). Liverworts and hornworts are fewer in number; Schofield (1990) estimates that there are about 250 species in British Columbia. This province has one of the richest bryoflora in North America, reflecting both the diverse climate and topography, and the presence of several phytogeographic groups with ranges that include at least part of British Columbia. Although several reports that include rare and endangered bryophytes have appeared in the literature (e.g., Godfrey 1977a; McIntosh 1986; Schofield 1990), no attempt has been made to provide a complete list of the rare and endangered species of the province.

The purpose of this report is to provide a *preliminary* list of rare and endangered bryophyte species and, based on these findings, to provide recommendations for the future inventory requirements of the bryoflora of British Columbia.

PREVIOUS WORK

The first collection of bryophytes in British Columbia was made by A. Menzies in 1792, as part of Captain George Vancouver's voyage to the west coast of North America. The first serious collection of bryophytes was not made until nearly a hundred years later, when John Macoun made extensive collections of bryophytes, as well as other organisms, on the southwest coast between 1872 and 1920. Not being particularly active in the field of bryology, he sent many of his specimens to N.C. Kindberg in Sweden. Unfortunately, Kindberg (who never visited British Columbia) proceeded to describe hundreds of "new species" as well as many subspecies and varieties, which created a taxonomic nightmare, and impeded attempts to provide a better understanding of the bryoflora for years to come (Steere 1977). Further problems associated with Macoun's collections resulted from the questionable habitat and locality information he provided with the specimens; the locality for many specimens is still in doubt, and many individual packets include several species collected in different places (see Godfrey 1977b). However, much of the early knowledge of cryptogamic species in British Columbia and Canada is directly attributed to his *Catalogue of Canadian Plants*, published between 1892 and 1902.

Other bryologists who made important collections in the late nineteenth and early twentieth centuries include R.S. Williams, G. Gibbs, A.H. Brinkman, E. MacKenzie, and F. MacFadden. Important publications from that period include Frye and Clark (1937–1947), Brinkman (1934), and Grout (1928–1940).

Since these early works, only occasional papers have appeared, often dealing with single species. It was not until the early 1960s that extensive work on the bryoflora was initiated by Dr. Wilf Schofield at the University of British Columbia. Since then, Dr. Schofield and his students have produced a wealth of invaluable and extensive information on the bryophytes of British Columbia. Some of the more important works by Schofield include:

- A Selectively Annotated Checklist of British Columbia Mosses* (1968a)
- A Checklist of the Hepaticae and Anthocerotae of British Columbia* (1968b)
- Bryophytes of British Columbia. I. Mosses of Particular Interest* (1968c)
- Bryophytes of British Columbia. II. Hepaticae of Particular Interest* (1968d)
- Some Common Mosses of British Columbia* (1969a)
- Bryology in Arctic and Boreal North America and Greenland* (1972)
- Bryophytes of British Columbia III: Habitat and Distributional Information for Selected Mosses* (1976a)
- Rare and Endangered Bryophytes in B.C.* (1990)
- Some Common Mosses of British Columbia*, 2nd. ed. (1993b)

Some of Dr. Schofield's students studied specific regions of the province. Their publications include:

The Hepaticae and Anthocerotae of Southwestern British Columbia, by J.L.D. Godfrey (1977a)

A Moss Flora of Selkirk and Purcell Mountain Ranges, Southeastern British Columbia, by B.C. Tan (1980)

The Bryophytes of the Semi-Arid Steppe of South-central British Columbia, by T. McIntosh (1986)

The Montane Moss Flora of Southwestern British Columbia and Northwestern Washington State, by J.R. Spence (1987)

In addition to these students, other collections include those of T. Ahti, L.E. Anderson, R. Belland, F.M. Boas, C. Chuang, H. Crum, N. Djan-Chekar, G.W. Douglas, S. Flowers, T. Goward, R. Halbert, W.S. Hong, D. Horton, A. von Hübschmann, R. Ireland, D. Jamieson, D.W. Jamieson, V.J. Krajina (and a number of his students), V. Kujula, M.C. Melbourne, H. Persson, A. Szczawinski, T. Taylor, D.H. Vitt, and H. van Zelsen.

METHODS

The Conservation Data Centre (CDC), B.C. Ministry of Environment, Lands and Parks, uses a ranking system as a basis for identifying rare species in British Columbia (see Appendix B). The CDC system ranks a species on a scale of 1 (critically imperilled) to 5 (common to very common), based on the number of occurrences of the species within the province (S) and throughout the world (G), although the degree of threat may also influence the category assigned to a species. Hence, a species that has been collected at three localities within the province but is known from a total of 13 localities globally, would usually be ranked as S₁ and G₂ levels, respectively. Because the task was daunting and the funds limited, only those species that could tentatively be assigned a rank of S₁ or G₁—critically imperilled at the provincial and global levels, respectively—were considered in this report. These are species that have been found at five or fewer localities within British Columbia.

The first step was to review the literature to identify those species that appear to have been rarely collected within the province. Then, the herbaria at the Royal British Columbia Museum and the University of Victoria were systematically searched to identify species that have been rarely collected (fewer than five specimens), and to record habitat and locality information on the herbarium label.

The same procedure could not be followed at the University of British Columbia (UBC) herbarium because of the enormous size of its bryology collection (it contains about 100 000 B.C. specimens). Instead, using the checklists of Ireland et al. (1987) and Stotler and Crandall-Stotler (1977), Dr. Scholfield generously provided a list of species he believes to be rare in British Columbia. Habitat and locality information was compiled for these species based on specimens in the UBC herbarium. Because some of these species were missed in the initial survey, herbaria at the Royal British Columbia Museum and the University of Victoria were searched a second

time. Unfortunately, specimens of some species were either missing or located at herbaria outside the province so that total habitat and locality information was not available.

Important collections at the University of Alberta (except for a few genera) and the Canadian Museum of Nature in Ottawa have not been examined. These herbaria may contain specimens of rare species collected at additional localities in British Columbia.

Once the list was completed, species that have been collected at more than five localities in the province were omitted (see Appendix C for a list of rare bryophytes with habitat and locality). Using locality information recorded on the herbarium label (place name, or latitude and longitude), the biogeoclimatic zone in which each specimen was collected was identified by using a clear overlay of latitudes and longitudes on a biogeoclimatic base map (Biogeoclimatic Zones of British Columbia, 1988; scale 1:2 000 000). O.S.C., p. 6A. Unfortunately, the locality recorded on the herbarium label was often imprecise and the surrounding vascular vegetation at the collection site was rarely recorded. As a result, a number of specimens may have been assigned to the wrong biogeoclimatic zone or ecoregion, particularly specimens that were collected in areas where two or more biogeoclimatic zones are in close proximity. For example, specimens collected in the dry southern interior and assigned to the Bunchgrass zone may actually have been collected in the Ponderosa Pine zone. Similarly, it is difficult to determine if some specimens were collected in the Coastal Western Hemlock zone, the Mountain Hemlock zone, or even the Alpine Tundra zone. As a result, biogeoclimatic-zone designations should be viewed as rough approximations. Last, some specimens could not be assigned to any ecoregion or zone because the herbarium label lacked latitude and longitude information or a distinctive or recognizable place name (using the *Gazetteer of British Columbia*). Although these specimens have been excluded from the analysis, they are listed in Appendix C.

The resulting information was tabulated to rank the biogeoclimatic zones and ecoregions according to their respective share of the occurrences of the province's rare bryophytes. This ranking was further modified based on the degree that human activities in each zone or ecoregion threaten known bryophyte populations. The substrate and habitat conditions recorded on herbarium labels were then examined to identify likely habitats for future collection of these and other rare species.

RANKING OF RARE AND ENDANGERED BRYOPHYTE SPECIES

The following is a tentative ranking of rare and endangered bryophytes that have been found in British Columbia. All of the species listed are known to occur at five or fewer localities in the province. In ranking the species, it was difficult to decide whether or not a given species should be assigned the status 'U – uncertain,' assuming it is seldom collected only because of low search effort, the cryptic nature of the species, or because critical identifying features, such as capsules, are absent in collected material. A 'U' ranking would remove the species from the 'rare' list, and any protection or attention

which that would bring. Some of these species may be found in future inventories, particularly in northern or relatively remote areas, or in the dry interior, but I feel it would be erroneous to make this assumption. I have, therefore, tentatively assigned a G1 or S1 status to species that might otherwise be considered 'Uncertain.'

Nomenclature follows Stotler and Crandall-Stotler (1977) for hepatics, and Anderson et al. (1990) for mosses except for *Sphagnum*, which is found in Anderson (1990) and the family Pottiaceae, which follows Zander (1993).

1 Species that have been collected in the past but all known populations are extirpated (X)

Mosses

Discelium nudum (Dicks.) Brid.

Micromitrium tenerum (Bruch & Schimp. in B.S.G.) Crosby

Pseudephemerum nitidum (Hedw.) Loeske

Liverworts

Blepharostoma arachnoideum M.A. Howe

Cephaloziella brinkmani Douin

Dendrobazzania griffithiana (Steph.) Schust. & Schof.

Scapania hians ssp. *salishensis* J. Godfrey & G. Godfrey

2 Species tentatively ranked as G1 (critically imperilled at the global level)

Mosses

Aloina rosei (Williams) Delgad.

Andreaea schofieldiana B. Murr.

Dicranella stickinensis Grout

Hilpertia scotteri (Zand. & Steere) Zand.

Seligeria careyana Vitt & Schof.

Sphagnum schofieldii Crum

Trematodon boasii Schof.

Trematodon montanus Belland & Brass.

It was not possible to rank these species according to their global distribution although all of them are known to occur at more than five localities throughout the world.

3 Species tentatively ranked as S1 (critically imperilled at the provincial level)

Hornworts

Phaeoceros hallii (Aust.) Prosk.

Liverworts

Arnellia fennica (Gott.) Lindb.

Barbilophozia binsteadii (Kaal.) Loeske

Bucegia romanica Radian

Calycularia crispula Mitt.

Cephalozia connivens (Dicks.) Lindb.

Cephalozia macounii (Aust.) Aust.

Cephaloziella elachista (Jack) Schiffn.

Cephaloziella phyllacantha (Mass. et Carest.) K.Müll.

Chandonanthus hirtellus (Web.) Mitt

Cololejeunea macounii (Spruce ex Underw.) Evans

Eremonotus myriocarpus (Carring.) Lindb. et Kaal.

Gymnomitrium apiculata (Schiffn.) K. Müll.

Herbertus sendtneri (Nees) Evans
Jungermannia borealis Damsh. & Vana
Jungermannia confertissima Nees
Jungermannia hyalina Lyell
Jungermannia subelliptica (Lindb. ex Kaal.) Lev.
Kurzia trichoclados (K. Müll.) Grolle
Lophozia ascendens (Warnst.) Schust.
Lophozia bantriensis (Hook.) Steph.
Lophozia collaris (Nees) Dum.
Lophozia elongata Steph.
Lophozia laxa (Lindb.) Grolle
Lophozia rutheana (Limpr.) M.A. Howe
Lophozia sudetica (Nees) Grolle
Lunularia cruciata (L.) Dum.
Marsupella revoluta (Nees) Dum.
Mesoptychia sahlbergii (Lindb. et S. Arnell) Evans
Nardia breidlerii (Limpr.) Lindb.
Nardia insecta Lindb.
Peltolepis quadrata (Saut.) K. Müll.
Riccia frostii Aust.
Sauteria alpina (Nees) Nees
Scapania gymnostomophila Kaal.
Scapania mucronata Buch
Scapania obscura (H. Arnell et C. Jens.) Schiffn.
Scapania paludicola Loeske et K. Müll.
Scapania simmonsii Bryhn et Kaal.
Scapania spitzbergensis (Lindb.) K. Müll.
Sphaerocarpos texanus Aust.
Sphenolobopsis pearsonii (Spruce) Schust.
Tritomaria exsecta (Schrad.) Loeske

Mosses

Aloina bifrons (De Not.) Delgad.
Andreaea mutabilis Hook. f. & Wils.
Andreaea sinuosa B. Murr.
Andreaeobryum macrosporum Steere and B. Murr.
Atrichum tenellum (Röhl.) Bruch & Schimp. *in* B.S.G.
Aulacomnium acuminatum (Lindb. & Arnell) Kindb.
Barbula amplexifolia (Mitt.) Jaeg.
Barbula convoluta var. *gallinula* Zand. “ST₁” – rare variety ¹
Bartramia halleriana Hedw.
Bartramia stricta Brid.
Brachydontium olympicum (Britt. *in* Frye) McIntosh & Spence
Bryhnia hultenii Bartr. *in* Grout
Bryoerythrophyllum columbianum (Herm. & Lawt.) Zand.
Bryum amblyodon C. Müll.
Bryum arcticum (R.Br.) Bruch & Schimp. *in* B.S.G.

¹ ST₁ – Rare variety. The letter “T” signifies that the variety, but not the species, is considered to be rare or endangered in British Columbia (see Appendix b).

Bryum blindii Bruch & Schimp. *in* B.S.G.
Bryum calophyllum R.Br.
Bryum cyclophyllum (Schwaegr.) Bruch & Schimp. *in* B.S.G.
Bryum gemmiparum De Not.
Bryum schleicheri Schwaegr.
Bryum uliginosum (Brid.) Bruch & Schimp. *in* B.S.G.
Bryum violaceum Crundw. & Nyh.
Callicladium haldanianum (Grev.) Crum
Campylium calcareum Crundw. & Nyh.
Campylopus japonicus Broth.
Cinclidium arcticum Bruch & Schimp. *in* B.S.G.
Cinclidium subrotundum Lindb.
Claopodium pellucinerve (Mitt.) Best
Coscinodon cribrosus (Hedw.) Spruce
Cynodontium glaucescens (Lindb. & Arnell) Par.
Daltonia splachnoides (Sm. *in* Sm. & Sowerby) Hook. & Tayl.
Dichelyma falcatum (Hedw.) Myr.
Didymodon johansenii (Williams) Crum
Drepanocladus capillifolius (Warnst.) Warnst.
Encalypta affinis Hedw. *f. in* Web. & Mohr
Encalypta affinis var. *macounii* (Aust.) Crum & Anderson
Encalypta brevipes Schljak.
Encalypta longicolla Bruch
Entodon concinnus (De Not.) Par.
Entosthodon rubiginosus (Williams) Grout
Fabronia pusilla Raddi
Fissidens fontanus (B. Pyl.) Steud.
Fissidens pauperculus Howe
Gollania turgens (C. Müll.) Ando
Grimmia brittoniae Williams
Grimmia mollis Bruch & Schimp. *in* B.S.G.
Grimmia unicolor Hook. *in* Grev.
Hygrohypnum cochlearifolium (Vent. *ex* De Not.) Broth.
Hygrohypnum norvegicum (Schimp. *in* B.S.G.) Amann
Hygrohypnum polare (Lindb.) Loeske
Isopterygiopsis muelleriana (Schimp.) Iwats.
Lescuraea saxicola (Schimp. *in* B.S.G.) Milde
Loeskyprum badium (Hartm.) Paul
Microbryum vlassovii (Laz.) Zand.
Mielichhoferia macrocarpa (Hook. *in* Drumm.) Bruch & Schimp. *ex* Jaeg.
Mielichhoferia mielichhoferiana (Funck *in* Hook.) Loeske
Molendoa sendtneriana (Bruch & Schimp. *in* B.S.G.) Limpr.
Myrinia pulvinata (Wahlenb.) Schimp.
Oedipodium griffithianum (Dicks.) Schwaegr.
Oreas martiana (Hoppe & Hornsch. *in* Hornsch.) Brid.
Orthothecium intricatum (Hartm.) Schimp. *in* B.S.G.
Orthotrichum diaphanum Brid.
Orthotrichum hallii Sull. & Lesq. *in* Sull.
Orthotrichum pallens Bruch *ex* Brid.
Orthotrichum pylaisii Brid.

Orthotrichum rivulare Turn.
Orthotrichum tenellum Bruch ex Brid.
Philonotis yezoana Besch. & Card. in Card.
Physcomitrella patens (Hedw.) Bruch & Schimp. in B.S.G.
Physcomitrium immersum Sull.
Plagiobryum demissum (Hook.) Lindb.
Pleuroziopsis ruthenica (Weinm.) Kindb. ex Britt.
Pohlia cardotii (Ren. in Ren. & Card.) Broth.
Pohlia crudoides (Sull. & Lesq.) Broth.
Pohlia erecta Lindb.
Pohlia longicolla (Hedw.) Lindb.
Pohlia sphagnicola (Bruch & Schimp.) Lindb. & Arnell
Pohlia tundrae Shaw
Polytrichum sphaerothecium (Besch.) C. Müll.
Pseudobryum cinclidioides (Hüb.) T. Kop.
Pseudoleskea julacea (Besch. & Card. in Card.) Crum et al.
Psilopilum cavifolium (Wils.) Hag.
Pterygoneurum kozlovii Laz.
Pterygoneurum lamellatum (Lindb.) Jur.
Racomitrium obesum Frisv.
Racomitrium pygmaeum Frisv.
Rhizomnium punctatum (Hedw.) T. Kop.
Rhodobryum roseum (Hedw.) Limpr.
Scouleria marginata Britt.
Seligeria acutifolia Lindb. in Hartm.
Sphagnum jensenii Lindb.
Sphagnum junghuhnianum var. *pseudomolle* (Warnst.) Warnst.
Sphagnum platyphyllum (Lindb. ex Braithw.) Sull. ex Warnst.
Sphagnum subobesum Warnst.
Sphagnum wilfii Crum
Sphagnum wulfianum Girg.
Steerecleus serrulatus (Hedw.) Robins.
Stegonia latifolia (Schwaegr. in Schultes) Vent. ex Broth.
Stegonia latifolia var. *pilifera* (Brid.) Broth. “ST₁” - rare variety²
Syntrichia laevipila Brid.
Tayloria froelichiana (Hedw.) Mitt. ex Broth.
Tetraplodon pallidus Hag.
Tetradontium repandum (Funck in Sturm) Schwaegr.
Timmia sibirica Lindb. & Arnell
Tortella humilis (Hedw.) Jenn.
Tortula guepinii (B. & S. in B.S.G.) Broth.
Tortula nevadensis (Card. & Thér.) Zand.
Tortula protobryoides Zand.
Tortula wilsonii (Hook.) Zand.
Trichostomum arcticum Kaal.
Trichostomum recurvifolium (Tayl.) Zand.
Ulota curvifolia (Wahlenb.) Lilj.

² ST₁ – Rare variety. The letter “T” signifies that the variety, but not the species, is considered to be rare or endangered in British Columbia (see Appendix b).

Warnstorfia procera (Ren. & Arnell *in* Husn.) Tuom. & T. Kop.
Warnstorfia pseudostraminea (C. Müll.) Tuom. & T. Kop.
Warnstorfia trichophylla (Warnst.) Tuom. & T. Kop.
Warnstorfia tundrae (Arnell) Loeske
Zygodon gracilis Wils. *in* Berk.

RARE AND ENDANGERED BRYOPHYTES BY BIOGEOCLIMATIC ZONE

This section lists, by biogeoclimatic zone, the rare and endangered bryophytes that have been found in each zone. Species collected in more than one zone are listed more than once; those without sufficient locality information are not listed.

Biogeoclimatic zones are ranked in descending order according to the relative proportion of sites at which rare species have been collected, as indicated by the number enclosed in parentheses following the name of each zone.

1 Coastal Western Hemlock (31.09%)

Liverworts

Blepharostoma arachnoideum M.A. Howe
Calycularia crispula Mitt.
Cephalozia connivens (Dicks.) Lindb.
Cephaloziella phyllacantha (Mass. *et* Carest.) K.Müll.
Chandonanthus hirtellus (Web.) Mitt.
Cololejeunea macounii (Spruce *ex* Underw.) Evans
Dendrobazzania griffithiana (Steph.) Schust. & Schof.
Herbertus sendtneri (Nees) Evans
Jungermannia borealis Damsh. & Vana
Jungermannia confertissima Nees
Jungermannia hyalina Lyell
Jungermannia subelliptica (Lindb. *ex* Kaal.) Lev.
Kurzia trichoclados (K.Müll.) Grolle
Lophozia ascendens (Warnst.) Schust.
Lophozia bantriensis (Hook.) Steph.
Lophozia collaris (Nees) Dum.
Lophozia elongata Steph.
Lophozia sudetica (Nees) Grolle
Lunularia cruciata (L.) Dum.
Nardia insecta Lindb.
Riccia frostii Aust.
Scapania gymnostomophila Kaal.
Scapania hians ssp. *salishensis* J. Godfrey & G. Godfrey
Scapania mucronata Buch
Sphenolobopsis pearsonii (Spruce) Schust.
Tritomaria exsecta (Schrad.) Loeske

Mosses

Atrichum tenellum (Röhl.) Bruch & Schimp. *in* B.S.G.
Barbula amplexifolia (Mitt.) Jaeg.

Barbula convoluta var. *gallinula* Zand.
Brachydontium olympicum (Britt. in Frye) McIntosh & Spence
Bryhnia hulthenii Bartr. in Grout
Bryum amblyodon C. Müll.
Bryum gemmiparum De Not.
Callicladium haldanianum (Grev.) Crum
Campylopus japonicus Broth.
Claopodium pellucinerve (Mitt.) Best
Daltonia splachnoides (Sm. in Sm. & Sowerby) Hook. & Tayl.
Discelium nudum (Dicks.) Brid.
Entodon concinnus (De Not.) Par.
Fabronia pusilla Raddi
Fissidens fontanus (B. Pyl.) Steud.
Fissidens pauperculus Howe
Isopterygiopsis muelleriana (Schimp.) Iwats.
Micromitrium tenerum (Bruch & Schimp. in B.S.G.) Crosby
Oedipodium griffithianum (Dicks.) Schwaegr.
Orthotrichum diaphanum Brid.
Orthotrichum hallii Sull. & Lesq. in Sull.
Orthotrichum pylaisii Brid.
Orthotrichum rivulare Turn.
Orthotrichum tenellum Bruch ex Brid.
Physcomitrium immersum Sull.
Pleuroziopsis ruthenica (Weinm.) Kind. ex Britt.
Pohlia sphagnicola (Bruch & Schimp.) Lindb. & Arnell
Pseudephemerum nitidum (Hedw.) Loeske
Pseudoleskea julacea (Besch. & Card. in Card.) Crum et al.
Rhizomnium punctatum (Hedw.) T. Kop.
Rhodobryum roseum (Hedw.) Limpr.
Seligeria acutifolia Lindb. in Hartm.
Seligeria careyana Vitt & Schof.
Sphagnum junghuhnianum var. *pseudomolle* (Warnst.) Warnst.
Sphagnum schofieldii Crum
Sphagnum subobesum Warnst.
Sphagnum wilfii Crum
Steelecleus serrulatus (Hedw.) Robins.
Syntrichia laevipila Brid.
Tortula nevadensis (Card. & Thér.) Zand.
Trichostomum recurvifolium (Tayl.) Zand.
Warnstorfia pseudostraminea (C. Müll.) Tuom. & T. Kop.
Zygodon gracilis Wils. in Berk.

2 Alpine Tundra
 (21.50%)

Liverworts

Barbilophozia binsteadii (Kaal.) Loeske
Blepharostoma arachnoideum M.A. Howe
Bucegia romanica Radian
Cephaloziella brinkmani Douin
Eremonotus myriocarpus (Carring.) Lindb. et Kaal.
Gymnomitrium apiculata (Schiffn.) K. Müll.
Herbertus sendtneri (Nees) Evans

Jungermannia confertissima Nees
Jungermannia hyalina Lyell
Marsupella revoluta (Nees) Dum.
Nardia breidleri (Limpr.) Lindb.
Nardia insecta Lindb.
Sauteria alpina (Nees) Nees
Scapania obscura (H. Arnell et C. Jens.) Schiffn.
Scapania simmonsii Bryhn et Kaal.
Scapania spitzbergensis (Lindb.) K. Müll.
Tritomaria exsecta (Schrad.) Loeske

Mosses

Andreaea mutabilis Hook. f. & Wils.
Atrichum tenellum (Röhl.) Bruch & Schimp. in B.S.G.
Brachydontium olympicum (Britt. in Frye) McIntosh & Spence
Bryum arcticum (R.Br.) Bruch & Schimp. in B.S.G.
Bryum cyclophyllum (Schwaegr.) Bruch & Schimp. in B.S.G.
Bryum schleicheri Schwaegr.
Cinclidium arcticum Bruch & Schimp. in B.S.G.
Didymodon johansenii (Williams) Crum
Encalypta brevipes Schljak.
Entodon concinnus (De Not.) Par.
Hygrohypnum polare (Lindb.) Loeske
Lescuraea saxicola (Schimp. in B.S.G.) Milde
Loeskypnum badium (Hartm.) Paul
Oedipodium griffithianum (Dicks.) Schwaegr.
Oreas martiana (Hoppe & Hornsch. in Hornsch.) Brid.
Orthothecium intricatum (Hartm.) Schimp. in B.S.G.
Plagiobryum demissum (Hook.) Lindb.
Pohlia cardotii (Ren. in Ren. & Card.) Broth.
Pohlia erecta Lindb.
Pohlia tundrae Shaw
Polytrichum sphaerothecium (Besch.) C. Müll.
Pseudoleskea julacea (Besch. & Card. in Card.) Crum et al.
Psilopilum cavifolium (Wils.) Hag.
Racomitrium pygmaeum Frisv.
Rhizomnium punctatum (Hedw.) T. Kop.
Stegonia latifolia (Schwaegr. in Schultes) Vent. ex Broth.
Tayloria froelichiana (Hedw.) Mitt. ex Broth.
Tetraplodon pallidus Hag.
Tetradontium repandum (Funk. in Sturm) Schwaegr.
Trematodon montanus Belland & Brass.
Trichostomum arcticum Kaal.
Trichostomum recurvifolium (Tayl.) Zand.
Ulota curvifolia (Wahlenb.) Lilj.

3 Spruce-Willow-Birch (10.88%)

Liverworts
Arnellia fennica (Gott.) Lindb.
Cephalozia macounii (Aust.) Aust.
Eremonotus myriocarpus (Carring.) Lindb. et Kaal.

Lophozia rutheana (Limpr.) M.A. Howe
Marsupella revoluta (Nees) Dum.
Mesoptychia sahlbergii (Lindb. et S. Arnell) Evans
Scapania simmonsii Bryhn et Kaal.

Mosses

Andreaebryum macrosporum Steere & B. Murr.
Aulacomnium acuminatum (Lindb. & Arnell) Kindb.
Bryum arcticum (R.Br.) Bruch & Schimp. in B.S.G.
Cinclidium arcticum Bruch & Schimp. in B.S.G.
Cynodontium glaucescens (Lindb. & Arnell) Par.
Drepanocladus capillifolius (Warnst.) Warnst.
Encalypta affinis Hedw. f. in Web. & Mohr.
Encalypta affinis var. *macounii* (Aust.) Crum & Anderson
Encalypta brevipes Schljak.
Encalypta longicolla Bruch
Entodon concinnus (De Not.) Par.
Grimmia unicolor Hook. in Grev.
Lescuraea saxicola (Schimp. in B.S.G.) Milde
Mielichhoferia macrocarpa (Hook. in Drumm.) Bruch & Schimp. ex Jaegr.
Mielichhoferia mielichhoferiana (Funck in Hook.) Loeske
Molendoa sendtneriana (Bruch & Schimp. in B.S.G.) Limpr.
Orthotrichum pylaisii Brid.
Pohlia longicolla (Hedw.) Lindb.
Pseudobryum cinclidioides (Hüb.) T. Kop.
Stegonia latifolia (Schwaegr. in Schultes) Vent. ex Broth.
Warnstorfia tundrae (Arnell) Loeske

4 Engelmann Spruce– Subalpine Fir (6.74%)

Liverworts

Jungermannia confertissima Nees
Jungermannia hyalina Lyell
Lophozia bantriensis (Hook.) Steph.
Scapania hians ssp. *salishensis* J. Godfrey & G. Godfrey
Scapania mucronata Buch
Scapania obscura (H. Arnell et C. Jens.) Schiffn.
Scapania paludicola Loeske et K. Müll.

Mosses

Bryum calophyllum R.Br.
Encalypta affinis Hedw. f. in Web. & Mohr.
Encalypta affinis var. *macounii* (Aust.) Crum & Anderson
Grimmia mollis Bruch & Schimp. in B.S.G.
Lescuraea saxicola (Schimp. in B.S.G.) Milde
Pohlia longicolla (Hedw.) Lindb.
Racomitrium pygmaeum Frisv.
Scouleria marginata Britt.
Sphagnum jensenii Lindb.
Sphagnum platyphyllum (Lindb. ex Braithw.) Sull. ex Warnst.
Steelecleus serrulatus (Hedw.) Robins.
Warnstorfia procera (Ren. & Arnell in Husn.) Tuom. & T. Kop.

Warnstorfia trichophylla (Warnst.) Tuom. & T. Kop.
Warnstorfia tundrae (Arnell) Loeske

5 Bunchgrass

(5.96%)

Mosses

Aloina bifrons (De Not.) Delgad.
Aloina rosei (Williams) Delgad.
Bryoerythrophyllum columbianum (Herm. & Lawt.) Zand.
Hilpertia scotteri (Zand. & Steere) Zand.
Microbryum vlassovii (Laz.) Zand.
Tortula wilsonii (Hook.) Zand.
Pterygoneurum kozlovii Laz.
Pterygoneurum lamellatum (Lindb.) Jur.
Tortula guepinii (B. & S. in B.S.G.) Broth.
Tortula protobryoides Zand.

6 Mountain Hemlock

(5.18%)

Liverworts

Calycularia crispula Mitt.
Cephaloziella phyllacantha (Mass. et Carest.) K.Müll.
Sphenobolopsis pearsonii (Spruce) Schust.

Mosses

Andreaea schofieldiana B. Murr.
Andreaea sinuosa B. Murr.
Bryum amblyodon C. Müll.
Bryum gemmiparum De Not.
Bryum schleicheri Schwaegr.
Gollania turgens (C. Müll.) Ando
Oedipodium griffithianum (Dicks.) Schwaegr.
Pohlia cardotii (Ren. in Ren. & Card.) Broth.
Trematodon boasii Schof.
Trichostomum recurvifolium (Tayl.) Zand.

7 Coastal Douglas-fir

(4.92%)

Hornwort

Phaeoceros hallii (Aust.) Prosk.

Liverwort

Sphaerocarpos texanus Aust.

Mosses

Bartramia stricta Brid.
Bryum gemmiparum De Not.
Bryum violaceum Crundw. & Nyh.
Pleuroziopsis ruthenica (Weinm.) Kind. ex Britt.
Syntrichia laevipila Brid.
Tortella humilis (Hedw.) Jenn.

8 Interior Cedar-Hemlock

(4.66%)

Liverworts

Cephaloziella elachista (Jack) Schiffn.
Lophozia ascendens (Warnst.) Schust.
Scapania spitzbergensis (Lindb.) K. Müll.

Mosses

Bartramia halleriana Hedw.
Bryum blindii Bruch & Schimp. *in* B.S.G.
Callicladium haldanianum (Grev.) Crum
Campylium calcareum Crundw. & Nyh.
Encalypta affinis Hedw. *f. in* Web. & Mohr.
Hygrohypnum norvegicum (Schimp. *in* B.S.G.) Amann
Orthotrichum pallens Bruch *ex* Brid.
Rhizomnium punctatum (Hedw.) T. Kop.
Steerecleus serrulatus (Hedw.) Robins.

9 Boreal White and Black Spruce (2.85%)

Liverworts

Arnellia fennica (Gott.) Lindb.
Scapania paludicola Loeske et K. Müll.

Mosses

Bryum amblyodon C. Müll.
Bryum cyclophyllum (Schwaegr.) Bruch & Schimp. *in* B.S.G.
Drepanocladus capillifolius (Warnst.) Warnst.
Encalypta affinis var. *macounii* (Aust.) Crum & Anderson
Sphagnum platyphyllum (Lindb. *ex* Braithw.) Sull. *ex* Warnst.
Warnstorfia trichophylla (Warnst.) Tuom. & T. Kop.
Warnstorfia tundrae (Arnell) Loeske

10 Sub-Boreal Spruce (2.85%)

Liverworts

Lophozia ascendens (Warnst.) Schust.
Lophozia laxa (Lindb.) Grolle

Mosses

Bartramia halleriana Hedw.
Hygrohypnum polare (Lindb.) Loeske
Myrinia pulvinata (Wahlenb.) Schimp.
Orthotrichum pylaisii Brid.
Sphagnum platyphyllum (Lindb. *ex* Braithw.) Sull. *ex* Warnst.
Tayloria froelichiana (Hedw.) Mitt. *ex* Broth.
Tetraplodon pallidus Hag.
Tortula nevadensis (Card. & Thér.) Zand.

11 Interior Douglas-fir (1.55%)

Liverworts

Riccia frostii Aust.
Scapania mucronata Buch

Mosses

Bryum gemmiparum De Not.
Bryum uliginosum (Brid.) Bruch & Schimp. *in* B.S.G.
Physcomitrella patens (Hedw.) Bruch & Schimp. *in* B.S.G.
Plagiobryum demissum (Hook.) Lindb.

12 Ponderosa Pine (1.04%)

Mosses

Bryum uliginosum (Brid.) Bruch & Schimp. *in* B.S.G.

Entosthodon rubiginosus (Williams) Grout
Orthotrichum hallii Sull. & Lesq. in Sull.

13 Montane Spruce
(0.78%)

Liverworts

Lophozia bantriensis (Hook.) Steph.
Lophozia rutheana (Limpr.) M.A. Howe

Mosses

Campylium calcareum Crundw. & Nyh.

PRIORITY LISTING OF BIOGEOCLIMATIC ZONES

In this section, biogeoclimatic zones are ranked in descending order based on the relative number of localities in which rare species have been collected and the degree of direct or indirect threats to known populations by human activities. The collection of a species in a specific zone does not imply a relationship between the characteristics of the zone and the habitat requirements and range of the species. Differences between biogeoclimatic zones are based on large-scale differences in the vascular flora and do not necessarily correspond to natural divisions in the bryoflora. As noted by Godfrey (1977a) in an examination of the hepatics of southwestern British Columbia, fewer than 25% of the species could be regarded as representative of any particular biogeoclimatic zone, and even for those species that appear to be characteristic of a particular zone, the same species may be found in suitable microhabitats in other zones. For example, a few species that typically occur in subalpine habitats may also occur at low elevations in cold-air drainages such as those found near waterfalls or adjacent to streams near the ocean.

A number of species have likely been assigned to the wrong zone, particularly in areas where two or more zones are in close proximity. Hence, some zones have been grouped together in the following discussion where it was felt that specimens assigned to one zone may just as likely have been collected in the adjacent zone.

**1 Coastal Western
Hemlock Zone**
(31.09%)

Almost a third of all occurrences of rare bryophytes occur in the Coastal Western Hemlock Zone. Areas particularly rich in bryophytes include the Queen Charlotte Islands, Brooks Peninsula on Vancouver Island, and the lower mainland. Over half of the rare species found in this zone are not found in other zones, including 12 liverworts and 27 mosses. Unfortunately, one of these species, *Bryhnia hulthenii*, is known only from a single locality (Inver Creek near Prince Rupert), which has since been logged, and it is doubtful that this species is extant in British Columbia (Schofield pers. comm. 1993).

This zone occurs at lower elevations along the entire coast of British Columbia, including most of Vancouver Island and the Queen Charlotte Islands. Abundant rainfall and mild temperatures make it the most productive forested area in Canada. However, much of it has been logged or, on the lower mainland, converted to agricultural and residential uses. Although many rare species do not appear to occur directly in forested habitats (e.g.,

along creek channels, on rock outcrops, or in bogs), it is likely that logging and urbanization will detrimentally affect the habitats in which these species occur by altering microclimatic conditions. It is interesting that areas with the greatest number of rare species are those that have remained relatively unaltered by human activities because they are either inaccessible or otherwise protected from human disturbance.

More collections have been made from this biogeoclimatic zone than from any other in the province. However, because so much of coastal B.C. remains inaccessible by vehicles much remains bryologically unexplored except for parts of Vancouver Island and the Queen Charlottes, areas around Prince Rupert, and areas near Vancouver.

**2 Bunchgrass
(5.96%)
and Ponderosa
Pine zones
(1.04%)**

The Bunchgrass and Ponderosa Pine zones encompass the driest and hottest areas of British Columbia. Although they would not be expected to support a rich flora of bryophytes, the little work done in these zones (primarily by McIntosh [1986]) indicates that, despite their small size, they contain a surprisingly large number of rare bryophytes. No rare liverworts have been collected in either zone but all 10 rare moss species found in the Bunchgrass Zone are found in no other zone, and, similarly, *Entosthodon rubiginosus*, is found only in the Ponderosa Pine Zone. Two species found in the Bunchgrass Zone, *Aloina rosei* and *Hilpertia scotteri*, are globally rare species.

Unfortunately, much of the native vegetation in these zones has been altered, primarily by agricultural activities. Activities resulting from residential, transportation, and recreational demands have also contributed to destruction of suitable habitats. Except for McIntosh, little field work has been completed here, so it is likely that additional rare species will be found with further research. It is also likely that some species have already been eliminated because so much of the native vegetation has been destroyed or altered.

**3 Coastal Douglas-fir
Zone
(4.92%)**

The Coastal Douglas-fir Zone lies in the lee of the Olympic and Vancouver Island mountains, and is confined to the southeast coast of Vancouver Island, the Gulf Islands, and a thin strip on the mainland coast. While it supports less than 5% of the rare bryophytes in the province, it ranks third because of the degree of threat to the bryoflora of this zone. The Coastal Douglas-fir zone is one of the most bryologically diverse zones, but because of location and mild climate, it is also one of the most heavily altered zones in the province. Much of the vegetation has been changed either through agricultural and residential development, or by logging activities. Very little of the original old-growth forests remain, except in small, scattered remnants. Of the eight rare species found here, the hornwort *Phaeoceros hallii*, the liverwort *Sphaerocarpos texanus*, and the mosses *Bartramia stricta*, *Bryum violaceum*, and *Tortella humilis*, are not found in any other zone. Three species, *Phaeoceros hallii* (hornwort), *Bartramia stricta* (moss), and *Syntrichia laevipila* (moss), have only been found in Garry oak stands, which are one of the rarest ecosystems in Canada. Despite comparatively easy access to many parts of this zone, much of it, including southern Vancouver Island, has not been extensively inventoried and other rare species may yet be discovered.

This zone occupies low- and mid-elevation sites in the southeastern and west-central parts of the province. Of 12 rare species that occur in this zone,

**4 Interior Cedar–
Hemlock Zone**
(4.66%)

one liverwort, *Cephaloziella elachista*, and three mosses, *Bryum blindii*, *Hygrohypnum polare*, and *Orthotrichum pallens*, are not found in any other zone. Forestry is the primary activity.

**5 Engelmann Spruce–
Subalpine Fir
and Montane Spruce
zones**
(6.74%)
(0.78%)

The Engelmann Spruce–Subalpine Fir Zone encompasses upper forested slopes in the southern three-quarters of the province. Logging is common in the most accessible parts of these zones. Of the seven liverwort and 13 moss species found in this zone, five mosses, *Bryum calophyllum*, *Grimmia mollis*, *Scouleria marginata*, *Sphagnum jensenii*, and *Warnstorfia procera*, are not found in any other zones.

The Montane Spruce Zone occurs in the southern third of the province at middle elevations. Only two liverworts (*Lophozia bantriensis*, *Lophozia ruthenica*) and one moss (*Campylium calcareum*) are found in this zone. These species also occur in other zones.

**6 Mountain
Hemlock Zone**
(5.18%)

The Mountain Hemlock zone occupies the montane and subalpine areas along coastal British Columbia. Of the three liverworts and 10 mosses found in this zone, four species of mosses, *Andreaea schofieldiana*, *Trematodon boasii*, *Andreaea sinuosa*, and *Gollania turgens*, are globally rare species; the first two species are absent in other zones. Because of the short growing season, forests are less productive and have not been altered to the same extent as those in the Western Hemlock Zone. However, some of these species were collected along trails and they may be affected by recreational activities.

7 Alpine Tundra Zone
(21.50%)

Over a fifth of the rare bryophytes found in B.C. occur in the alpine and tundra areas. Except for recreational activities, these areas remain relatively undisturbed, so that much of the bryoflora in this zone is protected from logging and other industrial disturbances. Unfortunately, the inaccessibility of much of the Alpine Tundra Zone also makes it one of the least explored zones for bryophytes. A single trip (July 1992) by Geoff Godfrey in the northwest corner of the province resulted in the collection of a number of rare liverworts (*Arnellia fennica*, *Blepharostoma arachnoideum*, *Eremonotus myriocarpus*, *Nardia breidleri*). Of the 17 liverworts and 35 mosses that have been collected in this zone, seven liverworts and 15 mosses are not found in other zones. Many of the remaining species collected here are also found in the Spruce–Willow–Birch zone. *Cephaloziella brinkmani* is one of the rarest species in British Columbia; it is only known from a single population in Yoho National Park. Similarly, *Trematodon montanus*, which has been collected from two alpine locations on the Queen Charlotte Islands, is only known elsewhere in the world from Newfoundland. Many collections of rare species were made on or adjacent to trails and are, therefore, subject to trampling by hikers.

**8 Spruce–Willow–
Birch Zone**
(10.88%)

This zone occurs throughout the northwest and north-central interior of B.C., and is the province's most northerly subalpine region. Inaccessibility and low forest and agriculture resource values have left much of it relatively undisturbed. About 11% of rare bryophyte occurrences are in this zone, but much of it has not been inventoried for bryophytes. Of the seven liverworts and 21 mosses collected here, two liverworts and 10 mosses are not found in

other zones. Like the Alpine Tundra Zone, rare species do not appear to be immediately threatened by human activities.

9 Sub-Boreal Spruce Zone

(2.85%)

The Sub-Boreal Spruce Zone, a mid-elevation forest zone occupying the gentle-rolling plateaus of the central interior, it is an active forest-harvesting area. Of the two liverworts and eight mosses that occur here, the liverwort *Lophozia laxa* and the moss *Myrinia pulvinata* are not found in other zones.

10 Boreal White and Black Spruce Zone

(2.85%)

The Boreal White and Black Spruce Zone occupies the northeast corner of the province. All nine species of bryophytes that have been collected in this zone have also been collected in other zones. Like other northern zones, few areas have been surveyed for bryophytes except those that are accessible.

11 Interior Douglas-fir Zone

(1.55%)

The Interior Douglas-fir Zone occurs in the south-central and southeastern parts of the province. Of the six species found in this zone, *Physcomitrella patens* is the only species restricted to this zone.

RARE AND ENDANGERED BRYOPHYTES BY ECOREGION

This section lists, by ecoprovince and ecoregion, the rare and endangered bryophytes that have been found in each area. Some species have been collected in more than one ecoregion and are, therefore, listed more than once. Precise locational information was not available for all species; hence, some species are absent from the following list.

The relative proportion of all localities in which rare species have been collected is enclosed in parentheses following the ecoprovince and ecoregion name.

COAST AND MOUNTAINS ECOPROVINCE (35.24%)

Mosses

1 Cascade Range

(0.52%)

Barbula amplexifolia (Mitt.) Jaeg.
Barbula convoluta var. *gallinula* Zand.

Liverworts

2 Coastal Gap

(2.59%)

Chandonanthus hirtellus (Web.) Mitt.
Calycularia crispula Mitt.

Mosses

Bryhnia hultenii Bartr. in Grout
Callicladium haldanianum (Grev.) Crum
Entodon concinnus (De Not.) Par.
Isopterygiopsis muelleriana (Schimp.) Iwats.
Pleuroziopsis ruthenica (Weinm.) Kind. ex Britt.
Sphagnum subobesum Warnst.

Mosses

3 Nass Ranges
(0.26%)

Orthotrichum rivulare Turn.

4 Pacific Ranges
(11.14%)

Liverworts

Blepharostoma arachnoideum M.A. Howe
Calycularia crispula Mitt.
Cephaloziella phyllacantha (Mass. et Carest.) K. Müll.
Jungermannia confertissima Nees
Lophozia ascendens (Warnst.) Schust.
Nardia breidleri (Limpr.) Lindb.
Scapania hians ssp. *salishensis* J. Godfrey & G. Godfrey
Scapania mucronata Buch
Scapania obscura (H. Arnell et C. Jens.) Schiffn.
Tritomaria exsecta (Schrad.)

Mosses

Andreaea schofieldiana B. Murr.
Andreaea sinuosa B. Murr.
Atrichum tenellum (Röhl.) Bruch & Schimp. in B.S.G.
Brachydontium olympicum (Britt. in Frye) McIntosh & Spence
Bryum gemmiparum De Not.
Bryum schleicheri Schwaegr.
Callicladium haldanianum (Grev.) Crum
Fissidens fontanus (B. Pyl.) Steud.
Orthotrichum pylaisii Brid.
Pohlia cardotii (Ren. in Ren. & Card.) Broth.
Pohlia erecta Lindb.
Pohlia tundrae Shaw
Polytrichum sphaerothecium (Besch.) C. Müll.
Racomitrium pygmaeum Frisv.
Rhizomnium punctatum (Hedw.) T. Kop.
Tetradontium repandum (Funck in Sturm) Schwaegr.
Tortula nevadensis (Card. & Thér.) Zand.
Trematodon boasii Schof.
Warnstorfia pseudostraminea (C. Müll.) Tuom. & T. Kop.

**5 Queen Charlotte
Lowland**
(1.04%)

Liverworts

Jungermannia subelliptica (Lindb. ex Kaal.) Lev.

Mosses

Campylopus japonicus Broth.
Discelium nudum (Dicks.) Brid.
Syntrichia laevipila Brid.

**6 Queen Charlotte
Ranges**
(16.32%)

Liverworts

Calycularia crispula Mitt.
Cephalozia connivens (Dicks.) Lindb.
Chandonanthus hirtellus (Web.) Mitt.
Cololejeunea macounii (Spruce ex Underw.) Evans
Dendrobazzania griffithiana (Steph.) Schust. & Schof.
Eremonotus myriocarpus (Carring.) Lindb. et Kaal.

Herbertus sendtneri (Nees) Evans
Jungermannia hyalina Lyell
Kurzia trichoclados (K.Müll.) Grolle
Lophozia bantriensis (Hook.) Steph.
Lophozia collaris (Nees) Dum.
Nardia insecta Lindb.
Sphenolobopsis pearsonii (Spruce) Schust.
Tritomaria exsecta (Schrad.) Loeske

Mosses

Andreaea mutabilis Hook. f. & Wils.
Andreaea sinuosa B. Murr.
Bryum amblyodon C. Müll.
Bryum gemmiparum De Not.
Claopodium pellucinerve (Mitt.) Best
Daltonia splachnoides (Sm. in Sm. & Sowerby) Hook. & Tayl.
Entodon concinnus (De Not.) Par.
Gollania turgens (C. Müll.) Ando
Lescuraea saxicola (Schimp. in B.S.G.) Milde
Oedipodium griffithianum (Dicks.) Schwaegr.
Pleuroziopsis ruthenica (Weinm.) Kind. ex Britt.
Pseudoleskea julacea (Besch. & Card. in Card.) Crum et al.
Rhodobryum roseum (Hedw.) Limpr.
Seligeria careyana Vitt & Schof.
Sphagnum junghuhnianum var. *pseudomolle* (Warnst.) Warnst.
Sphagnum schofieldii Crum
Sphagnum subobesum Warnst.
Sphagnum wilfii Crum
Trematodon montanus Belland & Brass.
Trichostomum recurvifolium (Tayl.) Zand.
Zygodon gracilis Wils. in Berk.

Liverworts

**7 Western Vancouver
Island
(3.37%)**

Blepharostoma arachnoideum M.A. Howe
Calycularia crispula Mitt.
Lophozia elongata Steph.
Sphenolobopsis pearsonii (Spruce) Schust.

Mosses

Andreaea schofieldiana B. Murr.
Andreaea sinuosa B. Murr.
Oedipodium griffithianum (Dicks.) Schwaegr.
Pohlia sphagnicola (Bruch & Schimp.) Lindb. & Arnell
Seligeria acutifolia Lindb. in Hartm.
Sphagnum subobesum Warnst.

GEORGIA DEPRESSION ECOPROVINCE (15.28%)

**1 Eastern Vancouver
Island**
(5.96%)

Hornworts

Phaeoceros hallii (Aust.) Prosk.

Liverworts

Cephaloziella phyllacantha (Mass. et Carest.) K.Müll.

Nardia insecta Lindb.

Scapania obscura (H. Arnell et C. Jens.) Schiffn.

Sphaerocarpos texanus Aust.

Mosses

Andreaea schofieldiana B. Murr.

Bartramia stricta Brid.

Bryum amblyodon C. Müll.

Bryum gemmiparum De Not.

Bryum schleicheri Schwaegr.

Bryum violaceum Crundw. & Nyh.

Orthotrichum hallii Sull. & Lesq. *in* Sull.

Orthotrichum rivulare Turn.

Pleuroziopsis ruthenica (Weinm.) Kind. *ex* Britt.

Syntrichia laevipila Brid.

Trematodon boasii Schof.

2 Lower Mainland
(7.77%)

Liverworts

Cephalozia connivens (Dicks.) Lindb.

Cephaloziella phyllacantha (Mass. & Carest.) K. Müll.

Cololejeunea macounii (Spruce *ex* Underw.) Evans

Jungermannia borealis Damsh. & Vana

Lophozia sudetica (Nees) Grolle

Lunularia cruciata (L.) Dum.

Riccia frostii Aust.

Scapania gymnostomophila Kaal.

Scapania mucronata Buch

Tritomaria exsecta (Schrad.) Loeske

Mosses

Callicladium haldanianum (Grev.) Crum

Discelium nudum (Dicks.) Brid.

Fabronia pusilla Raddi

Fissidens pauperculus Howe

Micromitrium tenerum (Bruch & Schimp. *in* B.S.G.) Crosby

Orthotrichum diaphanum Brid.

Orthotrichum tenellum Bruch *ex* Brid.

Physcomitrium immersum Sull.

Pseudephemerum nitidum (Hedw.) Loeske

Rhizomnium punctatum (Hedw.) T. Kop.

Steerecleus serrulatus (Hedw.) Robins.

Hornworts

Phaeoceros hallii (Aust.) Prosk.

**3 Georgia-Puget
Basin**
(1.55%)

Liverworts
Sphaerocarpos texanus Aust.

Mosses
Bryum gemmiparum De Not.
Bryum violaceum Crundw. & Nyh.
Tortella humilis (Hedw.) Jenn.

CENTRAL INTERIOR ECOPROVINCE (0.52%)

Mosses
Stegonia latifolia (Schwaegr. in Schultes) Vent. ex Broth.
Tortula nevadensis (Card. & Thér.) Zand.

1 Fraser Plateau
(0.52%)

SUB-BOREAL INTERIOR ECOPROVINCE (1.30%)

Mosses
Bryum amblyodon C. Müll.

**1 Central Canadian
Rocky Mountains**
(0.26%)
2 Fraser Basin
(1.04%)

Mosses
Myrinia pulvinata (Wahlenb.) Schimp.
Sphagnum platyphyllum (Lindb. ex Braithw.) Sull. ex Warnst.
Tetraplodon pallidus Hag.

SOUTHERN INTERIOR MOUNTAINS ECOPROVINCE (13.99%)

Liverworts
Cephaloziella elachista (Jack) Schiffn.
Lophozia ascendens (Warnst.) Schust.
Scapania spitzbergensis (Lindb.) K. Müll.

**1 Columbia
Mountains and
Highlands**
(8.29%)

Mosses
Bryum blindii Bruch & Schimp. in B.S.G.
Bryum calophyllum R.Br.
Bryum uliginosum (Brid.) Bruch & Schimp. in B.S.G.
Callicladium haldanianum (Grev.) Crum
Campylium calcareum Crundw. & Nyh.
Grimmia mollis Bruch & Schimp. in B.S.G.
Hygrohypnum norvegicum (Schimp. in B.S.G.) Amann
Lescuraea saxicola (Schimp. in B.S.G.) Milde
Orthotrichum pallens Bruch ex Brid.
Pohlia longicolla (Hedw.) Lindb.
Racomitrium pygmaeum Frisv.
Rhizomnium punctatum (Hedw.) T. Kop.
Scouleria marginata Britt.
Sphagnum jensenii Lindb.
Sphagnum platyphyllum (Lindb. ex Braithw.) Sull. ex Warnst.
Steerecleus serrulatus (Hedw.) Robins.

Tayloria froelichiana (Hedw.) Mitt. ex Broth.
Warnstorfia procera (Ren. & Arnell in Husn.) Tuom. & T. Kop.
Warnstorfia tundrae (Arnell) Loeske

Mosses

Bryum uliginosum (Brid.) Bruch & Schimp. in B.S.G.
Physcomitrella patens (Hedw.) Bruch & Schimp. in B.S.G.

**2 Southern Rocky
Mountain Trench**
(0.52%)

Liverworts

Bucegia romanica Radian
Cephaloziella brinkmani Douin
Jungermannia hyalina Lyell
Lophozia ascendens (Warnst.) Schust.
Lophozia bantriensis (Hook.) Steph.
Lophozia laxa (Lindb.) Grolle
Lophozia rutheana (Limpr.) M.A. Howe
Sauteria alpina (Nees) Nees

**3 Western
Continental Ranges**
(5.18%)

Mosses

Bartramia halleriana Hedw.
Encalypta affinis Hedw. f. in Web. & Mohr
Encalypta affinis var. *macounii* (Aust.) Crum & Anderson
Orthothecium intricatum (Hartm.) Schimp. in B.S.G.
Orthotrichum pylaisii Brid.
Steerecleus serrulatus (Hedw.) Robins.
Warnstorfia trichophylla (Warnst.) Tuom. & T. Kop.

SOUTHERN INTERIOR ECOPROVINCE (8.81%)

Liverworts

Jungermannia confertissima Nees
Scapania paludicola Loeske & K. Müll.
Scapania hians ssp. *salishensis* J. Godfrey & G. Godfrey

**1 Interior Transition
Ranges**
(2.07%)

Mosses

Hilpertia scotteri (Zand. & Steere) Zand.
Orthotrichum hallii Sull. & Lesq. in Sull.
Racomitrium pygmaeum Frisv.
Warnstorfia trichophylla (Warnst.) Tuom. & T. Kop.

Mosses

Bryoerythrophyllum columbianum (Herm. & Lawt.) Zand.
Entosthodon rubiginosus (Williams) Grout
Pterygoneurum kozlovii Laz.
Pterygoneurum lamellatum (Lindb.) Jur.

**2 Okanagan
Highland**
(2.33%)

Mosses

Aloina bifrons (De Not.) Delgad.
Tortula protobryoides Zand.

3 Okanagan Range
(0.78%)

Liverworts

Riccia frostii Aust.

**4 Thompson-
Okanagan Plateau**
(3.63%)

Mosses

Aloina bifrons (De Not.) Delgad.

Aloina rosei (Williams) Delgad.

Bryoerythrophyllum columbianum (Herm. & Lawt.) Zand.

Microbryum vlassovii (Laz.) Zand.

Orthotrichum hallii Sull. & Lesq. *in* Sull.

Plagiobryum demissum (Hook.) Lindb.

Pterygoneurum kozlovii Laz.

Tortula guepinii (B. & S. *in* B.S.G.) Broth.

Tortula wilsonii (Hook.) Zand.

BOREAL PLAINS ECOPROVINCE (0.52%)

Liverworts

Scapania paludicola Loeske et K. Müll.

1 Alberta Plateau
(0.52%)

Mosses

Sphagnum platyphyllum (Lindb. *ex* Braithw.) Sull. *ex* Warnst.

TAIGA PLAINS ECOPROVINCE (0.78%)

Liverworts

Scapania paludicola Loeske et K. Müll.

1 Mackenzie Plains
(0.78%)

Mosses

Bryum cyclophyllum (Schwaegr.) Bruch & Schimp. *in* B.S.G.

Oreas martiana (Hoppe & Hornsch. *in* Hornsch.) Brid.

NORTHERN BOREAL MOUNTAINS ECOPROVINCE (23.58%)

Liverworts

Barbilophozia binsteadii (Kaal.) Loeske

1 Kluane Plateau
(1.04%)

Mosses

Pohlia tundrae Shaw

Stegonia latifolia (Schwaegr. *in* Schultes) Vent. *ex* Broth.

Warnstorfia tundrae (Arnell) Loeske

Mosses

Bryum amblyodon C. Müll.

Drepanocladus capillifolius (Warnst.) Warnst.

2 Liard Basin
(0.78%)

Liverworts

Arnellia fennica (Gott.) Lindb.

Cephalozia macounii (Aust.) Aust.

**3 Northern
Canadian Rocky
Mountains**
(8.03%)

Scapania simmonsii Bryhn et Kaal.

Mosses

Andreaeobryum macrosporum Steere and B. Murr.
Aulacomnium acuminatum (Lindb. & Arnell) Kindb.
Bryum arcticum (R.Br.) Bruch & Schimp. in B.S.G.
Cinclidium arcticum Bruch & Schimp. in B.S.G.
Cynodontium glaucescens (Lindb. & Arnell) Par.
Encalypta affinis Hedw. f. in Web. & Mohr
Encalypta affinis var. *macounii* (Aust.) Crum & Anderson
Encalypta brevipes Schljak.
Encalypta longicolla Bruch
Entodon concinnus (De Not.) Par.
Grimmia unicolor Hook. in Grev.
Mielichhoferia macrocarpa (Hook. in Drumm.) Bruch & Schimp. ex Jaegr.
Mielichhoferia mielichhoferiana (Funck in Hook.) Loeske
Molendoa sendtneriana (Bruch & Schimp. in B.S.G.) Limpr.
Orthotrichum pylaisii Brid.
Pohlia longicolla (Hedw.) Lindb.
Stegonia latifolia (Schwaegr. in Schultes) Vent. ex Broth.
Trichostomum arcticum Kaal.

Liverworts

Bucegia romanica Radian
Eremonotus myriocarpus (Carring.) Lindb. et Kaal.
Gymnomitrium apiculata (Schiffn.) K. Müll.
Lophozia rutheana (Limpr.) M.A. Howe
Marsupella revoluta (Nees) Dum.
Mesoptychia sahlbergii (Lindb. et S. Arnell) Evans
Sauteria alpina (Nees) Nees
Scapania simmonsii Bryhn et Kaal.
Scapania spitzbergensis (Lindb.) K. Müll.

Mosses

Atrichum tenellum (Röhl.) Bruch & Schimp. in B.S.G.
Bryum arcticum (R.Br.) Bruch & Schimp. in B.S.G.
Bryum cyclophyllum (Schwaegr.) Bruch & Schimp. in B.S.G.
Cinclidium arcticum Bruch & Schimp. in B.S.G.
Didymodon johansenii (Williams) Crum
Encalypta affinis Hedw. f. in Web. & Mohr
Encalypta affinis var. *macounii* (Aust.) Crum & Anderson
Encalypta brevipes Schljak.
Encalypta longicolla Bruch
Hygrohypnum polare (Lindb.) Loeske
Lescuraea saxicola (Schimp. in B.S.G.) Milde
Loeskygnum badium (Hartm.) Paul
Oreas martiana (Hoppe & Hornsch. in Hornsch.) Brid.
Orthothecium intricatum (Hartm.) Schimp. in B.S.G.
Plagiobryum demissum (Hook.) Lindb.
Pohlia tundrae Shaw

**4 Northern
Mountains and
Plateaus**
(10.88%)

Pseudobryum cinclidioides (Hüb.) T. Kop.
Psilopilum cavifolium (Wils.) Hag.
Rhizomnium punctatum (Hedw.) T. Kop.
Stegonia latifolia (Schwaegr. in Schultes) Vent. ex Broth.
Tayloria froelichiana (Hedw.) Mitt. ex Broth.
Tetraplodon pallidus Hag.
Ulota curvifolia (Wahlenb.) Lilj.
Warnstorfia trichophylla (Warnst.) Tuom. & T. Kop.
Warnstorfia tundrae (Arnell) Loeske

Liverworts

Arnellia fennica (Gott.) Lindb.
Blepharostoma arachnoideum M.A. Howe
Eremonotus myriocarpus (Carring.) Lindb. et Kaal.
Nardia breidlereri (Limpr.) Lindb.

5 St. Elias Mountains
(2.07%)

Mosses

Drepanocladus capillifolius (Warnst.) Warnst.
Encalypta brevipes Schljak.
Hygrohypnum polare (Lindb.) Loeske

**6 Yukon-Stikine
Highlands**
(0.78%)

RANKING OF ECOREGIONS

In this section, ecoregions are ranked in descending order based on the number of localities in which rare species have been collected and the degree of direct or indirect threats to known populations by human activities.

Although some species have been collected in only one ecoregion, this does not imply a relationship between the characteristics of the ecoregion and the habitat requirements and range of the species; the species may be found in other ecoregions when a more comprehensive inventory of the province is complete. Ecoregions are used in this report as a convenient way to attribute the occurrence of rare and endangered species to different areas of the province. It is not necessarily the best system, but it is desirable to use an existing scheme (particularly one on which management policies and decisions are based).

The Lower Mainland ecoregion contains a substantial proportion of the known occurrences of rare bryophytes in the province. This reflects the extent to which the flora of this region have been investigated, but it also reflects the range in microhabitat conditions found within this area. It is considered to be the ecoregion where bryophytes are most critically endangered for several reasons:

1 Lower Mainland
(7.77%)

a. This is the most densely populated part of the province and, with rapid residential and agricultural development, many rich habitats for bryophytes are directly threatened. Even within protected areas, increased recreation activities may severely affect existing populations of rare species.

- b. The lower mainland of British Columbia, particularly the Fraser Valley, suffers from relatively high levels of air pollution (particularly photochemical smog). Unfortunately, many species of bryophytes are very sensitive to air pollution, and it is possible that some species will become increasingly rare, particularly in and around the Vancouver area.
- c. This is the only ecoregion where known populations of the rare moss species *Micromitrium tenerum* and *Pseudephemerum nitidum* have been extirpated. They have not been found elsewhere in North America (although these may have been introduced species).
- d. Eleven of the remaining 18 rare species occurring in this ecoregion are not found elsewhere in the province (the liverworts *Jungermannia borealis*, *Lophozia sudetica*, *Lunularia cruciata*, and *Scapania gymnostomophila*, and the mosses *Fabronia pusilla*, *Fissidens pauperculus*, *Micromitrium tenerum*, *Orthotrichum diaphanum*, *Orthotrichum tenellum*, *Physcomitrium immersum*, and *Pseudephemerum nitidum*).

Localities in this ecoregion that support a number of rare species include Lynn Canyon and Pitt Meadows.

2 Thompson-Okanagan Plateau
(3.63%)

The Thompson-Okanagan Plateau is one of the hottest and driest ecoregions in the province. As expected, it supports a limited number of bryophytes; only 77 species of bryophytes are currently known from the semi-arid steppe vegetation of southern B.C. (McIntosh 1989). Yet, in a survey of the bryoflora, McIntosh (1989) reports four mosses new to North America, seven species new to Canada, and seven species new to British Columbia.

- Despite the fact that this ecoregion contains less than 5% of the rare species of bryophytes, it has been ranked second in this list for three reasons:
- a. The area remains largely unsampled by bryologists. Some of the species reported by McIntosh (1989) extend the ranges of some species thousands of kilometres from other known populations, for example, *Aloina rosei*, known elsewhere only from Peru (G1 ranking).
 - b. Much of the area has been extensively altered by agricultural and residential expansion; only in relatively undisturbed areas, in which cattle grazing has not been too heavy, have the thin cryptogamic crusts overlying soil (composed of lichens, fungi, bryophytes, and bluegreen algae) remained intact. All of the rare species found within this ecoregion are found on soil and are, therefore, very much at risk.
 - c. Four of the 10 rare species found in this ecoregion are found in no other ecoregion within the province. These include *Aloina rosei*, *Tortula guepinii*, *Microbryum vlassovii*, and *Tortula wilsonii*.

Important areas where rare bryophytes have been collected include the Skaha Lake and Kamloops areas.

3 Okanagan Highland
(2.33%)

In comparison to other similarly sized ecoregions, the Okanagan Highland supports a large number of bryophyte species. Like the Thompson-Okanagan Plateau, much of this ecoregion has been heavily altered by agricultural activities. Of the four species found within this ecoregion, two, *Entosthodon rubiginosus* and *Pterygoneurum lamellatum*, are found in no other ecoregion.

Although this ecoregion supports substantially fewer rare species than several other ecoregions, rapidly expanding residential development and increasing

4 Eastern Vancouver Island
(5.96%)

population pressure directly threaten rare bryophytes. Of greatest concern are Garry oak communities, particularly those located at Ash Point and Pedder Bay, where the rare endemic hornwort *Phaeoceros hallii*, and the mosses *Syntrichia laevipila* and *Bartramia stricta* have been found. *Syntrichia laevipila* is also known from Nanoose Hill near Nanaimo (as is *Bartramia stricta*) and from Beacon Hill Park, Victoria. Although the latter area is a park, recreational pressures and the possible removal of understorey vegetation pose a serious threat to these populations.

Two globally rare mosses are found in this ecoregion: the endemics *Andreaea schofieldiana* (holotype) and *Trematodon boasii* (holotype), both found on Forbidden Plateau. They are relatively protected within Strathcona Provincial Park, but may be subject to trampling because of their proximity to hiking trails.

5 Georgia-Puget Basin
(1.55%)

The Gulf Islands support only five species of rare bryophytes, but these populations are seriously threatened because of the small area encompassed by this ecoregion and increased land-use pressures. *Tortella humilis* is known in the province only from this ecoregion. Furthermore, the endemic hornwort, *Phaeoceros hallii*, has been collected on North Pender and Galiano islands.

6 Queen Charlotte Ranges
(16.32%)

The Queen Charlotte Ranges contain the largest proportion of rare bryophytes of any ecoregion. This includes 16 species found in no other ecoregion (liverworts: *Dendrobazzania griffithiana*, *Herbertus sendtneri*, *Kurzia trichoclados*, *Lophozia collaris*; mosses: *Andreaea mutabilis*, *Claopodium pellucinerve*, *Daltonia splachnoides*, *Gollania turgens*, *Pseudoleskea julacea*, *Sphagnum wilfii*, *Seligera careyana*, *Sphagnum junghuhnianum*, ***Sphagnum schofieldii***, *Trematodon montanus*, *Trichostomum recurvifolium*, *Zygodon gracilis*). The four species marked in bold are known from five or fewer locations throughout the world.

Areas particularly rich in rare species include the Athlow Bay, Mine Mountain, Takakia Lake, Moresby Mountain, and Moresby Lake areas. The degree of threat to each of these species varies according to its location; those on southern Moresby Island are protected in the South Moresby National Park Reserve, and those at Athlow Bay are protected in the V.J. Krajina Ecological Reserve. However, some species in submontane or montane areas outside parks or ecological reserves may be threatened by forest harvesting.

7 Pacific Ranges
(11.14%)

The Pacific Ranges ecoregion includes south coastal British Columbia. Of the 29 species located in this ecoregion, eight species are found in no other ecoregion and three are globally rare species (*Blepharostoma arachnoideum*, *Scapania hians* ssp. *salishensis*, and *Trematodon boasii*). Most of the 29 species have been collected in accessible areas, including Whistler, Garibaldi, Mount Seymour, and Cypress Bowl. These areas encompass alpine or subalpine areas, which affords them some protection from most human activities, but species at lower elevations are at risk from forest harvesting activities.

Although parts of this ecoregion are easily accessible, many areas, particularly fiords and inlets along the coast, remain largely inaccessible, so much of the ecoregion has not been inventoried for bryophytes.

Only 10 rare species have been found on western Vancouver Island. Five species (liverworts: *Blepharostoma arachnoideum*, *Calycularia crispula*, *Lophozia*

**8 Western Vancouver
Island**
(3.37%)

elongata, *Sphenolobopsis pearsonii*; mosses: *Oedipodium griffithianum*) occur in the Brooks Peninsula Recreational Area where they are protected from logging. The area is also very remote, which likely minimizes the effect of recreational activities.

However, several low-elevation species, *Pohlia sphagnicola*, *Seligeria acutifolia*, and *Sphagnum subobesum*, are found in unprotected areas (Bamfield, Kennedy Lake) and are at risk, primarily from forest harvesting activities.

9 Coastal Gap
(2.59%)

Eight rare species are known to occur in the Coastal Gap ecoregion, which encompasses the central coastal area of British Columbia. However, much of the ecoregion has not been inventoried for bryophytes, particularly the inaccessible areas along the coast, so the number of rare species may be substantially larger than current estimates suggest.

Only four known sites within this ecoregion support rare bryophytes: Inver Creek, Kwintisa River, Thornhill Creek, and Pitt Island. Logging activities in the Inver Creek area have likely eliminated local populations of three rare species; unfortunately, one of these species, *Bryhnia hultenii*, is not known from any other site in the province (Schofield pers. comm. 1993).

**10 Northern
Mountains and
Plateaus**
(10.88%)

This ecoregion encompasses a large part of northern British Columbia and contains a substantial proportion of rare bryophytes. However, localities where rare bryophytes have been found are relatively few (Glacial Lake, Simpson Peak, Peak Lake, and Atlin areas). This reflects the limited number of collections that have been made in this ecoregion, and it is likely that some of these species will probably be found at other sites in the future. Estimating the degree of risk to bryophytes is difficult because so few areas have been investigated to any extent. The Glacial Lake area, where the largest number of rare species has been collected, is located near the treeline; therefore, logging is not likely to be a threat to these species.

Of the 34 rare species found within this ecoregion, eight species are found in no other ecoregion (liverworts: *Gymnomitrium apiculata*, *Marsupella revoluta*, *Mesoptychia sahlbergii*; mosses: *Didymodon johansenii*, *Loeskypnum badium*, *Pseudobryum cinclidioides*, *Psilopilum cavifolium*, *Ulotia curvifolia*).

**11 Columbia
Mountains and
Highlands**
(8.29%)

The Columbia Mountains and Highlands ecoregion covers a large area of the province west of the Southern Rocky Mountain Trench. None of the 22 rare species found here is globally rare, although eight species (liverwort: *Cephaloziella elachista*; mosses: *Bryum blindii*, *Grimmia mollis*, *Hygrohypnum norvegicum*, *Orthotrichum pallens*, *Scouleria marginata*, *Sphagnum jensenii*, *Warnstorfia procera*) are found in no other ecoregion in British Columbia.

Rare species have been collected at a large number of sites; two of the richest are Wells Gray Provincial Park and the Revelstoke area. Many collection sites appear to be in subalpine or alpine areas, meadows, lake margins and creek banks. Changes in microhabitat conditions resulting from forest harvesting activities in nearby areas (e.g., changes in water flow, increased light intensity, and extremes in temperature) may have a negative impact on some species.

Much of this ecoregion is inaccessible. Of the 20 rare species, 10 species (liverworts: *Cephalozia macounii*; mosses: *Andreaeobryum macrosporum*,

12 Northern Canadian Rocky Mountains
(8.03%)

Aulacomnium acuminatum, *Cynodontium glaucescens*, *Encalypta longicolla*, *Grimmia unicolor*, *Mielichhoferia macrocarpa*, *M. mielichhoferiana*, *Molendoa sendtneriana*, *Trichostomum arcticum*) are found in no other ecoregion. Almost all rare species are found in the Wokkpash Lake, westernmost Tuchodi Lake, and Summit Lake areas. No doubt some of these species will be found at other locations, but until further bryological investigations have been made, we cannot determine which species are undercollected and which are actually rare. The inaccessibility of this ecoregion probably minimizes potential threats to rare bryophytes.

13 Western Continental Ranges
(5.18%)

One of the rarest species of bryophytes within the province is *Cephaloziella brinkmani*, a globally rare species known only from a single site in Yoho National Park. Of the other 11 species known in this ecoregion, two (liverworts: *Lophozia laxa*; mosses: *Bartramia halleriana*) are found in no other ecoregion. Fortunately, most of these rare species have been collected in protected areas (Yoho National Park and Mount Robson Provincial Park).

14 Other Ecoregions

The remaining ecoregions support only a few, if any, rare bryophytes. The most likely explanation for the lack of rare species is that for most ecoregions only superficial, if any, bryological inventories have been made. This is particularly true for northern ecoregions (e.g., St. Elias Mountains, Kluane Plateau, Yukon-Stikine Highlands), where lack of funding and accessibility have prevented serious bryological investigations. The smaller ecoregions (e.g., Southern Rocky Mountain Trench [0.52%], Okanagan Range [0.78%], Cascade Range [0.52%]) probably support proportionally fewer rare species in comparison to larger ecoregions.

POTENTIAL THREATS TO RARE AND ENDANGERED BRYOPHYTE SPECIES

1 Forest Harvesting

In discussing potential threats to rare bryophytes, it is important first to examine the types of habitats in which these species have been found. Based on habitat descriptions provided on specimen labels or in the literature, the proportion of occurrences of rare bryophytes on various substrates are as follows:

soil	46.3%
rock	40.2%
logs	4.5%
epiphytes	6.9%
other	2.1%

It is surprising that few rare bryophytes have been collected on trees, logs, and the forest floor, particularly considering the extent to which bryophytes are a major component of coastal forests. Although habitat information is vague for many of the examined specimens, many rare species appear to have been collected on soil or rock substrates in relatively open sites such as those found in subalpine and alpine regions, on cliff faces (including limestone) and boulders, along the margins of creeks and lakes, or in fens, meadows, or bogs. Although many rare specimens appear to have been collected at high elevations, habitat information prevents an accurate estimate of the number

of specimens found in subalpine and alpine regions and therefore protected from logging. For species occurring at lower elevations in open habitats, forest harvesting remains a potential threat. This is particularly true for species that are found along creeks and on cliffs adjacent to forested areas (Schofield 1990). Removal of the forest would drastically change the microhabitat conditions. Changes in water flow, increased light levels, and increased exposure to air currents would probably mean longer and more intense periods of desiccation for the bryophytes.

Forest harvesting is the largest industry in British Columbia and has the greatest overall impact on the native vegetation. Yet few studies have been made of either the short-term or long-term impacts of clearcut logging on the bryoflora. Personal observations (Ryan and Fraser 1993) on southeast Vancouver Island indicate that clearcut logging eliminates almost all bryophyte species. Yet, once regenerating conifers had reached a sufficient size to form a forest canopy, many of the eliminated species are, once again, present on the forest floor, rotten logs, and rocks. Hence, at a local scale, there appears to be little impact on the bryoflora. However, with increasing fragmentation of the forest, as more areas are logged and old-growth forests are converted to short-rotation, second-growth stands, serious questions arise regarding the impact these local extinctions of populations will have on the long-term survival of a species. This is particularly important for those species (including vascular plants) that are characterized by very short dispersal distances. It may be that some species will slowly be eliminated because they are unable to become re-established in immature or mature forests because diaspore sources are too far away or the number of years allowed in a rotation are too short, so that the length of time for establishment and population growth are insufficient for the long-term survival of the species. Likewise, although many species are not restricted to old-growth forests, they may reach their greatest abundance in these stands and may be the main source of inoculum by which many species become established in younger second-growth forests. With the elimination of old-growth forests, there may be serious declines in the abundance of some species. However, more inventory work is required to identify which of these species are most likely to be negatively affected by logging.

In association with Spotted Owl studies in Pacific Northwest states, the Forest Ecosystem Assessment Team (1993) recently assessed the effect on bryoflora of harvesting old-growth forests. The findings suggest that most species of bryophytes do not become established until stands are at least 100 years old, and do not reach their greatest development until stands are 400 years old. Three areas where bryophyte diversity was particularly high included riparian habitats, shaded rock outcrops, and trees along ridges and summits where fog interception is common. Of the 106 species examined, eight species were considered to be rare. Five of these species are confined to, or are often found in, riparian habitats; they include *Blindia flexipoda*, *Marsupella emarginata* var. *aquatica*, *Pseudoleskeella serpentinese*, *Racomitrium pacificum*, and *Tritomaria exsectiformis*. In addition, *Diplophyllum plicatum* is a rare species found on bark, decaying wood, and soil over rock, and *Schistostega pennata* occurs on shaded moist soil beneath the roots of windfall. An eighth species, *Ptilidium californicum*, is common on tree trunks and is only rare in northern California.

Similar concerns have been expressed in other studies where researchers have found that some species are absent or in reduced quantities in young stands in the western United States (e.g., Norris 1987; Lesica et al. 1991; McCune 1993). Similarly, in Terra Nova National Park in Newfoundland, Hedderson (1992) reported that a number of rare species were found in old-growth *Abies-Hylocomium* forests, but were absent in other forest types.

In European countries, including Sweden (Söderström 1988; Gustafsson et al. 1992), Finland (Laaka 1992; Lampolahti and Syrijänen 1992), Germany (Meinunger 1992), Hungary (Orbán 1992), and Russia (Konstantinova 1992), forest harvesting has been cited as an important factor in the decline of many bryophyte species because immature forests do not provide suitable habitats necessary for the establishment and growth of rare species.

2 Agricultural Activities

A second threat to rare bryophytes is the expansion of agricultural activities into relatively undisturbed areas that support native vegetation. This is a critical concern in the southern interior of the province. Although the area supports a limited number of bryophytes, recent work by McIntosh (1989) uncovered a large number of species previously unknown in British Columbia. In fact, some of the species reported as new records to B.C. or Canada were fairly common at a number of sites. Yet in many areas, much of the fragile cryptogamic crust covering the soil has been eliminated by heavy cattle-grazing. It is unfortunate that so much native vegetation in this region has been either altered or damaged before a thorough investigation has been made of the bryoflora. McIntosh (1989) estimates that 76% of the bryoflora is terricolous (occurring on soil) and is more at risk than those species that inhabit rock substrates (which appear to remain relatively undisturbed in areas influenced by agricultural activities).

3 Air Pollution

A third threat to bryophytes is air pollution (including acid rain). Areas of greatest concern are Vancouver, the Fraser Valley, possibly the Victoria region, and smaller populated areas where industry may be emitting a substantial amount of air pollution. It has long been known that lichens are extremely sensitive to air pollution and are often the first organisms to either show some evidence of damage or to disappear from a polluted area. It has also been shown that bryophytes are sensitive to air pollution (e.g., Gilbert 1970; LeBlanc and de Sloover 1970; Nash and Nash 1974; Rao et al. 1977; Puckett 1988; Winner 1988; Burton 1990; Lee et al. 1990; Tyler 1990).

Unlike vascular plants, which limit and control the area of gas exchange with the atmosphere, lichens and most bryophytes readily exchange gases over their entire surface and have no functional stomata to control gas exchange. Furthermore, they readily absorb water, including dissolved pollutants, over their entire surface. Hence, these organisms are often the first to show signs of stress or are the first to disappear from a site because of air pollution. Unfortunately, no studies have been completed in B.C. to determine if bryophytes are currently being damaged by air pollution, nor has anyone estimated what impacts the most common air pollutants may have on the province's bryoflora. An additional problem with air pollution is that, unlike forestry and agricultural activities, which can be banned in protected areas, air pollution does not recognize political or jurisdictional boundaries, so that, even in a park, rare species may be eliminated because of declining

air quality. Despite the lack of information, it is unlikely that air pollution is currently as great a threat to bryophytes as it is in many European countries, where it is often cited as an important cause in the decline of many species (e.g., Greven 1992; Hallingbäck 1992; Konstantinova 1992; Meinunger 1992; Vána 1992, van Zanten 1992).

4 Residential Development

Of particular concern in the lower mainland and southeastern portion of Vancouver Island is the rate of development into relatively undisturbed areas. For example, Garry oak communities, largely restricted to southeastern Vancouver Island, are rapidly disappearing. Although sometimes a few trees are left standing, the understorey vegetation is destroyed and many epiphytic species are eliminated because of drastic changes in microclimatic conditions. Three rare bryophytes restricted to Garry oak stands include the hornwort *Phaeoceros hallii* and the mosses *Bartramia stricta* and *Syntrichia laevipila*. Residential development also poses a serious threat to bryophytes within local parks. With expanding population, recreational pressure on existing parks in the Vancouver and Victoria areas increases the likelihood that existing populations of bryophytes will be eliminated by foot, horse, or, more recently, mountain-bike traffic. Unfortunately, bryophytes in many parks, particularly those in the Victoria area, have not been adequately inventoried, if at all.

It is interesting that some rare species were previously collected in habitats altered by humans. These include the mosses *Discelium nudum*, *Micromitrium tenerum*, and *Pseudephemerum nitidum*, located along ditch banks, beneath powerlines, and on silt hummocks, respectively. Unfortunately, these disturbed habitats are also subject to invasion by vascular plants or further human disturbance. All known populations of these species are extirpated (Schofield 1990).

5 Global Warming

The potential threat of global warming is difficult to assess for British Columbia. Bryophyte species that are probably most at risk are those that inhabit alpine areas. With increased temperatures, it is likely that alpine areas will shrink, resulting in the elimination of bryophytes adapted to open and exposed sites. This is of particular concern in small, discrete alpine habitats because an entire area may eventually become dominated by subalpine forests, which would result in the local extinction of alpine bryophytes. Alternatively, increasing temperatures will likely result in the introduction of bryophyte species not currently found in the province, including species that currently reach their northern ranges in Washington and Oregon.

An additional risk associated with global warming (which may have a much more serious impact on the bryoflora than increasing temperatures) is a possible change in rainfall pattern throughout the province. Moisture availability is one of the most critical factors influencing the distribution of bryophytes, which, unlike vascular plants, are in intimate contact with the current moisture conditions of their habitat. Increased periods of drought and decreased precipitation generally associated with higher temperatures (increased rates of evaporation) will likely result in changes in the bryoflora over much of the province. It is possible that the ranges of species associated with drier areas of the province will expand, whereas the ranges of species associated with wetter regions will contract.

6 Ignorance

Lastly, the greatest threat to any population of bryophytes is ignorance; the odds are very remote that anyone has knowingly eliminated a rare bryophyte species in British Columbia. Part of this ignorance lies in the fact that bryophytes are small; their diminutive stature and lack of showy flowers protects them from indiscriminate collecting, but it also puts them at risk of unintentional destruction. Unfortunately, ignorance about bryophytes is also commonplace in many government and private institutions, including those that may have a tremendous influence on the continued existence of rare species. Although British Columbia has one of the most diverse examples of bryoflora in the world, financial support for bryological research has been very poor. Only the University of British Columbia (W.B. Schofield) and the Royal British Columbia Museum (C. Chuang) have supported full-time bryological researchers. Unfortunately, neither institution has hired a full-time replacement after the death of Chuang and the recent retirement of Schofield. Similarly, support for the maintenance of bryological collections is limited. Yet these collections are important for several reasons:

- a) With increasing concern over the preservation of endangered species, herbaria represent a storehouse of information needed to identify those species that have been rarely collected and are, therefore, likely to be rare in the province. Herbaria collections probably do not provide a completely accurate view of B.C.'s bryoflora; some rare species may have been overcollected, while some more common (but difficult to identify) species may be underrepresented. Yet these collections provide one of the few sources of information by which to objectively assess the bryoflora of British Columbia. If these collections were absent, we would have to rely solely on literature reports that would fail to identify many rare species. Without these herbaria, it is likely that the species listed in this report would only number about 50, because so much of this information has not been published.
- b) The herbaria provide the only physical evidence that many of these species have been collected in the province. This is critically important, given the difficulties in identifying some species. Furthermore, without voucher specimens, there is no means by which records of previously collected specimens may be annotated.
- c) Collections are important when taxonomic research suggests alterations in the delineation of species so that specimens must be re-examined to confirm their identity.
- d) Herbaria are a critically important source of information for confirming the identity of recently collected specimens (particularly the more difficult species).

Taxonomic research of bryophytes provides the cornerstone on which other avenues of bryological research are based. Without a strong taxonomic base to identify and distinguish species, our understanding of B.C.'s bryoflora would be seriously impaired. Unfortunately, basic taxonomic or ecological research of bryophytes, as well as vascular plants, appears to garner little support at most universities; it is often viewed as old-fashioned or outdated in comparison to other biological endeavours. Interestingly, in recent years, government agencies appear to have taken the lead in funding and supporting ecological investigations of vascular plants, and occasionally bryophytes,

particularly with increased interest in biodiversity. Yet, to many biologists, “A moss is a moss is a moss . . .” (Taylor 1980). No doubt part of this attitude is due to the difficulty, time, and patience that is required to become familiar with many species, although most of the common species are easily identified with a little practice. Yet a large number of species remain unidentifiable without dissecting and light microscopes, an adequate key, a certain amount of practice and patience, and an adequate herbarium containing accurately identified specimens.

Unfortunately, there is no comprehensive key for the liverworts of British Columbia. Schuster’s flora (1966–1992) provides detailed descriptions and keys of liverworts, but it was written for eastern North America and does not include many species found in the west, including common species such as *Scapania bolanderi*. Alternatively, Godfrey’s thesis (1977a) provides excellent descriptions and keys of many western North American species but only considers those species that are found in southwestern British Columbia.

Lawton’s flora (1971) includes all of the mosses (except the genus *Sphagnum*) found in southern British Columbia (although a number of species have been found since publication). Unfortunately, the generic key is somewhat difficult to use and the layout of the manual, with descriptions of the species in the first half and drawings of the species in the second half, may quickly lead to frustration. Also, species descriptions include very little ecological and distributional information, and the drawings for many species are inadequate (a single leaf or a cross-section showing leaf cells is all that is shown for many species). Both of Schofield’s handbooks (1969a, 1993b) and that of Vitt, Marsh and Bovey (1988) provide substantial ecological and distributional information on many species of bryophytes in British Columbia; however, many of the less common species are absent, so that it is of limited use in attempting to provide a complete inventory of the bryoflora for a given area.

Fortunately, most species of bryophytes are “taxonomically stable,” so that the characters used to distinguish closely related species are reliable (although sometimes difficult to use). A possible exception is the moss genus *Bryum*, which contains a large number of species, many having few reliable characters to distinguish them (Schofield pers. comm.). A problem with some genera is that distinctions between closely related species are clear, but the species have been assigned different names by different researchers so that it is often difficult to determine which name applies to which species (Schofield pers. comm.). This is a problem for the genera that includes the large group of liverworts that belong, or are closely related, to the genus *Jungermannia*, and the large moss genus *Grimmia*, which has undergone several changes so that groups of *Grimmia* species have now been assigned to other genera. Recently, an extensive review of the moss family Pottiaceae by Zander (1993) resulted in many changes to the genera and species of this family.

An additional reason bryophytes have been of little interest to non-bryologists is that much of the research has maintained a narrow focus, and the results provide little applicable information either to the processes occurring in the ecosystem or to other groups of organisms. This partly reflects the early stage in the development of bryology, where much of the research is focused on describing the flora of an area or understanding basic ecological

or physiological processes. Fortunately, in recent years there has been greater interest in research that has implications for other organisms (see Gerson 1982, review by Davidson et al. 1990; During and Van Tooren 1990), or the role of bryophytes in ecosystems (e.g., Pike 1971; Lee and La Roi 1979; Binkley and Graham 1981; McCune and Antos 1981; Brown and Bates 1990).

Currently, there is no system within any government or private agency for bringing information on rare or endangered bryophytes to the attention of key personnel who may have a great impact on existing populations. Even in protected areas, bryophytes may easily be eliminated by the construction of a new trail, increased trampling, or by unintentional modification or destruction of their habitat, simply because neither managers nor users are aware of their existence.

CHARACTERISTICS OF RARE AND ENDANGERED BRYOPHYTE SPECIES

As discussed above, most rare bryophytes are found on soil or rock substrates in fairly open habitats. Several other characteristics may apply to these species, but further research is required before they can be considered to be accurate statements. Some of these characteristics include:

- a) A number of bryophyte species infrequently produce spores or asexual gemmae, restricting their ability to successfully invade new habitats. Another factor, which may be associated with the lack of spore production, is that the species may show little genetic variation and thus little ability to adapt to changes in the environment. This could result in the elimination of established populations, over time, as environmental conditions change.
- b) A species may be rare because it has specific habitat requirements that are infrequent or rare in British Columbia (e.g., species confined to Garry oak stands). Unfortunately, the habitat requirements of even the most common species in the province have not been adequately documented. However, field observations of the substrate and microhabitat conditions in which rare species have been collected provide valuable clues about the range of conditions under which they may be found in other locations.
- c) As noted by Schofield (1990), a number of rare species that occur in British Columbia are at the limits of their range. These include species more frequently found either in coastal and arid regions of the United States or in arctic regions of Alaska and Canada. Some of these species are probably limited because suitable microclimatic or substrate conditions are rare for either establishment or reproduction of these species. Alternatively, other species are rare throughout their range but, again, specific habitat conditions or the lack of reproduction may limit their establishment in adjacent areas. Although it could be argued that species that are more common elsewhere need not be of concern, their occurrence represents an integral part of the natural heritage of the province and these populations may be composed of rare genotypes not found in other locations.
- d) Some of these species may not be truly rare because:

- i) they occur in areas of the province that have not been adequately inventoried;
- ii) they are rarely collected because they are tiny and are often overlooked;
- iii) they rarely occur in sufficient quantities to provide enough material for proper identification; or
- iv) collected specimens usually lack the structures (e.g., capsules or spores) necessary for accurate identification.

Hedderson (1992) reported that a disproportionate number of rare species in Terra Nova National Park in Newfoundland reproduce primarily by fragmentation. Likewise, in a recent examination of rare and endangered bryophytes in Great Britain, most rare species tended to be those that were (1) dioecious and never or rarely produced spores, but were maintained by asexual forms of reproduction (e.g., fragmentation), and (2) monoecious species that produced sporophytes (Longton 1992). Monoecious species may reproduce exclusively by self-fertilization so that, like the rare dioecious species, they may lack the genetic variability needed for rapid adaptation to environmental change. Another factor may be that the small number of existing colonies limits the dispersal ability of species belonging to either group, particularly if they are adapted exclusively to rare or widely dispersed microsites. Of the 67 species in Britain that are considered to be globally rare, Longton (1992) reports that most are small acrocarpous species (those with erect stems that often occur in clumps or cushions) occurring on rock faces, disturbed habitats, or other sites where the colonies persist for a limited period and are eventually replaced by other species.

SURVEY TECHNIQUES

As discussed above, many bryophytes are easy to identify in the field with a little practice and patience. It is not uncommon to see the most common species, such as *Hylocomium splendens*, *Pleurozium schreberi*, *Rhytidiadelphus loreus*, or *Eurhynchium oreganum*, recorded in general vegetation surveys. These species are most abundant on the forest floor where they often form extensive mats. Unfortunately, the greatest diversity of bryophytes often occurs on atypical substrates, such as rocks, cliff faces, rotten logs, or tree trunks. These substrates are often ignored in vegetation surveys because they do not, at least to some ecologists, reflect overall site conditions. However, if these substrates are sampled in future surveys, they could yield a wealth of information on the distribution patterns of many species and provide further information on the distribution of rare species.

There is no expedient method by which the bryophytes of an area may be adequately inventoried; it requires intensive sampling of the many specialized microhabitats in which most bryophytes are found. All microsites should be examined to collect representative species as well as species that occur sporadically in the area. Samples of all species should be collected. Collecting duplicate specimens of species that cannot be accurately identified in the field, including many of the minute leafy liverworts and mosses, is particularly critical. Unfortunately, rapid surveys in which only a few of the

most abundant bryophytes are collected will serve little purpose in providing information on rare and endangered species.

It is apparent from examining herbarium labels that, to meet the basic information requirements for maintaining bryological diversity in the province, more detailed and accurate information must be recorded. In terms of preserving bryological diversity, it serves little purpose if a rare species is collected but not enough information is available to locate the population in the field at a future date.

When specimens of bryophytes thought to be rare are collected, the following information should be recorded:

1. Species name

2. Locality A record of locality is particularly critical for finding rare species in the field at a future date. Information should include a place name (recognized in the B.C. Gazetteer), latitude and longitude or, preferably, the U.T.M. reference point, and the distance from a recognizable and more or less permanent landmark.

3. Habitat Habitat information is important, particularly the substrate from which the specimen was collected. Dr. Judy Godfrey developed the form below to quickly identify habitat conditions when collecting liverwort specimens in the field. This form may be modified to suit the requirements of specific inventories. Some categories may be further sub-divided to provide more detailed habitat information. (See the form on page 39.)

4. Associated Vegetation Information should also be recorded about the type of vascular vegetation in the area where the specimen was collected, with a notation of the ecoregion and biogeoclimatic zone, subzone, or variant. It would also be useful to include an estimate of the area (m²) over which the species occurred, and the number of colonies (clumps or mats) found at the site.

5. Date of collection

6. Name of collector(s) and collection number

7. Determined by Name of individual who identified the specimen.

8. Specimen Enough material to permit an accurate identification of the specimen should be collected. Although it depends on the size of the plant and the amount of available material, roughly a handful should be collected. It is also useful to collect plants bearing sporangia and sporophytes, as these are required for the identification of some species. In the field, specimens should be placed in paper bags or in folded paper packets (see Ireland [1982]; Schofield [1993b]; or Vitt et al. [1988] for instructions on constructing paper packets). Although plastic bags are not recommended for collecting mosses (specimens will quickly decay), they may be practical for use in very wet weather provided that specimens are transferred to paper bags or packets

SAMPLE FORM

Habitat Information

ID:.....

Circle one item per entry

Site:

forest, woods, meadow, ridge, slope, valley, canyon, ravine, beach, waterfall, lake, pond, river, ocean, stream, bank, swamp, marsh, bog, depression, trail, roadside

Tree:

trunk, branch, root, leaf, stump
height above ground.....

Log:

recent, decorticated, decaying

Soil:

gravel, sand, clay, litter, humus, peat, over rock

Type of rock:

- a) siliceous, basic
- b) rock, boulder, outcrop, ledge, cliff base/cliff, roof of overhang, crevice, crest, vertical

Other Information:.....

dry, meso, moist, wet, spray, seep, submerged (stand, flow, rapids)

Exposure: N S E W

Elevation:.....

open: full – diffused light

shade: partial – full

very abundant, abundant, infrequent, rare, very rare (.....%)

Found with:.....

soon after. Specimens of mosses should be allowed to dry out at room temperature. Thallose liverworts often become unrecognizable once they have dried, so they should be kept in a plastic bag in a cool place, such as a fridge, to prevent desiccation (although they will decay and turn mouldy within a few weeks). Likewise, leafy liverworts should be kept moist and cool until they can be identified because many species contain characteristic subcellular oil bodies that are useful in identification and would be destroyed if the plant was allowed to dry out.

Although many common species of bryophytes are easily identifiable, many others are extremely difficult to identify. It is unrealistic to expect the casual collector to adequately sample the bryoflora of an area or to identify many of the less common species with a high degree of accuracy. Furthermore, even relatively small collections may take a long time to identify. For example, in one 8-day period, Geoff Godfrey collected over 600 specimens in the Alsek-Tatshenshini area. However, after 150 hours of work spent on

identification, only half have been examined, 70 species have been identified, and many minute and difficult specimens still await identification (Geoff and Judy Godfrey pers. comm.).

RECOMMENDATIONS

This report provides only a preliminary examination of rare and endangered bryophytes in British Columbia. It is restricted to species considered critically imperilled because they have been collected at five or fewer locations in British Columbia (S1 species).

1. Further research is required to identify species belonging to other categories designated by the Conservation Data Centre at provincial and global levels (see Appendix B). Specimens located at herbaria outside of British Columbia (primarily those at the University of Alberta and the Canadian Museum of Nature [Natural Sciences]) also need to be examined for information regarding additional locations where some of these species may be found.

Information is critically important, both for a proper understanding of the bryoflora of British Columbia and for the developing inventory requirements. Although many areas have not been adequately inventoried, much information is available in published and unpublished documents and on herbarium labels. Unfortunately, this information has not been consolidated into an accessible and organized catalogue. At present, about two-thirds of the UBC herbarium specimens are in a database (being modified by René Belland for PC-use), and all of the Royal British Columbia Museum herbarium specimens are in a database, but most records consist of only accession numbers and species names. None of the specimens at the University of Victoria, University of Alberta, or the Canadian Museum of Nature is in a suitable database.

2. A database should be set up, containing, at the very least, records of all rare bryophyte species that have been collected in British Columbia. The individual record should include species name, habitat, locality (latitude and longitude or U.T.M.), collector, date of collection, person who identified the specimen, accession number, and herbarium. The database should be easily accessible and periodically updated. Locality records should also be compiled for species that are not critically rare but that have a very restricted distribution, or species that reproduce rarely by spores (potentially, genetically uniform populations).

There is no current checklist or comprehensive key for the liverworts of British Columbia. Lack of a key means that collection and identification of liverworts is limited to those few researchers who have accumulated most of the widely scattered literature (reports, monographs, identification manuals for other regions) necessary to identify liverworts within the province.

3. Funding should be provided to construct a comprehensive checklist for the liverworts in British Columbia, with an annotated bibliography of literature pertinent to identifying genera and species.

4. Funding should be provided to support a co-ordinator to carry out recommendations 2 and 3, and to help naturalist groups to assemble species lists for areas where conservation or preservation issues are important.

Much could be learned about the distribution and habitat conditions of species that are currently rare or endangered in British Columbia by exchanging information with individuals and groups in adjacent areas. This would also facilitate compiling a list of species not currently known in British Columbia, but likely to be found in suitable habitats.

5. A network should be formed that includes B.C. researchers and individuals and groups interested in rare and endangered bryophytes in adjacent provinces and states. The most important inventory requirements are outlined in the first three recommendations. However, until the inventories are complete, concurrent field studies should be conducted, particularly in areas scheduled for development (Schofield and Belland pers. comm.). To lose substantial areas of the landbase without knowing what we are losing, including the bryoflora, is not responsible management.

Similarly, although they are relatively protected, bryophytes in parks and ecological reserves have not been adequately inventoried. It is ironic that these areas have been set aside to preserve examples of our natural heritage, but that our knowledge of their bryoflora is almost non-existent. Future decisions on conservation and preservation of bryophytes must be based on information rather than on educated guesses.

It is also important to inventory ecoregions and biogeoclimatic zones where bryophytes are most at risk (e.g., Lower Mainland, Thompson-Okanagan Plateau, Coastal Douglas-fir). Field studies could search for other potentially rare species, particularly on rock and soil substrates, and re-identify localities of known populations to ensure that they still exist (e.g., the moss *Tortula truncata* [= *Pottia truncata*] was once much more abundant in the province than it is today [Schofield 1990]). Field studies would also help to determine if species are truly rare or merely undercollected, and provide more accurate information on the distribution of other species.

6. Funding and support must be provided for field studies. Priorities include: areas scheduled for development, existing parks and ecological reserves, and those ecoregions and biogeoclimatic zones in which bryophytes are most at risk.
7. A standardized method for collecting bryophytes should be developed, particularly for non-bryologists who may provide too little material or insufficient information for identification.

Without some form of legal protection, there is little hope that rare and endangered bryophyte species can be protected from destruction when they are in conflict with competing interests.

8. Legislation, in the form of an “Endangered and Threatened Species Act” for British Columbia, is required to provide protection for threatened and endangered bryophyte species.

Important collections of British Columbia bryophytes include:

1. Herbarium, Department of Botany, University of British Columbia, #3529-6270 University Boulevard, Vancouver, BC V6T 1Z4. Attn: Olivia Lee (Approximately 100 000 specimens from British Columbia.)
2. Herbarium, Department of Botany, University of Alberta, Edmonton, AB. T6G 2E9 (Approximately 20 000 specimens from British Columbia.)
3. Herbarium, Botany Division, Canadian Museum of Nature, Ottawa, ON. K1A 0M8 (Approximately 20 000 specimens from British Columbia.)
4. Herbarium, Royal British Columbia Museum, 675 Belleville Street, Victoria, BC V8V 1X4 (Approximately 3500 specimens from British Columbia.)
5. Herbarium, Department of Biology, University of Victoria, Victoria, BC V8W 2Y2 (Approximately 2300 specimens from British Columbia.)

The following people may provide support in identification or confirmation of some bryophyte specimens. The terms and conditions for providing assistance varies according to their own schedule, the type and number of specimens being sent, and the individual or institution requesting aid. It is strongly advised to write before sending any specimens for identification or confirmation.

**British Columbia and
Canada**

1. Dr. Wilf Schofield, Department of Botany, University of British Columbia, #3529-6270 University Boulevard, Vancouver, BC V6T 1Z4.
2. Dr. Dale H. Vitt, Department of Botany, University of Alberta, Edmonton, AB T6G 2E9.
3. Dr. René Belland, Department of Botany, University of British Columbia, #3529-6270 University Boulevard, Vancouver, BC V6T 1Z4.
4. Dr. Robert Ireland, 23 Parkfield Crescent, Nepean, ON K2G 0R9.
5. Dr. Terry McIntosh, Biology Department, Wilfrid Laurier University, 75 University Avenue, Waterloo, ON N2L 3C5.
6. Frank Boas, Box 462, Cowichan Lake, BC V0R 2G0.
7. Dr. Judy Godfrey, 2864 Colquitz Road, Victoria, BC V9A 2M1 (liverworts).
8. Michael Ryan, 4467 Wilkinson Road, Victoria, BC V8Z 5C2.

United States

1. Dr. Diana G. Horton, Department of Botany, University of Iowa, Iowa City, IA 52242.
2. Dr. Won S. Hong, Department of Biology, College of Great Falls, Great Falls, MT 59405 (liverworts).
3. Dr. Barbara Murray, University of Alaska Museum, University of Alaska, Fairbanks, AK 99775-1200.
4. Dr. Richard Andrus, Department of Biological Sciences, Binghamton University, Binghamton, NY 13902-6000 (*Sphagnum*).
5. Dr. William Buck, New York Botanical Garden, Bronx, NY 10458-5126.
6. Dr. L.E. Anderson, Department of Botany, Duke University, Durham, NC 27706.

The Conservation Data Centre uses a ranking system as a basis for identifying those bryophyte species that are rare or endangered in British Columbia.

Each “element” (for example, a species) on the Conservation Data Centre’s list is ranked using the system developed over the last 20 years by the Nature Conservancy. This system is now in use in three Canadian provinces, all U.S. states, and a number of Latin American countries. Most government agencies within these jurisdictions have also adopted this ranking system.

Each element is ranked at two levels: global (G) and provincial or “subnational” (S). The global rank is based on the status of the element throughout its entire range, whereas the provincial rank is based solely on its status within British Columbia. The global rank is established by a biologist assigned to that element by the Nature Conservancy; the provincial rank cannot exceed the global rank.

The status of an element is indicated on a scale of 1 to 5; the score is based primarily on the number of extant occurrences of the element, but other factors, such as abundance, range, protection, and threats are also considered if the information is available. Generally speaking, the Conservation Data Centre will track only those species with ranks of 1 to 3. In addition to the ranks 1 to 5, there are several letter ranks; all are defined below.

- 1 = Critically imperilled because of extreme rarity (five or fewer extant occurrences or very few remaining individuals) or because of some factor(s) making it especially vulnerable to extirpation or extinction.
- 2 = Imperilled because of rarity (typically 6 to 20 extant occurrences, or few remaining individuals) or because of some factor(s) making it vulnerable to extirpation or extinction.
- 3 = Rare or uncommon (typically 21 to 100 occurrences); may be susceptible to large-scale disturbances (e.g., may have lost extensive peripheral populations).
- 4 = Frequent to common (greater than 100 occurrences); apparently secure but may have a restricted distribution, or there may be perceived future threats.
- 5 = Common to very common; demonstrably secure and essentially in-eradicable under present conditions.

Letter Ranks

- H = Historical occurrence; usually not verified in the last 40 years, but with the expectation that it may someday be rediscovered.
- X = Apparently extinct or extirpated, without the expectation that it will be rediscovered.
- U = Status uncertain, often because of low search effort, or the cryptic nature of the element; uncertainty spans a range of four or five ranks.
- R = Reported from the province, but without persuasive documentation for either accepting or rejecting the report.

Appendix B Continued

- RE = Reported in error, but this error has persisted in the literature.
? = No information is available or the number of extant occurrences is estimated.
A = An element (usually an animal) that is considered accidental or casual in the province; a species that does not appear on an annual basis.
E = An exotic or introduced species to the province.
Z = Occurs in the province but as a diffuse, usually moving population; difficult or impossible to map static occurrences.

In addition to the above ranks, four letter qualifiers are sometimes used in conjunction with them:

- T = Designates a rank associated with a subspecies.
B = Breeding; the associated rank refers to breeding occurrences of mobile animals.
N = Non-breeding; the associated rank refers to non-breeding occurrences of mobile animals.
Q = Taxonomic validity of the element is not clear or is in question.

The following is a list of rare and endangered bryophyte occurrences in British Columbia; all species are known from five or fewer localities. Some species have been collected more than once from the same locality, but duplicate specimens are not listed. The source of the report (or the herbarium for examined specimens), the habitat, and the locality for each reported occurrence are shown (if the information is available).

Hornworts

Phaeoceros hallii (Aust.) Prosk.

Phaeoceros hallii is endemic to the west coast of North America. It grows in ephemeral habitats that are vulnerable to destruction (Schofield 1990).

1. Source: UBC Herbarium
Habitat: under rock, with *Pityrogramma triangularis*
Locality: oak bluffs, North Pender Island; ca. 48°48'N 123°18'W
2. Source: UBC Herbarium
Habitat: earth slope by sea
Locality: Lot 89, streamlet and sea beach, Galiano Island, south Strait of Georgia
3. Source: UBC Herbarium
Habitat: very wet soil in spring seepage exposed
Locality: near Ash Point on Pedder Bay, Garry oak knobs and surrounding field, Vancouver Island; 48°21'N 123°34'W
4. Source: Dr. Judy Godfrey (pers. comm.)
Habitat: data not available
Locality: Rocky Point, Metchosin

Liverworts

Arnellia fennica (Gott.) Lindb.

1. Source: UBC Herbarium
Habitat: shaded cliff face
Locality: Wokkpash Lake, southwest shore, Mount Roosevelt–Churchill Peak area
2. Source: (Godfrey and Godfrey, pers. comm.)
Habitat: lowlands by river
Locality: on Tatshenshini River (elev. 200 m)

Barbilophozia binsteadii (Kaal.) Loeske

1. Source: UBC Herbarium
Habitat: on wet peat at margin of sedge fen ponds
Locality: open tundra, Three Guardsmen Pass, Haines Highway

Blepharostoma arachnoideum M.A. Howe

Blepharostoma arachnoideum is endemic to western North America (Godfrey 1977a).

1. Source: UBC Herbarium
Habitat: damp cliff in streamlet
Locality: west side of Raza Island, Raza Passage; 50°18'N 125°01'W

Appendix C Continued

2. Source: UBC Herbarium
Habitat: shaded humic cliff face
Locality: lagoon near base camp, Brooks Peninsula, Vancouver Island; ca. 50°18'N 127°45'W
3. Source: (Godfrey 1977a)
Habitat: data not available
Locality: Port Renfrew
4. Source: (Godfrey and Godfrey, pers. comm.)
Habitat: Tatshenshini area (elev. 1040 m)
Locality: alpine
5. Source: (Godfrey and Godfrey, pers. comm.)
Habitat: Tatshenshini area (elev. 760–800 m)
Locality: subalpine (different location from that of 4)

Bucegia romanica Radian

The only other locations where this species is found are in Europe (Schofield 1990).

1. Source: UBC Herbarium
Habitat: damp cliff crevice
Locality: Glacial Lake, Cassiar Mountains, east side, boulder slope near lake, foot of Glacial Mountain; ca. 58°20'N 129°30'W
2. Source: UBC Herbarium
Habitat: wet earth on rocks
Locality: south slope of Mount Bosworth, Stephens; elev. 2640 m.

Calycularia crispula Mitt.

This species is also found in Asia, Africa, and Mexico. In the Pacific Northwest, it is found in humid alpine and subalpine locations in coastal British Columbia and southeast Alaska (Davison and Smith 1992).

1. Source: Davison and Smith (1992)
Habitat: data not available
Locality: Mount Seymour (Schofield and Davison 1801) – specimen located at the University of Tennessee
2. Source: Davison and Smith (1992)
Habitat: data not available
Locality: Pitt Island, Patterson Inlet (Schofield 86925) – specimen located at UBC (specimen not present at this time)
3. Source: Davison and Smith (1992)
Habitat: data not available
Locality: Athlow Bay, Goose Cove, Graham Island, Queen Charlotte Islands (Schofield 64652) – specimen located at UBC (specimen not present at this time)
4. Source: Davison and Smith (1992)
Habitat: data not available
Locality: Harris Peak, Brooks Peninsula, Vancouver Island (Schofield 82463) – specimen located at UBC (specimen not present at this time)

Appendix C Continued

5. Source: Davison and Smith (1992)
Habitat: data not available
Locality: west of Orchard Point (elev. ca. 600 m) (Boas 10) – specimen located at UBC (specimen not present at this time)

Cephalozia connivens (Dicks.) Lindb.

A circumboreal species (Godfrey 1977a).

1. Source: UBC Herbarium
Habitat: decaying wood in peaty hole in bog, moist, abundant
Locality: Delta Bog
2. Source: UBC Herbarium
Habitat: rotten log
Locality: brooklet near entrance to East Narrows, Skidegate Channel, Moresby Island, Queen Charlotte Islands

Cephalozia macounii (Aust.) Aust.

No specimens were available at this time but it has been found in the Wokkpash Lake area in northern British Columbia (Schofield pers. comm.).

1. Source: UBC Herbarium
Habitat: data not available
Locality: Wokkpash Lake area

Cephaloziella brinkmani Douin

This species is known only from a single location in Yoho National Park (Schofield 1990).

1. Source: Hong (1987) (specimen located at Yale University)
Habitat: bank of Lake O'Hara
Locality: Lake O'Hara, Yoho National Park

Cephaloziella elachista (Jack) Schiffn.

Cephaloziella elachista has a disjunct North America–western Eurasia distribution (Godfrey 1977a).

1. Source: UBC Herbarium
Habitat: near hot spring
Locality: Halcyon, B.C.

Cephaloziella phyllacantha (Mass. et Carest.) K. Müll.

1. Source: UBC Herbarium
Habitat: partially shaded and sheltered boulders, steep, heavy soil accumulation, irregular rock surface
Locality: Sunset Creek, 18 m, Relevé 74; 49°25'N 123°10'W
2. Source: UBC Herbarium
Habitat: on ceiling and crevices of overhanging cliff grotto, shaded
Locality: Lynn Creek Canyon, North Vancouver
3. Source: UBC Herbarium
Habitat: soil in rock crevice
Locality: near Croteau Lake, Forbidden Plateau, Vancouver Island

Appendix C Continued

4. Source: UBC Herbarium
Habitat: shaded moist cliff
Locality: Owen Bay, Sonora Island; 50°19'N 125°13'W

Chandonanthus hirtellus (Web.) Mitt.

This species is rare throughout its range. It is confined to northern Pacific coastal locations (Schofield 1990).

1. Source: UBC Herbarium
Habitat: humus on ground near top of seepy cliff next to waterfall precipitate, in hummocks around base of stunted pine and cedar, partial shade to open
Locality: boggy barrens on beach up to ridge, V.J.K. Ecological Reserve, Athlow Bay, Port Channel, Empire Anchorage-Goose Cove, Graham Island, Queen Charlotte Islands; 53°35'N 132°55'W
2. Source: UBC Herbarium
Habitat: under dwarf *Chamaecyparis* of exposed outcrop knob
Locality: Skaat Harbour, ridge above north side of Inlet, Moresby Island, Queen Charlotte Islands
3. Source: UBC Herbarium
Habitat: dry areas near bog margin
Locality: stream over diagonal outcrops from lake on south side near mouth, Pitt Island, Monckton Inlet; 53°18'N 129°38'W

Cololejeunea macounii (Spruce ex Underw.) Evans

Cololejeunea macounii is confined to the northern Pacific and is rare throughout its range (Schofield 1990).

1. Source: UBC Herbarium
Habitat: along waterfall and seeps on exposed siliceous rock with a NW aspect on steep slope of mountain; intermittently forested with *Chamaecyparis nootkatensis*–*Picea sitchensis*–*Tsuga heterophylla*–*Alnus rubra*
Locality: northeast cove, Moresby Lake, Moresby Island, Queen Charlotte Islands (elev. 95–135 m); 52°56'N 132°06'W
2. Source: UBC Herbarium
Habitat: on bark of *Acer* species
Locality: Hastings, on the south shore of Burrard Inlet near the present location of Gastown, Vancouver

Dendrobazzania griffithiana (Steph.) Schust. & Schof.

A species confined to the northern Pacific region and considered to be rare throughout its range (Schofield 1990).

1. Source: UBC Herbarium
Habitat: shaded cliff shelves
Locality: Fairfax Inlet, Tasu Sound, Moresby Island, Queen Charlotte Islands; ca. 52°40'N 132°00'W
2. Source: UBC Herbarium
Habitat: shaded seepy cliff of canyon

Appendix C Continued

Locality: Goose Cove, near Anchorage, Athlow Bay, Graham Island,
Queen Charlotte Islands; 53°35'N 132°55'W

3. Source: UBC Herbarium
Habitat: on steep NW-facing slope
Locality: east corner of Moresby Lake, Moresby Island, Queen Charlotte
Islands

Eremonotus myriocarpus (Carring.) Lindb. et Kaal.

1. Source: UBC Herbarium
Habitat: boulders in talus
Locality: cliffs on south side of Takakia Lake, about 16 km south of
Moresby Logging Camp, Moresby Island, Queen Charlotte Islands
2. Source: UBC Herbarium
Habitat: damp cliff chimney
Locality: lake headwaters of stream flowing south, east of Simpson Peak,
Stikine Range, Cassiar Mountains; 59°40'N 131°18'W
3. Source: UBC Herbarium
Habitat: cliff crevice
Locality: up flanks of Glacial Mountain, Glacial Lake, Cassiar Mountains;
ca. 58°20'N 129°30'W
4. Source: UBC Herbarium
Habitat: on wet cliff
Locality: Cassiar district: east-facing slope above small glacial lake near
Peak Lake, Peak Range, Omineca Mountains (elev. ca. 1110–1200 m);
ca. 57°40'N 126°45'W
5. Source: (Godfrey and Godfrey pers. comm.)
Habitat: alpine
Locality: near Range Lake, Tatshenshini area

Gymnomitrion apiculata (Schiffn.) K. Müll.

1. Source: UBC Herbarium
Habitat: humus on damp cliff ledge
Locality: lake headwaters of stream flowing south, east of Simpson Peak,
Stikine Range, Cassiar Mountains

Herbertus sendtneri (Nees) Evans

1. Source: UBC Herbarium
Habitat: on humus of tundra slope
Locality: Takakia Lake, about 16 km south of Moresby Logging Camp,
Moresby Island, Queen Charlotte Islands
2. Source: UBC Herbarium
Habitat: among heaths of slope of alpine knife ridge
Locality: "Mine Mountain," above Tasu townsite, Moresby Island, Queen
Charlotte Islands; 52°40'N 132°03'W
3. Source: UBC Herbarium
Habitat: data not available
Locality: near Mount de la Touche, Tasu Inlet, Moresby Island, Queen
Charlotte Islands

Appendix C Continued

4. Source: UBC Herbarium
Habitat: data not available
Locality: Graham Island, 3.2 km east of Shields Island, Queen Charlotte Islands (elev. 690 m)

Jungermannia borealis Damsh. & Vana

1. Source: UBC Herbarium
Habitat: moist shaded rock crevice
Locality: cliff along creek, Lynn Canyon, North Vancouver

Jungermannia confertissima Nees

1. Source: UBC Herbarium
Habitat: stones in snow melt streamlet
Locality: Black Tusk Meadows area, Garibaldi Park
2. Source: UBC Herbarium
Habitat: shaded and sheltered basal part of boulder along river, in splash zone, <1 cm. soil accumulation, irregular rock surface
Locality: Cheakamus River Valley (elev. 610 m); 50°05'N 123°05'W
3. Source: UBC Herbarium
Habitat: sheltered rock surface in crevice, 1 cm soil accumulation, seepage site
Locality: Whistler Mountain, (elev. 2286 m); 50°05'N 122°50'W
4. Source: Godfrey (1977a)
Habitat: data not available
Locality: Joffre Creek trail area
5. Source: Godfrey (1977a)
Habitat: data not available
Locality: Birkenhead Lake area

Jungermannia hyalina Lyell

1. Source: UBC Herbarium
Habitat: on exposed earth of trail banks and on calcareous outcrops with abundant *Tortula ruralis*
Locality: along trail to Berg Lake, ca. 15 km in to just beyond second swinging bridge (elev. 10 00–1 065 m), in mesic, montane forest of *Thuja plicata*–*Tsuga mertensiana*–*Pseudotsuga menziesii* with carpets of *Hylocomium splendens*–*Ptilium crista-castrensis*, Mount Robson Provincial Park; 53°04'N 119°13'W
2. Source: UBC Herbarium
Habitat: exposed outcrop crevice
Locality: Mine Mountain, Tasu Sound, Moresby Island, Queen Charlotte Islands; 52°40'N 132°W
3. Source: UBC Herbarium
Habitat: wet rock
Locality: east side, head of Dawson Inlet, Graham Island, Queen Charlotte Islands

Appendix C Continued

4. Source: UBC Herbarium
Habitat: data not available
Locality: Moresby Mountain, Moresby Island, Queen Charlotte Islands
5. Source: UBC Herbarium
Habitat: data not available
Locality: Kunghit Island, Queen Charlotte Islands

Jungermannia subelliptica (Lindb. ex Kaal.) Lev.

1. Source: UBC Herbarium
Habitat: soil, cliff top
Locality: Tow Hill, northeast of Masset (volcanic plug) (ca. elev. 90 m)
Graham Island, Queen Charlotte Islands

Kurzia trichoclados (K. Müll.) Grolle

A rare species also found in Europe (Schofield 1990).

1. Source: UBC Herbarium
Habitat: damp humus bank at brow of boggy cliff
Locality: "Carey" Cove, directly south of Mike Inlet, Moresby Island,
Queen Charlotte Islands; 52°30'N 131°08'W

Lophozia ascendens (Warnst.) Schust.

1. Source: UBC Herbarium
Habitat: up tree trunk, bare
Locality: south end of Clearwater Lake, Wells Gray Provincial Park;
52°10'N 120°10'W
2. Source: UBC Herbarium
Habitat: boulder on talus
Locality: Brandywine Falls, east of Garibaldi Station; ca. 50°N 123°05'W
3. Source: UBC Herbarium
Habitat: data not available
Locality: Mount Revelstoke National Park (elev. 612 m); 51°05'N 118°W
4. Source: UBC Herbarium
Habitat: humus, forest floor
Locality: Robson River Campsite, just west of Mount Robson Station
on Highway 16

Lophozia bantriensis (Hook.) Steph.

1. Source: UBC Herbarium
Habitat: wet niche of cliff
Locality: northeast side of Hibben Island, northwest coast of Moresby
Island, Queen Charlotte Islands
2. Source: UBC Herbarium (*Lophozia hornschurchiana*)
Habitat: data not available
Locality: Banff-Windermere Highway near Vermilion
3. Source: UBC Herbarium (*Lophozia hornschurchiana*)
Habitat: on rocks
Locality: Yoho Pass

Lophozia collaris (Nees) Dum.

1. Source: UBC Herbarium
Habitat: data not available
Locality: near Mount de la Touche, Tasu Inlet, Moresby Island, Queen Charlotte Islands
2. Source: UBC Herbarium
Habitat: marble cliff, very shaded
Locality: Cumshewa Inlet, northwest coast of Moresby Island, Queen Charlotte Islands

Lophozia elongata Steph.

A rare species throughout its range (western North America, Greenland, and western Europe). This species requires verification (Godfrey and Godfrey pers. comm.).

1. Source: (Godfrey, 1977a)
Habitat: growing on sand over cliff face, wall of ravine on ocean beach, substrate mesic, partial shade
Locality: Brooks Peninsula, Vancouver Island

Lophozia laxa (Lindb.) Grolle

1. Source: UBC Herbarium
Habitat: in rich fen with scattered *Picea mariana* and *Betula* shrubs, the herb layer dominated by *Menyanthes trifoliata* and *Scirpus* sp., and the ground layer by *Tomenthypnum nitens*–*Campylium stellatum*–*Calliergon trifarium*–*Scorpidium scorpioides* dominant
Locality: along Highway 5 south of Mount George Graham, 5.3 km west of Grant Brook Crossing, Mount Robson Provincial Park (elev. 1065 m); 52°55'N 118°48'W

Lophozia rutheana (Limpr.) M. A. Howe

1. Source: UBC Herbarium
Habitat: data not available
Locality: Yoho Pass, Rocky Mountains
2. Source: UBC Herbarium
Habitat: in wet meadow, woods and meadows
Locality: just north of Sustut Lakes, Swannell Range, Omineca Mountains, Cassiar District (elev. 1290 m); 56°35'N 126°25'W

Lophozia sudetica (Nees) Grolle

1. Source: UBC Herbarium
Habitat: boulders in flatlands
Locality: Lynn Canyon, North Vancouver; 49°20'N 123°00'W

Lunularia cruciata (L.) Dum.

An introduced cosmopolitan species that is found in greenhouses and gardens (Godfrey 1977a). It is likely that this species is much more common than is indicated by the following specimens.

Appendix C Continued

1. Source: UBC Herbarium
Habitat: on soil at base of rockery
Locality: Kitsilano Beach, west of Kitsilano Yacht Club; ca. 49°20'N 123°15'W
2. Source: UBC Herbarium
Habitat: on shale cliff
Locality: north foot of Blenheim Street, Vancouver; ca. 49°15'N 123°15'W
3. Source: UBC Herbarium
Habitat: on bare soil of lawn margin in shade of shrubs; probably an “escape” from nursery greenhouse plants
Locality: “Eddie’s Nursery,” Point Grey area, Vancouver
4. Source: UBC Herbarium
Habitat: on bare wet soil
Locality: van Dusen Botanical Garden, Oak Street and 37th Avenue, Vancouver; 49°15'N 123°07'W

Marsupella revoluta (Nees) Dum.

1. Source: UBC Herbarium
Habitat: open damp cliff
Locality: south end of Glacial Lake, flanks of Horn Mountain, Cassiar Mountains; 58°20'N 129°30'W
2. Source: UBC Herbarium
Habitat: On granite boulders and in *Abies* scrub along streams; on seepy granite walls of valley and in late snow melt patches.
Locality: Along creek from central shore of lake and in cirque valley above, lake at headwaters of south-flowing stream, southeast of Simpson Peak, Stikine Range, Cassiar Mountains; 59°40'N 131°18'W

Mesoptychia sahlbergii (Lindb. et S. Arnell) Evans

1. Source: UBC Herbarium
Habitat: along margin of lake beneath *Abies lasiocarpa* and *Betula-Salix* bushes, and around siliceous boulders, *Nephroma-Cladina-Phyllodoce* abundant
Locality: central west shore of lake at headwaters of south-flowing stream, southeast of Simpson Peak (elev. 1250 m); 59°40'N 131°16'W

Nardia breidleri (Limpr.) Lindb.

A circumboreal arctic-alpine-subalpine species (Godfrey 1977a).

1. Source: UBC Herbarium
Habitat: sheltered boulders along stream, moderate slope, 1-2 cm accumulation, smooth rock surface
Locality: Whistler Mountain (elev. 2286 m); 50°05'N 122°50'W
2. Source: (Godfrey and Godfrey, pers. comm.)
Habitat: alpine
Locality: Range Lake, Tatshenshini area

Appendix C Continued

3. Source: (Godfrey and Godfrey, pers. comm.)
Habitat: alpine
Locality: ridge to the northwest of the confluence of the Tatshenshini and Alsek rivers
4. Source: (Godfrey and Godfrey, pers. comm.)
Habitat: alpine
Locality: Noisy Range, Tatshenshini area (elev. 900 m)
5. Source: (Godfrey and Godfrey, pers. comm.)
Habitat: alpine
Locality: southeast corner of the Noisy Range, Tatshenshini area

Nardia insecta Lindb.

1. Source: UBC Herbarium
Habitat: wet bank
Locality: slopes on northwest of Takakia Lake, about 16 km south of Moresby Logging Camp, Moresby Island, Queen Charlotte Islands
2. Source: (Godfrey and Godfrey pers. comm.)
Habitat: data not available
Source: Forbidden Plateau, Vancouver Island

Peltolepis quadrata (Saut.) K. Müll.

1. Source: (Schofield pers. comm.)
Habitat: data not available
Locality: known from southeastern British Columbia

Riccia frostii Aust.

Riccia frostii is also known from Asia, Europe and Mexico (Godfrey 1977a).

1. Source: UBC Herbarium
Habitat: mud bank of backwater
Locality: east end of Seabird Island, ca. 16 km north of Agassiz, north side of Fraser River
2. Source: UBC Herbarium
Habitat: muddy silt exposed at lake edge
Locality: Ellison Lake, ca. 12 km north of Kelowna; 50°00'N 119°23'W

Sauteria alpina (Nees) Nees

1. Source: UBC Herbarium
Habitat: data not available
Locality: Neptuak
2. Source: UBC Herbarium
Habitat: shaded humid cliff shelf
Locality: Glacial lake, Cassiar Mountains, cliff on east side, near lake, base of Glacial Mountain; ca. 58°20'N 129°30'W

Scapania gymnostomophila Kaal.

This species is also found in Alaska, the Yukon, Montana, Idaho, eastern North America, and Eurasia (Godfrey 1977a).

Appendix C Continued

1. Source: Godfrey (1977a) (no specimens available)
Habitat: growing on soil and rock, base of limestone cliff, moist, open to partly shaded
Locality: Chilliwack River area

Scapania hians* ssp. *salishensis J. Godfrey & G. Godfrey

Scapania hians ssp. *hians* is known from a single collection in China. British Columbia specimens are similar but minor differences have justified the creation of a separate subspecies (ssp. *salishensis*) (Godfrey & Godfrey 1978). These are the only collections made of this species outside of China.

1. Source: UBC Herbarium (portion of type specimen)
Habitat: muddy silt (glacial) over rocks and boulders in Joffre Creek; moist-wet; open to partial shade; abundant; occurring with *Plagiochila asplenioides*, *S. obovatum*, *Scapania*, *B. trichophyllum*.
Locality: Joffre Mountain Trail, 27.2 km east of Pemberton on logging road to Lillooet (elev. ca. 1380–1410 m)
2. Source: UBC Herbarium
Habitat: sandy humus over cliff wall; moist from mist, open
Locality: Coin Creek, in Ashlu Creek Valley; logging road west of Squamish (elev. ca. 511 m); ca. 49°50'N 123°10'W

Scapania mucronata Buch

This is a circumboreal species (Godfrey 1977a).

1. Source: UBC Herbarium
Habitat: exposed boulder in stream, 1–2 cm soil accumulation, smooth rock surface
Locality: Whistler Mountain (elev. 1219 m); 50°05'N 122°50'W
2. Source: UBC Herbarium
Habitat: exposed boulders, rock surface, 1 cm soil accumulation, smooth rock surface, dry
Locality: Chilliwack Lake (elev. 305 m); 49°05'N 121°35'W
3. Source: UBC Herbarium
Habitat: soil over boulder; meso; open; abundant occurring with *Lophozia incisa*
Locality: boulder slope (bulldozed) 4.8 km south of Boston Bar, Highway 1
4. Source: UBC Herbarium
Habitat: soil over outcrop ledge; meso-moist, open, abundant occurring with *B. barbata*, *S. americana*, *J. autumnalis*
Locality: Chehalis River, roadside cliffs by slough, west of bridge below canyon
5. Source: UBC Herbarium
Habitat: shaded side of boulder
Locality: Lighthouse Park (elev. 18 m); 49°20'N 123°15'W

Scapania obscura (Arnell et C. Jens.) Schiffn.

1. Source: UBC Herbarium
Habitat: brownish green patches of damp flats near stream

Appendix C Continued

Locality: subalpine slopes near moraine, Whistler Mountain, (elev. 1800 m)

2. Source: UBC Herbarium
Habitat: moist humus, exposed rock outcrops on alpine slope
Locality: trail leaving Cameron Lake travelling south to summit of Mount Arrowsmith
3. Source: Godfrey (1977a)
Habitat: growing on humusy soil on a subalpine meadow slope, substrate mesic to moist, with seepage from melting soil, open
Locality: Alta Lake area

Scapania paludicola Loeske et K. Müll.

A circumboreal–circumpolar species (Godfrey 1977a).

1. Source: UBC Herbarium
Habitat: spruce muskeg
Locality: Mile 340 on Alaska Highway
2. Source: UBC Herbarium
Habitat: on ground
Locality: shrub *Betula* Meadow, Mile 17.5 on Alaska Highway
3. Source: UBC Herbarium
Habitat: humus and *Sphagnum* in bog around first lake, open, abundant
Locality: Joffre Mountain Trail, 27.2 km east of Pemberton on logging road to Lillooet (elev. 1290 m)

Scapania simmonsii Bryhn et Kaal.

1. Source: UBC Herbarium
Habitat: forming humus, open cliff ledge
Locality: Glacial Lake, Cassiar Mountains, south end, flanks of Horn Mountain; ca. 58°20'N 129°30'W
2. Source: UBC Herbarium
Habitat: open forest slope
Locality: Wokkpash Lake, southwest shore, Mount Roosevelt-Churchill Peak area

Scapania spitzbergensis (Lindb.) K. Müll.

1. Source: UBC Herbarium
Habitat: deep shaded niche among boulders of talus
Locality: Glacial Lake, Cassiar Mountain Range, near Horn and Glacial mountains
2. Source: Bisang and Schumacker (1987)
Locality: Sutherland Falls, Blanket Creek Provincial Park

Sphaerocarpos texanus Aust.

In addition to occurring in western North America, *S. texanus* is also found in western Eurasia (Godfrey 1977a).

1. Source: UBC Herbarium
Habitat: peaty hummocks on open terraces

Appendix C Continued

- Locality: Uplands Park, Victoria, Vancouver Island; ca. 48°35'N 123°25'W
2. Source: UBC Herbarium
Habitat: open slope, on shallow soil, oak bluffs
Locality: North Pender Island; ca. 48°45'N 123°25'W
 3. Source: UBC Herbarium
Habitat: moist clay soil of park lawn
Locality: Saanich Peninsula, Beaver Lake Provincial Park, ca. 5.6 km north of Victoria; 48°31'N 123°23'W (first Canadian record)
 4. Source: Godfrey (pers. comm.)
Habitat: data not available
Locality: Rocky Point, Vancouver Island

Sphenolobopsis pearsonii (Spruce) Schust.

1. Source: UBC Herbarium
Habitat: on shaded rocks
Locality: Brooks Bay Beach, Brooks Peninsula, Vancouver Island; ca. 50°10'N 127°50'W
2. Source: UBC Herbarium
Habitat: damp, shaded cliff
Locality: Van Inlet, southwest end, near mouth, southwest Graham Island, Queen Charlotte Islands; 53°15'N 132°33'W
3. Source: UBC Herbarium
Habitat: wet, subalpine cliff
Locality: Trounce Creek, Trounce Inlet, south Graham Island, Queen Charlotte Islands

Tritomaria exsecta (Schrad.) Loeske

A circumboreal species (Godfrey 1977a).

1. Source: UBC Herbarium
Habitat: on rocky point, humus over rock, sea stacks along beach at stream mouth
Locality: V.J.K. Ecological Reserve, Graham Island, Queen Charlotte Islands; 53°35'N 132°55'W
2. Source: UBC Herbarium
Habitat: humus soil, terrace on cliff
Locality: Mine Mountain, Tasu Sound, Moresby Island, Queen Charlotte Islands; 52°40'N 132°W
3. Source: UBC Herbarium
Habitat: on rotten wood, earth and rocks
Locality: on Anticosti, Rocky Mountains, and Vancouver Island (unknown location)
4. Source: UBC Herbarium
Habitat: upper side of cedar log, dry, partial shade
Locality: UBC Research Forest, Haney
5. Source: UBC Herbarium
Habitat: trunk and branches of apple trees, *Malus*, 1 m above water level, dry, partial shade, infrequent

- Locality: banks of Widgeon Creek, southeast corner of Pitt Lake
6. Source: UBC Herbarium
Habitat: trunk, *Alnus rubra*, on riverbank, partly shaded, open, dry, infrequent
Locality: Chehalis River, Canadian Forest Products, Harrison Mills Road, Mile 10, Statlu Creek by bridge, near Margaret Creek Road

Mosses

Aloina bifrons (De Not.) Delgad.

Aloina bifrons is distributed from British Columbia south to Mexico and is also found in Chile, western Europe, North Africa, South Africa, New Zealand, and Australia (McIntosh 1989).

1. Source: UBC Herbarium
Habitat: clay crust on bank
Locality: ca. 10 km east of Kamloops along gravel road north of Thompson River. ca. 50°40'N 120°20'W
2. Source: UBC Herbarium
Habitat: clay flat below bank
Locality: northwest side of Skaha Lake, west of Penticton airport on Okanagan Indian Reserve 1
3. Source: UBC Herbarium
Habitat: sandy crust
Locality: sandy banks just south of Halston suburb in northwest Kamloops; ca. 50°40'N 120°20'W
4. Source: UBC Herbarium
Habitat: clay soil beneath outcrop
Locality: from Cawston up dirt road towards Oliver (northeast of Cawston) (elev. 671 m); ca. 49°10'N 119°40'W
5. Source: UBC Herbarium
Habitat: on clay crust
Locality: silt banks east of Kamloops along Barnhartvale Road; Dallas Cliffs; ca. 50°40'N 120°10'W

Aloina rosei (Williams) Delgad.

This species is only known from British Columbia and Peru (McIntosh 1989). In Anderson et al. (1990) this species is known as *Crossidium rosei* Williams. Zander (1993), in his extensive treatment of the family Pottiaceae, considers it to be a species of *Aloina* as treated by Delgadillo (1973). This following specimen is located under the synonym *Crossidium rosei*.

1. Source: UBC Herbarium
Habitat: on clay bank
Locality: northwest side of Skaha Lake, west of Penticton airport on Okanagan Indian Reserve 1; 49°30'N 119°35'W

Andreaea mutabilis Hook. f. & Wils.

Although widely distributed in the southern hemisphere, *A. mutabilis* is found in only a few locations in the northern hemisphere (Schofield 1990).

Appendix C Continued

1. Source: UBC Herbarium
Habitat: crevices of alpine ridge
Locality: Moresby Mountain, southeast face on peaks just east of summit, Moresby Island, Queen Charlotte Islands (elev. 914 m.);
ca. 53°07'N 132°W

Andreaea schofieldiana B. Murr.

Globally, *A. schofieldiana* is known from three locations in British Columbia and two locations in northern California (Murray 1987).

1. Source: UBC Herbarium (holotype)
Habitat: subalpine meadows and slopes sparsely forested with mountain hemlock and alpine fir
Locality: trail to summit of Mount Becher, Forbidden Plateau, Strathcona Park (elev. ca. 1260 m); 49°39'N 125°12'W
2. Source: UBC Herbarium
Habitat: face of outcrop
Locality: Mount Seymour, north Vancouver; elev. 1320 m.
3. Source: UBC Herbarium
Habitat: shaded cliff, on vertical rock
Locality: subalpine cirque on Donnes Mountain, Strathcona Park (elev. 1440 m); ca. 49°42'N 125°54'W

Andreaea sinuosa B. Murr.

A rare species with a disjunct distribution (western North America–northwestern Europe). It occurs in subalpine and alpine areas with a humid temperate climate (Murray 1986).

1. Source: UBC Herbarium (holotype)
Habitat: boulder in late snow area
Locality: Cypress Bowl area, Howe Sound Crest Trail towards the Lions, West Vancouver; ca. 49°20'N 123°10'W
2. Source: UBC Herbarium
Habitat: clay boulder top
Locality: Mount Seymour, north Vancouver (elev. 1200 m)
3. Source: UBC Herbarium
Habitat: shaded face of boulder, steep subalpine slope
Locality: subalpine slopes of Mount Cain, north of Schoen Lake (elev. above 1350 m); 50°14'N 126°20'W
4. Source: Murray (1986) specimen at UBC but not present at this time
Habitat: no data available
Locality: Mount Brown, Graham Island, Queen Charlotte Islands

Andreaeobryum macrosporum Steere and B. Murr.

1. Source: UBC Herbarium
Habitat: dripping limestone cliff face
Locality: Mount Stalin area, about one-third of the way from southeast end of westernmost Tuchodi Lake, on the south shore

Appendix C Continued

2. Source: UBC Herbarium
Habitat: dry cliff face
Locality: Wokkpush Lake, southwest shore, Mount Roosevelt-Churchill area

Atrichum tenellum (Röhl.) Bruch & Schimp. in B.S.G.

1. Source:
Habitat: on clay soil beside stream
Locality: Cassiar District: Omineca Mountains, Peak Range, Peak Glacier, near Peak Lake, waterfall and stream below glacier (elev. 1200–1500 m); ca. 57°39'N 126°46'W
2. Source: UBC Herbarium
Habitat: raw earth at base of stump
Locality: lowland alder–maple–poplar forest, somewhat swampy; just north of Squamish, Howe Sound

Aulacomnium acuminatum (Lindb. & Arnell) Kindb.

1. Source: UBC Herbarium
Habitat: depression among outcrops
Locality: Fern Lake, east end near waterfalls, Bordeaux Pass
2. Source: UBC Herbarium
Habitat: base of small cliff near lake
Locality: Wokkpush Lake, southwest shore, Mount Roosevelt-Churchill Peak area
3. Source: University of Alberta Herbarium
Habitat: at head of stream in box canyon
Locality: Summit Lake–Muncho Lake area; 11.4 km along road at third ford of Racing River Bridge over Alaska Highway, 4.2 km west of Summit Lake. 124°16'W 58°41'N
4. Source: University of Alberta Herbarium
Habitat: in *Pinus contorta* and *Picea* woods with mats of *Hylocomium–Cladina* and *Cetraria*, on calcareous outcrops; also on calcareous outcrops at higher elevations in dry tundra with few seeps
Locality: Mount Roosevelt–Churchill Peaks area; along southwest shore of Wokkpush Lake; (elev. 1376–1516 m); 58°27'N 124°52'W

Barbula amplexifolia (Mitt.) Jaeg.

1. Source: (Schofield pers. comm.)
Habitat: data not available
Locality: Bridal Falls

Barbula convoluta var. *gallinula* Zand.

1. Source: (Schofield pers. comm.)
Habitat: data not available
Locality: Bridal Falls

Bartramia halleriana Hedw.

This species is common in tropical and subtropical regions but is only represented by three populations in North America, two of which are in British Columbia (Schofield 1990).

1. Source: UBC Herbarium
Habitat: on deeply shaded sandstone cliffs
Locality: above Fraser River, Mount Robson Station, Mount Robson Provincial Park (elev. 870 m)
2. Source: Schofield (1968c)
Habitat: data not available
Locality: Wood River (tributary of the Columbia River)

Bartramia stricta Brid.

In British Columbia, *B. stricta* occurs on exposed outcrops in Garry oak stands and is vulnerable to human disturbance (Schofield 1990).

1. Source: UBC Herbarium
Habitat: rock cliffs on south-facing slope
Locality: Nanoose Hill, north of Nanaimo, Vancouver Island;
49°17'N 124°10'W
2. Source: UBC Herbarium
Habitat: seepy outcrop slope near oak woodland
Locality: head of Pedder Bay, Vancouver Island; cliff above sea; 48°20'N
123°29'W

Brachydontium olympicum (Britt. in Frye) McIntosh & Spence

This species is found in subalpine and alpine areas in northwestern North America and in Japan (McIntosh and Spence 1986).

1. Source: UBC Herbarium
Habitat: on shaded bases of rocks in late snowbed on steep slopes
Locality: Little Diamond Head, Mount Garibaldi; 49°35'N 123°05'W
2. Source: McIntosh and Spence (1986) (specimen reported to be at UBC but was not present at this time)
Habitat: crevice on side of boulder
Locality: Glacier Lake, Garibaldi Provincial Park
3. Source: McIntosh and Spence (1986) (specimen reported to be at UBC but was not present at this time)
Habitat: data not available
Locality: Tretheway Creek, above Harrison Lake, North Shore Mountains, New Westminster District

Bryhnia hultenii Bartr. in Grout

A rare species throughout its north Pacific range (Schofield 1990).

1. Source: UBC Herbarium
Habitat: log by creek
Locality: Inver Creek, Skeena River

Bryoerythrophyllum columbianum (Herm. & Lawt.) Zand.

This species is also known from the Northwest Territories, Oregon, Washington, and Bolivia.

1. Source: UBC Herbarium
Habitat: outcrop face
Locality: slope of townsite, Oliver; 49°10'N 119°37'W
2. Source: University of Victoria Herbarium
Habitat: in *Stipa comata* subxeric community on lacustrine terrace with rock outcrops
Locality: Osoyoos, Desert Park Road on Crown land, aspect 42, slope 32% (elev. 305 m); 49°00'30"N 119°28'30"W
3. Source: McIntosh (1989) – specimen at UBC but not present at this time
Habitat: data not available
Locality: near northwest side of Osoyoos Lake
4. Source: McIntosh (1989) – specimen at UBC but not present at this time
Habitat: data not available
Locality: Valleyview, east side of Kamloops

Bryum amblyodon C. Müll.

(The following specimens are located in the UBC Herbarium under the synonym, *Bryum stenotrichum* and *Bryum inclinatum*)

1. Source: UBC Herbarium
Habitat: shaded humid cliff shelf
Locality: high sandstone outcrop terraces, Bullhead Mountain slopes above highway to Williston Lake, ca. 3.2 km from junction to road to W.A.C. Bennett Dam
2. Source: UBC Herbarium
Habitat: on shaded soil on limestone ledge
Locality: Marble Meadows, west side of Buttle Lake, Strathcona Provincial Park, Vancouver Island
3. Source: UBC Herbarium
Habitat: shaded cliff crevices
Locality: Whirlpool Canyon. Mile 538.5 of Alcan Highway, 66.2 km north-west of Liard River Crossing at Liard Hot Springs
4. Source: UBC Herbarium
Habitat: data not available
Locality: Echo Inlet, Queen Charlotte Islands

Bryum arcticum (R.Br.) Bruch & Schimp. in B.S.G.

A predominantly arctic-alpine species that is found in western North America (Spence 1988).

1. Source: UBC Herbarium
Habitat: on soil in dry exposed habitat
Locality: alpine (elev. 1530 m) Teresa Island, Atlin 59°N 133°W
2. Source: UBC Herbarium
Habitat: on earth cliff crevice
Locality: westernmost Tuchodi Lake, ca. one-third of the way from south-east end of lake, on south shore, Mount Stalin area

Appendix C Continued

Bryum blindii Bruch & Schimp. in B.S.G.

This species has been collected in British Columbia, Alaska, the Yukon, Alberta, and Colorado (Spence 1988).

1. Source: UBC Herbarium
Habitat: in seepy wet area along the creek
Locality: anonymous creek 1.6 km north of Toby Creek Settlement on the Jumbo Creek Settlement on the Jumbo Creek logging road near the Purcell Wilderness Conservancy Area; 50°22'N 116°40'W

Bryum calophyllum R.Br.

Specimens have also been collected in the Northwest Territories (Spence 1988).

1. Source: UBC Herbarium
Habitat: on exposed dry rock cliff along the side of the road, disturbed and logged subalpine forest
Locality: Buchanan Lookout Point (elev. 1935 m) 11.2 km west of Kaslo along the road to New Denver (Hwy. 31A), Selkirk Mountains; 49°50'N 116°50'W

Bryum cyclophyllum (Schwaegr.) Bruch & Schimp. in B.S.G.

Bryum cyclophyllum is distributed in western North America.

1. Source: UBC Herbarium
Habitat: growing in wet saturated runoff ponds beside running water in mats
Locality: alpine, Birch Mountain, Teresa Island, Atlin (elev. 1620 m); 59°N 133°W
2. Source: UBC Herbarium
Habitat: data not available
Locality: Sheep Lick Mountain, Spatsizi (ca. elev. 1800 m); 57°40'N 129°00'W
3. Source: UBC Herbarium
Habitat: in silty-clay wet area of muskeg
Locality: Mile 340 on Alaska Highway

Bryum gemmiparum De Not.

This species is found in low-elevation and subalpine sites in western North America. It prefers calcareous substrates (Spence 1988).

1. Source: UBC Herbarium
Habitat: dry cliff
Locality: Blubber Bay, Texada Island
2. Source: UBC Herbarium
Habitat: dry soil over rock in dry streambed
Locality: Marble Meadows, west side of Buttle Lake, Strathcona Provincial Park. Subalpine meadows and along stream on ridge below camp; ca. 49°45'N 125°35'W
3. Source: UBC Herbarium
Habitat: damp, exposed, seepy sand
Locality: near ferry, Boston Bar, Fraser Canyon; 49°50'N 121°25'W

Appendix C Continued

4. Source: UBC Herbarium
Habitat: red tufts in wet cliff
Locality: Marie Lake near source of Gold Creek, Yakoun River, Graham Island, Queen Charlotte Islands

Bryum schleicheri Schwaegr.

Bryum schleicheri has also been collected in Washington and Alberta (Spence 1988).

1. Source: UBC Herbarium
Habitat: margins of late snow patch
Locality: Coquihalla Highway, ca. 2 km west of Falls Lake turnoff, subalpine talus and cirque; 49°25'N 121°10'W
2. Source: UBC Herbarium
Habitat: exposed wet sand and muck along stream
Locality: subalpine meadows and along stream on ridge below camp towards Buttle Lake, Strathcona Provincial Park, Vancouver Island; 49°45'N 125°35'W
3. Source: UBC Herbarium
Habitat: wet margin of snow-melt streamlet
Locality: Sentinel Glacier, end of Garibaldi Lake, (elev. ca. 1440 m)

Bryum uliginosum (Brid.) Bruch & Schimp. *in* B.S.G.

In addition to British Columbia, this species has also been collected in Alberta and Montana (Spence 1988).

1. Source: UBC Herbarium
Habitat: on rock near creek
Locality: anonymous creek bank near mouth of Plumbob Creek, 8 km northwest of Kikomun Creek Park, Purcell Mountain Range; ca. 49°17'N 115°22'W
2. Source: UBC Herbarium
Habitat: on earth, wet, with *Meesia uliginosa*
Locality: in larch, Ponderosa Pine and sagebrush community, Whitetail Lake and Blue Lake area, lake margin, swampy, 17.6–19.2 km west from Canal Flats on Findlay Creek logging road, Purcell Mountain Range, East Kootenay; ca. 50°15'N 116°3'W
3. Source: UBC Herbarium
Habitat: on soil-covered rock ledges
Locality: along small creek at south end of park with sandstone and calcareous shale outcrops in dry *Pinus contorta*–*Picea glauca* forest with abundant *Eurhynchium pulchellum* and *Rhynchostegiella compacta*, Dawson Creek area. East Pine River Provincial Park. At Pine River Crossing on Highway 97, 73.6 km west of Dawson Creek. 55°43'N 121°13'W

Bryum violaceum Crundw. & Nyh.

The species is named after its violet-coloured rhizoids. It has been collected in British Columbia, Washington, California, and Idaho (Spence 1988).

Appendix C Continued

1. Source: UBC Herbarium
Habitat: soil of abandoned field
Locality: disturbed field along highway west of Bazan Bay; 48°38'N
123°25'W
2. Source: UBC Herbarium
Habitat: roadside gravel
Locality: road to Menhininck Road, Saltspring Island

Callicladium haldanianum (Grev.) Crum

1. Source: UBC Herbarium
Habitat: on rotten, coniferous log
Locality: beside Pitt River, near de Boville Slough; 49°14'N 122°46'W
2. Source: UBC Herbarium
Habitat: rotten log in floodplain thickets
Locality: near Cheekye, Squamish River; ca. 49°48'N 123°09'W
3. Source: UBC Herbarium
Habitat: ground, logs
Locality: Sumpter, New Denver
4. Source: UBC Herbarium
Habitat: log of lake margin
Locality: Namu Lake, near mouth of Barke Channel; 51°51'N 127°51'W

Campylium calcareum Crundw. & Nyh.

1. Source: UBC Herbarium
Habitat: on slope in forest
Locality: Wapta Lake, Yoho National Park
2. Source: UBC Herbarium
Habitat: shaded face of boulder in forest
Locality: ca. 4.8 km south of Ainsworth Hot Springs, Kootenay Lake
3. Source: UBC Herbarium
Habitat: on aspen root, immature forest
Locality: Trout Lake, Gerrard (elev. 900 m)

Campylopus japonicus Broth.

1. Source: Frahm (1993)
Habitat: blanket bogs with mud-bottom pools, "lawns" and "forests"
Locality: southeast of Prospect Lake, Graham Island, Queen Charlotte
Islands; 53°58'N 131°45'W

Cinclidium arcticum Bruch & Schimp. *in* B.S.G.

1. Source: UBC Herbarium
Habitat: forming humus, open cliff ledge
Locality: Glacial Lake, Cassiar Mountains, south end, flanks of Horn
Mountain; ca. 58°20'N 129°30'W
2. Source: UBC Herbarium
Habitat: damp seepage meadow

Appendix C Continued

Locality: southwest shore, Wokkpash Lake, Mount Roosevelt-Churchill Peak area

Claopodium pellucinerve (Mitt.) Best

A rare species throughout its north Pacific range (Schofield 1990).

1. Source: UBC Herbarium
Habitat: shaded pocket in cliff
Locality: limestone cliffs, north side of Mosquito Lake, near Pallant Creek, Moresby Island, Queen Charlotte Islands; 53°08'N 132°10'W
2. Source: UBC Herbarium
Habitat: shaded limestone cliff
Locality: Tasu Creek mouth, head of Newcombe Inlet, Tasu Sound, Moresby Island, Queen Charlotte Islands; 52°50'N 132°08'W
3. Source: UBC Herbarium
Habitat: dry limestone cliff
Locality: Kaisun, north head of Inskip Channel, northwest Moresby Island, Queen Charlotte Islands

Coscinodon cribrosus (Hedw.) Spruce

1. Source: (Schofield pers. comm.) – no specimens available
Habitat: data not available
Locality: northern B.C.

Cynodontium glaucescens (Lindb. & Arnell) Par.

This specimen is located under the synonym, *Cnestrum glaucescens*.

1. Source: UBC Herbarium
Habitat: on highly calcareous outcrops with abundant *Seligeria–Tortella tortuosa*, abundant on steep slopes below outcrops
Locality: along southwest shore of Haworth Lake, Rocky Mountains

Daltonia splachnoides (Sm. in Sm. & Sowerby) Hook. & Tayl.

Daltonia splachnoides is rare throughout its range. It is also found in Europe (Schofield 1990).

1. Source: UBC Herbarium
Habitat: trunk of *Sambucus pubens* on forest slope
Locality: above first lake on south side of Bigsby Inlet, Moresby Island, Queen Charlotte Islands; 52°38'N 131°46'W
2. Source: UBC Herbarium
Habitat: among hepatics on trunk of *Thuja plicata*
Locality: about halfway down north shore of Mercer Lake, near Athlow Bay, Graham Island, Queen Charlotte Islands

Dicranella stickinensis Grout

This species is known from only a single location (Schofield 1990).

1. Source: (Schofield pers. comm.) – no specimens available
Habitat: data not available
Locality: Stikine area

Appendix C Continued

Didymodon johansenii (Williams) Crum

1. Source: UBC Herbarium
Habitat: humid cliff shelf
Locality: Glacial Lake, Cassiar Mountains, south end, east side, Horn Mountain flanks; 58°20'N 129°50'W

Discelium nudum (Dicks.) Brid.

This species has been found in eastern and western North America (Schofield 1972). All known populations in British Columbia have been eliminated. It is only found on open earth banks that are subject to slumping and invasion by vascular species (Schofield 1990).

1. Source: UBC Herbarium
Habitat: damp mud of ditch bank
Locality: Richmond, Steveston Highway; ca. 49°09'N 123°10'W
2. Source: UBC Herbarium
Habitat: locally abundant on stiff silt banks of ditch behind dike
Locality: near Sturgeons Banks, west Richmond, Lulu Island; 49°10'N 123°15'W
3. Source: UBC Herbarium
Habitat: very local on clayey banks of ditch
Locality: near Point Grey Golf Course, Fraser River, Vancouver
4. Source: UBC Herbarium
Habitat: silt bank of river
Locality: Yakoun River Bridge, about 3.2 km from mouth, Graham Island, Queen Charlotte Islands; 53°40'N 132°20'W

Drepanocladus capillifolius (Warnst.) Warnst.

1. Source: (Schofield pers. comm.) no specimens available
Habitat: data not available
Locality: Wells Gray Park
2. Source: Royal British Columbia Museum
Habitat: edge of pond, in shallow water
Locality: Liard Plateau (elev. 1520 m); 59°45'N 125°28'W
3. Source: Royal British Columbia Museum
Habitat: on rock in stream
Locality: Mile 581, Alaska Highway (elev. 450 m); 59°59'N 127°33'W
4. Source: Royal British Columbia Museum
Habitat: trail
Locality: Fantail River to Bighorn Creek, Kirtland (elev. 657 m); 59°34'N 134°19'W

Encalypta affinis Hedw. f. in Web. & Mohr

This species has a circumpolar, montane-arctic distribution (Horton 1983).

1. Source: UBC Herbarium
Habitat: Wakionu Caves Trail
Locality: data not available
2. Source: UBC Herbarium
Habitat: on boulder

Appendix C Continued

Locality: on mountains on west side of Katherine Lake, northwest of Mount Hartley, Omineca Mountains, Peak Ranges, Cassiar District; ca. 57°26'N 126°51'W

3. Source: UBC Herbarium
Habitat: in tufts on limestone rock
Locality: subalpine meadow, Anne Alice Ridge, 7 km northwest of Berg Lake, Mount Robson Provincial Park; 53°11'N 119°13'W
4. Source: University of Alberta Herbarium
Habitat: along avalanche slope with abundant *Veratrum*, *Alnus*, and *Pteridium*; and in *Thuja plicata*–*Tsuga heterophylla*–*Pseudotsuga menziesii* rainforest; acid rock seeps common
Locality: Monashee Mountains; northeast slope of Malton Range, west side of Kinbasket Lake, 20.3 km south of bridge over Canoe River at north end of lake (elev. 1040–1280 m); 52°38'N 119°01'02"W
5. Source: University of Alberta Herbarium
Habitat: colluvium veneer on inclined rock, avalanched well-drained, lithic orthic humic regasol rich meadow (*Fragaria virginiana*–*Spiraea lucida*–*Galium boreale*)
Locality: Whitetail Creek, lower subalpine zone (elev. 1870 m)
6. Source: University of Alberta Herbarium
Habitat: on alluvial fan; on calcareous outcrops in *Pinus*–*Arctostaphylos* woods and in *Picea glauca*–*Salix* woods; in mesic lowlands along rushing stream; in dry tundra with calcareous outcrops
Locality: Mount Roosevelt–Churchill Peaks area; along stream at south-west end of Wokkpash Lake (elev. 1376–1656 m); 58°27'N 124°53'W

Encalypta affinis var. *macounii* (Aust.) Crum & Anderson

These specimens are listed under the synonym, *Encalypta affinis* ssp. *macounii* (Aust.) Horton

1. Source: University of Alberta Herbarium
Habitat: on exposed soil and lava outcrops on steep slope, *Grimmia* species abundant on rocks and *Encalypta vulgaris* ssp. *rhaptocharpa* in crevices and on exposed soil
Locality: Dease Lake area; 12.8 km west of Tuya River crossing on road between Dease Lake and Telegraph Creek (elev. 860 m); 58°02'N 130°58'W
2. Source: University of Alberta Herbarium
Habitat: on calcareous (?) outcrops with a siliceous influence in dense *Abies* scrub with late snow melt herb fields; in *Salix reticulata*–*Hylocomium* tundra; on calcareous outcrops above with some seep
Locality: Bedeaux Pass, southwest end of Fern Lake (elev. 1500–1780 m); 57°45'N 124°50'W
3. Source: University of Alberta Herbarium
Habitat: on north-facing limestone outcrop in subalpine-upper montane zone
Locality: 3.2 km west of Summit Lake on small side road to north at 2.4 km west of lake; about 160 km west of Fort Nelson (elev. 1320 m); 58°39'N 124°43'W

Appendix C Continued

4. Source: University of Alberta Herbarium
Habitat: stream-side habitat in subalpine meadow
Locality: near Amiskwi Pass (elev. 1950 m); 51°36'N 116°40'W
5. Source: University of Alberta Herbarium
Habitat: at upper elevation on ground in *Pseudotsuga* forest grading into *Picea–Pinus* forest at upper elevations; on bank overhangs along trail, on trees and metamorphic rock face with southwest aspect
Locality: trail to Mount Hunter Lookout, three miles east of west entrance to Yoho National Park (elev. 1200–1800 m)
6. Source: University of Alberta Herbarium
Habitat: on limestone canyon walls surrounding rushing montane stream in *Pinus–Pseudotsuga* forest
Locality: Marble Canyon, Kootenay National Park, 85.3 km north of Radium Hot Springs on Highway 93; 51°11'N 116°07'W

Encalypta brevipes Schljak.

This species is found in the Western Cordillera, Iceland, Europe, and Asia (Horton 1983).

1. Source: UBC Herbarium
Habitat: earth on cliff ledge
Locality: Glacial Lake, Cassiar Mountain Range, near Horn and Glacial mountains
2. Source: UBC Herbarium
Habitat: lake headwaters of stream flowing south
Locality: mi. east of Simpson Peak
3. Source: UBC Herbarium
Habitat: earth of cliff ledge
Locality: westernmost Tuchodi Lake, ca. one-third of way from southeast end of lake on south shore, Mount Stalin area
4. Source: UBC Herbarium
Habitat: earth on cliff ledge
Locality: Bennett area, White Pass and Yukon Railway near Bennett, Bennett Lake; 59°50'N 135°00'W
5. Source: University of Alberta Herbarium
Habitat: in alpine tundra of *Stereocaulon–Cladina* sp., *Cassiope–Empetrum*, with *Abies–Betula* crumholtz–*Conostomum* abundant; and on slope with siliceous boulders
Locality: lake 17.6 km east of Kedahda Lake at headwaters of Kahan Creek flowing into Jennings River, Atsutla Range, Cassiar Mountains (elev. 1400–1550 m); 59°15'N 131°14'W

Encalypta longicolla Bruch

Encalypta longicolla is rare throughout its range. It is restricted to montane and arctic locations in circumpolar regions (Horton 1983).

1. Source: UBC Herbarium
Habitat: open bank
Locality: Wokkpash Lake, southwest shore, Mount Roosevelt-Churchill Peak area

Appendix C Continued

2. Source: UBC Herbarium
Habitat: damp cliff crevice
Locality: Summit Lake, limey cliffs, ca. 4 km west of east end of lake, Alcan Highway
3. Source: UBC Herbarium
Habitat: shaded earth on cliff ledge
Locality: Muncho Lake; 21 km north of Peterson Creek Bridge No. 4 on Alcan Highway, mile 457.5 of Alcan Highway
4. Source: UBC Herbarium
Habitat: cliff ledge
Locality: westernmost Tuchodi Lake, ca. one-third of way from southeast end of lake on south shore, Mount Stalin area
5. Source: University of Alberta Herbarium
Habitat: on highly calcareous outcrops with abundant *Seligeria-Tortula tortuosa*, abundant on steep slopes below outcrops
Locality: along southwest shore of Haworth Lake (elev. 1140 m); 57°47'N 125°07'W

Entodon concinnus (De Not.) Par.

1. Source: UBC Herbarium
Habitat: common mats on open forest floor of slope cliff
Locality: westernmost Tuchodi Lake, ca. one-third of way from southeast end of lake on south shore, Mount Stalin area; ca. 58°50'N 124°40'W
2. Source: UBC Herbarium
Habitat: on alder trunks
Locality: Kwinitza River, near Skeena
3. Source: UBC Herbarium
Habitat: among herbs of stabilized talus
Locality: "Mine Mountain" above Tasu townsite, Tasu Sound, Moresby Island, Queen Charlotte Islands; 52°40'N 132°03'W
4. Source: UBC Herbarium
Habitat: creek canyon
Locality: Alaska Highway, Mile 398
5. Source: UBC Herbarium
Habitat: data not available
Locality: Cirque Lake, southwest side of Moresby Island, Queen Charlotte Islands; 53°05'N 132°W

Entosthodon rubiginosus (Williams) Grout

This is a rare species endemic to western North America (McIntosh 1989).

1. Source: UBC Herbarium
Habitat: clay soil in crust near lake
Locality: around White Lake west of Okanagan Falls; ca. 49°20'N 119°35'W

Fabronia pusilla Raddi

1. Source: UBC Herbarium

Appendix C Continued

Habitat: dry cranny of sandstone cliff
Locality: Sumas Mountain, west end near Chilliwack

2. Source: UBC Herbarium

Habitat: trunk of *Populus trichocarpa*
Locality: 4.8 km north of Yarrow, Jock MacDonald Park, near Chilliwack;
ca. 49°15'N 122°00'W

Fissidens fontanus (B. Pyl.) Steud.

1. Source: UBC Herbarium

Habitat: concrete faces of floodgate at end of lake near hotel
Locality: Harrison Hot Springs; ca. 49°20'N 121°50'W

Fissidens pauperculus Howe

Lynn Canyon is the only location in which this species has been found (Schofield 1990).

1. Source: UBC Herbarium

Habitat: on consolidated silt bank wet from seasonal streamlet
Locality: Lynn Creek Canyon near suspension bridge, North Vancouver

Gollania turgens (C. Müll.) Ando

Gollania turgens is found in North America and Asia (Schofield 1984).

1. Source: UBC Herbarium

Habitat: cliff chimney on shelves
Locality: Mine Mountain above Tasu, Moresby Island, Queen Charlotte Islands; ca. 52°45'N 132°W

Grimmia brittoniae Williams

1. Source: (Schofield pers. comm.) no specimen available

Habitat: data not available
Locality: interior B.C.

Grimmia mollis Bruch & Schimp. *in* B.S.G.

1. Source: UBC Herbarium

Habitat: along a creeklet in subalpine meadows
Locality: below ridge between ? (label indecipherable), Mount Revelstoke National Park; 51°04'N 118°06'W

Grimmia unicolor Hook. *in* Grev.

1. Source: UBC Herbarium

Habitat: dry cliff ledge
Locality: westernmost Tuchodi Lake, ca. one-third of way from southeast end of lake, on south shore, Mount Stalin area

Hilpertia scotteri (Zand. & Steere) Zand.

The only other location where this species has been collected is in the Northwest Territories (see McIntosh 1989, Zander 1989, Zander and Steere 1978).

Appendix C Continued

This species was formerly considered to be *Tortula scotteri* Zand. & Steere and is listed under this name at UBC.

1. Source: UBC Herbarium
Habitat: on soil crust
Locality: shrub steppe, east side of Fraser River at Big Bar

Hygrohypnum cochlearifolium (Vent. ex De Not.) Broth.

1. Source: (Schofield pers. comm.) no specimens available
Locality: ?

Hygrohypnum norvegicum (Schimp. in B.S.G.) Amann

1. Source: UBC Herbarium
Habitat: on wet base of boulder in a cove beside the creek
Locality: Porcupine Creek on the east side of Highway 6 between Salmo and Ymir, Nelson Range, Selkirk Mountains

Hygrohypnum polare (Lindb.) Loeske

1. Source: UBC Herbarium
Habitat: near lake shore
Locality: Glacial Lake, base of Glacial Mountain; ca. 58°20'N 129°30'W
2. Source: UBC Herbarium
Habitat: splashed rock in rapids bank
Locality: Bennett area, White Pass and Yukon Railway, near east end of Lindeman Lake; 59°50'N 135°00'W

Isopterygiopsis muelleriana (Schimp.) Iwats.

1. Source: UBC Herbarium
Habitat: shaded cliff shelf near creek
Locality: Inver Creek, Skeena River area
2. Source: UBC Herbarium
Habitat: shaded shelf of boulder
Locality: northwest side of Wyndham Lake, Pitt Island; 53°40'N 129°55'W

Lescuraea saxicola (Schimp. in B.S.G.) Milde

1. Source: UBC Herbarium
Habitat: among boulders near lake
Locality: Glacial Lake, Cassiar Mountains up flanks of Glacial Mountain; ca. 58°20'N 129°30'W
2. Source: UBC Herbarium
Habitat: on bluff in woods
Locality: below lake of Hanging Glaciers
3. Source: UBC Herbarium
Habitat: shaded stones in herb slope
Locality: Mount Brown, southwest Graham Island, Queen Charlotte Islands (elev. 914 m+); ca. 53°N 132°W
4. Source: UBC Herbarium
Habitat: in rock crevice

Appendix C Continued

Locality: wet, open alpine meadow and sedge community, Meadow Mountain, British Columbia Forestry Alpine Recreation Area (elev. 2070 m); ca. 50°15'N 117°W

5. Source: UBC Herbarium

Habitat: on boulder beside stream

Locality: Katherine Creek at Katherine Lake, Peak Range, Omineca Mountains, Cassiar District; 57°25'N 126°50'W

Loeskypnum badium (Hartm.) Paul

1. Source: UBC Herbarium, none present

Habitat: data not available

Locality: Glacial Lake and two or three other locations (information on label not specific)

Microbryum vlassovii (Laz.) Zand.

This is a rare species, which has also been collected in central Asia, Armenia, and the Ukraine (McIntosh 1989). Until recently it was known as *Phascum vlassovii* Laz. (see Zander 1993) and is listed under this synonym at UBC.

1. Source: UBC Herbarium

Habitat: roadside embankment, shaded, clayey

Locality: silt banks east of Kamloops along Barnhartvale Road, Dallas Cliffs; ca. 50°40'N 120°0'W

2. Source: UBC Herbarium

Habitat: open clay crust, steep

Locality: east side of Penticton, clay banks and roadcut to south of Green Road just east of Main Street; ca. 49°30'N 119°33'W

Micromitrium tenerum (Bruch & Schimp. *in* B.S.G.) Crosby

These were the only known populations of this species in North America. These sites have been destroyed by human activity (Schofield 1990).

1. Source: UBC Herbarium

Habitat: on humus of moist, nearly dried-up pool of open area near trail near Camosun Bog

Locality: UBC Endowment Lands, Point Grey

2. Source: UBC Herbarium

Habitat: hard-packed pool depressions of open area on powerline through University Endowment Lands forest

Locality: end of 25th Avenue, near Camosun Bog, Point Grey

Mielichhoferia macrocarpa (Hook. *in* Drumm.) Bruch & Schimp. *ex* Jaeg.

1. Source: (Schofield pers. comm.) specimen located at the University of Alberta

Habitat: data not available

Locality: Summit Lake area, northern B.C.

Mielichhoferia mielichhoferiana (Funck *in* Hook.) Loeske

1. Source: (Schofield pers. comm.) specimen located at the University of Alberta

Appendix C Continued

Habitat: data not available

Locality: Summit Lake area, northern B.C.

Molendoa sendtneriana (Bruch & Schimp. *in* B.S.G.) Limpr.

The following specimen is located under the synonym, *Anoectangium sendtnerianum*.

1. Source: UBC Herbarium

Habitat: humid cliff face

Locality: westernmost Tuchodi Lake, ca. one third of way from southeast end of lake on south shore, Mount Stalin area

Myrinia pulvinata (Wahlenb.) Schimp.

1. Source: UBC Herbarium

Habitat: on trees temporarily submerged in water

Locality: Red Rocky Creek along Hart Highway

2. Source: UBC Herbarium

Habitat: on bushes and sticks in pond

Locality: McLeod's Lake

Oedipodium griffithianum (Dicks.) Schwaegr.

1. Source: UBC Herbarium

Habitat: damp humus of shaded cliff crevices

Locality: cliffs on south side of Takakia Lake, ca. 16 km south of Moresby Logging Camp, Moresby Island, Queen Charlotte Islands; 52°56'N 132°04'W

2. Source: UBC Herbarium

Habitat: data not available

Locality: Mount Doom, Brooks Peninsula, Vancouver Island; ca. 50°20'N 127°40'W

3. Source: UBC Herbarium

Habitat: damp humus of shaded cliff crevices

Locality: south side of unnamed alpine lake, ca. 32 km south of Moresby Logging Camp, Moresby Island, Queen Charlotte Islands

4. Source: UBC Herbarium

Habitat: wood

Locality: west side of unnamed lagoon west of Orchard Point, Brooks Peninsula (elev. 900 m); 50°12'N 127°47'

5. Source: UBC Herbarium

Habitat: earth of bank on terrace near creek

Locality: north face of Mount Moresby, Moresby Island, Queen Charlotte Islands; 53°08'N 132°05'W

Oreas martiana (Hoppe & Hornsch. *in* Hornsch.) Brid.

Oreas martiana has also been collected in the central United States, Alaska, and Greenland.

1. Source: UBC Herbarium

Habitat: hummock faces, on ledge, buttressing flanks of mountain

Appendix C Continued

Locality: up flanks of Glacial Mountain, Glacial Lake, Cassiar Mountains;
ca. 58°20'N 129°30'W

2. Source: UBC Herbarium

Habitat: in moist soil pockets among grasses in vicinity of Summit Lake

Locality: above small lake at Mile 304 (above Fort Nelson), above timber-
line on south-facing slope of high moraines (elev. 1650 m)

Orthothecium intricatum (Hartm.) Schimp. *in* B.S.G.

1. Source: UBC Herbarium

Habitat: on cliff

Locality: east-facing slope above small glacial lake near Peak Lake, Peak
Range, Omineca Mountains, Cassiar District (ca. elev. 1110–1200 m);

57°40'N 126°45'W

2. Source: UBC Herbarium

Habitat: data not available

Locality: Marble Canyon, Tokumm Creek, Kootenay National Park
(elev. 4800–5000 m)

Orthotrichum diaphanum Brid.

This may be an introduced species (Schofield pers. comm.).

1. Source: UBC Herbarium

Habitat: small tufts on shaded face of concrete wall

Locality: wall below Hycroft Estate, near corner of Granville and 16th
Street, Vancouver; 49°15'N 123°07'W

Orthotrichum hallii Sull. & Lesq. *in* Sull.

1. Source: UBC Herbarium

Habitat: dry cliff

Locality: creek, ca. 16 km north of Lytton on Lillooet Road

2. Source: UBC Herbarium

Habitat: outcrop face

Locality: north-north west of Summerland along Eneas Creek; ca. 49°35'N
119°40'W

3. Source: Royal British Columbia Museum

Habitat: on bark of alder along ocean in *Picea sitchensis*–*Alnus rubra*
forest

Locality: Point-No-Point, Vancouver Island

Orthotrichum pallens Bruch *ex* Brid.

1. Source: UBC Herbarium

Habitat: on tree trunk *Populus* sp.

Locality: rocky lake margin of St. Mary Lake, near outlet of Alki Creek,
west of Kimberley (1020 m)

2. Source: UBC Herbarium

Habitat: on twigs of *Picea* within the spray of waterfalls

Locality: in mature red cedar–Douglas–fir forest in the valley of Beaver
Creek, trail passing the Bear Creek Falls, Glacier National Park on
Highway 1

Appendix C Continued

3. Source: UBC Herbarium
Habitat: on spruce
Locality: in floodplain of mature western hemlock forest bordering a creek that drains into the valley of Goldstream River, ca. 40 km east of Highway 23 (elev. ca. 960 m); 51°35'N 118°05'W

Orthotrichum pylaisii Brid.

1. Source: UBC Herbarium
Habitat: limestone
Locality: Summit Lake, Alaska Highway
2. Source: UBC Herbarium
Habitat: dry basalt cliff face
Locality: near McGuire, Garibaldi area – extensive volcanic area
3. Source: Royal British Columbia Museum
Habitat: on rocks
Locality: east of Gihta Creek, (elev. 374 m); 52°51'N 118°39'W

Orthotrichum rivulare Turn.

1. Source: UBC Herbarium
Habitat: on small shrubs flooded by creek
Locality: Wolf Creek Campground, Wolf Creek; 49°40'N 123°20'W
2. Source: UBC Herbarium
Habitat: rocks and roots on creek bank
Locality: Thornhill Creek, Terrace
3. Source: UBC Herbarium
Habitat: on boulder
Locality: south-facing, stony, oak-dominated slope just west of Goldendale; 45°45'N 120°45'W
4. Source: Vitt (1973)
Habitat: data not available
Locality: Stamp Falls, Vancouver Island

Orthotrichum tenellum Bruch ex Brid.

1. Source: UBC Herbarium
Habitat: rare on buttressing roots of two *Populus* trees
Locality: Quilchena Park, Vancouver; 49°15'N 123°07'W
2. Source: UBC Herbarium
Habitat: on bark of maple
Locality: west end of Sumas Mountain, conglomerate and sandstone cliffs area

Philonotis yezoana Besch. & Card. in Card.

1. Source: (W.B. Schofield pers. comm.)
Locality: known from 1 or 2 locations

Physcomitrella patens (Hedw.) Bruch & Schimp. in B.S.G.

1. Source: UBC Herbarium

Appendix C Continued

Habitat: dried-up pond bottom

Locality: on way to Purcell Wilderness Conservancy, ca. 2.4–3.2 km from Invermere/Atholmere, East Kootenay Region

Physcomitrium immersum Sull.

1. Source: UBC Herbarium

Habitat: margin of cultivated field

Locality: near Ladner

2. Source: UBC Herbarium

Habitat: rare in damp silt, margin of fallow field

Locality: Langley, Vancouver area

Plagiobryum demissum (Hook.) Lindb.

1. Source: UBC Herbarium

Habitat: data not available

Locality: northwest slopes above eastern end of Nicola Lake, 64 km south of Kamloops

2. Source: UBC Herbarium

Habitat: on soil over cliff

Locality: east-facing slope above small glacial lake near Peak Lake, Peak Range, Omineca Mountains, Cassiar District (elev. 1110–1200 m);
ca. 57°40'N 126°45'W

Pleuroziopsis ruthenica (Weinm.) Kind. ex Britt.

This species is rare throughout its north Pacific range (Schofield 1990).

1. Source: UBC Herbarium

Habitat: locally abundant among grasses at upper floodplain

Locality: Yakoun River bank, ca. 24 km south of Juskatla, Graham Island, Queen Charlotte Islands; 53°25'N 132°20'W

2. Source: UBC Herbarium

Habitat: abundant on banks of creek and on logs in skunk cabbage swamp just above tidal influence

Locality: Inver Creek, Skeena River, near Skeena; 54°15'N 129°30'W

3. Source: UBC Herbarium

Habitat: riverbank

Locality: road to Kwinitisa River, Skeena drainage

4. Source: UBC Herbarium

Habitat: data not available

Locality: Lagins Creek, on way to Mount Needham, Graham Island, Queen Charlotte Islands

5. Source: UBC Herbarium

Habitat: data not available

Locality: on highway between Victoria and Cowichan Lake

Pohlia cardotii (Ren. in Ren. & Card.) Broth.

1. Herbarium: UBC Herbarium

Habitat: edge of streamlet, subalpine

Appendix C Continued

Locality: Mount Seymour, north Vancouver; ca. 49°20'N 123°10'W

2. Source: UBC Herbarium

Habitat: peaty tundra slope, somewhat seepy

Locality: Whistler Mountain area of moraine and outwash at upper end of chair-lift, 50°06'N 123°10'W

3. Source: UBC Herbarium

Habitat: damp soil along stream, watery flats

Locality: Garibaldi Provincial Park, Russet Lake–Singing Pass area, behind Whistler Mountain (elev. 1860 m); ca. 49°50'N 122°55'W

Pohlia crudoides (Sull. & Lesq.) Broth.

There is a literature report (see Ireland et al. 1987) of this species in British Columbia, but no specimens were available.

Pohlia erecta Lindb.

1. Source: UBC Herbarium

Habitat: damp alpine terrace

Locality: Mount Brackenridge, northeast of Harrison Lake (elev. 1800 m)

Pohlia longicolla (Hedw.) Lindb.

1. Source: UBC Herbarium

Habitat: limestone

Locality: Summit Lake, Alaska Highway

2. Source: UBC Herbarium

Habitat: on shaded trail bank, in disturbed subalpine Spruce–Larch–Douglas-fir forest

Locality: 3.4 km up trail to Sunset Lake vicinity, Kokanee Glacier Provincial Park, Selkirk Mountain Range; ca. 49°46'N 117°4'W

Pohlia sphagnicola (Bruch & Schimp.) Lindb. & Arnell

1. Source: UBC Herbarium

Habitat: in a sphagnum bog

Locality: near Bamfield, Vancouver Island

2. Source: UBC Herbarium

Habitat: in a sphagnum bog

Locality: White Creek bog area, Graham Island, Queen Charlotte Islands

Pohlia tundrae Shaw

Pohlia tundrae is only found in the Western Cordillera of the United States and as two disjunct populations in northern British Columbia (Shaw 1981).

1. Source: UBC Herbarium

Habitat: on damp soil

Locality: Sentinel Glacier foreland, Garibaldi Park; ca. 50°N 123°W

2. Source: Shaw (1981) – specimen located at National Museum of Nature (Ottawa)

Habitat: alpine meadow

Locality: Mile 84, Haines Highway

Appendix C Continued

3. Source: Shaw (1981) – specimen located at the University of Alberta
Habitat: data not available
Locality: ca. 16 km northeast of Surprise Lake on road to Mount Barhan, Atlin area

Polytrichum sphaerothecium (Besch.) C. Müll.

This species has been found in British Columbia, the Aleutian Islands, Iceland, and Asia (Schofield 1972). It has recently been reported in Oregon (Oregon Natural Heritage Program 1991).

1. Source: UBC Herbarium
Habitat: on crevices of large lava boulders above lake
Locality: trail from Garibaldi station to Garibaldi Lake

Pseudephemerum nitidum (Hedw.) Loeske

This was the only known North American location of this species, which has subsequently been eliminated as a result of human activity (Schofield 1968c).

1. Source: UBC Herbarium
Habitat: on silt hummocks in grassy area near riverbank
Locality: Fraser River Delta, MacDonald Beach, Sea Island

Pseudobryum cinclidioides (Hüb.) T. Kop.

1. Source: UBC
Habitat: near streamlet in *Abies* thicket
Locality: Glacial Lake, Cassiar Mountains, north end, west side
ca. 58°20'N 129°30'W

Pseudoleskea julacea (Besch. & Card. *in* Card.) Crum et al.

These specimens are listed under the synonym, *Lescuraea julacea*.

1. Source: UBC Herbarium
Habitat: shaded limestone cliff
Locality: Kitgoro Inlet, northwest Moresby Island, Queen Charlotte Islands; ca. 53°05'N 132°30'W
2. Source: UBC Herbarium
Habitat: limestone boulder
Locality: cliffs on south side of Takakia Lake, ca. 16 km south of Moresby Logging Camp, Moresby Island, Queen Charlotte Islands

Psilopilum cavifolium (Wils.) Hag.

1. Source: (Schofield pers. comm.) no specimen available
Habitat: data not available
Locality: Glacial Lake area

Pterygoneurum kozlovii Laz.

This species is rare throughout its range. It has been found in British Columbia, Czechoslovakia, and the Ukraine (McIntosh 1989).

1. Source: UBC Herbarium
Habitat: on soil in dry, grassy area adjacent to saline lake

Appendix C Continued

- Locality: north-north west of Oliver behind Silica works and mine;
ca. 49°15'N 119°35'W
2. Source: UBC Herbarium
Habitat: silty flat near slough, damp
Locality: north of highway near Spotted Lake, Osoyoos area; ca. 49°03'N
119°35'W
 3. Source: UBC Herbarium
Habitat: edge of forma lake
Locality: outside fence near road, 1.5 km northwest of Osoyoos; ca.
49°03'N 119°20'W
 4. Source: UBC Herbarium
Habitat: sandy soil near salt pan
Locality: alkaline lake and steppe west of Kamloops; ca. 50°40'N 120°20'W
 5. Source: UBC Herbarium
Habitat: hard soil near grassy salt pan
Locality: northwest of Osoyoos; ca. 49°03'N 119°20'W

Pterygoneurum lamellatum (Lindb.) Jur.

This species has been collected in British Columbia, Arctic North America, Utah, Arizona, and western Eurasia (McIntosh 1989).

1. Source: UBC Herbarium
Habitat: on soil among grasses of flats near lake
Locality: White Lake, west of Vaseux River, Oliver area

Racomitrium obesum Frisv.

This rare species has been collected in British Columbia (Schofield pers. comm.), but no other information is available at this time. No specimens are located at herbaria in British Columbia.

Racomitrium pygmaeum Frisv.

1. Source: UBC Herbarium
Habitat: exposed dry soil
Locality: meadow, Manning Provincial Park; ca. 49°03'N 120°40'W
2. Source: UBC Herbarium
Habitat: on dry gravel/sand moraine
Locality: Mount Garibaldi, Black Tusk Meadows, Panorama Ridge, Gentian Ridge; ca. 49°50'N 122°55'W
3. Source: UBC Herbarium
Habitat: on moist soil in early snowbed
Locality: Mount Garibaldi, Little Diamond Head; ca. 49°35'N 123°05'W
4. Source: UBC Herbarium
Habitat: on exposed earth
Locality: trail to Cobalt Lake (Blue Lake) at 2280 m crossing over a ridge at 2400 m, spruce and larch forest at lower elevation with alpine meadow over the ridge (includes Walter Lake) Bugaboo Glacier Provincial Park
5. Source: UBC Herbarium
Habitat: on rock, along trail

Appendix C Continued

Locality: rocky margin and slides of Kokanee Lake (elev. 1981 m),
Kokanee Glacier Park, Selkirk Mountains

Rhizomnium punctatum (Hedw.) T. Kop.

1. Source: UBC Herbarium
Habitat: swampy area near lake
Locality: Glacial Lake, Cassiar Mountains south end of lake; ca. 58°20'N
129°30'W
2. Source: UBC Herbarium
Habitat: basal portion of exposed rock of boulder slope, <1 cm (heavy) soil
accumulation, irregular rock surface
Locality: Lynn Canyon 49°20'N 123°05'W (elev. 30 m)
3. Source: UBC Herbarium
Habitat: exposed rock, <1 cm soil accumulation, irregular rock surface, in
spray zone of fall, heavy spray influence
Locality: Brandywine Falls (elev. 457 m); 50°02'N 123°08'W
4. Source: UBC Herbarium
Habitat: data not available
Locality: near crossing of Eagle River on Hwy 1, ca. 32 km west of
Revelstoke
5. Source: UBC Herbarium
Habitat: on rock, wet, mainly mature Red Cedar–Douglas-fir forest
Locality: 19.2 km up the trail following the Hamill Creek Valley to Earl
Grey Pass (elev. ca. 900 m), Purcell Wilderness Conservancy, Purcell
Mountain Range

Rhodobryum roseum (Hedw.) Limpr.

A rare species that is only known elsewhere from Europe (Schofield 1990).

1. Source: UBC Herbarium
Habitat: data not available
Locality: Victoria (locality doubtful)
2. Source: UBC Herbarium
Habitat: data not available
Locality: Tasu Inlet, Moresby Island, Queen Charlotte Islands

Scouleria marginata Britt.

1. Source: UBC Herbarium
Habitat: on rock, creek margin
Locality: headwater of Boundary Creek, adjacent to the Canada–USA
International Border (elev. 4300 m); ca. 49°N 116°56'W

Seligeria acutifolia Lindb. *in* Hartm.

1. Source: UBC Herbarium
Habitat: data not available
Locality: Kennedy Lake, Vancouver Island

Seligeria careyana Vitt & Schof.

1. Source: UBC Herbarium (paratype)
Habitat: shaded limestone cliff
Locality: Kaisun, north, head of Inskip Channel, Moresby Island, Queen Charlotte Islands
2. Source: UBC Herbarium (paratype)
Habitat: shaded limestone cliff
Locality: mountain directly above Tasu townsite, Moresby Island, Queen Charlotte Islands; 52°45'N 132°02'W
3. Source: UBC Herbarium
Habitat: humid cliff face
Locality: limestone cliffs on south side of Kootenay Inlet Narrows, Moresby Island, Queen Charlotte Islands

Sphagnum jensenii Lindb.

1. Source: UBC Herbarium
Habitat: dominant in large, wet fen
Locality: upper Tsuga zone, north end of Wells Gray Provincial Park, ca. 1.6 km up Murtle Lake; ca. 52°N 120°W
2. Source: UBC Herbarium
Habitat: wet, mesotrophic fen
Locality: upper subalpine zone, Wells Gray Provincial Park (outside park) near the southeast corner, ca. 19.2 km southwest of Blue River Station, Fish Lake Hill; ca. 52°N 120°W

Sphagnum junghuhnianum var. *pseudomolle* (Warnst.) Warnst.

This species is confined to the Pacific region and is rare throughout its range (Schofield 1990).

1. Source: UBC Herbarium
Habitat: forming dirty green, swollen cushions on seepy cliff shelf in canyon
Locality: Athlow Bay, Goose Cove, Graham Island, Queen Charlotte Islands; 53°35'N 132°55'W

Sphagnum platyphyllum (Lindb. ex Braithw.) Sull. ex Warnst.

1. Source: UBC Herbarium
Habitat: depression in fen
Locality: Summit Lake, ca. 46.4 km north of Prince George
2. Source: UBC Herbarium
Habitat: open transitional poor fen with abundant *Salix* and *Betula* shrubs, numerous hummocks of *Sphagnum centrale* present, associated with *Tomenthypnum falcifolium*, *Menyanthes trifoliata*, *Meesia longiseta*, *Sphagnum subsecundum*, and *S. magellanicum*
Locality: Dawson Creek area, 34.5 km east of Pine River, crossing of Highway 97, ca. 40 km west of Dawson Creek
3. Source: UBC Herbarium
Habitat: wet, mesotrophic fen

Appendix C Continued

Locality: upper subalpine zone, Wells Gray Provincial Park (outside park) near the southeast corner, ca. 19.2 km southwest of Blue River Station, Fish Lake Hill

4. Source: UBC Herbarium
Habitat: meso-eutrophic, alluvial fen on lakeshore
Locality: upper Tsuga zone, Wells Gray Provincial Park, Murtle Lake southwest end, east side of Diamond Lake

Sphagnum schofieldii Crum

The taxonomic status of this species is uncertain. Although it was included in a recent checklist by Anderson (1990), Andrus et al. (1992) considered it to be synonymous with the species *Sphagnum quinquefarium*. This is the only known location of *S. schofieldii* in the world (Schofield 1990).

1. Source: UBC Herbarium (portion of holotype)
Habitat: rounded cushion on seepy cliff ledge
Locality: Goose Cove, Athlow Bay, Graham Island, Queen Charlotte Islands; 53°35'N 132°55'W

Sphagnum subobesum Warnst.

This species is rare throughout its north Pacific range (Schofield 1990).

1. Source: UBC Herbarium
Habitat: lake margin
Locality: Holmes Lake, south shore, Pitt Island
2. Source: UBC Herbarium
Habitat: on steep, wet, northwest-facing slope, mixed with *Sphagnum compactum*, *Herberta adunca*
Locality: east corner of Moresby Lake, Moresby Island, Queen Charlotte Islands (elev. 135 m); 52°56'N 132°06'W
3. Source: UBC Herbarium
Habitat: damp cliff fissure
Locality: base of north slope, Moresby Mountain, Moresby Island, Queen Charlotte Islands
4. Source: UBC Herbarium
Habitat: wet cliff ledge
Locality: Goose Cove, Athlow Bay, Graham Island, Queen Charlotte Islands; ca. 53°35'N 132°55'W
5. Source: UBC Herbarium
Habitat: common in bog
Locality: bog near east end of Kennedy Lake, Vancouver Island

Sphagnum wilfii Crum

This was the only known location of this species (Schofield 1990), but has recently been located at a number of sites in Alaska (Andrus pers. comm., Schofield pers. comm.).

1. Source: UBC Herbarium (portion of holotype)
Habitat: red tufts in pygmy pine slope of bleak ridge
Locality: Goose Cove, Athlow Bay, Graham Island, Queen Charlotte Islands; 53°35'N 132°55'W

Sphagnum wulfianum Girg.

1. Source: UBC Herbarium
Habitat: data not available
Locality: this species has been reported for British Columbia, but the specimens could not be located in the herbarium at this time.

Steerecleus serrulatus (Hedw.) Robins.

These specimens are listed under the synonym *Rhynchostegium serrulatum*.

1. Source: UBC Herbarium
Habitat: Orchid greenhouse
Locality: Burnaby
2. Source: UBC Herbarium
Habitat: on soil
Locality: Buck Hill Falls Penna ??
3. Source: UBC Herbarium
Habitat: cedar–hemlock–spruce, “cat-logged”
Locality: Blueberry River, Columbia River, southeast exposure, 10% slope (elev. 930 m)
4. Source: University of Victoria Herbarium
Habitat: on wet ground
Locality: MacDonald Creek, Nakusp

Stegonia latifolia (Schwaegr. in Schultes) Vent. ex Broth.

1. Source: UBC Herbarium
Habitat: clods among stones on tundra slope
Locality: 12 mi. west of BC–Yukon border, Haines Highway; 59°40'N 136°40'W
2. Source: UBC Herbarium
Habitat: no data available
Locality: on peak of Big Dog Mountain, Lillooet area (elev. 2817 m)
3. Source: UBC Herbarium
Habitat: small earth hummocks on slope
Locality: Wokkpash Lake, southwest shore, Mount Roosevelt–Churchill Peak area
4. Source: UBC Herbarium
Habitat: earth lumps on open slope
Locality: Mile 472, Alcan Highway; 59°126'N 126°05'W
5. Source: UBC Herbarium
Habitat: alpine
Locality: Birch Mountain, Teresa Island, Atlin Lake (elev. 6175 m); 59°N 133°W

Stegonia latifolia var. *pilifera* (Brid.) Broth.

This variety was formerly treated as a distinct species by Anderson et al. (1990), but is now considered by Zander (1993) to be a variety of *S. latifolia*. This variety has been reported for British Columbia (see Ireland et al. 1987), but no specimens are available.

Syntrichia laevipila Brid.

Other than a single location on the Queen Charlotte Islands, this species is only found in British Columbia as an epiphyte on Garry oak on southern Vancouver Island. This species is threatened by habitat destruction from increasing urban and residential development. Until recently (see Zander 1993), this species was known as *Tortula laevipila* (Brid.) Schwaegr. and is listed under this synonym at UBC and the University of Victoria.

1. Source: UBC Herbarium
Habitat: on bark of oaks
Locality: Beacon Hill Park, Victoria
2. Source: UBC Herbarium
Habitat: epiphytic on Garry oak
Locality: Duncan, Vancouver Island
3. Source: UBC Herbarium
Habitat: on silt of branches of Sitka spruce
Locality: Rose Spit, Graham Island, Queen Charlotte Islands
4. Source: UBC Herbarium
Habitat: trunk of *Quercus garryana*
Locality: Pedder Bay, Vancouver Island
5. Source: UBC Herbarium
Habitat: on *Quercus garryana* trunk
Locality: Nanoose Hill, Nanoose Bay, Vancouver Island; ca. 49°15'N
124°15'W

Tayloria froelichiana (Hedw.) Mitt. ex Broth.

In North America, this species is restricted to the tundra and high-elevation sites in the Western Cordillera.

1. Source: UBC Herbarium
Habitat: humus on cliff ledge
Locality: Glacial Lake, Cassiar Mountain Range, near Horn and Glacial mountains
2. Source: (LaFarge–England and Vitt 1985)
In addition to the above locations, LaFarge–England and Vitt (1985) report that it occurs in eastern British Columbia; one location appears to be near Bowron Lake.

Tetraplodon pallidus Hag.

1. Source: UBC Herbarium
Habitat: dung on exposed ridge
Locality: lake at headwaters of Kahan Creek flowing into Jennings River, Cassiar Mountains, Atlulta Range
2. Source: UBC Herbarium
Habitat: no data available
Locality: 1.6 km north of Parsnip River on Hart Highway
3. Source: UBC Herbarium
Habitat: dung on outcrop

Appendix C Continued

Locality: Glacial Lake, Cassiar Mountain Range, near Horn and Glacial mountains

Tetradontium repandum (Funck *in* Sturm) Schwaegr.

1. Source: UBC Herbarium
Habitat: frequent in crevices of lava boulders
Locality: south end of Garibaldi Lake, near Barrier

Timmia sibirica Lindb. & Arnell

1. Source: (Schofield pers. comm.) no specimens available
Habitat: data not available
Locality: northern B.C.

Tortella humilis (Hedw.) Jenn.

1. Source: UBC Herbarium
Habitat: dry log and rocks in Madrone–Juniper forest of seaside headlands
Locality: Blubber Bay, Texada Island, Strait of Georgia

Tortula guepinii (B. & S. *in* B.S.G.) Broth.

In addition to British Columbia, this species has also been collected in Alberta, California, New Mexico, Mexico, and western Eurasia (McIntosh 1989). It is listed under the synonym *Desmatodon guepinii* B.S.G.

1. Source: UBC Herbarium
Habitat: soil crust
Locality: ca. 1 km east of Cache Creek; ca. 50°45'N 121°10'W

Tortula nevadensis (Card. & Thér.) Zand.

Until recently (see Zander 1993), this species was known as *Pottia nevadensis* Card. & Thér. and is listed under this name at UBC.

1. Source: UBC Herbarium
Habitat: base of cliff, dry
Locality: on dry outcrops north of Anzus Lake, Endako area
2. Source: UBC Herbarium
Habitat: on soil
Locality: Yale

Tortula protobryoides Zand.

Tortula protobryoides Zand., until recently (see Zander 1993) was known as *Pottia bryoides* (Dicks.) Mitt. and is listed under this synonym at UBC. It has been reported to occur in British Columbia, Arizona, California, western Eurasia, and possibly Saskatchewan (McIntosh 1989).

1. Source: UBC Herbarium
Habitat: soil in steppe
Locality: steppe and outcrop, east of Cawston; ca. 49°10'N 119°50'W
2. Source: UBC Herbarium
Habitat: sandy soil in talus
Locality: west-facing *Artemisia*-grassland south of Cawston along secondary paved road, east of highway; 49°10'N 119°40'W

Tortula wilsonii (Hook.) Zand.

This species is also known from western Eurasia (McIntosh 1989). Until recently (see Zander 1993) it was known as *Pottia wilsonii* (Hook.) B.S.G. and is listed under this name at UBC.

1. Source: UBC Herbarium
Habitat: on clay bank
Locality: clay bank northwest side of Skaha Lake, west of Penticton airport on Okanagan Indian Reserve 1

Trematodon boasii Schof.

Once believed to be confined to the following locations in British Columbia, this species has also been reported to occur in Oregon (Oregon Natural Heritage Program 1991).

1. Source: UBC Herbarium (type)
Habitat: on trail
Locality: Albert Edward trail, Forbidden Plateau, Vancouver Island
2. Source: UBC Herbarium
Habitat: on peaty, shaded, damp banks of streamlet through subalpine meadow
Locality: Table Mountain base near Table Bay, Garibaldi Lake (elev. ca. 1500 m)

Trematodon montanus Belland & Brass.

This species is only known from three locations in the world; in addition to the following locations, this species is also known from a single location in Newfoundland (Belland and Brassard 1983).

1. Source: UBC Herbarium (paratype)
Habitat: damp, peaty earth of depression in alpine saddle of mountain top
Locality: mountain just south of Van Inlet Head, Graham Island, Queen Charlotte Islands
2. Source: UBC Herbarium
Habitat: earth bank, small pond on ridge
Locality: Mount Brown, Graham Island, Queen Charlotte Islands (elev. +914 m); ca. 53°N 132°W

Trichostomum arcticum Kaal.

1. Source: UBC Herbarium
Habitat: on boulders on slope
Locality: Wokkpash Lake, southwest shore, Mount Roosevelt–Churchill Peak area

Trichostomum recurvifolium (Tayl.) Zand.

These specimens are listed under the synonym *Leptodontium recurvifolium*. The only other locations of this species are in Europe (Schofield 1990). The species was also known until recently as *Paraleptodontium recurvifolium* (Tayl.) Long but was renamed by Zander (1993).

1. Source: UBC Herbarium

Appendix C Continued

Habitat: grassy talus

Locality: ridge (elev. 561 m) on southeast end of Takakia Lake about 16 km south of Moresby Logging Camp, Moresby Island, Queen Charlotte Islands

2. Source: UBC Herbarium

Habitat: wet cliff shelves

Locality: near unnamed alpine lake, ca. 32 km, south of Moresby Logging Camp, Moresby Island, Queen Charlotte Islands

3. Source: UBC Herbarium

Habitat: mixed with *Thuidium* on cliff shelf

Locality: north face of Moresby Mountain, Moresby Island, Queen Charlotte Islands

4. Source: UBC Herbarium

Habitat: stream to lake on northeast side of Newcombe Inlet

Locality: Tasu Sound, Moresby Island, Queen Charlotte Islands; 52°50'N 132°05'W

5. Source: UBC Herbarium

Habitat: grassy bank of lake shore

Locality: north side of Mercer Lake about halfway down lake near Athlow Bay, Graham Island, Queen Charlotte Islands

Ulota curvifolia (Wahlenb.) Lilj.

1. Source: UBC Herbarium

Habitat: shaded cliff face

Locality: Glacial Lake, Cassiar Mountain Range, near Horn and Glacial mountains

Warnstorfia procera (Ren. & Arnell *in* Husn.) Tuom. & T. Kop.

These specimens are listed under the synonym, *Drepanocladus procerus*.

1. Source: UBC Herbarium

Habitat: poor *Carex physocarpa* fen in 15-cm-deep pool

Locality: orohemiarctic zone, Battle Mountain, south slope, Fight Lake Meadows (ca. elev. 1750 m), Wells Gray Provincial Park

Warnstorfia pseudostraminea (C. Müll.) Tuom. & T. Kop.

These specimens are listed under the synonym *Drepanocladus pseudostramineus*.

1. Source: UBC Herbarium

Habitat: on log of margin of swamp

Locality: stream draining from Harrison Lake Hot Springs

Warnstorfia trichophylla (Warnst.) Tuom. & T. Kop.

These specimens are listed under the synonym *Drepanocladus trichophyllus*.

1. Source: UBC Herbarium

Habitat: acidic rocks surrounding seeps and waterfalls in subalpine krummholz of *Picea–Abies*, numerous acid fens and seeps among morainic debris covered by *Cassiope* and *Empetrum*.

Appendix C Concluded.

Locality: around waterfalls and subalpine fens, below third tarn in alpine basin of four tarn lakes, south of Horse Creek and northwest of large tarn (elev. 2073 m), east side of Kinbasket Lake, Selwyn Range, Rocky Mountains; 52°42'N 118°56'W

2. Source: UBC Herbarium
Habitat: floating mat in pools in bog
Locality: trail following three lakes, slopes of Mount Matier, east of Pemberton
3. Source: UBC Herbarium
Habitat: floating in pond margin
Locality: Mile 47, Atlin Highway; 59°40'N 133°45'W
4. Source: UBC Herbarium
Habitat: floating in pond
Locality: Mile 968, Alcan Highway, Mendenhall Creek campground

Warnstorfia tundrae (Arnell) Loeske

These specimens are listed under the synonym, *Drepanocladus tundrae*.

1. Source: UBC Herbarium
Habitat: mire
Locality: 1.6 km west of B.C.–Yukon border, Haines Highway; 59°59'N 136°55'W
2. Source: UBC Herbarium
Habitat: snowbank drainage area, saturated
Locality: (elev. 1620 m)
3. Source: UBC Herbarium
Habitat: spring-fed brook
Locality: in mountain meadow, upper subalpine zone, Battle Mountain, south slope, Fight Lake Meadow, Wells Gray Provincial Park
4. Source: UBC Herbarium
Habitat: data not available
Locality: Lake Atlin

Zygodon gracilis Wils. in Berk.

Zygodon gracilis is rare throughout its range. In addition to its occurrence in British Columbia, this species has also been found in Europe (Schofield 1990).

1. Source: UBC Herbarium
Habitat: in very dry limestone cliff
Locality: Moresby Logging Camp, Gilliatt Arm, Cumshewa Inlet, Moresby Lake, Moresby Island, Queen Charlotte Islands; 53°03'N 132°01'W

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