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Macrolichens and their zonal distribution in Wells Gray Provincial Park and its vicinity, British Columbia, Canada

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The distribution and general ecology of 293 macrolichen taxa are recorded for approximately 600 000 ha of mountainous terrain in Wells Gray Provincial Park and its vicinity in south-central British Columbia, Canada. Thirty-one taxa are documented for the first time from British Columbia, including seven from Canada, and five (*Leptogium subtile, Usnea wasmuthii,* and the lichenicolous fungi *Corticifraga fuckelii, Echinothecium reticulatum,* and *Refractohilum peltigerae*) from North America. 74% of the taxa included are essentially circumpolar, whereas only 11% are restricted to North America, in most cases western North America. A high proportion (71%) of the latter group is accounted for by corticoles. The Bioclimatic Zone System is used to indicate zonal distribution for the lichen species considered. Summaries of total ranges in the northern hemisphere are also provided. Duration of snow cover is considered to play a critical role in the distribution of many species, particularly terricoles. Numerous primarily coastal, oceanic lichen species are found to occur in the study area, including *Cavernularia hultenii, Cladonia umbricola, Dendriscocaulon intricatulum, Hypogynia enteromorpha, Parmelia pseudosulcata, Peltigera pacifica, Platismatia norvegica, Polychidium dendriscum, Pseudocyphellaria anomala, Sticta limbata*, and *Normandina pulchella*.

Key Words: British Columbia, Canada, flora, lichens, snow cover, vegetation zones

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I INTRODUCTION

The macrolichen flora of the Pacific Northwest of North America, though among the richest in the world, has attracted relatively little attention. Inland regions have been particularly overlooked, especially those lying east of the Coast Ranges and west of the Rocky Mountains. In the United States, these encompass eastern Oregon, eastern Washington, Idaho and western Montana, and, in Canada, the southern half of British Columbia. Moreover, the few accounts which have appeared (e.g. Räsänen 1933, Ohlsson 1973) make no attempt to provide a complete floristic overview. McCune's (1982) work in the Swan Valley of Montana is a notable exception, as is Imshaug's (1957) treatise on western alpine macrolichens. The lichen checklists of British Columbia (Otto & Ahti 1967, Noble et al. 1987) give a general idea of the flora, but are by no means complete.

In inland British Columbia (B.C.), however, no comprehensive studies at all have yet appeared — nothwithstanding that a few scattered records will be found in the literature, for example in Ahti (1966, 1980), Brodo & Hawksworth (1977), and Kärnefelt (1979). Many of these records are based on collections made by the author Ahti in the area in 1958 and 1961; these collections also in part form the basis of the present, more comprehensive report. A preliminary checklist of the macrolichens of the Wells Gray area, which was included in an unpublished report (Ahti 1962), included 143 species.

Additional data on the macrolichens of Wells Gray will also be found in Kujala (1945), Edwards & Ritcey (1960), Edwards et al. (1960), Hämet–Ahti (1965b, 1978), and Antifeau (1987). However, no specimen citations are listed in these papers.

The present study has four primary objectives: first to provide, for an area apparently representative of British Columbia's "interior wet-belt", a complete floristic account of the macrolichens; second to indicate the salient features of the local and northern hemisphere distribution of the species; third, to discuss these distributional patterns against a broader ecological and phytogeographic background; and fourth, to stimulate ecoclimatic studies on lichens elsewhere. To this latter end, we have presented considerable detail on the bioclimatic units present in the study area.

II METHODS

The material reported here consists in total of some 3 500 specimens of squamulose, foliose and fruticose lichens from 93 collecting localities. Of these, approximately 1 000 numbers were amassed by L. Hämet–Ahti and T. Ahti (labelled "Leena and Teuvo Ahti") in 1961 in connection with studies on range conditions of Mountain Caribou. Most of the remaining material was collected by Goward from 1977 through 1991 (in 1980 also together with Ahti). Ahti's specimens have been deposited in Helsinki (H), with replicates, where available, going to Ottawa (CANL) and Vancouver (UBC). Approximately half of Goward's collection is now housed at UBC; the rest is maintained in his private herbarium (GOWARD).

Roughly 150 relevés and transects of corticolous and terricolous plant communities were performed by the authors during the course of the study. As data from these were only indirectly incorporated in the present report, we have decided against giving an account of our methods at this time. The methodology of Ahti's relevés, however, has already been outlined in detail in Ahti (1962); see also Hämet–Ahti (1965b, 1978).

Thin-layer chromatography (TLC) was used in the initial identification of taxonomically critical species, especially within *Bryoria*, *Cetraria*, *Cladonia*, *Hypogymnia*, *Parmelia*, *Stereocaulon*, *Usnea*, and *Xanthoparmelia*. Many groups were also submitted to specialists for verification, including *Bryoria* (I.M. Brodo), *Collema* (G. Degelius), *Leptogium* (P.M. Jörgensen), *Peltigera* (O. Vitikainen), *Physcia* s. lat. (R. Moberg), *Psora* (E. Timdal) and *Usnea* (I. Tavares).

Our taxonomy and nomenclature essentially follow Egan (1987, 1989, 1990).

III THE STUDY AREA

The study area is located in south-central British Columbia (52°N, 120°W), 140 km due north of Kamloops and 400 km northeast of Vancouver (Fig. 1). At approximately 600 000 ha, its boundaries are roughly defined by the North Thompson River on the east and south, the Clearwater River on the west and Azure Lake on the north. Approximately half of this area lies within the southern portion of Wells Gray Provincial Park, and is essentially wilderness. The remainder, though increasingly modified by settlement, agriculture and logging, retains several large tracts of undisturbed forest lands.

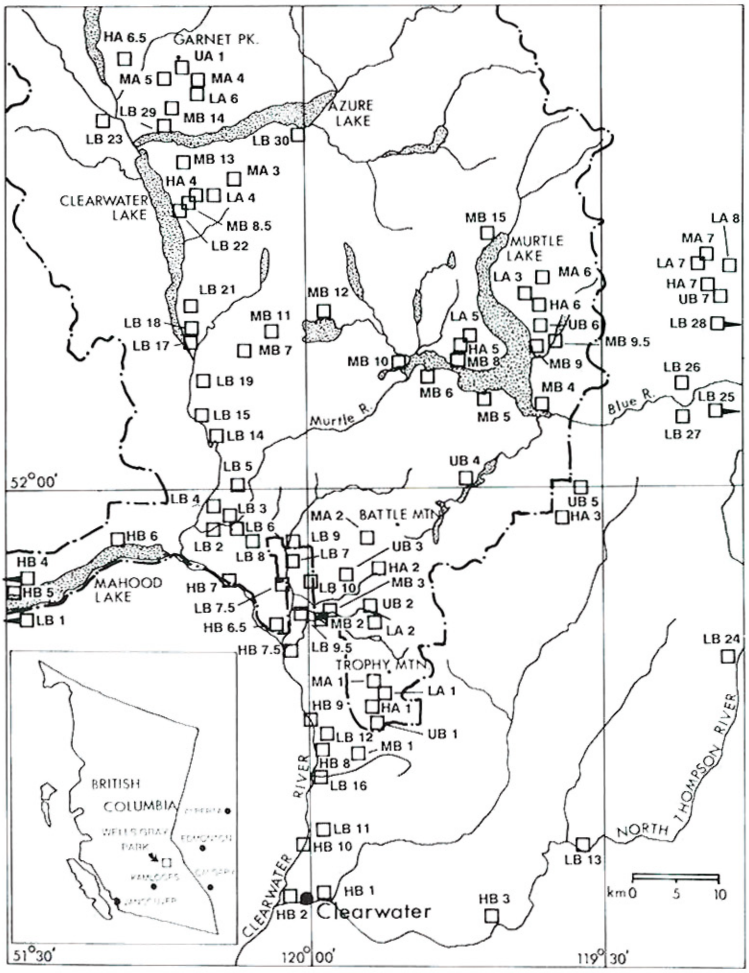

Fig. 1. Wells Gray Provincial Park and the Lower Clearwater Valley, showing collection localities (inset: the location of the study area in British Columbia).

1. Geology and landform

Much of the study area is underlain by Hadrynian and possibly younger metamorphic rocks, of which the petrographic composition is "predominantly quartzofeldspathic biotite gneiss and schist, containing garnet and sillimanite and minor amphibolite, quartzite, marble and 15 to 25 percent pegmatite" (Campbell & Tipper 1971). The main features of the landscape are believed to have developed during early Cenozoic uplift and erosion. Much later, during the Quaternary, the southwestern portion was subjected to several episodes of volcanic activity, with the result that the major valleys became partially filled with plateau basalts. This activity has continued episodically almost to the present, culminating in the eruption of post-glacial lava flows and cinder cones (Hickson 1986). The lavas are base-rich, and may be classified petrographically as alkali olivine basalt.

The study area falls within the Southern Interior Mountains Ecoprovince of Demarchi et al. (1990), and may be divided into three different physiographic units, namely the Shuswap Highlands (55%), the Cariboo Mountains (30%) and the Murtle Plateau (15%) (see for example Goward & Hickson 1989).

The Shuswap Highlands, comprising much of the southern portions, may be characterized as elevated plateaux of gentle relief that are intersected by deep, steep-sided, narrow valleys (Holland 1964). The upland surface lies between about 1 800 and 2 100 m, though localized areas of resistant rock may be considerably higher, e.g. 2 577 m on the Trophy Mountains (Fig. 2). The valley bottoms average about 400 to 700 m.

The Cariboo Mountains are restricted to the northern half of the study area, and are much more rugged than the Highlands. Characteristically they combine precipitous north and northeast slopes with gentler south and southwest slopes (Holland 1964). The lower peaks, having been subjected to erosion by the Pleistocene icesheet, tend to be rounded, but the higher peaks, above 2 400 m, are rugged and sharp, and are often connected to one another by sawtooth ridges. Garnet Peak, at 2 950 m, is the highest point in the study area. The valley bottoms lie at between 600 m and 1 000 m.

Fig. 2. A view from Battle Mountain, Wells Gray Park, toward Trophy Mountain. The foreground shows the timberline meadows, with clumps of *Picea engelmannii* and *Abies lasiocarpa* characteristic of the orohemiarctic subzone. The mountains in the background rise to the middle oroarctic subzone. Photo Trevor Goward.

The Murtle Plateau, at between 600 and 800 m, is an anomalous, diamond-shaped widening of the Clearwater Valley (Fig. 3) near the western edge of the study area (Hickson 1986). Though limited in extent, it is geologically highly distinctive, owing to the presence of recently extruded basalt (see above) and other volcanic features. The differential erosion of the lava by water and ice has produced numerous canyons, most of which are accompanied by one or several waterfalls. In other places, volcanic activity is so recent that the resulting lava flows have not yet been completely revegetated. The net effect is a highly diverse landscape that supports a rich lichen flora.

2. Climate

Most of the study area belongs within the "Northern Wet" climatic region of Lloyd et al. (1990), though southwestern portions belong in the drier "Northern Wet-belt Transition", and extreme northeastern portions in the "Northern Very Wet".

The main features of the climate are controlled by the study area's intermediate position relative to the Cariboo and Rocky Mountains to the east and the Coast Mountains to the west. In winter, for example, the former ranges tend to protect the area from outbreaks of polar and arctic air masses originating in central Canada. By contrast, the Coast Mountains modify, but do not entirely negate, the flow of mild, moist maritime air from the Pacific Ocean.

Trewartha (1968) has already called attention to an anomalous lobe of oceanic influence which, he asserts, is narrowly centred on the 49th parallel, and extends inland roughly 600 km. More recently McCune (1984) has discussed this phenomenon in relation to the occurrence of several "Pacific coastal–maritime" lichens in the Bitterroot Mountains of Montana and Idaho. This relative oceanic influence is well expressed in the study area, and is therefore certainly much more widespread in the interior regions of the Pacific Northwest than has previously been recognized.

In mid winter, daytime highs average roughly –5°C at valley bottom, and nighttime lows about –10°C to –15°C. Arctic outbreaks occur on occasion, and temperatures may then drop to –35°C–40°C; such extremes, however, are infrequent and generally of short duration. Summer values are also comparatively moderate, in July averaging between 22°C and 25°C at valley elevations during the day, and 7°C and 12°C at night (Environment Canada 1975a). Though no data are available for upland localities, the adiabatic lapse rate would predict a temperature decrease of 0.9°C for every 100 m increase in elevation. For more detailed climatic data, refer to Goward and Hickson (1989).

Precipitation is more or less evenly distributed through the year, with spring, however, being somewhat the driest season, and summer (especially June) the wettest. In general, precipitation values increase from southwest to northeast, in response to a corresponding increase in topography in this direction. At valley elevations in the Highlands and Murtle Plateau, annual precipitation varies from 425 mm at Vavenby to 561 mm at Hemp Creek. In the valleys of the Cariboo Mountains these values increase to 1 127 mm near Blue River (Environment Canada 1975b). At higher elevations in the northeastern portion of the study area, values may be as high as 2 000 mm per year (Goward & Hickson 1989). These patterns are summarized (for the summer months only!) in Fig. 4.

Winter snowpacks can be impressive. At one upper level station, snow depth averages about 350 cm during May, the month of maximum total accumulation, with a water content of roughly 1 500 mm (Water Management Branch 1985). Using a multiplier of ten, this represents roughly 1 500 cm of fallen snow. While amounts are considerably less at lower elevations (e.g. 441 cm of fallen snow at Blue River), and less again in the southwest (e.g. 182 cm at Hemp Creek; 103 cm at Vavenby — Environment Canada 1975b), snow is a conspicuous environmental feature throughout the study area.

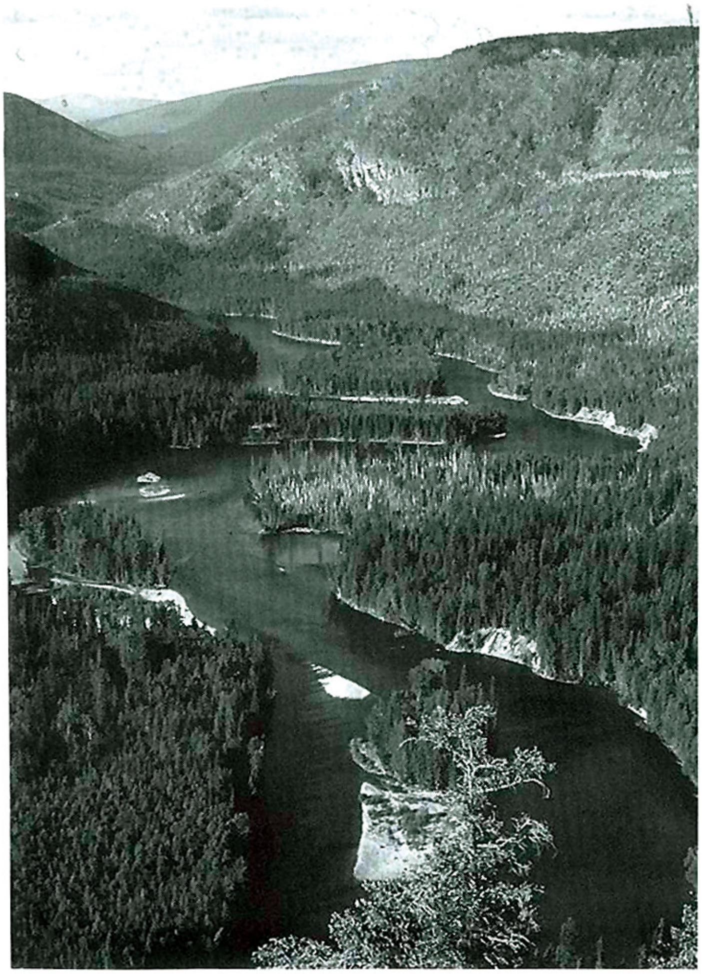

Fig. 3. The Clearwater River valley, Wells Gray Park (hemiboreal subzone or Moist Warm Interior Douglas-Fir Subzone). *Pseudotsuga menziesii* var. *glauca* and *Pinus contorta* var. *latifolia* dominant trees in the valley bottom forest. Photo Trevor Goward.

Fig. 5 depicts the average duration of continuous snow cover for different elevations, based on several years of observation (Goward, unpublished data). While it is true, as indicated, that most areas receive five or more months of continuous snow cover each year, conditions vary considerably with aspect and exposure. Southerly slopes, for example, may be clear of snow as much as five weeks earlier than the average. At oroarctic elevations, many ridges actually remain bare throughout much of the winter. These patterns exert a profound influence over the distribution of terricolous and saxicolous lichens.

Winds are, as a rule, rather light in the study area, particularly at valley elevations. Presumably this reflects the north–south axis of the major valleys, which thus cut across the prevailing winds. At any rate, the strongest winds are generally confined to the east–west valleys, such as those occupied by Mahood Lake, Murtle Lake (south arm) and Azure Lake. At higher elevations, especially above treeline, wind tends to become more prominent, leading to drifting snow and rapid desiccation, at least in exposed sites. In the valleys, by contrast, snow regularly accumulates for extended periods over the branches of trees, forming protective "qali". Air humidity also tends to be much higher here than elsewhere.

3. Vegetation

The vascular vegetation of the study area has been described in detail by Hämet-Ahti (1965b, 1978) and Lea (1986). In general, the lowlands are heavily forested, with *Thuja plicata* performing as a climax species virtually throughout. Because, however, climax forest types are extremely rare in the drier, warmer southwestern portions, owing to the frequency of forest fires, *Pinus contorta*, *Pseudotsuga menziesii* and *Populus tremuloides* tend to dominate here, accompanied on moister sites by *Picea engelmannii* x *glauca*. Important shrubs in these seral forests include *Acer glabrum* var. *douglasii*, *Salix bebbiana*, *S. scouleriana* and *Shepherdia canadensis* (see also Hämet-Ahti 1965a). Under more humid climatic regimes near the Cari-

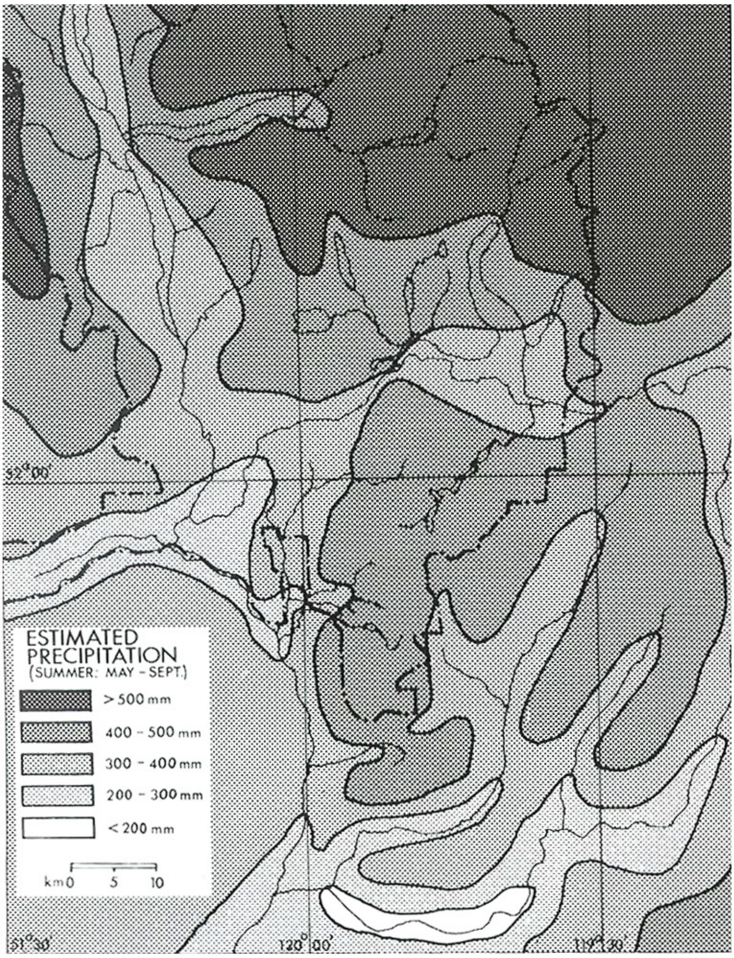

Fig. 4. Estimated summer precipitation (May through September) in Wells Gray Park and its vicinity.

boo Mountains, seral forests are dominated primarily by *Abies lasiocarpa, Betula papyrifera, Picea engelmannii* x *glauca, Thuja plicata* and *Tsuga heterophylla,* though the last two species alone predominate in climax forest types.

Above about 1 350 m, the lowland forests give way to a considerably less diverse forest of *Abies lasiocarpa* and *Picea engelmannii.* These upland forests occur over nearly half of the total study area. Different from the lowland forests, they are for the most part in climax condition, having escaped fire for hundreds, perhaps thousands, of years.

Treeline occurs at about 2 000 m, and here the forest is reduced largely to small tree islands surrounded by lush orohemiarctic (subalpine) meadows (Fig. 2) which are in turn dominated by *Arnica latifolia, Lupinus arcticus, Valeriana sitchensis,* etc. (Hämet-Ahti 1978). Above 2 100 m the meadows are replaced by barren heaths in which trees, if present at all, are widely scattered and severely dwarfed. Here the dominant vascular plants include various species of *Cassiope* and *Carex,* though with increasing elevation even these become sparse.

Further details will be found in the papers cited above.

4. Bioclimatic zonation

It is axiomatic that vegetational units are not distributed randomly over space, but can be meaningfully grouped into more or less coherent assemblages or life zones. Over the past few centuries, numerous systems for the description of life zones have been developed. The form each of these systems takes is determined largely by the function(s) it is intended to perform. In most cases, the primary function is simply to map the vegetational units of a given region. To this end, Lea (1986) and Lloyd et al. (1990) have recently described the vegetation of the study area using revised versions of the Biogeoclimatic Zone System of Krajina (1965). For a recent summary of this system see Meidinger and Pojar (1991).

Other systems have been developed specifically to permit detailed ecoclimatic comparisons of vegetation in different regions of the world. The Bioclimatic Zone System of Ahti et al. (1968) belongs in this category. Hämet-Ahti (1965b) has already applied (an early form of) this system to the forested portions of the study area, and has also used it to describe the vegetation of timberline meadows in southern Wells Gray Park (Hämet-Ahti 1978). More recently, Tuhkanen (1984) has attempted to quantify the major axes of the Bioclimatic System using several critical climatic variables. Because a major objective in the present paper is to compare local macrolichen distribution patterns with patterns observed elsewhere, we find it convenient to adopt the revised Bioclimatic System as a framework for discussion.

The Biogeoclimatic System, with its rather local terms of reference, does not lend itself to ecoclimatic comparisons with areas outside the Pacific Northwest. Because, however, it is more familiar to most B.C. botanists and plant ecologists than the Bioclimatic System we provide a rough comparison of these systems in Fig. 6.

As summarized by Tuhkanen (1984), the Bioclimatic System gives priority to three climatic elements that collectively control the main details of life zone distribution over the earth. These elements are zonality, humidity and continentality.

Zonality, as used here, is strictly a thermal expression: it reflects the quantity of heat available to plants during the growing season. Tuhkanen (1984) attempted to quantify the major zonal units of the Bioclimatic System using the average of the sum of mean monthly temperatures (in degrees Celsius) from May through September. He termed the resulting value "biotemperature".

As thus defined, biotemperature can be shown to decrease both with increasing altitude and with increasing latitude. This observation is fundamental to the Bioclimatic System, in which vegetation zonation is expressed using the same sequence of terms whether the movement is upward or poleward. This zonal nomenclature is perhaps more appropriate at boreal and arctic latitudes than in the tropical and temperate zones; at any rate, it clearly applies to Canada and the northern United States.

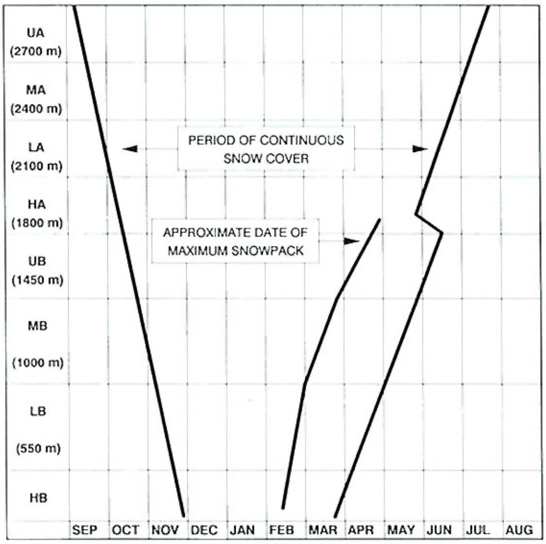

Fig. 5. Average duration of continuous snow cover in Wells Gray Park and its vicinity.

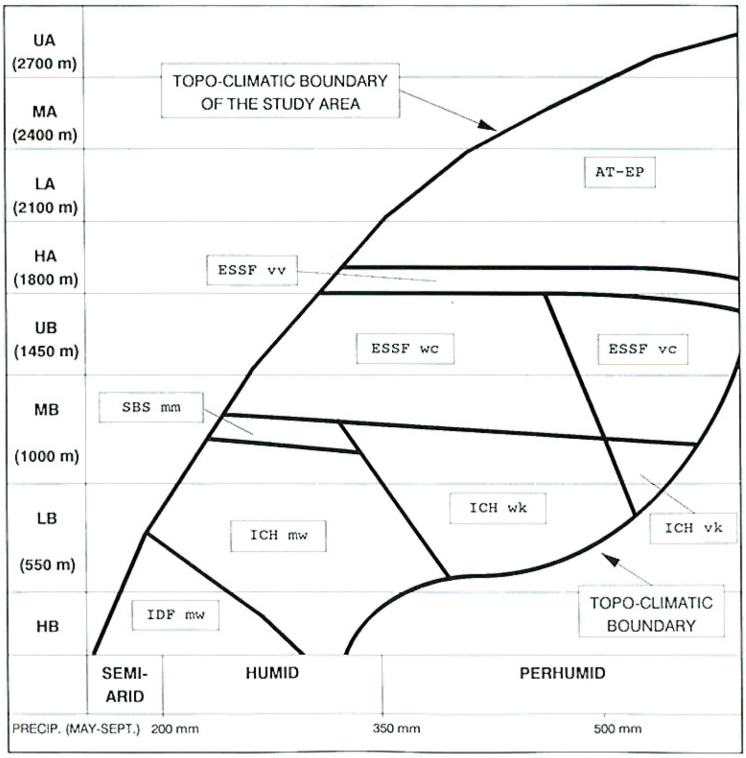

Fig. 6. The bioclimatic and biogeoclimatic zone systems as expressed in Wells Gray Provincial Park and its vicinity (see text for the explanation of the bioclimatic zone symbols HB to UA). Biogeoclimatic units (after Lloyd et al. 1990): AT–EP = Alpine Tundra–Engelmann Spruce Parkland; ESSFvv = Very Wet Very Cold Engelmann Spruce–Subalpine Fir Subzone; ESSFvc = Very Wet Cold Engelmann Spruce–Subalpine Fir Subzone; ESSFwc = Wet Cold Engelmann Spruce–Subalpine Fir Subzone; SBSmm = Moist Mild Sub-boreal Spruce Subzone; ICHvk = Very Wet Cool Interior Cedar–Hemlock Subzone; ICHwk = Wet Cool Interior Cedar–Hemlock Subzone; ICHmw = Moist Warm Interior Cedar–Hemlock Subzone; IDHmw = Moist Warm Interior Douglas-Fir Subzone

As an aid to clarity, however, the prefix "oro" (Gr. "oros" = mountain) may be appended when referring to an altitudinal gradient (see Table 1).

The abbreviations at right in the Table are adopted in the following species accounts. In addition, we have also occasionally found it useful to employ a "combined" terminology when describing the zonation of species having identical subzonal limits both on altitudinal and latitudinal gradients. Such species have been characterized, for example, as having a "High Arctic" (= Northern Arctic and Upper Oroarctic), "Mid Arctic" (= Middle Arctic and Middle Oroarctic), "Low Arctic" (= Southern Arctic and Lower Oroarctic) or "Subarctic" (= Hemiarctic and Orohemiarctic) distribution, etc.

Table 2 provides a summary of the subzones present in the study area, emphasizing their approximate elevational limits and thermal thresholds (expressed as biotemperature). In order to aid future field work, we have also indicated a few of the more salient vegetational and floristic characteristics of each subzone. Note that the thermal thresholds, though primarily based on Tuhkanen (1984), have been checked locally using available climatic data. Unfortunately no local data exist for oroarctic elevations; here our proposed thresholds are very approximate.

Tuhkanen (1984) defines humidity in terms, not of water vapour, but of "effective precipitation". Effective precipitation refers specifically to total precipitation, in mm, received during the summer half-year, i.e. between May and September inclusive. Using this definition, Tuhkanen recognizes three humidity provinces, namely semi-arid, humid and perhumid. All three of these are expressed in the study area (see Fig. 4), though the semi-arid province occurs only very marginally.

Finally, continentality may be defined as the apportioning of heat through the year, i.e. whether more or less evenly (as in oceanic sectors), or seasonally (as in continental sectors). According to Tuhkanen (1984), the most biologically meaningful expression of this variable is provided by the Conrad Index of Continentality (Conrad 1946). Using this index, the climate of the study area yields an average value of between 30 and 35, and can therefore be described as being of "intermediate" continentality ("OC" in Tuhkanen's terminology). By contrast, the Pacific coast averages between 5 and 20 (= extremely to moderately oceanic), and the Great Plains east of the Rocky Mountains average between 50 and 65 (= moderately continental).

Table 1. Subzonal units of the Bioclimatic Zone System.

Latitudinal gradient		Altitudinal gradient	
Zones	Subzones	Zones	Subzones
Arctic	Northern Arctic	Oroarctic	Upper Oroarctic (UA)
	Middle Arctic		Middle Oroarctic(MA)
	Southern Arctic		Lower Oroarctic (LA)
	Hemiarctic		Orohemiarctic(HA)
Boreal	Northern Boreal	Oroboreal	Upper Oroboreal (UB)
	Middle Boreal		Middle Oroboreal(MB)
	Southern Boreal		Lower Oroboreal (LB)
	Hemiboreal		Orohemiboreal (HB)
Temperate	Northern Temperate	Orotemperate	Upper Orotemperate (UT)
	etc.		etc.

Table 2. Bioclimatic subzones in Wells Gray Park and its vicinity — as characterized by elevation, estimated biotemperature* and vegetation (* in part after Tuhkanen 1984).

Subzone	Elevational limit (lower)	Biotemperature threshold	Major vegetational characteristics
Upper (oro)arctic	2 700 m	1.00 (estim.)	Vascular plants essentially absent; lichen fellfields dominant
Middle (oro)arctic	2 400 m	1.75 (estim.)	Trees absent; heaths scattered
Lower (oro)arctic	2 100 m	2.50	Trees dwarfed; understory of continuous heaths
(Oro)hemiarctic	1 800 m	3.25	Trees sparse and clumping; understory mostly herbaceous
Upper (oro)boreal	1 450 m	4.25	Forests open, entirely coniferous; understory dominated by *Rhododendron* thickets
Middle (oro)boreal	1 000 m	5.25	Forests closed; coniferous trees dominate
Lower (oro)boreal	550 m	6.25	Deciduous and coniferous trees present; spruce on mesic sites
(Oro)hemiboreal	> 500 m	< 6.25	Deciduous and coniferous trees present; spruce restricted to hygric sites

IV COLLECTING LOCALITIES

In Table 3, we have attempted to arrange the collecting localities according to the Bioclimatic units discussed above: first by subzone (i.e. warmer to cooler); and second by province (i.e. from subarid to perhumid). Subzonal abbreviations correspond to those given in the previous section. Site locations are mapped in Fig. 1.

Table 3. Collecting localities arranged according to the Bioclimatic Zone System and the Biogeoclimatic Zone System (see Fig. 4).

Bioclimatic subzone	Altitude (m)	Location	Biogeoclimatic subzone
HB 1	575	Raft River	IDF Moist Warm
HB 2	450	Clearwater Village	
HB 3	450	Vavenby north	
HB 4	625	Mahood Lake west	ICH Moist Warm
HB 5	625	Mahood Lake northwest	
HB 6	625	Mahood Lake northeast	
HB 6.5	550	Hemp Creek	ICH Wet Cool
HB 7	490	Whitehorse Bluff	
HB 7.5	550	Moul Creek Canyon	
HB 8	600	"The Shadden"	
HB 9	490	Camp Creek	
HB 10	450	"The Kettle"	
LB 1	640	Canim Falls	ICH Wet Cool
LB 2	800	Helmcken Falls	
LB 3	800	Helmcken Falls turnoff	
LB 4	760	"Snake Hill"	
LB 5	1000	Pyramid Mountain	
LB 6	800	Dawson Falls	
LB 7	600	Hemp Creek	
LB 7.5	650	"The Flatiron"	
LB 8	650	"South Gate"	
LB 9	600	"The Bee Ranch"	
LB 9.5	600	Philip Creek	
LB 10	700	Battle Mountain base	
LB 11	650	Candle Creek	
LB 12	625	Canyon Creeks	
LB 13	575	Porte D'Enfer	
LB 14	640	Ray Farm	
LB 15	640	Bailey's Chute	
LB 16	760	Spahats Falls	
LB 17	680	Clearwater Lake south	
LB 18	880	"The Osprey Overlook"	
LB 19	760	"The Dragon's Tongue"	
LB 20	700	Shadow Bog	
LB 21	880	Chain Lake	
LB 22	700	Clearwater Lake mid	
LB 23	850	Lickskillet Creek	
LB 24	610	Avola north	
LB 25	670	Blue River Village	
LB 26	760	Blue River northwest	ICH Very Wet Cool
LB 27	760	Blue River southwest	
LB 28	700	Cook Creek	
LB 29	690	Azure Lake west	
LB 30	690	Azure Lake east	
MB 1	1350	Trophy Mountain	ICH Wet Cool
MB 2	1000	Moul Lake	
MB 3	1250	Philip Creek	
MB 4	1080	Murtle Lake east	

(Contd.)

Table 3. Contnd.

Bioclimatic subzone	Altitude (m)	Location	Biogeoclimatic subzone
MB 5	1080	Murtle Lake mid	
MB 6	1070	Murtle Lake west	
MB 7	1220	Kostal Lake trail	
MB 8	1080	Central Mountain	
MB 8.5	1100	Trumpeter Mountain	
MB 9	1080–1215	Wavy Range	
MB 9.5	1200	Strait Lake	
MB 10	1080	File Creek	
MB 11	1350	Kostal Lake trail	
MB 12	1250	Kostal Lake	
MB 13	1100–1450	Azure Lake southwest	ICH Very Wet Cool
MB 14	1370	Azure Lake northwest	
MB 15	1080	Murtle Lake north	
MB 16	1000	Cook Creek	
UB 1	1770	Trophy Mountain	ESSF Wet Cold
UB 2	1590	Philip Lake	
UB 3	1680–	Fight Lake trail	
UB 4	1500	Stevens Lakes	
UB 5	1525	Fish Lake Hill	
UB 6	1550–1675	Wavy Range	ESSF Very Wet Cold
UB 7	1430–1550	Cook Creek	
HA 1	1980	Trophy Mountain	ESSF Very Wet Very Cold
HA 2	1860	Fight Lake	
HA 3	1830	Fish Lake Hill	
HA 4	2050	Trumpeter Mountain	
HA 5	1980	Central Mountain	
HA 6	1980	Wavy Range	
HA 6.5	1800	Goat Creek	
HA 7	1590–1680	Slide Lake	
LA 1	2100–2250	Trophy Mountain	Alpine Tundra
LA 2	2200	Table Mountain	
LA 3	2125–2230	Wavy Range	
LA 4	2280	Trumpeter Mountain	
LA 5	2100	Central Mountain	
LA 6	2130	Huntley Ridge	
LA 7	2130	Mount Dudley	
LA 8	2130	Mount Cook	
MA 1	2500–2560	Trophy Mountain	Alpine Tundra
MA 2	2320–2370	Battle Mountain	
MA 3	2470	Azure Mountain	
MA 4	2470	"Alabaster Ridge"	
MA 5	2625	Garnet Peak	
MA 6	2450	Wavecrest Peak	
MA 7	2290	Mount Dudley	
UA 1	2870	Garnet Mountain	Alpine Tundra

V ANNOTATED LIST OF MACROLICHENS

Each of the following species accounts is divided into as many as seven different categories. These are: 1) Species Name (including nomenclatural notes where appropriate); 2) known Subzonal Distribution within the study area; 3) Frequency Status; 4) Taxonomic Notes (where appropriate); 5) Ecological (and other) Remarks; 6) Northern Hemisphere Distribution; 7) Representative Specimens.

Because lichens are not always uniformly distributed throughout their zonal range, we have attempted to approximate their relative degree of frequency in the different subzones of the study area.

Thus, the use of parentheses () denotes scarcity relative to the subzone of optimum occurrence, while double parentheses (()) denotes rarity. We stress, however, that these symbols are based entirely upon local abundance relative to the subzone of optimum occurrence; they may not apply elsewhere.

By contrast, our designation of Frequency Status is based on more or less quantifiable units of frequency, and is intended to record the local abundance of each species within its subzone of optimum occurrence. The frequency units are defined below:

Frequency status	Approximate definition
very rare	only one or two specimens observed
rare	present in less than 30% of hypothetical 100 sq.m relevés, placed in appropriate habitat
scattered	present in 31% to 60% of such relevés
frequent	present in 61% to 90% of such relevés
very frequent	present in more than 90% of such relevés

Because our material is large (approx. 3 500 specimens), we have limited ourselves to citing only a few representative specimens of most species, usually one per subzone. However, for taxa for which five or fewer specimens exist, we have listed all available material. Note that the different numbering systems used for the specimen citations permit them to be traced to the appropriate author, i.e. Goward when the citation includes the year of collection (e.g. 79-1234), and Ahti when it does not (e.g. 12345).

Several species were listed in the "Second Checklist" of British Columbia lichens (Noble et al. 1987) on the basis of the present study. However, no published documentation yet exists for a majority of these reports; the records cited below therefore document them for the first time. An addition sign (+) denotes a first documented record for B.C.; two addition signs (++), for Canada; and three addition signs (+++), for North America. Taxa which, though present in the study area, have not yet been collected within the boundaries of Wells Gray Park, are signalled by the use of an asterisk (*).

Ahtiana sphaerosporella (Müll. Arg.) Goward

Syn. *Parmelia sphaerosporella* Müll. Arg. — ((LB))HA-LA, rare.

Over *Pinus albicaulis* in open, exposed sites; also rarely as scraps over *Abies, Picea* and *Pseudotsuga.* A very frequent lichen of the Canadian Rocky Mountains (Kalgutkar & Bird 1969), but rare in the wetter Columbia Mountains, presumably owing to the corresponding scarcity of its primary host, *P. albicaulis.*

The zonal distribution of *A. sphaerosporella* is determined by that of its host, which is primarily a HA species. One lakeside stand of *P. albicaulis* in the MB, however, was found to support a rich cover of this lichen.

Western North America (Goward 1985), essentially orohemiarctic to middle oroboreal.

LB 8 (77-225); HA 6 (79-1307); HA 7 (79-1417); LA 5 (78-724b).

Alectoria nigricans (Ach.) Nyl.

(HA)-UA, rare.

Over humous soil in exposed oroarctic sites, though less strictly confined to ridge-top situations than *A. ochroleuca.*

Circumpolar, (oro)arctic to rarely northern boreal (Brodo & Hawksworth 1977).

LA 2 (80-329); LA 2.5 (14314); MA 3 (78-765); UA 1 (79-1274).

Alectoria ochroleuca (Hoffm.) Massal.

LA-MA, rare.

Over soil in oroarctic ridgetop situations throughout.

Circumpolar, (oro)arctic to rarely northern boreal (Brodo & Hawksworth 1977).

LA 1 (79-1173); LA 2.5 (14277); MA 1 (80-359); MA 7 (79-1420).

Alectoria sarmentosa (Ach.) Ach. subsp. *sarmentosa*

HB-(LA), very frequent.

Over branches of all tree species, especially *Picea* and *Abies*, in open, somewhat humid sites.

Edwards et al. (1960) have emphasized its abundance locally, though it becomes sparse in the semiarid HB and in the upper phase of the HA and above. Their quantitative study did not distinguish *Ramalina thrausta,* which can be very similar, and was more abundant on their plot no. 1 than *A. sarmentosa* (Ahti 1962). Also sparse in very shady forest types.

One specimen from the LB measured 110 cm in length.

Western North America–eastern North America–western Eurasia (Hawksworth 1972), (oro)arctic to temperate (but chiefly oroboreal), with oceanic tendencies.

LB 2 (77-410); MB 10 (10290); HA 5 (78-721b); LA 1 (78-559).

Alectoria sarmentosa (Ach.) Ach. subsp. *vexillifera* (Nyl.) D. Hawksw.

LA-MA, very rare.

Over soil and stone on windswept ridges and other areas of minimal snow-lie. Observed only in the less humid portion of the study area, often with *A. ochroleuca*.

Western North America–eastern North America–western Eurasia, (oro)arctic (Brodo & Hawksworth 1977).
LA 2 (80-332); MA 1 (80-308, 80-358); MA 2 (77-253).

Allantoparmelia alpicola (Th. Fr.) Essl.

(MB-)LA-MA, scattered.

Very close in ecology to *Brodoa oroarctica* (which see), though less tolerant of calcareous substrates.

Essentially circumpolar, (oro)arctic (Esslinger 1977a) to occasionally high boreal.
MB 2 (78-891b); LA 5 (78-777a); MA 7 (77-464).

Arctoparmelia centrifuga (L.) Hale

Syn. *Xanthoparmelia centrifuga* (L.) Hale; *Parmelia centrifuga* (L.) Ach. — LB-HA, scattered.

Over clean, often near-vertical, acid or base-rich (e.g. peralkaline basalt) rock faces, especially in open boulder beds.

Circumpolar, (oro)arctic to hemiboreal, with continental tendencies (Ahti 1964, Thomson 1984).
LB 17 (78-431b); MB 8 (13699); HA 2 (78-636).

Arctoparmelia incurva (Pers.) Hale

Syn. *Xanthoparmelia incurva* (Pers.) Hale; *Parmelia incurva* (Pers.) Fr. — ?-MB-?, very rare.

Collected only once: over vertical acid rock face in an open boulder bed.

Circumpolar (Thomson 1984), (oro)arctic to hemiboreal, with oceanic tendencies.
MB 8 (13565).

Arctoparmelia subcentrifuga (Oxner) Hale

Syn. *Xanthoparmelia subcentrifuga* (Oxner) Hale; *Parmelia subcentrifuga* Oxner — ?-LB-?, very rare.

Collected only once: over dry acid rock in a north-facing boulder bed. On the basis of observations elsewhere, apparently more tolerant of shade than other members of its genus.

Apparently western North America–eastern North America–eastern Eurasia (Hale 1986), (oro)arctic to southern boreal, with continental tendencies, probably rare, but range poorly known.
LB 29 (78-431a).

(+) *Baeomyces carneus* Flörke

?-LB-?, very rare.

Contains norstictic acid, and trace of stictic acid.
Collected only once: on bare soil near mineral spring.

Probably circumpolar, arctic to temperate.
LB 14 (38672).

(+) *Baeomyces placophyllus* Ach.

LB, very rare.

Collected only once: over moss on an open north-facing basaltic bluff.

Circumpolar (Thomson 1984), arctic to upper, rarely to low (oro)boreal.
LB 7.5 (84-830).

Baeomyces rufus (Huds.) Rebent.

HB-(UB), scattered.

Over rock, earth and, rarely, lignum in open, humid sites, becoming less common, however, in perhumid districts.

The fruiting structures mature during late summer.

Circumpolar, (oro)boreal to temperate (Thomson 1984).
LB 2 (13849); LB 14 (80-411); LB 19 (78-601); UB 2 (80-326).

Brodoa oroarctica (Krog) Goward

Syn. *Hypogymnia oroarctica* Krog — LA-MA-?, rare.

Over rock, rarely over duff. Restricted to exposed oroarctic ridges, avoiding sites subject to prolonged snow cover (see also Krog 1974).

Circumpolar, (oro)arctic to northern boreal (Krog 1974).
LA 1 (79-1161); LA 5 (78-739); MA 2 (77-264).

Bryoria abbreviata (Müll. Arg.) Brodo & D. Hawksw.

(HB)-((LB-))-(HA)-LA, scattered.

Over conifer branches in open, well-ventilated sites, locally frequent in the HA and LA subzones, and, rarely, in exposed, semi-arid forests of the HB. More widespread in drier regions elsewhere.

All conifer species are colonized, excepting *Thuja* and *Tsuga*, which are presumably too hygrophilic.

Western North America (Brodo & Hawksworth 1977), oroarctic to temperate.
MB 6 (13326); LA 1 (78-538); MA 2 (14269).

Bryoria capillaris (Ach.) Brodo & D. Hawksw.

HB-(HA-)-((LB)), scattered to frequent.

Over conifers. Well adapted to shady conditions, avoiding only densest forest types. Also absent, however, from open, exposed sites.

Probably incompletely circumpolar (see Brodo & Hawksworth 1977), predominantly middle (oro)boreal to northern temperate, with oceanic tendencies.
HB 7 (78-300b); LB 2 (77-403); MB 6 (13322); HA 1 (80-336).

Bryoria fremontii (Tuck.) Brodo & D. Hawksw.

Syn. *Alectoria tenerrima* Mot. — HB-(LB-UB)-LA, very frequent.

The type material of *Alectoria tenerrima* is from Murtle Lake, Wells Gray Park (Motyka 1964). Brodo and Hawksworth (1977) synonymized it with *Bryoria lanestris,* but later I.M. Brodo (unpubl.) referred it to *B. fremontii,* which seems to be correct. The material (holotype and isotype in H) is extremely finely branched and almost black in colour. No secondary substances were detected with TLC.

Over conifers in open, well-ventilated sites. With the exception of *B. abbreviata* and *B. simplicior,* this is the least shade tolerant of the local arboreal Bryoriae. Best developed in semi-arid portions of the HB, and in the hygrically analogous HA and LA (see also Edwards et al. 1960). In humid and perhumid forests, it is virtually absent within the two-metre column studied, though it often occurs in the crowns of most conifers, excepting *Thuja* and *Tsuga.*

Traditionally used as a foodstuff by the indigenous peoples of Western North America (Turner 1977), though no record exists of it being collected for this purpose in the study area.

Western North America–western Eurasia, oroarctic to temperate, with continental tendencies (see Brodo & Hawksworth 1977).
LB 2 (77-412); MB 6 (6519); UB 2 (78-353); HA 7 (77-443); LA 1 (78-540).

Bryoria friabilis Brodo & D. Hawksw.

?-LB-?, evidently very rare.

Holien (1989) considers *B. friabilis* to be a conspecific chemotype of *B. implexa* (Hoffm.) Brodo & D. Hawksw.

Over conifers in open, well ventilated sites. Not distinguished from *B. fremontii* in the field; detected only through TLC by the presence of gyrophoric acid.

Western North America–eastern North America, low (oro)boreal to temperate (Brodo & Hawksworth 1977).
LB 14 (77-359); LB 17 (7332).

Bryoria fuscescens (Gyelnik) Brodo & D. Hawksw.

HB-(LA), very frequent.

Over conifers and (less commonly) deciduous trees, best developed in open sites, but also in poorly ventilated, humid forests thoughout. Apparently most frequent, however, over *Pseudotsuga.*

The parasitic fungus (+) *Phacopsis huuskonenii* Räs. was collected in the study area on *B. fuscescens,* e.g. 77-293 and 78-219.

Circumpolar, (oro)hemiarctic to northern temperate (see Brodo & Hawksworth 1977).
LB 6 (77-396); MB 6 (13320); HA 2 (14258); LA 2 (78-658a).

Bryoria glabra (Mot.) Brodo & D. Hawksw.

HB-(LA), very frequent.

Ecologically very close to *B. fuscescens,* which see.

Western North America–eastern North America (Brodo & Hawksworth 1977), western Europe (Holien 1992) orohemiarctic to temperate.
LB 17 (77-422); MB 10 (10348); HA 7 (77-446); LA 1 (79-1153).

Bryoria lanestris (Ach.) Brodo & D. Hawksw.

(HB)-HA-(LA), frequent.

Over conifers in open habitats with good air circulation, especially well developed in HA "island" forests.

The local material is frequently parasitized by a spinule-producing coelomycete (?), possibly undescribed.

Circumpolar (Brodo & Hawksworth 1977), (oro)arctic to hemiboreal.
HB 2 (79-52-1); LB 20 (79-1180); MB 10 (6512); UB 5 (13920); HA 2 (14233).

Bryoria oregana (Tuck. ex Willey) Brodo & D. Hawksw.

(HB)-LA, scattered to frequent.

The previous reports of *B. subdivergens* (E. Dahl) Brodo & D. Hawksw. from continental North America (Brodo & Alstrup 1981, McCune 1984) actually represent terricolous morphotypes of *B. oregana.*

Over conifers in both exposed and rather shady sites, present in all forested subzones. Deciduous trees are rarely colonized; among the conifers, however, only *Thuja* is avoided. Also once over rock in LA.

Western North America, low (oro)arctic to temperate (see Brodo & Hawksworth 1977).

LB 7 (13048); MB 6 (13325); HA 2 (78-616); LA 1 (79-1399).

Bryoria pseudofuscescens (Gyelnik) Brodo & D. Hawksw.

(LB)-HA(-LA), frequent to very frequent.

Holien (1989) considers *B. pseudofuscescens* to be a conspecific chemotype of *B. implexa* (Hoffm.) Brodo & D. Hawksw.

Over conifers in open, well-ventilated sites, especially in open HA forests. At lower elevations, most common in exposed habitats in perhumid forests.

Western North America–western Eurasia, oroarctic to temperate (see Brodo & Hawksworth 1977).

LB 14 (77-350); MB 8 (13390); UB 5 (13923); HA 4 (78-753b); LA 2 (78-566d).

Bryoria simplicior (Vainio) Brodo & D. Hawksw.

HA-LA, very rare.

Over conifers, apparently restricted locally to exposed timberline trees. Much more common in semi-arid forests outside the study area.

Circumpolar (Brodo & Hawksworth 1977), low (oro)arctic to orohemiboreal, with continental tendencies.

HA 1 (78-530a); LA 2.5 (14273).

(+) *Bryoria subdivergens* (E. Dahl) Brodo & D. Hawksw.

LA-?, very rare.

The present and previous reports of *B. subdivergens* from continental North America (Brodo & Alstrup 1981, McCune 1984) appear to represent terricolous morphotypes of *B. oregana.*

Collected only once: over siliceous rock on an exposed, south-facing LA ridge adjacent to clumps of dwarfed *Picea* on which *B. oregana* was found growing. Confirmed by I.M. Brodo.

Western North America–eastern North America (Greenland), oroarctic to orohemiarctic (Brodo & Alstrup 1981).

Bryoria tortuosa (G.K. Merr.) Brodo & D. Hawksw.

?-HA, very rare.

B. tortuosa is morphologically very close to *B. fremontii,* distinguished by its yellow pseudocyphellae (versus pseudocyphellae white or absent in *B. fremontii),* and lack of soredia (versus yellow soredia present or absent in *B. fremontii).* Given, however, that several collections now exist which combine these characters in varying degrees, it would appear that the primary distinction between these species is actually a chemical one: the more prolific and generalized (but variable: Brodo & Hawksworth 1977: 179) production of the yellow pigment vulpinic acid in *B. tortuosa. B. tortuosa* might therefore more appropriately be regarded as a variety of *B. fremontii* — a view supported by the observation that *B. tortuosa* is not distributionally distinct, but occurs sporadically throughout the range of *B. fremontii.*

Over *Abies* and *Picea* in timberline tree "islands".

Western North America–western Europe (Norway, Carpathian Mountains), orohemiarctic to temperate (see Brodo & Hawksworth 1977, Holien 1989).

HA 4 (78-753); HA 6 (80-39-3).

Catapyrenium cinereum (Pers.) Körber

Syn. *Dermatocarpon cinereum* (Pers.) Th. Fr. — ?-UB-HA-?, very rare.

Recently reported as new to B.C. on the basis of a specimen from the study area: muscicolous over mossy siliceous rock on a south-facing outcrop (Goward & Thor 1992). Also collected once from crevices in a basalt boulder in an open meadow.

Circumpolar, middle (oro)arctic to northern temperate (see Thomson 1987).

UB2 (91-274); HA 7 (79-1427).

(+) *Catapyrenium squamulosum* (Ach.) O. Breuss

Syn. *Dermatocarpon hepaticum* (Ach.) Th.Fr. — ?-LB, very rare.

Collected only once: over dead moss on a west-facing, vertical cliff face near a lake. Becomes frequent, however, in more arid districts outside the study area.

Circumpolar, hemiboreal to subtropical (Thomson 1989, Breuss 1990).

LB 17 (88-172).

Cavernularia hultenii Degel.

LB, very rare.

Collected only once: over *Picea* in an open site near mineral springs on an abandoned farm. Subsequent searching turned up no further material. A first record for inland North America.

Western North America–eastern North America–western Eurasia, (oro)boreal to temperate, with strong oceanic tendencies (Ahti & Henssen 1965, Maass 1981).
LB 14 (78-852).

Cetraria canadensis (Räsänen) Räsänen

Syn. *Tuckermannopsis canadensis* (Räsänen) Hale — HB-(MB), scattered.

Hale (in Egan 1987) places *C. canadensis* in the genus *Tuckermannopsis*. Although we agree that this and various other cetrarioid species (e.g. *C. ciliaris* var. *halei*) are not congeneric with *Cetraria* s. str., we think it best not to segregate them until a thorough review of all related species has been undertaken, and at least a majority of taxa are correctly classified.

Described from interior B.C. by Räsänen (1933) as *C. juniperina* var. *canadensis* Räs. and var. *crispata* Räs. *C. juniperina* (L.) Ach., however, is regularly provided with conspicuous, black, cylindrical, marginal coniodiomata, whereas *C. canadensis* typically lacks conidiomata or produces immersed and laminal to submarginal conidiomata; the conidia are also different in shape (Mattsson 1991). Note, however, that a lichenicolous fungus much resembling conidiomata is also common on this lichen. *C. juniperina* is widespread in eastern Asia (on *Pinus pumila*) and in Europe (on *Juniperus communis*), particularly in somewhat oceanic boreal regions. The related *C. viridis* Schwein., occurring in temperate eastern North America, is readily distinguished by its pale greenish yellow colour (Esslinger 1973).

Over conifers. Locally most common in the driest forest types, especially over *Pinus contorta* and *Pseudotsuga*; most other tree species are only rarely colonized. The absence of this species in HA timberline forests, as well as from the uppermost stands of its preferred hosts, suggests that thermal requirements may play a major part in restricting its distribution.

Western North America, oroboreal to temperate (see Hale 1979).
HB 7 (77-177); LB 2 (77-413); LB 18 (78-227); MB 8 (13391).

Cetraria chlorophylla (Willd.) Vainio

HB-(HA), very frequent.

Over trees, especially conifers.

Although never a dominant species, *C. chlorophylla* was found to be the most widespread corticole in the study area, occurring in shady and in exposed habitats alike. Only in the HA is it sparse.

In the humid NT of southern inland B.C., this lichen has been collected over siliceous boulders; locally, however, it appears to be strictly epiphytic.

Incompletely circumpolar, common on west coasts and far inland in North America and Eurasia but very rare on the east coasts (e.g. Newfoundland; Ahti 1983), and absent in large areas in the interior boreal lowlands of North America (Thomson 1984) and Eurasia, (oro)hemiarctic to temperate.
HB 7 (77-171); LB 8 (7374); MB 8 (78-710b); HA 2 (78-629a); LA 2.5 (14275).

Cetraria ciliaris Ach. var. *halei* (Culb. & C. Culb.) Ahti

Syn. *Cetraria halei* Culb. & C. Culb., *Tuckermannopsis americana* (Sprengel) Hale — HB-((MB)), scattered.

Because *C. halei* seems to be a morphologically indistinguishable chemical strain of *C. ciliaris,* we feel that it deserves at most the rank of variety (see also Brodo 1984), though most American lichenologists have followed W. Culberson & C. Culberson (1967) in recognizing them as separate species.

Over conifers, especially in rather open forests. Locally almost entirely restricted to the semi-arid portions of the HB and LB subzones, where it is most common over *Pinus contorta* and *Pseudotsuga*.

Incompletely circumpolar (absent from the west coast of North America and coastal western Eurasia), (oro)boreal to temperate (see W. Culberson & C. Culberson 1967, Brodo 1984), with continental tendencies.
HB 2 (78-1290b); LB 7 (14996); MB 2 (78-860).

Cetraria commixta (Nyl.) Th.Fr.

LB-(UB-LA)MA, rare (overlooked?).

Over acid rock, especially in rather exposed sites with minimal snow-lie. Ecologically very similar to *C. hepatizon* and *Melanelia stygia*.

Circumpolar (Thomson 1984), (oro)arctic to hemiboreal.
LB 29 (78-442); MB 8 (13530); MA 3 (78-769a).

Cetraria cucullata (Bellardi) Ach.

(HA-)LA-MA, scattered.

Terricolous, locally restricted to oroarctic sites having moderate snow cover. In semi-arid districts elsewhere, also rarely collected on leeward ridges down to the MB. On the whole a more faithful indicator of (oro)arctic conditions than *C. nivalis*.

Circumpolar, essentially (oro)arctic to northern boreal (Ahti 1964, Thomson 1984).
LA 1 (78-577); MA 1 (78-548).

Cetraria ericetorum Opiz subsp. *reticulata* (Räsänen) Kärnef.

HB-(MB-)MA, scattered.

Subsp. *reticulata* was described from inland B.C. by Räsänen (1933), the lectotype (called "holotype" by Kärnefelt 1979) being from Kamloops. The main identifying character of this subspecies are the lobe ends, which tend to become reticulate–ridged.

Over soil or humus in rather xeric, often exposed sites of minimal snow-lie. Well represented in the semi-arid forests of the HB, and in windswept oro-arctic summits, where it may occasionally adopt a vagant life form; otherwise rare. In areas having deeper, more persistent snowpacks, it not infrequently colonizes decorticate, but generally sound, conifer logs in open sites. As a lignicole, however, it has not been observed to attain full development, nor does it produce apothecia.

North America (Kärnefelt 1979), (oro)arctic to northern temperate.

According to Kärnefelt (1979), subsp. *reticulata* grows primarily in the alpine tundra, and is principally a western North American taxon. In light of additional field observations, however, its zonal range actually closely resembles that of subsp. *ericetorum*, which is primarily boreal, but also extends into the arctic and oroarctic subzones. Subsp. *reticulata* is widespread throughout boreal Ontario and at lower elevations of oroboreal British Columbia, for instance. In boreal eastern North America it may be absent only along the coast and in most of the arctic zone.

HB 7 (78-314); LB 19 (80-313); MB 4 (6531); LA 2.5 (14262); MA 3 (78-763).

Cetraria hepatizon (Ach.) Vainio

LB-(UB-)MA, scattered.

Saxicolous. Very close in ecology to *C. commixta,* though locally more frequent than that species. Also rarely collected over lignum in the LA.

Circumpolar, (oro)arctic to (oro)boreal (Ahti 1964).
HA 7 (77-179); LA 4 (78-776); MA 3 (78-769b).

Cetraria idahoensis Essl.

Syn. *Esslingeriana idahoensis* (Essl.) Hale & Lai — HB-((MB)), scattered to frequent.

Over conifers, especially *Pinus contorta* and *Pseudotsuga*, locally confined to semi-arid forest types at lower elevations, though elsewhere observed into the UB (see also Bird & Marsh 1973).

Western North America (Esslinger 1971), oroboreal to temperate.
HB 2 (78-1290a); LB 7 (13061); MB 2 (78-861b).

Cetraria islandica (L.) Ach. subsp. *crispiformis* (Räsänen) Kärnef.

LB-((MB-UB))-HA-?, very rare.

Over humous earth in open sites. Primarily an arctic and coastal lichen preferring more humid districts than *C. ericetorum* subsp. *reticulata* and even *C. islandica* subsp. *islandica.*

Essentially circumpolar, (oro)arctic to (oro)boreal (Kärnefelt 1979), with oceanic tendencies.
LB 19 (80-488); HA 2 (6533).

Cetraria islandica (L.) Ach. subsp. *islandica*

(LB-)HA-MA, scattered.

Over humous earth, especially in exposed oro-arctic sites. Prolonged snow cover may be limiting in most parts of the study area; in more arid districts, this is not an uncommon lichen of open sites at HB and even NT elevations.

Circumpolar, (oro)arctic to temperate.
HA 2 (14992); LA 1 (78-591); MA 2 (77-261).

Cetraria merrillii Du Rietz

HB-(UB-)((HA-LA)), scattered.

Over conifers, especially *Pinus contorta* and, to a lesser extent, *Pseudotsuga*. Most common in open, semi-arid forest types.

Frequently associated with *C. canadensis* at lowland elevations. Unlike that species, however, *C. merrillii* regularly extends upward into the UB and, rarely, into the LA.

Western North America (with one report from Spain, Kärnefelt 1980), orohemiarctic to temperate.
LB 7 (13046); MB 4 (15135); LA 1 (79-1152).

Cetraria nivalis (L.) Ach.

(HA)-MA, scattered.

Terricolous, very close in ecology to (the less common) *C. cucullata*. Though locally oroarctic in distribution, in more arid districts elsewhere it may descend, on north-facing outcrops, as low as the HB. Apparently benefits from some degree of snow cover, but does not colonize areas adjacent to permanent snow fields (see Larson & Kershaw 1974, Richardson & Finegan 1977).

Circumpolar, essentially (oro)arctic to northern boreal (Ahti 1964), but with low oroboreal outliers.
LA 4 (78-774); MA 2 (77-262).

Cetraria orbata (Nyl.) Fink

Syn. *Tuckermannopsis orbata* (Nyl.) Lai — HB-((MB-))HA-(LA), scattered.

Over conifers in open forest types. At lower elevations, similar in ecology to *C. ciliaris* var. *halei*, but occurring also into the oroarctic in highly exposed sites.

This is clearly a distinct species, not a mere chemical strain of *C. ciliaris*, like *C. halei*. It normally has no marginal cilia, for instance.

Western North America–eastern North America (Noble 1982), essentially orohemiarctic to temperate.
LB 7 (13123); MB 6 (79-1340); HA 5 (78-721a); LA 1 (78-558).

Cetraria pallidula Tuck. ex Riddle

?-LB, very rare.

Over conifers, especially *Pseudotsuga*.

In the study area found only in tree tops, perhaps suggesting a requirement for relatively low humidity and high illumination. Though locally restricted to the LB, in more arid districts *C. pallidula* may occur upward into the UB.

Western North America (Ohlsson 1973), upper oroboreal to hemiboreal.
LB 8 (7377a); LB 15 (80-333).

Cetraria pinastri (Scop.) S. Gray

HB-(MB-)((HA-))(LA), scattered.

Over bark, especially near the bases of trees. Colonizes both conifers and deciduous trees and shrubs (e.g. including *Salix*, *Alnus*, *Shepherdia canadensis*); also occasional over rock.

Though *C. pinastri* is often classified as a chionophile, its microdistribution appears to be more closely associated with humidity than with snowlie *per se*. In perhumid forests, for example, it often colonizes branches high above the winter snowline — even in places where insulating snow clumps would not be expected to form. Moreover, the fact that in snowy localities it regularly disappears from its usual habitat at the bases of trees, may suggest an actual intolerance for prolonged snow cover. Of course, in more continental regions elsewhere, snow cover may indeed favour the occurrence of this species.

Circumpolar, oroarctic to essentially (oro)boreal and temperate (Ahti 1964, Thomson 1984).
LB 7 (77-324); MB 5 (13787); UB 2 (78-359); LA 5 (78-725).

Cetraria platyphylla Tuck.

HB-(MB-)LA, frequent.

Over a broad range of conifers, especially in well illuminated sites. Apparently less tolerant of shade than *C. canadensis* and *C. merrillii*.

Western North America (Brodo 1984), oroarctic to temperate.
LB 7 (13050); MB 6 (79-1338); UB 2 (78-360); HA 7 (77-448); LA 1 (78-535).

Cetraria sepincola (Ehrh.) Ach.

LB-(MB), scattered.

Over deciduous trees and shrubs in open sites. Restricted locally to *Betula papyrifera*, *B. glandulosa* and *Shepherdia canadensis* (once over *Pinus contorta* in a bog).

In other parts of its range, *C. sepincola* is common up to low arctic latitudes; its absence from the upper subzones of the study area was therefore unexpected. On the other hand, most of its host species likewise disappear above the MB. In the mountains of southwestern Alberta, Bird and Marsh (1973) did not record it at all.

Circumpolar, arctic to hemiboreal, with continental tendencies (Ahti 1964, Thomson 1984).
LB 14 (79-874); LB 21 (80-311).

Cetraria subalpina Imsh.

((MB-))(UB-)HA-(LA), frequent.

Over (the bases of) *Rhododendron*, *Menziesia* and *Vaccinium*, especially in open sites. In the LA, also over duff, or occasionally vagant.

May occur downward to the MB in perhumid forests having a prolonged snow cover; elsewhere it appears to be mostly confined to the UB and HA, though it can also be fairly common over duff in snowy oroarctic depressions. On the other hand, based on relevés performed in the HA of Battle Mountain, Hämet–Ahti (1978) reported this species to be most abundant over low ridges in dry meadow types.

Western North America, lower oroarctic to upper oroboreal, with oceanic tendencies (see Kärnefelt 1979).
UB 7 (78-394a); HA 3 (13899); LA 1 (78-586).

Cladina arbuscula (Wallr.) Hale & Culb. subsp. *beringiana* (Ahti) Golubk.

HB-LB(-HA), scattered.

Over soil, duff and rock (both acid and base-rich) in open forests and boulder beds, especially at lower elevations in semi-arid areas. Rare also over decaying logs.

Much less common in the study area than in more arid portions of the boreal zone. Though Ahti (1962) proposed that this and other Cladinae are limited locally by the fertility of the soil, our more recent observations suggest that the effects of prolonged snow cover and a well developed shrub layer are probably of much greater importance. In this connection it is interesting to note that the Cladinae become much less common in forested subzones above the LB; in less snowy, less shrubby regions, the reverse is true.

C. arbuscula is circumpolar, (oro)arctic to temperate (Thomson 1984). Subsp. *beringiana*, however, is restricted to western North America and eastern Eurasia, and is oroarctic to temperate, with suboceanic tendencies (Ahti 1961); its taxonomic status requires further studies though.
HB 8 (78-1029); LB 29 (14047); MB 8 (7231); UB 2 (78-386); HA 2 (14125a).

Cladina mitis (Sandst.) Hustich

Syn. *Cladonia arbuscula* subsp. *mitis* (Sandst.) Ruoss — HB-(-UB)-LA(-MA), scattered.

Over soil and rocks in open sites.

C. mitis is essentially the only member of its genus to occur above the UB in the study area; presumably this reflects its rather xerophilous ecology (Ahti 1961, Larson & Kershaw 1974).

Circumpolar, (oro)arctic to temperate, with continental tendencies (Ahti 1961).
LB 29 (78-426); MB 8 (13574); HA 2 (6506); LA 5 (79-1045); MA 5 (79-1246).

Cladina rangiferina (L.) Nyl.

HB-(-UB), rare to scattered.

Over rocks, soil and moss in open forests and boulder beds. Poorly represented locally, generally disappearing altogether above the MB.

Circumpolar, arctic to temperate (Thomson 1984).
LB 2 (13858); MB 8 (6536); UB 2 (78-385).

Cladonia acuminata (Ach.) Nyl.

Syn. *C. norrlinii* Vainio — LB, rare.

Over calcareous soil and mossy boulders; once also on driftwood by lake.

Circumpolar, arctic to temperate (Ahti 1964, Thomson 1984).
LB 7 (14812); LB 19 (80-439); LB 29 (80-449).

Cladonia amaurocraea (Flörke) Schaerer

HB-MB, scattered to frequent.

Over thin soil in open sites. Always on rocky substrates, especially boulder beds. A very common lichen of climatically continental boreal and arctic areas (see, for example, Bird et al. 1980), but relatively scarce in oroboreal regions, and locally not found in the oroarctic at all.

Circumpolar, arctic to hemiboreal, with continental tendencies.
HB 10 (80-478); LB 29 (78-424); MB 8 (13655).

Cladonia bacilliformis (Nyl.) Glück

LB-(UB), rare.

Over decaying logs, also terricolous in rather open forests. Definitely very sparse in the study area.

Circumpolar, northern boreal to hemiboreal, with continental tendencies (Ahti 1964).
LB 7 (13015); MB 6 (79-1332).

Cladonia bellidiflora (Ach.) Schaerer

(LB-)HA-LA, frequent.

In the oroarctic subzones, mainly over soil, e.g. in dry timberline heaths and meadows (Hämet–Ahti 1978); in the UB and especially the LB, almost entirely confined to thin soils over rock, especially in humid areas near lake shores.

Very common in coastal B.C., being common down to the temperate zone (unlike in Europe where the front of distribution stops in the hemiboreal zone; Hasselrot 1953), but lacking, for example, in the mountains of southwestern Alberta (Bird & Marsh 1972).

Incompletely circumpolar (Ahti 1977), (oro)arctic to northern temperate, with oceanic tendencies (Ahti 1964).
LB 29 (14041); UB 7 (77-204); HA 2 (14993); LA 1 (80-339).

Cladonia borealis Stenroos

LB-UA, scattered to frequent.

The specimens tested with TLC proved to contain usnic, barbatic and 4-0-demethylbarbatic acids as major secondary substances. This taxon is the one that Thomson (1968) and others in North America have called *C. coccifera* s. str.; that species, however, contains zeorin, and is not definitely known from B.C. (Stenroos 1989a).

Over soil and (mossy) rocks, both acid and basic, rarely over wood in open, often xeric, sites.

As Imshaug (1957) has noted, apothecia are very rare in specimens collected above the HA.

Circumpolar, (oro)arctic to northern temperate (Ahti 1964, Stenroos 1989a).
LB 6 (13136); MB 8 (13719); UB 4 (14971); HA 7 (77-189); LA 7 (77-467); MA 5 (79-1255); UA 1 (79-1286).

Cladonia botrytes (K. Hagen) Willd.

HB-LB, rare.

Over dead *Sphagnum* and especially decaying logs in open sites.

Circumpolar, (oro)boreal to northern temperate (Ahti 1964), somewhat continental.
HB 7 (79-1084); LB 7 (13812); LB 8 (80-635).

Cladonia cariosa (Ach.) Sprengel

HB-((MB-))HA-MA, scattered.

On bare soil and (mossy) rocks, especially in open, grassy, calcareous localities. This is one of the pioneer Cladoniae, colonizing disturbed soils in calcium-rich areas, including lava beds.

Reported for Wells Gray by W. Culberson (1969), who included some of our *C. symphycarpa* in his concept of *C. cariosa.*

Circumpolar, (oro)arctic to temperate (Imshaug 1957, Ahti 1964).
HB 4 (79-1220); LB 18 (79-1389); MB 8 (13388); HA 7 (79-1425); LA 2.5 (14750); MA 6 (79-1322).

Cladonia carneola (Fr.) Fr.

(HB-)LB-HA, frequent.

Mainly lignicolous over decaying logs in open forests, but also occasional over mossy granitic boulders and on soil in dry timberline meadows.

Circumpolar, arctic to hemiboreal, with continental tendencies (Ahti 1964).
HB 2 (80-533); LB 17 (79-932); MB 6 (13339); UB 1 (80-365); HA 3 (13906).

Cladonia cenotea (Ach.) Schaerer

HB-(HA), very frequent.

Generally over decaying wood in rather shady, humid sites, but also occasional over earth or mossy rock.

Circumpolar, essentially (oro)boreal to northern temperate (Ahti 1964).
LB 7 (13016); MB 5 (13350); UB 2 (78-352).

Cladonia cervicornis (Ach.) Flotow subsp. *verticillata* (Hoffm.) Ahti

Syn. *C. verticillata* (Hoffm.) Schaer. — HB-(MB), rare to scattered.

Over disturbed, often sandy soils, primarily on open, south-facing slopes.

Circumpolar, arctic to temperate (Ahti 1964).
LB 7 (13113); LB 19 (80-486); LB 22 (78-803).

Cladonia chlorophaea (Flörke ex Sommerf.) Sprengel

HB-HA, scattered to frequent.

Only *C. chlorophaea* s. str. and *C. merochlorophaea* were recorded despite a search for other members of the morphologically similar *C. grayi* group. Several specimens were tested with TLC, but only fumarprotocetraric acid and its satellites (protocetraric acid and the unknown Cph-2) were detected.

Over various habitats: (mossy) siliceous rock, thin humus (e.g. in dry to mesic timberline meadows), moss, lignum, soil, predominantly in open sites.

Circumpolar, (oro)arctic to subtropical (Ahti & Lai 1979).
LB 7 (15486); MB 15 (13476); UB 2 (78-346); HA 2 (14295).

Cladonia coniocraea (Flörke) Sprengel

HB-(MB), very frequent.

Over bark and lignum, occasional over humous soil. Except in the most humid forest types, C. *coniocraea* generally occurs within 1 m of the ground. Among the most shade-tolerant of macrolichens; also a good indicator of high humidity.

Circumpolar, (oro)boreal to temperate (Ahti 1964, 1977).
LB 22 (78-448a); MB 15 (13449).

Cladonia cornuta (L.) Hoffm.

HB-(UB-HA), scattered.

Only subsp. *cornuta* was recorded; however, specimen 13537 (MB 8) approaches the coastal subsp. *groenlandica* (E. Dahl) Ahti (see Ahti 1980).

Mainly over decaying wood and soil, but recorded also from (mossy) basaltic and granitic boulders and from peat, generally in rather open forest types.

One of the later pioneer lichens following disturbance.

Circumpolar, low (oro)arctic to northern temperate (Ahti 1980).
HB 5 (79-1244); LB 7 (13009); MB 8 (13723); UB 2 (78-345).

Cladonia crispata (Ach.) Flotow

LB-(HA), rare to scattered.

Over (decaying) wood, mossy rocks and soil. Here rare above the MB, but elsewhere very common in the NB and HA; perhaps excluded by prolonged snow cover.

Circumpolar, arctic to northern temperate (Ahti 1964), with oceanic tendencies (Ahti 1983).
LB 7 (13018); MB 8 (13560).

Cladonia cyanipes (Sommerf.) Nyl.

?-MB-?, very rare.

Collected only twice: among moss on near-vertical rock faces in open boulder beds.

Incompletely circumpolar, arctic to hemiboreal, most abundant in the northern boreal zone (Ahti 1964), with oceanic tendencies (Ahti 1983).
MB 2 (83-876); MB 8 (13560).

Cladonia decorticata (Flörke) Sprengel

LB-MB, very rare.

Over mossy rocks and thin soil in open sites, especially in boulder beds.

Probably circumpolar, (oro)boreal to northern temperate (Ahti 1964).
LB 13 (15001); MB 2 (83-882); MB 8 (13715).

Cladonia deformis (L.) Hoffm.

LB-(LA), scattered.

Mainly over soil, but also rarely over decaying wood.

Locally much scarcer than its ally *C. sulphurina*, especially at upper elevations.

Circumpolar, (oro)arctic to northern temperate (Ahti 1964).
LB 20 (80-427); MB 15 (13447); UB 2 (78-367a); LA 4 (79-1308).

Cladonia digitata (L.) Hoffm.

LB-MB, rare.

Over decaying wood in humid, often shady sites.

Circumpolar, (oro)boreal to northern temperate (Thomson 1984).
LB 17 (79-928); MB 8 (13645).

Cladonia ecmocyna Leighton subsp. *intermedia* (Robb.) Ahti

(LB-MB)-LA, frequent to very frequent.

Ahti (1980) referred the western Canadian populations to subsp. *intermedia*, characterized by a thinner medulla and a more habitual production of scyphi and abundant squamules on the podetia than in the European–Greenlandic subsp. *ecmocyna*.

Over soil, mossy rocks and, occasionally, wood, primarily in open sites.

This is the most frequent *Cladonia* of the UB, HA and LA, both in open forests and especially in dry timberline meadows and heaths (Hämet–Ahti 1965b, 1978). It is particularly common in areas with prolonged snow cover (Bird & Marsh 1972, Ahti 1980).

Western North America, oroarctic to northern temperate, with oceanic tendencies (Ahti 1980).
LB 29 (14946); MB 4 (13288); UB 2 (78-372); HA 2 (14210); LA 1 (78-597).

Cladonia fimbriata (L.) Fr.

HB-MB, scattered.

Over lignum, tree bases, bare soil, mossy rocks, generally in open forests.

Circumpolar, (oro)boreal to southern temperate (Ahti 1964).
HB 7 (78-263); LB 7 (14842); MB 8 (13540).

Cladonia gracilis (L.) Willd. subsp. *elongata* (Wulfen) Vainio.

Syn. *C. gracilis* subsp. *nigripes* (Nyl.) Ahti (Stenroos & Ahti 1990). — HA-UA, scattered.

Although some specimens resemble subsp. *gracilis*, that subspecies is supposed to be confined to the east in North America, not reaching B.C. (Ahti 1980).

Over dry soil and thin humus over rock ridges in open localities.

Lacking below the HA in the study area, though elsewhere very common in the NB. Perhaps limited by prolonged snow cover.

Circumpolar, (oro)arctic to northern boreal (Ahti 1980).
HA 7 (77-188); LA 2.5 (14746); MA 3 (78-767); UA 1 (79-1281).

Cladonia gracilis subsp. *turbinata* (Ach.) Ahti

Syn. *C. gracilis* var. *dilatata* (Hoffm.) Schaer. s. auct. (e.g. Thomson 1968, Bird & Marsh 1972) — HB-UB, frequent.

The epithet *dilatata* is nomenclaturally of uncertain application (Ahti 1980).

Over soil, mossy rocks and wood, generally in somewhat open sites.

Subsp. *turbinata* is allopatric with subsp. *elongata* in the study area, though elsewhere their ranges may overlap to some extent; indeed, they are believed to hybridize (Ahti 1980).

Circumpolar, high (oro)boreal to northern temperate (Ahti 1980).

HB 7 (78-315); LB 7 (13017); MB 8 (13563); UB 2 (78-388).

Cladonia macilenta Hoffm.

Syn. *C. bacillaris* (Leighton) Arnold — LB-MB, frequent.

C. bacillaris is here considered to be a chemotype of *C. macilenta,* following Christensen (1987). All the material from the study area subjected to a TLC analysis represents the barbatic acid strain (= *C. bacillaris* s. str.).

Over wood: stumps, decaying logs, cedar shakes of a cabin roof. Tolerates considerable shade.

Circumpolar, (oro)boreal to temperate, even subtropical (Ahti 1964).

LB 7 (13005); LB 29 (80-447); MB 6 (13210).

Cladonia macrophyllodes Nyl.

(LB)-LA, scattered.

Over soil and mossy rocks in open, well drained sites, e.g. in the timberline meadows.

In Europe and eastern North America this species is regarded as an exclusively artic–oroarctic taxon; in western North America, it may descend to the forested subzones, especially in more arid localities, but also in the study area.

Probably circumpolar, (oro)arctic to occasionally hemiboreal.

LB 17 (79-915); UB 2 (78-372); HA 2 (14839); LA 2.5 (14304).

Cladonia merochlorophaea Asah.

?-LB-?, very rare.

Contains merochlorophaeic and fumarprotocetraric acids.

Collected only once: over mossy rock outcrop.

Circumpolar, arctic to temperate.

LB 17 (38657)

Cladonia metacorallifera Asah.

LB-MB, rare.

Over thin, humous soil in boulder beds in open localities.

Incompletely circumpolar, (oro)boreal to northern temperate, with oceanic tendencies (Stenroos 1989b).

LB 29 (78-434a); MB 8 (13622).

Cladonia multiformis G.K. Merr.

HB-(MB), scattered to frequent.

Over soil or mossy ground, both acid and base-rich, in somewhat open forests. Occasional over rock.

Ahti (1964) considers this species to be "clearly calciphilous"; at least one local collection, however, was made from a granitic boulder.

Endemic to North America, but largely absent from the west coast (the published reports refer to a coastal morph of *C. furcata* (Huds.) Schrader; reports from Asia and South Africa appear to be erroneous), (oro)hemiarctic to northern temperate (Ahti 1964).

HB 5 (79-1222); LB 7 (13034).

Cladonia norvegica Tönsb. & Holien

?-LB, apparently rare.

Over moss on decaying wood or at base of conifers in humid, often somewhat shaded forests. Probably best developed in the perhumid portions of the study area, where it may be more common than we have indicated.

C. norvegica was recently reported as new to North America by Tönsberg and Goward (1992) partly on the basis of material collected from the study area.

Western North America–eastern North America (Newfoundland)–western Eurasia (Tönsberg & Goward 1992), (oro)boreal, with oceanic tendencies.

LB 2 (91-70).

Cladonia ochrochlora Flörke

LB-MB, frequent.

This species is often overlooked or not readily distinguished from the related *C. coniocraea.*

Mainly over decaying logs and stumps in somewhat shady forests, but also once over thin humus in a siliceous boulder bed.

Very common in lowland forests of coastal B.C., this species is more frequent than *C. coniocraea* in wetter forest types in the study area.

Circumpolar, (oro)boreal to subtropical, with oceanic tendencies.
LB 7 (13041); LB 29 (83-737); MB 10 (13394).

(+) *Cladonia parasitica* (Hoffm.) Hoffm.

?-LB-?, very rare.

Collected twice: over cedar shakes of an old, dilapidated cabin roof and over decaying conifer log. A new record for western North America (see, for example, the map in Hale 1979).

Possibly circumpolar, (oro)boreal to southern temperate.
LB 9 (78-517), LB 16 (91-86).

Cladonia phyllophora Hoffm.

HB-LA, scattered.

Although highly variable in morphology, the local material appears to represent a single, discrete taxonomic unit.

Over soil and (mossy) rocks, particularly in open, xeric sites.

Circumpolar, (oro)arctic to northern temperate.
HB 8 (78-1025); LB 7 (13030); MB 8 (13724); UB 2 (78-374); HA 2 (80-291); LA 1 (80-337).

Cladonia pleurota (Flörke) Schaerer

LB-MA, scattered to frequent.

Over mossy soil (common in dry timberline meadows), decaying lignum and (mossy) rocks in open sites.

Circumpolar, (oro)arctic to northern temperate (Stenroos 1989a).
LB 17 (79-930); MB 15 (13455); UB 2 (78-387); HA 2 (14861); LA 5 (78-746a); MA 1 (79-1174).

Cladonia pocillum (Ach.) O. Rich.

HB-MB, scattered.

Over calcareous soil and mossy rocks in open places.

Circumpolar, arctic to temperate (Ahti 1964).
HB 5 (79-1211); LB 14 (77-327); MB 8 (13532).

Cladonia pseudomacilenta Asah.

?-MB-?, very rare.

The taxonomic status of this member of the *C. bacillaris* group requires further study.

Collected only once: over rotten wood in an open boulder bed. Primarily a coastal species.

Western North America–eastern Eurasia (Thomson 1968), (oro)boreal to perhaps northern temperate, predominantly oceanic.
MB 8 (13644).

Cladonia pyxidata (L.) Hoffm.

HB-MA, scattered to frequent.

Over mossy rocks and thin soil over rock, both acid and basic, in more or less open sites.

Circumpolar, (oro)arctic to temperate (Ahti 1964).
HB 7 (78-316); LB 13 (13235); MB 8 (13524); UB 4 (14970); HA 2 (14166); LA 7 (77-472).

Cladonia rei Schaerer

Syn. *C. nemoxyna* (Ach.) Arnold — LB, rare.

Over rich, well drained, often sandy soil, in open sites, generally of southern exposure. Apparently a pioneer species, most frequent following disturbance (Suominen & Ahti 1966).

Circumpolar (Thomson 1968), low (oro)boreal to temperate (Ahti 1964).
LB 7 (13035a); LB 19 (80-487).

Cladonia squamosa (Scop.) Hoffm. var. *squamosa*

LB-(UB)-LA, rare.

Over mossy rocks and soil in open sites.

Circumpolar, (oro)arctic to southern temperate (Ahti 1964).
LB 29 (78-434b); MB 2 (78-890a); HA 2 (14990); LA 4 (80-465).

Cladonia subulata (L.) Weber ex Wigg.

LB-(MB), rare to scattered.

Over soil and mossy rocks in open forests.

Circumpolar, arctic to temperate, most frequent in the low (oro)boreal and northern temperate subzones (Ahti 1964, Thomson 1984).
LB 7 (13920); MB 8 (13640).

Cladonia sulphurina (Michaux) Fr.

Syn. *C. gonecha* (Ach.) Asah. — (LB)-LA, frequent to very frequent.

The B.C. populations are often not unlike *C. digitata* in having corticate patches within the scyphi — a character unknown in eastern Canadian and European material. Also, the local populations tend to have a relatively low growth form. The taxonomic significance of these observations is as yet uncertain.

Over decaying wood and mossy soil in somewhat open sites, becoming considerably more abundant in the upper oroboreal subzones.

Circumpolar, (oro)arctic to northern temperate (Ahti 1964).
LB 19 (79-929); MB 10 (13402); UB 5 (14975); HA 5 (78-714); LA 1 (78-552).

Cladonia symphycarpa (Ach.) Fr.

HB-(MB-HA), rare to scattered.

All the specimens tested contain only atranorin, thus agreeing with the usual interpretation of *C. cariosa*. However, on the basis of morphology (podetia stout, fairly smooth and continuously corticate; squamules large) they appear to be closer to *C. symphycarpa*. In western North America *C. symphycarpa* commonly contains only atranorin (see Harris 1975, Brodo 1984).

Over calcareous soil or (mossy) rocks in open, often south-facing sites; apparently avoids localities having prolonged snow cover. Most common in semi-arid forests, especially where recently disturbed.

Probably circumpolar, (oro)arctic to temperate (Ahti 1964, Thomson 1984).
HB 5 (79-1201); LB 7 (13130); HA 2 (14127).

Cladonia umbricola Tönsb. & Ahti

LB-MB, rare to scattered.

Described on the basis of Norwegian and B.C. material by Tönsberg and Ahti (1980).

Over decaying logs, especially *Thuja*, in mature, shady, perhumid forests.

Western North America–western Eurasia, (oro)boreal, predominantly oceanic (Tönsberg & Ahti 1980).
LB 17 (80-432); MB 9 (80-460).

Cladonia uncialis (L.) Weber ex Wigg.

LB-(UB-)HA-MA, rare.

Over mossy rocks and soil, both acid and basic, in open sites; in the lower subzones, best represented in boulder beds.

Circumpolar, (oro)arctic to temperate (Thomson 1984).
LB 29 (14049); MB 2 (78-885b); HA 7 (77-187); LA 4 (78-781).

Cladonia verruculosa (Vainio) Ahti

Syn. *C. pityrea* var. *verruculosa* Vainio — HB-LB, rare.

Reported by Ahti (1978b) to be a widespread coastal species in western North America; the present record extends the range into the interior mountains.

Over bare, often sandy soil, particularly in recently disturbed sites; absent from humous soils.

Western North America, lower oroboreal to northern temperate, with oceanic tendencies.
HB 1 (80-558); LB 20 (80-418); LB 25 (80-368).

Coelocaulon aculeatum (Schreber) Link

Syn. *Cornicularia aculeata* (Schreb.) Ach. — LA-?, rare.

Over earth and rock in open sites. Locally restricted to the oroarctic, mostly in exposed sites with minimal snow cover, where it occasionally adopts a vagant habit. Elsewhere, in less snowy districts of B.C., *C. aculeatum* is common on windswept outcrops in the (oro)boreal and even temperate subzones.

Circumpolar, (oro)arctic to temperate, with slight oceanic tendencies (Ahti 1964, Kärnefelt 1986).
LA 1 (78-598); LA 7 (77-468).

Coelocaulon muricatum (Ach.) Laundon

Syn. *Cornicularia muricata* (Ach.) Ach. — ?-MA-UA, very rare.

Over thin soil in exposed oroarctic sites having minimal snow cover.

Circumpolar, (oro)arctic to temperate (Kärnefelt 1986).
MA 1 (14280); UA 1 (79-1284).

Collema bachmanianum (Fink) Degel. var. *bachmanianum*

?-LB-?, very rare.

Collected only once: over a spring-fed calcareous slope.

Circumpolar, (oro)boreal to northern temperate (see Degelius 1954, 1974).
LB 7 (13092, det. G. Degelius).

Collema crispum (Hudson) Weber ex Wigg.

HB-?, very rare.

Collected only once: over base-rich rock in an open, south-facing site.

Probably circumpolar, (oro)arctic to essentially temperate (see Degelius 1954).
HB 5 (79-1202ab).

Collema furfuraceum (Arnold) Du Rietz

HB-(MB), rare to scattered.

Mainly over bark of *Populus trichocarpa* and *Alnus incana,* though rarely also over base-rich rocks in wet sites, especially ephemeral water tracts.

Probably incompletely circumpolar, (oro)boreal to tropical, with clear oceanic tendencies (Ahti 1964, Degelius 1974).
HB 7 (78-313); LB 24 (78-1303); MB 4 (79-1354).

Collema fuscovirens (With.) Laundon

Syn. *Collema tuniforme* (Ach.) Ach. — HB-?, very rare.

Collected only once: over an open limestone outcrop in the semi-arid portion of the study area.

Circumpolar, (oro)arctic to temperate (Degelius 1954).
HB 5 (79-1202aa).

(+) *Collema glebulentum* (Nyl. ex Crombie) Degel.

HB-LB, rare.

This is the first report of *C. glebulentum* for the mountains of western Canada; most previous North American reports are from arctic regions (see the map in Thomson 1984).

Collected only once, saxicolous at river edge, seasonally submerged.

Circumpolar, arctic to hemiboreal (Thomson 1984).
HB 6.5 (91-875); LB 15 (84-1034).

Collema subflaccidum Degel.

LB-?, very rare.

Collected only twice: over bark (*Alnus tenuifolia* and *Picea glauca)* in the spray zone of a waterfall.

North America–eastern Eurasia, (oro)boreal to subtropical (see Degelius 1974).
LB 6 (77-369, 77-382).

Collema undulatum Laurer ex Flotow var. *granulosum* Degel.

?-LB-?, very rare.

Collected twice: over vertical basalt cliff in the spray zone of a waterfall; and over seasonally submerged phyllite beside a lake.

Probably incompletely circumpolar, (oro)arctic to northern temperate (see Degelius 1954, 1974, Thomson 1984).
LB 9.5 (88-142); LB 17 (79-24-8).

Cornicularia normoerica (Gunn.) Du Rietz

LA-MA, rare.

Over siliceous rocks in open, exposed sites, locally restricted to the oroarctic, but elsewhere (e.g. in more arid parts of B.C.) occasional down into the oroboreal. Prolonged snow cover appears to be a critical limiting factor.

Incompletely circumpolar, (oro)arctic to hemiboreal (see Krog 1968).
LA 2.5 (14337); MA 3 (78-771).

Dactylina arctica (Richardson) Nyl.

LA-MA-?, very rare.

Only the PD- strain was noted in the study area.

Over duff or among moss in somewhat sheltered depressions in otherwise highly exposed oroarctic sites.

Unlike many so-called "arctic–alpine" lichens, which occur sporadically, or even commonly, down to HB or even NT elevations in arid districts, *D. arctica* is evidently restricted to the (oro)arctic throughout its range — an observation suggesting that thermal factors may in part control its distribution.

Circumpolar, (oro)arctic (Thomson & Bird 1978).
LA 4 (78-775b); LA 6 (79-1290); MA 2 (77-263).

Dactylina ramulosa (Hook.) Tuck.

LA-MA-?, very rare.

Over duff in lime-rich sites at oroarctic elevations; here it otherwise exhibits roughly the same ecology as *D. arctica.*

Circumpolar, (oro)arctic (Thomson & Bird 1978).
LA 2.5 (14752); MA 1 (80-351).

Dendriscocaulon intricatulum (Nyl.) Henssen

LB-MB, very rare.

The North American material has traditionally been referred to *D. umhausense* (Auersw.) Degel. (syn. *Polychidium umhausense* (Auersw.) Henss.). According to James and Henssen (1976), however, that species does not occur in the new world.

Over damp siliceous rock and damp *Tsuga* branches in sheltered, but not shady, sites.

North America, (oro)boreal to temperate, primarily oceanic.
LB 30 (79-1031); MB 4 (79-1357).

Dermatocarpon intestiniforme (Körber) Hasse

HB-MB-?, very rare to possibly rare.

Over various rock types, including granite and limestone, in open sites. Probably more common locally than we have indicated — for example, it will almost certainly be found in the oroarctic.

Probably circumpolar (Thomson 1984), (oro)arctic to (oro)boreal.
HB 7 (78-305); MB 4 (79-1344).

Dermatocarpon luridum (With.) Laundon

Syn. *Dermatocarpon weberi* (Ach.) Mann; *D. fluviatile* (G. Web.) Th. Fr. — ?-LB-HA-?, rare to possibly scattered.

Over siliceous rock in periodically flooded runnels or semi-permanent streams in open sites. Possibly occurs locally in all subzones.

Circumpolar, (oro)arctic to temperate (Thomson 1984).
LB 20 (79-1009); MB 6 (13737); HA 2 (78-633); HA 7 (77-459).

Dermatocarpon miniatum (L.) Mann var. *complicatum* (Lightf.) Hellb.

HB-MB-?, very rare.

Over base-rich rock in open, often ephemerally inundated sites.

Circumpolar, (oro)arctic to temperate (Imshaug 1957, Krog 1968).
HB 5 (79-1206); LB 19 (78-249); MB 6 (79-1326).

Dermatocarpon reticulatum Magnusson

?-MB-MA, rare.

Over rock in shady or exposed sites.

Western North America, (oro)arctic to temperate (see Imshaug 1957, Noble 1982).
MB 8 (13623); HA 7 (80-377); LA 2.5 (14316); MA 1 (79-1319).

Dermatocarpon rivulorum (Arnold) Dalla Torre & Sarnth.

HB-((LB-HA))-LA, very rare.

The spore dimensions clearly fall within the norm for this species: 17.5–20 µm x 6–8 µm.
Over calcareous shale and in an intermittent stream bed, both times in open sites.

Probably circumpolar, (oro)arctic to (oro)boreal, though generally considered to be an "arctic–alpine" species (Thomson 1984).
HB 5 (79-1206); LA 4 (78-791).

(*) *Endocarpon pulvinatum* Th. Fr.

HB, very rare.

Collected only once: over a south-facing calcareous outcrop in the semi-arid portion of the study area.
First reported for B.C. by Goward and Thor (1992).

Probably incompletely circumpolar, arctic to temperate.
HB 1 (78-1316).

Endocarpon pusillum Hedw.

?-LB, very rare.

Collected only once, terricolous over a west-facing grassy outcrop in the semiarid portion of the study area.

Circumpolar, low boreal to temperate.
LB 7 (91-73A).

Ephebe lanata (L.) Vainio

?-MB-?, very rare.

Over siliceous rock at and below upper waterline of a small lake. Possibly overlooked.

Circumpolar, arctic to temperate (see Thomson 1984).
MB 2 (84-900); MB 7 (79-1342).

(*) *Evernia divaricata* (L.) Ach.

HB-((LB)), rare.

Over conifers along waterways and along a canyon rim near a waterfall, i.e. in sites combining high humidity with good lighting and ventilation. Locally frequent in the southern part of the study area, though not yet known elsewhere, despite the availability of appropriate habitat. Perhaps *E. divaricata* was excluded from points farther north in the great fire of 1926, which destroyed much of the lowland forests of the Clearwater Valley. In this case, it has simply not yet become reestablished over its entire ecological range.

Western North America (east to Manitoba; Bowler 1977)–western Eurasia, oroarctic to hemiboreal (Bird 1974).
HB 8 (80-306); HB 10 (80-479); LB 16 (78-817).

Evernia mesomorpha Nyl.

?-LB-?, very rare.

Collected only once: over *Pinus contorta* on an open, southwest facing hillside. Apparently a considerable southward range extension for British Columbia (see Thomson 1984).

Incompletely circumpolar, arctic to essentially boreal to northern temperate, continental (Ahti 1964, see Thomson 1984).
LB 14 (80-456).

Evernia prunastri (L.) Ach.

HB-(LB), scattered.

Over conifers, especially in somewhat open river-edge sites. Occurs into the LB in more arid districts elsewhere.

Western North America–eastern North America (where rare)–western Eurasia (Ahti 1977), (oro)boreal to temperate (Bird 1974).
HB 7 (78-294); HB 10 (80-480).

Gonohymenia nigritella (Lettau) Henssen

Syn. *Thyrea nigritella* Lettau — HB-?, very rare.

Collected only once: with *Collema fuscovirens* over calcareous rock in an open, xeric, south-facing outcrop.

The present report represents the second record for Canada; previously reported in North America from northern California (Tucker & Kowalski 1975), Texas (Wetmore 1976) and Quebec (Brodo 1988).

Apparently western North America–eastern North America–western Eurasia, hemiboreal to primarily temperate.
HB 5 (79-1202).

Hydrothyria venosa J. Russell

?-HA, rare.

Over boulders in small streams in the HA. Apparently restricted to streams of rather constant annual flow, e.g. especially spring-fed streams. Perhaps the frigid waters prohibit the growth of decay organisms.

Western North America–eastern North America, orohemiarctic to oroboreal, with oceanic tendencies (see McCune 1984).
HA 1 (79-1129); HA 2 (77-234).

Hypocenomyce friesii (Ach. *in* Liljeblad) P. James & G. Schneider

Syn. *Psora friesii* (Ach.) Hellb. — ?-LB-?, apparently very rare.

Lignicolous over a charred cedar stump in an open meadow. Possibly overlooked.

Incompletely circumpolar, (oro)boreal to temperate (see Timdal 1984).
LB 14 (83-686, 38666).

Hypocenomyce scalaris (Ach. *ex* Liljeblad) M. Choisy

Syn. *Psora scalaris* (Ach.) Hook. — HB-LB-?, scattered.

Though collected only twice, frequently noted forming extensive colonies over the fire-blackened trunks of old snags in open or somewhat shaded sites.

Incompletely circumpolar, low (oro)boreal to temperate (Timdal 1984).
LB 14 (38727); LB 17 (79-18-3).

Hypogymnia austerodes (Nyl.) Räsänen

HB-(MB-)HA-((MA)), frequent.

Over deciduous or, more often, coniferous trees in open or somewhat shady sites. Collected from every native tree species except *Tsuga heterophylla*. Most abundant in exposed forest edges, for example in the HA and semi-arid HB, as well as at the edges of bogs throughout. In exposed MA sites, also over duff and even acid rock.

Circumpolar (Thomson 1984), (oro)arctic to hemiboreal, with continental tendencies.
LB 7 (13075); MB 2 (78-863); UB 2 (78-364); HA 2 (14184); LA 4 (78-797); MA 1 (80-349).

Hypogymnia bitteri (Lynge) Ahti

HB-MB, very rare.

Specimen 80-32-1 was found to contain physodic, 2-0-methylphysodic, vittatolic, and cfr. alectoronic acids, as well as two terpenes and various fatty acids.

Over conifers, especially in semi-arid areas.

Circumpolar (Thomson 1984), (oro)boreal, especially northern boreal (Ahti 1964), with continental tendencies.
HB 7 (79-6-3); MB 2 (84-898); MB 9 (80-32-1).

Hypogymnia enteromorpha (Ach.) Nyl.

?-LB, very rare.

The material represents the PD+ strain of this species.

Collected only once: over an elevated log in the humid, but well-illuminated spray zone of a waterfall, where it grew with *Sticta fuliginosa* and *Pseudocyphellaria anomala*. In B.C., otherwise known only from coastal localities.

Western North America (Pike & Hale 1982), upper oroboreal to temperate, distinctly oceanic.
LB 17 (84-989).

Hypogymnia imshaugii Krog

HB-(MB-LA), scattered.

Over bark, especially *Pseudotsuga* and *Pinus contorta,* in open sites. Seldom noted over *Thuja* or *Tsuga*, though often collected from *Alnus*. Unlike *H. austerodes,* with which it often associates, *H. imshaugii* becomes less common above the MB.

Western North America, orohemiarctic to northern temperate.
HB 4 (79-1186); LB 7 (13054); MB 12 (80-322); UB 2 (78-357); HA 5 (78-718a); LA 5 (78-732a).

Hypogymnia metaphysodes (Asah.) Rass.

HB-(MB-)HA-LA, scattered.

A few sorediate populations were noted (e.g. 78-825 and 79-28-2).

Over bark, especially of conifers, in open habitats, though also in shady sites, if well ventilated. When highly exposed, it may assume a swollen, "sun-scalded" appearance, making it difficult to recognize. Nearly altogether absent from the perhumid portions of the study area.

Western North America–eastern Eurasia, oroarctic to hemiboreal.
HB 2 (78-1290c); LB 14 (77-353); MB 8 (78-712b); UB 2 (78-361); HA 1 (79-1126); LA 4 (78-796a).

Hypogymnia occidentalis Pike

HB-HA-(LA), very frequent.

Mostly over conifers, but also over deciduous trees, including *Populus trichocarpa* and *Acer glabrum.* In its hygric requirements, apparently intermediate between, for instance, the more xerophilous *H. metaphysodes* and the more hygrophilous *H. rugosa.* In its requirements for light, however, *H. occidentalis* is less demanding than either of these, alone colonizing even the well-shaded trunks of *Thuja* and *Tsuga.* Much more common in perhumid forest types, nearly disappearing altogether in semiarid forests.

Western North America, orohemiarctic to northern temperate.
HB 2 (78-1290d); MB 6 (13181); UB 7 (77-201b); HA 2 (78-626); LA 4 (79-796e).

Hypogymnia oceanica Goward

Syn. *H. pseudophysodes* (Asah.) Rass., s. auct. — LB-?, very rare.

The specimens were found to contain atranorin and physodalic, protocetraric, physodic acids and three unknowns.

Collected only twice, both times over *Tsuga* in rather shady, perhumid forests.

Western North America, low (oro)boreal to hemiboreal (see Goward 1988), with strong oceanic tendencies.
LB 28 (78-1161); LB 30 (79-3-2).

Hypogymnia physodes (L.) Nyl.

HB-(HA-)((LA)), very frequent.

Over bark and lignum in open or somewhat shady forests, occasionally also on rocks in the semiarid portions. Locally the most widely distributed *Hypogymnia,* colonizing every tree species in every forested subzone. Only above the HA does it fail to thrive, its thalli here blackened and deformed.

Circumpolar, low (oro)arctic to essentially boreal and temperate (Ahti 1964, Thomson 1984).
LB 6 (77-373); MB 4 (78-665a); UB 2 (78-362); HA 7 (77-439); LA 4 (78-796).

Hypogymnia rugosa (G.K. Merr.) Pike

(HB-)LB-HA, scattered.

Over bark, especially of conifers, in open sites. Apparently requires high humidity, though also rather strongly photophilous. Most frequent in well-illuminated sites in perhumid forests.

Western North America, orohemiarctic to hemiboreal, with subcontinental tendencies.
LB 14 (79-958); LB 30 (79-1018); MB 5 (78-333); UB 7 (77-201a); HA 7 (77-437); LA 4 (78-796d).

Hypogymnia tubulosa (Schaerer) Havaas

HB-(HA-LA), scattered.

Over bark of all tree species, including *Acer glabrum* and *Populus trichocarpa,* especially in well-illuminated sites.

The microdistribution of this species is somewhat problematic: though occurring broadly in humid and arid districts alike, it is nowhere common (see also Ahti 1964). Possibly the conditions required for establishment are more stringent than those required for growth. Reported, however, to be dominant over *Thuja* needles in the very humid Queen Charlotte Islands (Vitt et al. 1973).

Incompletely circumpolar (Ahti 1977), (oro)hemiarctic to temperate, with oceanic tendencies.
LB 14 (79-886); MB 4 (79-1059); HA 7 (77-437); LA 5 (78-731c).

Hypogymnia vittata (Ach.) Parr.

LB-MB, rare.

Thomson (1979) has suggested that the western material differs in some regards from populations in eastern North America.

Over conifers and mossy rock in humid, often somewhat shady sites. Locally known only from *Thuja* and *Tsuga*. Appears to require more constant humidity and to tolerate a more continuous shade than other local Hypogymniae. Occurs upward into the HA in less snowy districts elsewhere.

Probably incompletely circumpolar, (oro)arctic to temperate (Thomson 1984), with oceanic and suboceanic tendencies.
LB 22 (78-467); MB 8 (13478).

Imshaugia aleurites (Ach.) S.F. Meyer

Syn. *Parmeliopsis aleurites* (Ach.) Nyl. — HB-((MB)), rare.

Over *Alnus tenuifolia, Pseudotsuga* and especially *Pinus contorta;* also noted over cedar shakes of an old cabin roof. Invariably in rather open sites. Most abundant in semi-arid forests, becoming virtually absent in perhumid localities.

Circumpolar, hemiarctic to essentially (oro)boreal and northern temperate (Ahti 1964), with continental tendencies (see Goward & Schofield 1983, Thomson 1984).
LB 7 (13831); LB 9 (78-509); MB 6 (77-252).

(+) *Lasallia pensylvanica* (Hoffm.) Llano

LB-MB-?, very rare.

Collected twice: over granite in a dry, open boulder bed, where it is very abundant, and on basalt boulder in open woods. A new record for B.C., though known to occur in western North America also in the Yukon, Alaska, California (Llano 1950) and Alberta (John 1989).

North America–eastern Eurasia, arctic to northern temperate (Ahti 1964, Thomson 1984).
LB 9.5 (50952); MB 2 (78-883b).

Lecidoma demissum (Rutstr.) G. Schneider & Hertel

Syn. *Psora demissa* (Rutstr.) Hepp; *Lepidoma demissum* (Rutstr.) Choisy — HA-LA-?, scattered.

Over rocky soil on open, exposed ridges.

Incompletely circumpolar, mainly (oro)arctic (Thomson 1979), but extendig into the hemiboreal in oceanic sectors.
HA 2 (14150); LA 1 (14323).

Leprocaulon subalbicans (Lamb) Lamb & Ward

(LB-)LA, scattered.

The local material is chemically variable, containing: atranorin and thamnolic acid (14287; also reported from B.C. and Alberta by Lamb & Ward 1974); atranorin, thamnolic acid and fumarprotocetraric acid (14731; a new chemotype); or squamatic and baeomycesic acid (38582; also reported from Alaska and Greenland).

Over moss or earth in open sites, most common at oroarctic elevations.

Western North America–eastern North America (Greenland), (oro)arctic to hemiboreal (see Lamb & Ward 1974).
LB 29 (84-998) ; LA 1 (38582); MA 2 (14287, 14731).

Leptogium burnetiae Dodge var. *hirsutum* (Sierk) P.M. Jörg.

HB-LB((-MB)), rare.

Corticolous and saxicolous. Best developed in humid sites.

Incompletely circumpolar (Jörgensen 1975), oroboreal to subtropical.
HB 7 (78-312b); LB 11 (79-1443); LB 24 (78-1302); MB 2 (84-901).

Leptogium cyanescens (Rabenh.) Körber

LB-?, very rare.

Collected only once: among moss over siliceous rock in a shady site.

Incompletely circumpolar, northern boreal to subtropical, with oceanic tendencies (Sierk 1964, Ahti 1964, 1977).
LB 29 (79-1108).

Leptogium gelatinosum (With.) Laundon

Syn. *Leptogium sinuatum* (Huds.) Mass. — HB-?, very rare.

Collected only once: among saxicolous moss over a rather shady cliff face. Possibly overlooked.

Circumpolar, arctic to essentially boreal and temperate (Thomson 1984).
HB 7 (83-798b).

Leptogium lichenoides (L.) Zahlbr.

HB-UB-?, rare.

Typically over mossy outcrops in lime-rich areas, but once also from the bole of *Populus trichocarpa.* Good lighting appears to be of greater importance than substrate in its distribution.

Circumpolar, (oro)arctic to temperate (Sierk 1964, Thomson 1984).
HB 1 (78-1315); LB 6 (13141); MB 4 (79-1064); UB 7 (79-1426).

Leptogium minutissimum (Flörke) Fr., s. auct.

?-LB, very rare.

Collected only once: over base-rich soil on an open, somewhat exposed, south-facing slope.

Circumpolar, arctic to temperate (Thomson 1984).
LB 5 (91-48).

Leptogium saturninum (Dickson) Nyl.

HB-MB, rare to scattered.

Both saxicolous over acid and base-rich rock, and corticolous over a wide variety of trees and shrubs. Tolerates both shade and sun.

Circumpolar, arctic to temperate (Thomson 1984).
HB 4 (79-1195); LB 6 (77-383); MB 8 (13594).

(+++)*Leptogium subtile* (Schrader) Torss.

?-LB-?, very rare.

Collected twice: from a charred conifer log and from a mossy basalt outcrop — both in humid sites.

New to North America (earlier reports unreliable).

Probably incompletely circumpolar, (oro)boreal to temperate.
LB 16 (91-53); LB 17 (83-899).

Leptogium tenuissimum (Dickson) Körber

?-LB, very rare.

Collected only once: over soil under open, rather exposed, site, and over bark (*Acer glabrum*) in the spray zone of waterfall. Probably chionophobic.

Circumpolar, arctic to temperate (Thomson 1984).
LB 2 (91-43).

Leptogium teretiusculum (Wallr.) Torss.

?-LB-?, very rare.

Over bark (*Acer glabrum*) in the spray zone of waterfall. Probably much overlooked.

Circumpolar, northern boreal to subtropical
LB 7 (91-78).

Letharia vulpina (L.) Hue

HB-((MB-UB))-LA, scattered to frequent.

Over bark and lignum, primarily of conifers, in open, exposed sites. Locally most abundant in well-lit forest types of the HB and LA; in other subzones, often restricted to the tops of snags. Elsewhere, in more arid districts, it occurs in all forested subzones, occasionally even colonizing rock (see also Imshaug 1957).

The closely related *L. columbiana* (Nutt.) Thoms. was not detected locally, though it is known to occur a few km to the south.

(++) The parasitic fungus *Phacopsis vulpina* Tul. was collected in the study area on this species (IMI 260733). Determination by David Hawksworth.

Western North America–western Eurasia (Ahti 1977), oroarctic to northern temperate.
HB 7 (77-178); LB 2 (78-479); MB 6 (13331); UB 2 (78-354); HA 2 (14232); LA 1 (79-1151).

Lobaria hallii (Tuck.) Zahlbr.

LB-((MB)), very rare to rare.

Over bark, especially *Picea* and *Abies*. Contrary to Jordan's observation (1973) that this species in North America "shows a distinct habitat preference for the bark of cottonwood", no local collections were made from *Populus*.

Western North America–eastern North America (Greenland)–western Eurasia (Jordan 1973), oroboreal to northern temperate, with distinct oceanic tendencies.
LB 6 (77-160a); LB 24 (78-1300).

Lobaria linita (Ach.) Rabenh.

(LB)-LA, scattered.

Both the richly fertile var. *tenuior* (Del.) Asah. and the commonly sterile var. *linita* appear to be represented in the study area. The taxonomic distinctness of these taxa is, however, questionable.

Mainly over mossy, but well-lit, acid rocks, but also collected over the boles of *Betula* and *Thuja*. Most frequent above the MB, where typically found near the edges of tarns and leeward side of ridges. Tolerates prolonged snow cover, but absent from the semiarid LB.

The fertile specimens (= var. *tenuior*) come primarily from the LB.

var. *linita*: Circumpolar (Jordan 1973), (oro)arctic to (oro)boreal.
var. *tenuior*: western North America–eastern Eurasia, low (oro)boreal to temperate (see Krog 1968).
LB 29 (79-1111); MB 8 (13652); UB 7 (77-206); HA 7 (77-193); LA 3 (79-1309).

[*Lobaria oregana* (Tuck.) Müll. Arg.]

Reported by Palmer (1982) from the southern portion of the study area, but not observed by us, and not expected.

Lobaria pulmonaria (L.) Hoffm.

HB-(MB), frequent to very frequent.

A specimen from the study area was reported by Brodo (1984) to belong to "Chemical race 1" in the scheme of C. Culberson (1969), i.e. containing norstictic, stictic, constictic acids and unknown substances 3 and 4.

Corticolous over many tree species, especially *Picea* and *Acer glabrum*. Perhaps the most conspicuous species of humid and perhumid lowland forests. Disappears as a corticole, however, in the HB semi-arid, here restricted to mossy outcrops in damp situations. Also disappears above the MB.

Incompletely circumpolar, low (oro)boreal to temperate, with oceanic tendencies (Ahti 1983).
HB 6 (79-1236); LB 2 (13856); MB 4 (78-677).

Lobaria scrobiculata (Scop.) DC.

?-LB-((MB)), rare.

Corticolous over many tree species, especially in humid, but open, sites. In arid districts outside the study area, also saxicolous over sheltered, north-facing outcrops.

Incompletely circumpolar (Ahti 1983), hemiarctic to temperate, with oceanic tendencies (see Thomson 1984).
LB 6 (77-390a); LB 30 (79-1032); MB 4 (78-674).

Massalongia carnosa (Dickson) Körber

LB-HA, apparently rare.

Over earth or mossy rock in damp, open sites. Easily overlooked.

Probably circumpolar, (oro)arctic to temperate (see Thomson 1984), perhaps with oceanic tendencies.
LB 6.5 (91-1761); MB 8 (13691); HA 1 (79-1404); HA 7 (80-380).

Melanelia disjuncta (Zahlbr.) Essl.

Syn. *Melanelia granulosa* Essl., *Parmelia disjuncta* Erichsen — HB-MA, rare to scattered.

Primarily over rock, both acid and base-rich, in well-lit sites.

Circumpolar (Esslinger 1977a), (oro)arctic to hemiboreal.
LB 29 (78-419); MB 2 (78-882a); MA 6 (79-1321).

(*) *Melanelia elegantula* (Zahlbr.) Essl.

Syn. *Melanelia incolorata* (Parr.) Essl., *Parmelia elegantula* (Zahlbr.) Szat. — HB-?, very rare.

Over bark of *Pseudotsuga* and *Populus tremuloides* in open sites. Locally restricted to semi-arid forests types in the HB; much more common in arid districts elsewhere (see also Ahti 1969).

Western North America–western Eurasia, (arctic? to) hemiboreal and temperate (Esslinger 1977a; his arctic records need confirmation).
Though recorded by both authors, no specimens were collected.

Melanelia exasperatula (Nyl.) Essl.

Syn. *Parmelia exasperatula* Nyl. — HB-LA, rare to scattered.

Over bark, especially of *Alnus tenuifolia*, but also of conifers. Best developed in well illuminated sites. More common in arid districts elsewhere.

Possibly circumpolar, low (oro)arctic to temperate (see Esslinger 1977a, Thomson 1984).
LB 16 (80-578); MB 3 (79-876a); MB 6 (79-1337a); LA 5 (78-727a).

Melanelia multispora (A. Schneider) Essl.

Syn. *Parmelia multispora* Schneid. — HB-MB, scattered.

Over deciduous trees and shrubs in well illuminated sites, most common in humid portions of the study area (see also Ahti 1966). Its upper limits approximately coincide with those of its major host species, e.g. *Alnus tenuifolia, Populus tremuloides* and *Salix scouleriana*.

Western North America, (oro)boreal to temperate, with oceanic tendencies (Ahti 1966).
LB 7 (13799); LB 11 (79-1447); MB 4 (79-1057).

Melanelia panniformis (Nyl.) Essl.

Syn. *Parmelia panniformis* (Nyl.) Vain. — HB-MB-?, rare.

Over acid and base-rich rocks in open, but not exposed, sites, especially boulderbeds.

Probably circumpolar, low (oro)arctic to hemiboreal (see Imshaug 1957, Esslinger 1977a, Thomson 1984).
HB 7 (78-306); LB 29 (78-420 p.p.); MB 2 (78-891c); MB 8 (78-704b).

Melanelia septentrionalis (Lynge) Essl.

Syn. *Parmelia septentrionalis* (Lynge) Ahti — ?-MB-?, very rare.

Collected only once: over *Alnus tenuifolia* in an open, lake-edge site. Apparently a southward range extension for this species in B.C. (Thomson 1984).

Circumpolar, arctic to hemiboreal, with continental tendencies (see Ahti 1966).
MB 6 (79-1336).

Melanelia sorediata (Ach.) Goward & Ahti

Syn. *Melanelia sorediosa* (Almb.) Essl., *Parmelia sorediosa* Almb. — LB-MB-?, rare.

Generally over rock in open sites, but also rarely over lignum.

Circumpolar, (oro)arctic to hemiboreal (see Thomson 1984).
LB 7 (77-320); LB 8 (15482); LB 14 (80-412); LB 17 (77-433); MB 4 (78-685).

Melanelia stygia (L.) Essl.

Syn. *Parmelia stygia* (L.) Ach. — LB-(UB-HA)-MA, scattered.

Over siliceous rock in open, typically exposed sites, where often associated with *Cetraria commixta* and *C. hepatizon.*

Circumpolar, (oro)arctic to temperate (Esslinger 1977a).
LB 29 (77-248c); MB 8 (78-695b); LA 1 (78-575b).

Melanelia subaurifera (Nyl.) Essl.

Syn. *Parmelia subaurifera* Nyl. — HB-(MB), frequent to very frequent.

Generally over deciduous trees (including *Betula*), most common in semi-arid portions of the study area. Occasional also over conifers. Different from *M. multispora,* the upper zonal limits appear to be controlled more directly by climatic factors than by the disappearance of appropriate host species.

Probably circumpolar, (oro)boreal to temperate (see Esslinger 1977a, Thomson 1984).
HB 7 (78-299a); LB 8 (13802); MB 1 (78-521).

Melanelia subelegantula (Essl.) Essl.

Syn. *Parmelia subelegantula* Essl. — ?-MB-UB, very rare.

Collected only twice: once over *Alnus crispa* ssp. *sinuata* in an open thicket; and once over *Abies* in a herb forest.

Western North America (Esslinger 1977a), oroboreal to temperate.
MB 3 (79-876b); UB 6 (80-37-1).

Nephroma arcticum (L.) Torss.

(LB)-MB-(HA), rare to scattered.

Over mossy rocks, generally in somewhat open sites. A chionophile, primarily restricted to snowy MB and UB localities; also, however, collected at LB elevations in perhumid portions of the study area, where snow cover is also prolonged. On the other hand, its relative scarcity in the HA may reflect a sensitivity to snow cover that persists for more than 8 months.

Circumpolar, low (oro)arctic to low (oro)boreal, with oceanic tendencies (Ahti 1964, James & White 1987).
LB 29 (14032); MB 2 (78-878); UB 2 (78-839); HA 1 (79-1147).

Nephroma bellum (Sprengel) Tuck.

HB-(MB), frequent.

Over mossy rocks and decaying logs. In perhumid areas, also over conifers and deciduous trees. Both open and rather shady sites are colonized.

The upper zonal limits in the study area are probably controlled by a sensitivity to prolonged snow cover; in more arid districts elsewhere in southern B.C., *N. bellum* occurs into the UB.

Circumpolar, (oro)arctic to hemiboreal (James & White 1987).
LB 2 (13845); LB 19 (78-209a); MB 8 (13586).

Nephroma expallidum (Nyl.) Nyl.

?-LA, very rare.

Collected only once: over humous soil on the leeward side of an exposed oroarctic ridge. In more arid parts of the province, it occurs downward at least to the UB.

Circumpolar, (oro)arctic to high (oro)boreal, with continental tendencies (Ahti 1964, James & White 1987).
LA 2 (80-331).

Nephroma helveticum Ach. subsp. *helveticum*

HB-LB-?, rare.

Over dry boulders in open forest types. See notes under subsp. *sipeanum*, below.

Circumpolar, (oro)boreal to temperate (James & White 1987).
HB 7 (78-270); LB 2 (80-396); LB 7 (77-323).

Nephroma helveticum Ach. subsp. *sipeanum* (Gyelnik) Goward & Ahti

Synonyms: *N. helveticum* var. *sipeanum* (Gyeln.) Wetm., (?) *N. tropicum* (Müll. Arg.) Zahlbr., *Nephromium canadense* Räsänen — HB-LB(-MB), scattered.

Räsänen (1933) described this taxon as *Nephromium canadense* from Aleza Lake near Prince George, B.C.

Goward and Ahti (in Ahti et al. 1987) argued that this lichen deserves subspecific, not varietal, rank. Though closely related to subsp. *helveticum*, it differs from that taxon in having: 1) much thinner, more evenly tomentose lobes (especially near the lower margins); 2) generally longer, and more terete marginal teeth (e.g. 0.3–0.5 mm long vs 0.1–0.4 mm long); 3) a more hygric ecology; and 4) a more western distribution (see Wetmore 1960). However, James and White (1987) preferred to withhold taxonomic judgement on these and other, especially Asian, segregates of the *N. helveticum* "complex" pending further study.

Over trees and mossy rocks, especially in humid and perhumid forest types.

Essentially western North America–eastern Eurasia, low oroboreal to subtropical (Ahti 1964, James & White 1987), with oceanic tendencies.

LB 27 (78-1116); LB 30 (14027); MB 4 (78-675a); MB 8 (13661).

(++) *Nephroma isidiosum* (Nyl.) Gyelnik

?-LB-MB, apparently rare.

Over acid rock and *Acer glabrum* in open sites. Locally restricted to the lower subzones.

Western North America–eastern Eurasia–Europe (very rare), hemiarctic to northern temperate (James & White 1987).

LB 17 (13186a); LB 27 (78-1115); MB 4 (78-683).

(++) *Nephroma occultum* Wetm.

?-MB, very rare.

Collected only once: at breast height over branches of *Abies* in an open, damp *Picea–Abies* forest. The site is very humid, being located near a lake in a narrow, sheltered valley. Other collections (also at breast height) have been made near Terrace, B.C. Previous collections have come from high in the crowns of old growth forests (Wetmore 1980).

Western North America (Wetmore 1980), oroboreal to northern temperate, with oceanic tendencies.

MB 9.5 (83-838).

Nephroma parile (Ach.) Ach.

HB-((UB)), very frequent.

Over bark, rock, moss and lignum. The most widespread and abundant of the local *Nephroma* species. Probably also the most tolerant of shade, though apparently unable to withstand xeric conditions.

Circumpolar, arctic to northern temperate (Ahti 1964, James & White 1987).

HB 7 (78-281); LB 17 (7359); LB 19 (78-209b fertile!); MB 4 (78-682b).

Nephroma resupinatum (L.) Ach.

HB-(MB), scattered.

Over mossy rock and bark of conifers and deciduous trees and shrubs, especially in open, but humid, forests. Best represented in perhumid portions of the study area.

Circumpolar, low oroarctic to hemiboreal (James & White 1987).

LB 2 (13843); LB 27 (78-1118); MB 8 (78-698a).

Normandina pulchella (Borrer) Nyl.

?-LB-MB-((HA)), apparently very rare.

Over mossy rocks in shady seepage sites.

Probably incompletely circumpolar, (oro)boreal to tropical, essentially temperate, oceanic.

LB 17 (80-529); MB 8 (13686); HA (79-1426).

(+) *Omphalina hudsoniana* (Jenn.) H. Bigelow

Syn. *Phytoconis viridis* (Ach.) Redh. & Kuyper, *Coriscium viride* (Ach.) Vainio, *Botrydina viridis* (Ach.) Redh. & Kuyper — MB-?, very rare.

Collected only once: over mossy rock near a lake shore.

The present record represents a considerable southward range extension in western North America (see Thomson 1984). First reported for B.C. in Otto and Ahti (1967) on the basis of the present record.

Circumpolar, arctic to middle oroboreal (see Bigelow 1970, Thomson 1984).

MB 8 (13486).

Omphalina umbellifera (L.: Fr.) Quélet

Syn. *Phytoconis ericetorum* (Pers.: Fr.) Redh. & Kuyper, *Botrydina botryoides* (L.) Redh. & Kuyper, *B. vulgaris* Bréb., *Omphalina ericetorum* (Fr.: Fr.) M. Lange — HB-HA, frequent.

The nomenclature of this lichen-forming agaric follows Jörgensen and Ryman (1989).

Over mossy decaying logs in open or shady forests at all forested elevations.

Circumpolar, arctic to northern temperate (see Redhead 1989).

Frequently noted in fruit during the late summer and early autumn, but not collected.

Pannaria mediterranea Tavares

HB-?, very rare.

Over *Alnus incana* and *Betula papyrifera* in the open, well-ventilated, outer spray zone of a waterfall.

Though in North America primarily restricted to coastal localities, *P. mediterranea* has also recently been reported for the Bitterroot Mountains of Montana (McCune 1984) — again in the spray zone of a waterfall.

Western North America–western Eurasia (Jörgensen 1978), (oro)boreal to northern temperate.
HB 7.5 (91-62); HB 7.5 (91-63).

Pannaria pezizoides (Weber) Trevisan

LB-(UB-HA), scattered.

Generally over soil, moss, acid rock or decaying wood, though also occasionally over bark in perhumid portions of the study area. Tolerates considerable shade, but is apparently sensitive to prolonged snow cover. Better represented at UB and HA elevations in more arid districts elsewhere.

Circumpolar, (oro)arctic to temperate (Jörgensen 1978, Thomson 1984).
LB 19 (78-829); LB 26 (78-1171); MB 8 (13500); HA 7 (79-1424).

Pannaria praetermissa Nyl.

LB-((UB-HA)), rare to scattered.

Jörgensen (1978) notes that the western North American populations are probably not homogeneous.

Over acid rock (!) and moss in shady or open, but typically humid, sites.

Circumpolar, (oro)arctic to hemiboreal (Jörgensen 1978).
LB 17 (78-827); MB 4 (79-1353); MB 8 (13614); HA 2 (78-631).

Parmelia fraudans (Nyl.) Nyl.

HB-MB, scattered.

Over acid and base-rich rock in open to more often somewhat shady sites. Collected into the HA in more arid districts elsewhere.

Incompletely circumpolar, arctic to essentially high (oro)boreal and hemiboreal, with continental tendencies (Ahti 1964, Thomson 1984).
HB 7 (79-1077); MB 4 (79-1364); MB 8 (13556).

Parmelia hygrophila Goward & Ahti

HB-(HA), very frequent.

Over bark of conifers and deciduous trees and shrubs, except very rare over *Pinus contorta* and *Thuja*. Also occasionally saxicolous over base-rich boulders. Widely distributed in open and somewhat shady sites, though less common in semi-arid portions of the study area. Absent from more arid districts elsewhere.

Western North America, orohemiarctic to northern temperate (Goward & Ahti 1983).
HB 7 (78-290); LB 2 (80-562); MB 4 (13262); MB 8 (78-711b).

Parmelia omphalodes (L.) Ach.

LB-MB, rare.

The local material apparently belongs to subsp. *pinnatifida* (Kurok.) Skult. In North America, however, this subspecies is usually very close in morphology to subsp. *omphalodes* — perhaps owing to genetic exchange between the two (Skult 1987). Hale (1987) did not recognize subsp. *pinnatifida* in his world monograph of *Parmelia* s. str.

Over siliceous boulders, especially in shady sites. Known also from the oroarctic from more arid districts elsewhere (see also Bird & Marsh 1973).

P. omphalodes s. lat.: Circumpolar, (oro)arctic to northern temperate (Skult 1987), with oceanic tendencies.
LB 26 (78-1308); LB 29 (78-420); MB 2 (78-880).

Parmelia pseudosulcata Gyelnik

Syn. *Parmelia kerguelensis* Crombie, s. auct. — Syn.?-LB-?, very rare.

This species was included in *P. kerguelensis* by Hale (1987), but according to Stenroos (1991) the latter is a protocetraric acid chemotype of *P. saxatilis*, while *P. pseudosulcata* is also morphologically distinct (Goward & Ahti 1983).

Collected only twice: over bark of *Tsuga* and *Betula* in open, but damp, forests; apparently restricted to humid portions of the study area. An additional inland collection has been made from the vicinity of Revelstoke; otherwise reported strictly from coastal North America (Ohlsson 1973, Hale 1979, Noble 1982).

Western North America, oroboreal to temperate, with distinct oceanic tendencies.
LB 17 (79-1806); LB 29 (83-741).

Parmelia saxatilis (L.) Ach.

HB-(UB-)-MA, frequent.

Our treatment may possibly include two distinct taxa: one, *P. saxatilis* s. str., is characterized by concave lobes and predominantly laminal isidia; the other, locally more common, has largely convex lobes and marginal isidia (but lacks the squarrose rhizines of *P. squarrosa*!). Although they typically occupy, respectively, xeric verus subhygric sites, on occasion we have found them growing side by side. On the other hand, a number of apparently intergrading specimens exist in our collections. The problem was not discussed by Hale (1987), and warrants further study.

Over rock, rarely over duff in exposed sites. Of broad ecology, associating both with the shade-loving *P. fraudans* and with the highly xerophytic *Xanthoparmelia plittii*. Becomes sun-browned, however, in exposed sites.

Circumpolar, (oro)arctic to temperate (Ahti 1964, Hale 1987).

HB 7 (78-310a); LB 17 (78-414); MB 15 (13454); LA 5 (78-743b); MA 1 (80-354).

Parmelia sulcata Taylor

HB-(HA-LA), very frequent.

Colonizes virtually every available substrate — including, in perhumid portions of the study area, the needles of *Thuja* (see also Vitt et al. 1973). Locally among the most common and widespread of the macrolichens, becoming infrequent only in the oroarctic. Frequently adopts a broad-lobed habit when growing over base-rich substrates.

The Rufous Hummingbird (*Selasphorus rufus*) routinely applies this species (as camouflage) to the outside of its nest.

Several parasitic fungi were identified from this species in the study area, including (+) *Nesolechia oxyspora* Tul. (IMI 260712) and (+++) *Echinothecium reticulatum* Zopf (IMI 260724, fertile! and 260713). Determinations by David Hawksworth.

Circumpolar, (oro)arctic to temperate (Ahti 1964, Thomson 1984).

HB 7 (78-299b); LB 14 (77-351); MB 8 (13649); UB 2 (78-355); HA 7 (77-449); LA 5 (78-726a).

Parmeliella triptophylla (Ach.) Müll. Arg.

HB-MB, apparently rare.

Over *Populus trichocarpa, Tsuga* and *Thuja* in somewhat shaded sites, or over mossy rock subject to wave splash, seepage, or other discontinuous wetting. Most common in the perhumid portions of the study area.

Circumpolar, arctic to essentially (oro)boreal and northern temperate, with oceanic tendencies (see Jörgensen 1978, Thomson 1984).

HB 7 (78-278b); LB 19 (78-834b); LB 29 (78-1107); MB 4 (79-1346); MB 6 (79-1341a).

Parmeliopsis ambigua (Wulfen) Nyl.

HB-LA, very frequent.

Corticolous and lignicolous over conifers and other trees and shrubs having a low pH, e.g. *Betula* and *Shepherdia*; also occasional over acid rock. Open and shady sites are both colonized.

Circumpolar, (oro)arctic to temperate (Ahti 1964).

LB 7 (77-322); MB 4 (78-668); UB 4 (13403); HA 2 (78-630b); LA 2.5 (14270).

Parmeliopsis hyperopta (Ach.) Arnold

HB-LA, very frequent.

Ecology as in *P. ambigua*, but see the discussion below.

Both *P. hyperopta* and *P. ambigua* are remarkably tolerant of prolonged snow cover. Even in localities where snow persists into early July, they may occur nearly to the ground on the trunks of trees — often the only macrolichen species within two or three metres of the ground. Even so, *P. hyperopta* is clearly the more hygrophilous of the two (see also Thomson 1963, McCune 1982), its lower trimline invariably lying closer to the ground than that of *P. ambigua*. In semiarid localities, moreover, *P. hyperopta*'s upper trimline is likewise located lower on the tree trunks.

Circumpolar, (oro)arctic to northern temperate (Ahti 1964).

LB 7 (77-291); MB 5 (13405); UB 1 (79-1407); LA 2.5 (14266).

Peltigera aphthosa (L.) Willd.

HB-(UB-LA), very frequent.

Specimens growing in snowy sites above the MB (e.g. 90-1157) may be referable to a separate taxon; further studies are in progress.

Over earth, moss and mossy logs in open to somewhat shaded sites. One of the most widespread of the *Peltigerae*, rather tolerant of prolonged snow cover, becoming scarce only in the UB. In perhumid portions of the study area, as well as along the Pacific coast, occasional also as a corticole.

Circumpolar, (oro)arctic to northern temperate (Ahti 1964 Thomson 1984).

HB 7 (87-261); LB 29 (14035); UB 2 (78-350); LA 3 (79-1311).

Peltigera britannica (Gyelnik) Holtan–Hartw. & Tönsb.

?-LB-(MB), scattered.

P. britannica (see Tönsberg & Holtan–Hartwig 1983) comes close to *P. aphthosa*, from which it may be distinguished both morphologically (for example, in its very numerous, tiny, and somewhat marginally raised cephalodia) and ecologically (in being restricted to perhumid districts). Moreover, in B.C. it especially appears to (occasionally) produce blue–green phycotypes (see, for example, Brodo & Richardson 1978). Common along the B.C. coast.

Over mossy outcrops in open, but perhumid, forests; and once over the trunk of *Thuja* under similar conditions.

Apparently western North America–western Eurasia, lower oroboreal to temperate, with oceanic tendencies.
LB 16 (91-52); LB 26 (78-1306, with blue–green phycotype!); MB 2 (78-879); LB 27 (78-1231).

Peltigera canina (L.) Willd.

HB-(UB-LA), frequent.

Over earth, moss and rock, both acid and base-rich, in open to somewhat shady sites. *P. canina* has a very broad ecology, growing both in xeric sites (with *P. rufescens)* and in hygric sites (with *P. membranacea*).

The lichen parasites (++) *Scutula tuberculosa* (Th. Fr.) Rehm (IMB 260709) and (+++) *Corticifraga fuckelii* (Rehm) D. Hawksw. & R. Sant. (IMI 260717) have both been collected in the study area on *P. canina*. Determinations by David Hawksworth.

Circumpolar, (oro)arctic to northern temperate (Ahti 1964).
HB 9 (80-4866); LB 16 (79-857); MB 4 (79-1067); UB 1 (79-1133); HA 1 (79-1139); LA 1 (79-1401).

Peltigera collina (Ach.) Schrader

HB-MB, scattered.

Over moss, mossy logs, or base-rich or acid rock, in open or semi-shaded sites. Also occasionally corticolous, especially in perhumid portions of the study area, e.g. over *Tsuga* and *Alnus*.

Incompletely circumpolar, (oro)boreal to northern temperate, with oceanic tendencies (Ahti 1964, Thomson 1984).
HB 7 (78-302); LB 17 (78-413); MB 8 (13564).

Peltigera degenii Gyelnik

LB-HA, apparently very rare.

Only three of our specimens match the traditional concept of *P. degenii* in all regards: one from a decaying log in an open *Abies–Picea* forest; the others terricolous at a forest edge. Other specimens exhibit varying degrees of tomentum on the upper surface, e.g. HB 9 (80-303); HA 6 (80-464); LA 1 (79-1400).

Probably incompletely circumpolar, (oro)hemiarctic to temperate (see Thomson 1950, Ahti & Vitikainen 1977).
LB 20 (38661); UB 1 (80-364); HA 1 (80-335b).

Peltigera didactyla (With.) Laundon

Syn. *Peltigera spuria* (Ach.) DC. — HB-(MB-)LA-MA, scattered.

Over soil or moss, particularly in open, disturbed sites. Rare also over rock and lignum. Intolerant of shade; best represented in recent (south-facing) burns. Exposed oroarctic sites are also colonized.

Circumpolar, (oro)arctic to subtropical (Ahti 1964).
LB 7 (77-325); LB 22 (78-446a); MB 4 (79-1073); MB 6 (13335); HA 7 (79-1421); LA 1 (79-1402); MA 5 (79-1252).

Peltigera elisabethae Gyelnik

HB-((MB)), scattered.

Over moss, decaying logs and mossy boulders, both acid and base-rich, and both in open and in somewhat shady sites. Displays, with *P. horizontalis,* a marked sensitivity to prolonged snow cover: in snowy districts often restricted to the (elevated) surfaces of boulders or logs.

Probably circumpolar, hemiarctic to temperate.
HB 4 (79-1197); LB 2 (80-397); LB 29 (14064); MB 4 (79-1349).

(+)*Peltigera evansiana* Gyelnik

HB-?, very rare.

The specimen is atypical in some regards, for example in having lobulate isidia; it may prove to be a separate taxon.

Over soil and duff in open conifer forest.

North America (primarily eastern), low boreal to temperate (Ahti & Vitikainen 1977).
HB 7 (89-145).

Peltigera horizontalis (Huds.) Baumg.

HB-LB, frequent.

Ecology as in *P. elisabethae*, but less tolerant of open, xeric conditions.

Incompletely circumpolar (Thomson 1950), low (oro)boreal to temperate (Ahti 1964).
HB 7 (79-1083); LB 16 (79-861b).

Peltigera kristinssonii Vitik.

HB-UB, rare.

Published by Kristinsson (1968) as *P. occidentalis* (E. Dahl) H. Krist.; however, the type specimen does not belong to this species (see under *P. neopolydactyla*).

Over moss and mossy rock, often in somewhat xeric sites.

Probably incompletely circumpolar (in North America, specimens have been examined from B.C., Alberta, the Yukon, the Northwest Territories, and Quebec), arctic to (oro)boreal (Vitikainen 1985).

HB 1 (80-557); HB 2 (80-632); MB 16 (79-1439); UB 7 (79-1428).

Peltigera lepidophora (Nyl. ex Vainio) Bitter

HB-LB, scattered.

Over earth in open, generally xeric, often somewhat base-rich sites, especially roadcuts, river banks and young burns. Probably sensitive to prolonged snowcover. More common in grassland habitats in arid districts elsewhere.

Circumpolar, (oro)arctic to temperate (Thomson 1984).

HB 7 (79-1082); LB 2 (80-288).

Peltigera leucophlebia (Nyl.) Gyelnik

HB-(UB), very frequent.

Though *P. leucophlebia* is clearly a distinct species, we have detected a few colonies that seem to be intermediate with *P. aphthosa*.

Over earth, moss, mossy rocks and decaying logs. Locally more common than *P. aphthosa* in the semi-arid and humid HB and LB, perhaps reflecting the base-rich soils in this portion of the study area.

Circumpolar, arctic to temperate (Ahti 1964, Thomson 1984).

HB 3 (38627); LB 2 (38688); MB 5 (13398).

Peltigera malacea (Ach.) Funck

HB-(UB-)-MA, scattered.

Over moss on forest floor, and over mossy boulders, especially in open, somewhat xeric sites in semi-arid sectors. Also not infrequent on exposed oroarctic ridges.

Circumpolar, (oro)arctic to northern temperate (Ahti 1964, Thomson 1984), with continental tendencies.

HB 7 (78-1030); LB 13 (15004); MB 2 (78-884b); LA 1 (78-550); MA 2 (77-259).

Peltigera membranacea (Ach.) Nyl.

(HB)-LB-((UB)), frequent.

Over earth, moss, decaying logs and mossy boulders in damp, often somewhat shaded sites. Most common in perhumid forest types. Absent from open sites in semi-arid portions of the study area. Above the MB, confined to mossy logs, perhaps reflecting a sensitivity to prolonged snow cover.

The lichen parasite (+++) *Refractohilum peltigerae* (Keissler) D. Hawksw. has been collected in the study area over *P. membranacea* (IMI 260710). Determination by David Hawksworth.

Incompletely circumpolar, (oro)boreal to temperate, with oceanic tendencies (see Thomson 1984).

LB 6 (80-583a); LB 27 (78-1123); LB 30 (79-1035).

(+) *Peltigera neckeri* Hepp ex Müll. Arg.

HB-((MB)), rare.

Over soil, mossy rocks and decaying logs. Displays a broad ecology, occurring in both xeric and humid habitats, though most common over base-rich substrates. Absent, however, from more arid districts elsewhere. Also generally absent from localities having prolonged snow cover.

Probably circumpolar, arctic to temperate.

HB 1 (80-371); LB 8 (80-638); LB 19 (79-1006); MB 4 (79-1061).

Peltigera neopolydactyla (Gyelnik) Gyelnik

HB-(HA), scattered to frequent.

Included within our concept is a coriaceous "stress form" having short, tufted rhizines, and frequently, sparse interspaces between the veins. On the whole, this form has a more continental distribution than the type of the species; locally, it alone occurs above the MB. If recognized as a distinct species, it should probably be called *P. occidentalis* (E. Dahl) H. Krist. (Orvo Vitikainen, pers. comm.). However, as the two forms appear to intergrade, we prefer, for the present, to consider them conspecific.

Over earth, moss, decaying logs and mossy rocks, restricted to humid sites, shaded to well illuminated. Frequent in perhumid portions of the study area; scattered elsewhere. Absent from more arid parts of B.C.

Probably incompletely circumpolar, (oro)arctic to temperate (Ahti & Vitikainen 1977, Brodo et al. 1987).

LB 2 (80-288b); LB 27 (78-1173a); MB 4 (79-1071); UB 2 (79-369); HA 2 (83-862).

Peltigera pacifica Vitik.

LB, very rare.

Confined locally to mossy logs in perhumid, old growth forests. Much more frequent in coastal B.C. (Noble 1982). Probably the most hygrophilous of the local Peltigerae.

Western North America, oroboreal to northern temperate, with oceanic tendencies (Vitikainen 1985).
LB 29 (80-308); LB 29 (80-440); LB 30 (79-1034).

Peltigera polydactylon (Necker) Hoffm.

HB-LB, rare.

Generally a pioneer species over soil both in open and in shaded sites, especially in humid portions of the study area. Also occasional over mossy rocks and decaying logs.

Circumpolar, probably (oro)boreal to temperate.
HB 7 (79-1080); LB 21 (79-902); LB 29 (80-448).

Peltigera ponojensis Gyelnik

HB-((MB-))(HA-MA), rare to scattered.

Terricolous, especially over base-rich mineral soils in open, xeric sites; also occasional over moss. Highly sensitive to prolonged snow cover. Most common in semi-arid portions of the study area, where it is, however, much less frequent than *P. rufescens*. Interestingly, the reverse is true in arid grassland ecosystems elsewhere.

Probably circumpolar, (oro)arctic to temperate (Brodo et al. 1987).
HB 5 (79-1221); LB 17 (79-872); MA 1 (79-1403).

Peltigera praetextata (Flörke ex Sommerf.) Zopf

HB-(MB)((HA)), scattered.

The material assigned to this species is heterogeneous: it includes, for example, a nonlobulate, rather thick-lobed taxon having a distinctly rust-coloured lower surface. Further studies are in progress.

Over earth, decaying logs and mossy rocks in open or shaded forests. Often associated with *P. membranacea,* though that species appears to be more strictly hygrophilous.

Incompletely circumpolar, high (oro)boreal to temperate.
LB 6 (80-572); LB 16 (91-94); LB 30 (79-1033); MB 1 (80-334).

Peltigera rufescens (Weis) Humb.

HB-(MB-HA)-MA, scattered to frequent.

Primarily over bare mineral soil in open, xeric sites.

Circumpolar, (oro)arctic to southern temperate (Ahti 1964).
HB 5 (79-1214); LB 14 (79-893); MB 4 (79-1065); HA 1 (79-1139); LA 1 (78-592); MA 6 (79-1317).

Peltigera scabrosa Th. Fr.

HB-LA, rare.

The material appears to be taxonomically heterogeneous, varying from highly scabrid to very weakly scabrid.

Over moss and mossy rock in open, often somewhat xeric sites. Possibly intolerant of base-rich substrates.

Circumpolar, (oro)arctic to northern temperate (Ahti 1964, Thomson 1984).
LB 19 (79-936); LB 29 (79-1100); UB 1 (79-1397); HA 2 (14342); HA 6 (79-1310); LA 5 (79-1040).

Peltigera venosa (L.) Hoffm.

HB-((MB-HA)), scattered.

Over disturbed, base-rich soil, especially roadcuts, river banks and among roots of downed trees. Best developed in humid localities.

In several collections, a tiny *Leptogium*-like blue–green phycotype was found growing at the base of the thallus (see Tönsberg & Holtan–Hartwig 1983, Ott 1988).

Circumpolar, (oro)arctic to northern temperate (Ahti 1964, Thomson 1984).
LB 2 (78-826); LB 17 (7360); MB 4 (79-1062); UB 1 (79-1134); HA 7 (79-1436).

(+)(*) *Phaeophyscia constipata* (Norrlin & Nyl.) Moberg

HB-?, very rare.

Collected only once: over limestone in an open, rather exposed site.

North America (Thomson 1984)–western Eurasia (Moberg 1977), (oro)arctic to essentially (oro)boreal.
HB 1 (80-547).

Phaeophyscia endococcina (Körber) Moberg

Syn. *P. decolor* (Kashiw.) Essl. — HB-HA, rare.

Generally over rock on somewhat open sites; also once from a sheltered moose antler.

Probably circumpolar, (oro)arctic to temperate (Thomson 1984).
HB 7 (78-304a); LB 19 (79-1010); MB 4 (78-686a); HA 1 (78-581).

(+) *Phaeophyscia kairamoi* (Vainio) Moberg

HB-LB, very rare.

Over *Alnus tenuifolia* and *Populus trichocarpa* in very humid sites, especially in the spray zones of waterfalls.

Incompletely circumpolar (see Moberg 1974, Esslinger 1978), (oro)boreal to northern temperate, with continental tendencies.
HB 7 (78-278a); LB 6 (77-372); LB 6 (78-390).

Phaeophyscia orbicularis (Necker) Moberg

HB-?, very rare.

Collected only once: over *Alnus tenuifolia* near a lake. Much more common in semi-arid districts outside the study area.

Probably incompletely circumpolar; though reported by Esslinger (1977b) to be absent from eastern North America, it is common in southern Ontario, at least (Wong & Brodo 1992); (oro)boreal to temperate.
HB 5 (79-1237).

Phaeophyscia sciastra (Ach.) Moberg

HB-MB-?, scattered.

Over a wide range of rock types, especially in rather exposed sites. Mostly confined locally to vertical surfaces, perhaps suggesting a sensitivity to prolonged snow cover. In semi-arid districts elsewhere, not uncommon in the HA.

Circumpolar, (oro)arctic to hemiboreal or rarely temperate (see Thomson 1984).
HB 5 (79-1209); LB 2 (77-232a); LB 17 (78-412); MB 8 (78-704a).

Physcia adscendens (Fr.) H. Olivier

HB-((MB)), rare.

Virtually absent locally except in the vicinity of farms and pastures, where corticolous over *Populus*, *Salix* and *Sorbus*. Also once, however, over sheltered moose antlers. Considerably more widespread in arid districts elsewhere in B.C.

Circumpolar, low arctic to essentially (oro)boreal and temperate (Ahti 1964, Thomson 1984).
LB 7 (13798); LB 7 (77-240); MB 6 (77-276).

Physcia aipolia (Ehrh. ex Humb.) Fürnr. var. *alnophila* (Vainio) Lynge

HB-(MB), scattered.

Specimen 78-1188 (from *Alnus* at HB 4) approaches var. *aipolia*.

Over base-rich bark, especially in open sites. Also once over the calcium-enriched branches of *Picea glauca* near a mineral spring.

Circumpolar, low arctic to hemiboreal.
HB 4 (79-1188); LB 7 (13803a); LB 14 (78-843); MB 6 (79-1334).

Physcia caesia (Hoffm.) Fürnr.

HB-HA-?, rare.

Over acid (calcium-enriched?) rock in open or exposed sites, probably throughout. Restricted locally to near-vertical faces.

One specimen approaching *P. subalbinea* Nyl. (*P. wainioi* Räsänen) was found growing over *Populus trichocarpa* (79-1232). It has been referred by R. Moberg, however, to the present species.

Circumpolar, (oro)arctic to temperate (Ahti 1964, Thomson 1984).
HB 1 (80-555); HB 7 (77-176); MB 8 (13546); UB 2 (77-232); HA 1 (78-582).

Physcia dubia (Hoffm.) Lettau

HB-MA, rare.

Over vertical siliceous rock in open sites; also once over a fence rail in a farmyard.

Circumpolar, (oro)arctic to temperate (Thomson 1984).
HB 1 (80-556); LB 7 (13824); MB 6 (77-277); HA 7 (79-1432); MA 6 (79-1320).

Physcia phaea (Tuck.) Thomson

LB-MB, rare.

Over siliceous rock in open or somewhat shaded sites.

North America–western Eurasia, (oro)boreal to temperate (Thomson 1984).
LB 17 (77-435); MB 4 (79-1352); MB 8 (78-695a).

Physconia enteroxantha (Nyl.) Poelt

HB-((LB-MB)), rare.

Over (mossy) rocks and deciduous trees and shrubs, especially in open, but somewhat humid sites. Not noted from perhumid portions of the study area. Excluded by prolonged snow cover?

The endoparasitic lichen (++) *Buellia pulverulenta* (Anzi) Jatta was collected in the study area on *P. enteroxantha* (IMI 260711). Determination by David Hawksworth.

Probably incompletely circumpolar (see Moberg 1977), (oro)boreal to temperate.
HB 1 (78-1313); HB 4 (79-1192); HB 7 (78-280); MB 8 (13658).

Physconia muscigena (Ach.) Poelt

HB-(LB-MA), rare.

Widespread both over mossy rocks in shady sites, and over humous soil in open, exposed sites. Much more common in arid grassland ecosystems elsewhere.

Circumpolar, (oro)arctic to hemiboreal (Thomson 1984).
HB 5 (79-1200); HB 7 (78-309); LB 22 (79-1245); MA 5 (79-1253).

Physconia perisidiosa (Erichsen) Moberg

HB-(LB-MB), rare.

Over deciduous trees and shrubs in open sites; also over mossy rock.

Probably incompletely circumpolar, (oro)boreal to hemiboreal.
HB 5 (79-1234); LB 24 (78-1305); MB 8 (13677).

Pilophorus acicularis (Ach.) Th. Fr.

LB-MB, rare.

Mainly over clean, acid rock surfaces in open, but humid sites, often near waterfalls. More common in perhumid portions of the study area.

Western North America (and one collection from Ontario, Jahns 1981)–eastern Eurasia, (oro)boreal to temperate, with oceanic tendencies.
LB 19 (78-603); MB 4 (78-690).

(*) *Pilophorus cereolus* (Ach.) Th. Fr.

LB-?, very rare.

Over clean, (base-rich) basaltic boulders in somewhat open forests, often of southwest aspect. Possibly a pioneer species: in one site it was found to be restricted to boulders disturbed by trail construction five years earlier. Already reported in Goward and Thor (1992).

Western North America–eastern North America–western Eurasia (see Jahns 1981), low (oro)boreal to hemiboreal, with continental tendencies.
LB 10 (86-159).

Platismatia glauca (L.) Culb. & C. Culb.

HB-(HA-)((MA)), very frequent.

Widespread over virtually all tree species (except *Populus tremuloides* and *P. trichocarpa*). Also occasional over decaying logs and mossy rocks in semi-arid forest types, and rare over humous earth in exposed oroarctic sites. Among the most widespread of corticolous macrolichens, rare only in the most perhumid portions of the study area. Also disappearing, however, in arid districts elsewhere.

Incompletely circumpolar, (oro)arctic to temperate (Ahti 1977).
HB 7 (78-299c); LB 7 (13072); MB 4 (78-663a); HA 2 (14918); LA 5 (78-492); MA 1 (80-352).

Platismatia norvegica (Lynge) Culb. & C. Culb.

LB, rare.

Over *Tsuga* and *Thuja* in perhumid, but often semi-open, old growth forests. Also collected in the spray zones of waterfalls. Hitherto known in North America only from coastal localities (W. Culberson & C. Culberson 1968), and considered to be "truly oceanic" (Degelius 1935).

Specimen 79-1026 is apotheciate, and represents a first North American report of fertile material for this species (W. Culberson & C. Culberson 1968).

Incompletely circumpolar (Ahti 1977), (oro)boreal to northern temperate, with oceanic tendencies (see W. Culberson & C. Culberson 1968).
LB 17 (79-1292b); LB 27 (78-1149); LB 30 (79-1026).

Polychidium dendriscum (Nyl.) Henssen

HB-?, very rare.

Collected only once: corticolous and muscicolous over base of *Acer glabrum* in open spray zone of a waterfall. Previously reported in B.C. only from coastal localities (Ohlsson 1973).

Western North America–eastern North America (Florida)–western Eurasia–eastern Eurasia, hemiboreal to primarily tropical, with distinct oceanic tendencies.
HB 7 (91-79).

Polychidium muscicola (Swartz) S. Gray

HB-MB-?, scattered.

Generally over mossy rocks in open sites, often near water; once also, however, over *Juniperus scopulorum*.

Possibly circumpolar, arctic to essentially (oro)boreal and temperate (Thomson 1984), apparently with oceanic tendencies.

HB 7 (77-168); LB 6 (13136); MB 6 (78-693); MB 8 (13552).

Pseudephebe minuscula (Nyl. ex Arnold) Brodo & D. Hawksw.

LA-MA-?, rare to scattered.

Over siliceous rock, though once also from krummholz *Picea* in the LA. Restricted to exposed ridges.

Circumpolar, (oro)arctic, with continental tendencies (Brodo & Hawksworth 1977).
LA 1 (78-576); LA 4 (78-773b) LA 4 (78-801).

Pseudephebe pubescens (L.) M. Choisy

((LB))-LA-UA, scattered.

Generally over siliceous rock in exposed sites, but also occasional over branches of *Pinus* and *Juniperus*. Once also over earth. Though generally restricted locally to oroarctic elevations, elsewhere it is common in exposed (north-facing) outcrops down to the HB, e.g. in coastal B.C. (Noble 1982), and in arid grassland communities. Sensitive to prolonged snow cover.

Circumpolar, essentially (oro)arctic (Brodo & Hawksworth 1977), but with (oro)boreal extensions.
LB 6.5 (91-1762); LA 1 (79-1160); MA 1 (79-1176); UA 1 (79-1279).

Pseudocyphellaria anomala Brodo & Ahti

LB-(MB), rare.

Over conifers in somewhat open, but humid sites. Apparently restricted to perhumid sections of the study area.

Western North America (Ahti 1977), oroboreal to northern temperate, with oceanic tendencies.
LB 6 (77-338c); LB 19 (78-832a); LB 30 (79-1028, fertile!); MB 12 (80-321).

Psora decipiens (Hedwig) Hoffm.

Syn. *Lecidea decipiens* (Hedw.) Ach. — ?-MA-?, apparently very rare.

Collected only once: thin soil over calcareous rock in an exposed oroarctic site.

Circumpolar, (oro)arctic to temperate (Timdal 1987).
MA 4 (79-1263).

Psora globifera (Ach.) Massal.

HB-?, very rare.

Collected only once: terricolous in cranny of grassy basalt outcrop.

North America–western Eurasia (Timdal 1987), essentially hemiboreal to temperate.
HB 6.5 (90-1133).

Psora himalayana (Church. Bab.) Timdal

HB-((MB))-?, rare.

Over base-rich rock near a lake and over exposed calcareous soil.

Western North America–eastern Eurasia, (oro)arctic to hemiboreal (see Timdal 1987).
HB 5 (79-1216); HB 6.5 (91-73); MB 8 (13542).

Psora nipponica (Zahlbr.) G. Schneider

Syn. *Lecidea novomexicana* (B. de Lesd.) W. Weber & R. Anderson, *Psora novomexicana* B. de Lesd. — HB-HA-?, scattered.

Over moss and base-rich soil in open, exposed sites, including lake-edge basalt boulders.

Western North America–eastern Eurasia, oroarctic to hemiboreal (see Timdal 1987).
HB 7 (79-6-16); LB 6.5 (91-1756); MB 4 (79-1325); MB 8 (13544); HA 7 (79-1423).

Psora tuckermanii R. Anderson ex Timdal

HB-?, apparently very rare.

Over exposed, south-facing, base-rich rock outcrops.

First reported for B.C. by Timdal (1987).

Western North America, oroboreal to northern temperate (see Timdal 1987).
HB 5 (79-1204); HB 1 (78-1318); HB 7 (77-172).

Psoroma hypnorum (Vahl) S. Gray

LB-(MB-)HA, rare.

Over mosses in open, but typically humid sites. Restricted to near-vertical substrates in the oroarctic, suggesting a sensitivity to prolonged snow cover.

Circumpolar, (oro)arctic to temperate (Jörgensen 1978, Thomson 1984).
LB 19 (78-602); HA 2 (14911); HA 5 (78-715).

Racodium rupestre Pers.

?-MB, apparently rare.

Collected only once: from the overhanging surface of a damp granitic boulder in an open boulderbed.

Possibly western North America–western Eurasia, oroboreal to temperate.
MB 2 (78-864).

Ramalina dilacerata (Hoffm.) Hoffm.

Syn. *Fistulariella dilacerata* (Hoffm.) Hale, nom. inval., *F. minuscula* (Nyl.) Bowler & Rundel, *Ramalina minuscula* (Nyl.) Nyl. — HB-LB, rare to scattered.

Over deciduous bark, especially of *Alnus*, in well illuminated sites.

Circumpolar, (oro)boreal to northern temperate, with continental tendencies (Ahti 1964).
HB 4 (78-342); LB 7 (13047); LB 17 (79-1374).

Ramalina farinacea (L.) Ach.

HB-LB, rare to scattered.

Over bark of deciduous and coniferous trees and shrubs in humid, semi-shaded to rather open sites.

Circumpolar, boreal to temperate (Krog 1968).
HB 7 (78-276); LB 1 (79-1243); LB 7 (77-303).

Ramalina inflata auct.

Syn. *Fistulariella inflata* auct. (sensu Bowler & Rundel 1977), non *F. inflata* (J.D. Hook. & Taylor) J.D. Hook. & Taylor — HB-LB, rare.

Over *Alnus* in open, often disturbed sites. Also once over *Pyrus*.

Western North America (Bowler & Rundel 1977), oroboreal to temperate.
LB 5 (77-251); LB 11 (79-1450); LB 14 (78-845).

(+) *Ramalina obtusata* (Arnold) Bitter

HB-LB, scattered.

Over deciduous (especially *Alnus*) and coniferous trees and shrubs. Also once from rock. Generally in humid, well-illuminated sites, especially the edges of rivers and lakes.

Probably circumpolar, (oro)boreal to temperate, with continental tendencies.
HB 4 (78-344); HB 10 (80-481a); LB 2 (80-601); LB 7 (77-310).

Ramalina pollinaria (Westr.) Ach.

HB-(MB), rare.

Over *Alnus*, *Salix* and *Thuja* in open to semi-shaded sites; also once over overhanging acid rock at lake edge.

Probably circumpolar (Ahti 1964), mid (oro)boreal to temperate.
HB 4 (78-343); HB 7 (78-291); LB 7 (13890); MB 4 (80-458).

Ramalina thrausta (Ach.) Nyl.

HB-(MB), frequent.

Over deciduous and especially coniferous trees in shady or open, but always humid sites. Once also from an overhanging acid rock near a lake. Occurs throughout in the HB and LB, but most frequent in perhumid portions. Rare in more oceanic districts (e.g. Noble 1982).

More hygrophilous and shade-tolerant than the morphologically similar *Alectoria sarmentosa*, seldom occurring higher than three metres above the ground.

Circumpolar, arctic to essentially (oro)boreal and temperate (Ahti 1964, Bowler 1977, Thomson 1984).
HB 7 (78-282); LB 7 (77-311); LB 8 (7371); LB 22 (78-459b); MB 15 (6522).

Rhizoplaca chrysoleuca (Sm.) Zopf

Syn. *Lecanora chrysoleuca* (Sm.) Ach. — HB-LB, rare.

Over base-rich rock outcrops of south aspect. Sensitive to prolonged snow cover, occurring in more arid districts into the HA.

Circumpolar, (oro)arctic to temperate (Leuckert et al. 1977, McCune 1987).
HB 6 (79-1198); HB 6.5 (84-1009); LB 6.5 (91-1755).

Rhizoplaca melanophthalma (DC.) Leuck. & Poelt

Syn. *Lecanora melanophthalma* (Ram.) Ram. — ?-LB-((HA))-?, very rare.

Collected twice: over south-facing acid rock on an open, somewhat protected cliff face.

Circumpolar, (oro)arctic to temperate (Leuckert et al. 1977, McCune 1987).
LB 6.5 (91-1754); HA 1 (78-583).

(+) *Solorina bispora* Nyl.

?-MA-?, very rare.

Collected only once: over calcareous rock on an exposed summit.

Circumpolar, (oro)arctic (Thomson 1984).
MA 4 (79-1247).

Solorina crocea (L.) Ach.

((LB-))(MB-)UB-UA, scattered.

Over acid and base-rich soils, often in the lee of open oroarctic ridges, where best developed near lingering (annual) snowdrifts. A chionophile: the unusually broad local zonal distribution (cfr. Ahti 1977) is doubtless related to the prolonged snow cover characteristic of the study area.

Circumpolar (Thomson 1984), (oro)arctic to lower oro-boreal.
LB 23 (79-1037); UB 1 (79-1131); HA 2 (14161); LA 7 (77-184); MA 7 (77-475); UA 1 (79-1280).

(+) *Solorina octospora* (Arnold) Arnold

?-LA-?, very rare.

Collected only once: over calcareous rock in an exposed oroarctic site.

Possibly circumpolar, (oro)arctic (Thomson 1984).
LA 1 (14739).

Solorina saccata (L.) Ach.

?-LB-HA, rare.

Specimen 91-82, collected in the spray zone of a waterfall, has external cephalodia. These are not usually reported to occur in this species.

Over mossy rock in humid, often rather shady sites. Also occasional over earth.

Circumpolar, (oro)arctic to (oro)boreal (Thomson 1984).
LB 2 (78-393a); LB 30 (77-249); HA 7 (79-1437).

Sphaerophorus globosus (Huds.) Vainio, s. lat.

LB-(MB), rare.

Material from the Pacific Northwest is sometimes given separate species status as *S. tuckermanii* Räsänen (e.g. Thomson 1984).

Over *Thuja* and *Tsuga* in open to somewhat shaded old growth forests in perhumid portions of the study area. Often accompanied by *Platismatia norvegica*.

Probably circumpolar, arctic to temperate, with oceanic tendencies (Ahti 1964).
LB 27 (78-1133b); LB 30 (79-1023); MB 15 (13473).

Spilonema revertens Nyl.

?-MB-?, very rare.

Collected only once: over open, south-facing granite boulder near lake shore.

Possibly circumpolar, (oro)boreal to temperate (Ahti 1964).
MB 4 (79-1347).

Stereocaulon

Several Wells Gray specimens could not be identified with certainty. In addition to the species cited below, at least two further taxa may be present.

Stereocaulon alpinum Laur. ex Funck

((LB))(-UB)-MA, frequent to very frequent.

Over earth and mossy acid rock in open, dry meadows and oroarctic ridges.

Circumpolar, essentially (oro)arctic to high (oro)boreal (Ahti 1964, Thomson 1984).
LB 2 (13875); MB 4 (13284); UB 2 (78-349); HA 1 (79-1148); LA 2.5 (14352); MA 3 (78-766b).

Stereocaulon botryosum Ach.

?-LA-?, very rare.

Collected only once: over a rocky grass heath on an exposed summit.

Possibly circumpolar, (oro)arctic to high (oro)boreal (Thomson 1984).
LA 2.5 (14285).

Stereocaulon grande (Magnusson) Magnusson

HB-(UB-LA), scattered.

Over acid and base-rich rock, especially in open, somewhat xeric sites.

The lichen parasite (+) *Scutula stereocaulorum* (Anzi) Körber has been collected from the study area on *S. grande* (IMI 260705). Determination by David Hawksworth.

Circumpolar, low (oro)arctic to essentially (oro)boreal (Thomson 1984).
LB 6 (13162); LB 19 (78-1020a); MB 12 (80-314); HA 7 (80-384); LA 5 (78-744b).

Stereocaulon paschale (L.) Hoffm.

HB-((UB-MA)), frequent to very frequent.

Loosely over acid and base-rich boulders in open to somewhat shady sites. A dominant species of LB boulderbeds.

Circumpolar, (oro)arctic to northern temperate (see Thomson 1984).
LB 6 (13137); LB 29 (78-427); MB 8 (78-698b); MA 2 (77-255).

Stereocaulon rivulorum Magnusson

LA-MA, scattered.

Over unstable earth or moss, especially in open ephemeral water tracts and areas of prolonged snow cover.

Circumpolar, (oro)arctic (Thomson 1984).
LA 1 (80-345); LA 2.5 (14765); MA 5 (79-1270).

Stereocaulon tomentosum Fr.

HB-(MB-UB), scattered.

Over soil and rock in open or somewhat shady sites, especially in second-growth forests. Also rarely over lignum.

Circumpolar, (oro)boreal to temperate (Thomson 1984).
HB 5 (79-1223); LB 7 (77-315); MB 8 (13340); UB 2 (78-373).

Stereocaulon vesuvianum Pers.

LB-MB, very rare.

Collected only twice: from the summits of granitic boulders in lakeside boulderbeds.

Circumpolar, arctic to temperate (see Thomson 1984).
LB 29 (83-736); MB 8 (13579).

Sticta fuliginosa (Hoffm.) Ach.

LB-(MB), rare.

Over conifers in open or semi-shaded, but always humid, forests. Also occasional over mossy rock.

Incompletely circumpolar, low (oro)boreal to tropical, with oceanic tendencies.
LB 19 (78-613); LB 25 (13937); MB 4 (78-1075); MB 6 (13192).

Sticta limbata (Sm.) Ach.

HB-MB, very rare.

Locally scattered over *Alnus tenuifolia* in the outer spray zone of a waterfall. Also once as a scrap over *Picea* in an open conifer forest near a lake. Apparently a first record for inland North America.

Western North America–eastern North America–western Eurasia, (oro)boreal to essentially temperate (see Krog 1968), with oceanic tendencies.
HB 7.5 (91-64); MB 2 (84-899).

Thamnolia vermicularis (Swartz) Ach. ex Schaerer var. *subuliformis* (Ehrh.) Schaerer

Syn. *T. subuliformis* (Ehrh.) Culb. — LA-MA, rare to scattered.

Over earth, rocks and moss on exposed oroarctic ridges. Known also from exposed sites down to the LB in coastal localities (Noble 1982), and in arid inland districts.

Circumpolar, essentially (oro)arctic (Thomson 1984), but with oroboreal extensions.
LA 2.5 (14758); LA 8 (77-185); MA 2 (77-257); MA 7 (77-476).

Tholurna dissimilis (Norman) Norman

(HA)-LA, very rare.

Over branches and exposed trunks of (krummholz) *Picea* and *Abies* at upper treeline, especially favouring solitary trees in ridgecrest sites.

Western North America–western Eurasia (Östhagen 1974), low (oro)arctic to rarely low (oro)boreal (see Otto 1983).
HA 1 (78-529); LA 1 (78-795).

Umbilicaria angulata Tuck.

(LB-)LA-MA, scattered.

Over well-lit, hard, acid, snow-free rocks. Most frequent on oroarctic ridges; also occasional over lakeside cliffs and boulderbeds at lower elevations.

Western North America (Llano 1950, Thomson 1984), oroarctic to hemiboreal.
LB 29 (78-422); MB 8 (13639); HA 7 (77-198).

Umbilicaria cylindrica (L.) Delise ex Duby

(HA)-MA, scattered.

Over acid rock in open, exposed sites. Locally restricted to the oroarctic, but down to oroboreal elevations in more arid districts elsewhere.

Circumpolar (Llano 1950), (oro)arctic to (oro)boreal.
HA 2 (14173); HA 5 (79-1048); LA 8 (77-182); MA 1 (79-1177); MA 3 (78-768b).

Umbilicaria deusta (L.) Baumg.

HB-(LA-MA), scattered to frequent.

Over acid rock, especially in somewhat sheltered sites or in ephemeral water tracts. Apparently more tolerant of snow cover than other local Umbilicariae, excepting perhaps *U. hyperborea*.

Circumpolar, (oro)arctic to northern temperate (Ahti 1964, Thomson 1984).
LB 26 (78-1310); MB 8 (13550); HA 2 (14174a); LA 4 (78-761).

Umbilicaria havaasii Llano

(HA)-MA, scattered.

Over acid rock in well-lit sites, where often accompanied by *U. angulata*. In more arid districts, it may extend downward into the oroboreal.

Apparently North America–western Eurasia (Llano 1950, Thomson 1984), (oro)arctic to occasionally (oro)boreal.
LA 1 (79-1156); LA 5 (78-724a); MA 2 (77-265).

Umbilicaria hyperborea (Ach.) Hoffm.

(HB-UB)-UA, very frequent.

Over acid rock in open or somewhat sheltered sites. Rather tolerant of humidity and snow cover. The most widespread and frequent of the local Umbilicariae; in the oroarctic its colonies often create a dense "shadow" over exposed ridgecrests.

(++) Specimen 77-181 can be referred to the rare var. *radicicula* (Zetterst.) Hasselr.

Circumpolar, (oro)arctic to northern temperate (Ahti 1964, Thomson 1984).
LB 7 (77-319); MB 8 (13527); HA 5 (79-1047); LA 1 (78-533); LA 8 (77-181); MA 3 (78-768a); UA 1 (79-1277).

Umbilicaria lambii Imsh.

HA-MA, very rare.

Collected only twice: from highly exposed, south-facing acid outcrops in the oroarctic.

Western North America (Imshaug 1957), oroarctic to orohemiarctic.
HA 6.5 (84-1031); MA 1 (84-970).

(+) *Umbilicaria lyngei* Schol.

?-LA-?, apparently very rare.

Collected only once: over a highly exposed granitic ridge in the oroarctic.

Probably circumpolar (see Llano 1950), (oro)arctic to (oro)boreal (see Thomson 1984).
LA 4 (78-785).

Umbilicaria phaea Tuck.

?-MB, rare.

Collected only once (over an acid rock face near a lake), but noted on several other occasions in similar habitats — always out of reach.

Western North America, arctic to essentially oroboreal and temperate (Llano 1950, Thomson 1984).
MB 8 (13549).

Umbilicaria polyphylla (L.) Baumg.

LB-(MB-UB)-LA, frequent.

Over hard acid rock, generally in exposed oroarctic sites, but also in lowland boulder beds.

The rare lichen parasite *Clypeococcum grossum* (Körber) D. Hawksw. has been reported for North America (Hawksworth 1982) on the basis of material collected in the study area on *U. polyphylla*.

Circumpolar, (oro)arctic to temperate (Ahti 1964, Thomson 1984).
LB 29 (78-421); MB 8 (13638); HA 2 (77-233); LA 1 (78-532).

Umbilicaria proboscidea (L.) Schrader

LA-MA, very rare.

Collected only twice: over exposed acid rock in the oroarctic.

Circumpolar, (oro)arctic to (oro)boreal (see Llano 1950, Thomson 1984).
LA 1 (79-1156b); MA 1 (80-361).

Umbilicaria torrefacta (Lightf.) Schrader

HB-LA, scattered.

Over acid and base-rich rock in open, but not particularly exposed sites. Apparently one of the least sensitive of the local Umbilicariae to snow cover.

Circumpolar, (oro)arctic to hemiboreal (see Llano 1950, Thomson 1984).
HB 7 (79-6-23); LB 7 (13112); MB 8 (78-740a); LA 8 (77-181).

Umbilicaria vellea (L.) Ach.

HB-LA, scattered.

Over acid to somewhat base-rich cliff faces, especially where subject to occasional seepage. Tolerates considerable shade.

Circumpolar, (oro)arctic to northern temperate (Thomson 1984).
HB 7 (78-301); LB 17 (78-411); MB 8 (13548); HA 1 (78-584); LA 1 (78-587).

Umbilicaria virginis Schaerer

LA-UA, scattered.

Over hard acid rock in exposed oroarctic sites. Probably highly sensitive to prolonged snow cover.

Circumpolar, (oro)arctic (Thomson 1984).
LA 1 (79-1163); LA 7 (77-461); MA 7 (79-1419); UA 1 (79-1276).

Usnea

The western North American species of the difficult genus *Usnea* are currently undergoing a thorough taxonomic revision by I. Tavares (Berkeley) and P. Clerc (Berne); the treatment given here is provisional.

(+) *Usnea diplotypus* Vainio

HB, very rare.

Contains usnic and salazinic acids and morphologically conforms well with *U. diplotypus* as defined by Clerc (1987).

Over *Pseudotsuga*. Probably overlooked.

Possibly circumpolar, middle boreal to temperate.
LB 9.5 (91-3).

Usnea filipendula Stirton, s. lat.

HB-LB, very rare.

Two specimens contained usnic and salazinic acids, one (91-6) only usnic acid.

Two morphologically quite different specimens are tentatively united here: 78-293, from a rather shaded *Thuja* trunk adjacent to the Clearwater River; and 78-499b, from a dead roadside *Salix scouleriana*. Both specimens agree with *U. filipendula* in chemistry and habit, but differ morphologically. Specimen 78-293 bears copious isidia which are loosely clustered in punctiform "pseudocyphellae" which may in turn occasionally expand (as soralia) to encircle the branch. Specimen 78-499b bears neither isidia nor spinules, but has distinctly twisted terminal branches. Moreover, verrucose papillae are well developed over its primary and secondary branches, and weakly raised pseudocyphellae are present throughout.

U. cfr. *graciosa* Mot. was added to the British Columbia (Noble et al. 1987) and North America (Egan 1987) checklists on the basis of a tentative assessment of specimen 78-499b by I. Tavares.

Circumpolar, boreal to temperate.
HB 7 (78-293); LB 9 (78-499b).

Usnea glabrata (Ach.) Vainio

?-LB, scattered.

The specimens tested were found to contain either usnic acid alone, or usnic, fumarprotocetraric and protocetraric acids, and Cph-2.

Over deciduous shrubs (especially *Alnus tenuifolia*) in humid, open wetland sites. Collected once also over *Picea*. More or less absent from younger shrubs.

Specimen 77-308b was determined by I. Tavares as *U. kujalae* Räs., but is tentatively placed here. *U. kujalae*, described from Hazelton, north central British Columbia (Räsänen 1933), appears to be conspecific with *U. glabrata* — from which it is supposed to differ primarily in chemistry (medulla K–; contains usnic acid only; H) and in having a more delicate, and more copiously dichotomous branching pattern. However, the medulla in *U. glabrata* s. str. may also sometimes give a K– reaction (usnic acid alone), and the branching is variable.

Western North America–eastern North America–western Eurasia, low boreal to temperate, primarily oceanic (Motyka 1936-38; but see the map in Thomson 1984).
LB 9.5 (91-21); LB 14 (78-847a).

(*) *Usnea glabrescens* (Nyl. ex Vainio) Vainio

HB-LB, rare.

The specimen tested contained usnic and salazinic acids.

Over coniferous and deciduous trees and shrubs in open sites.

A few scattered isidia were noted among the soralia, though these were small and poorly formed, and should probably be considered "pseudoisidia" (see Clerc 1987).

Circumpolar, low boreal to temperate (Motyka 1936–1938).
LB 9 (77-239).

Usnea hirta (L.) Weber ex Wigg.

HB-LB, rare.

Most of the specimens tested with TLC contained usnic acid alone; in only one old individual was the fatty murolic acid complex detected.

Over trees. Most common in semi-arid forests at the extreme southern edge of the study area.

Circumpolar, northern boreal to temperate, with continental tendencies (Thomson 1984).
HB 3 (83-775b); LB 9.5 (91-26).

Usnea lapponica Vainio, s. lat.

Incl. *U. fulvoreagens* (Räs.) Räs. — HB-LB, frequent.

Here we include all tufted or subpendulous Usneae having strictly sorediate soralia that are more or less strongly excavate. The material is clearly heterogenous. While a majority of specimens contain salazinic acid, one (from outside of the study area) contains psoromic acid.

Of those specimens containing salazinic acid, two rather distinct taxa can be discerned: one (*U. lapponica* s. str.) is tufted and only moderately papillate; while the other (e.g. 89-56; 79-1356) is more often subpendulous, and bears tall, densely spaced papillae that extend into the upper third of the branches. The latter taxon is also not infrequently fertile, and appears to be especially susceptible to fungal parasites.

Over trees. Though widespread at lower elevations, *U. lapponica* s. lat. is clearly most abundant in drier forest types in the southern half of the study area, where it especially colonizes the branches of *Pseudotsuga*.

Dr. I. Tavares has referred two of the local specimens (79-1190c and 91-1194a: HB 4) to the more divergently branched *U. laricina* Vainio.

Circumpolar, northern boreal (hemiarctic?) to temperate.
U. lapponica s. str.: HB 3 (83-772); LB 14 (88-246).

Usnea scabrata Nyl. s. lat.

?-LB, rare.

The specimens tested contained usnic acid alone.

Over trees. Apparently restricted locally to open forest types. Much more widespread in drier (oro)boreal forests outside the study area.

U. cfr. *catenulata* Mot. was reported for British Columbia (Noble et al. 1987) and North America (Egan 1987) on the basis of Dr. I. Tavares' determination of our specimen 80-455. In our opinion, however, the material comes very close to *U. scabrata*, differing primarily in having more even and slightly smaller papillae.

Western North America–western Eurasia (Thomson 1984), northern boreal to hemiboreal, with continental tendencies.
LB 14 (80-455); LB 17 (79-30-1)

Usnea stuppea (Räs.) Mot.

?-LB, scattered.

Most of the specimens tested contained usnic and salazinic acids, though a few contained usnic acid alone, occasionally with an unidentified terpene. The type material (H) is heterogeneous as to chemistry, at least. We refrain from exact lectotypification of *U. stuppea*, but our concept conforms with the syntype distributed in the exsiccata Gyelnik: Lichenotheca no. 17 (H), which contains usnic and salazinic acids.

A widespread lichen of sheltered forests at lower elevations throughout, especially on *Pseudotsuga*.

Although originally described (from Hazelton, north central British Columbia) as a variety of *U. comosa* auct. (= *U. subfloridana* Stirton), *U. stuppea* is actually much more closely allied to *U. lapponica* s. lat. The only consistent point of separation we were able to detect between these two species are the soralia, which in *U. stuppea* are more copiously sorediate, and bear an admixture of soredia, isidia and spinules, and, in *U. lapponica*, are frequently more excavate and bear only soredia.

U. stuppea appears to be restricted primarily to humid, sheltered sites, whereas *U. lapponica*, in the study area at least, typically colonizes more open localities. This raises the possibility that the more abundant development of soredia in *U. stuppea*, together with its production of isidia and spinules, may simply reflect the more humid microclimatic conditions under which it occurs. Some specimens, at any rate, are very weakly isidiate, and seem to intergrade with *U. lapponica*.

Recently, Clerc (1987) proposed that soralia in the genus *Usnea* inevitably fall into one of two categories. In the first category, isidia develop first, and soredia only later. In the second category, soredia are present from the beginning; isidia are not produced at all. *U. stuppea*, however, appears to belong to neither category, its soralia initially being strictly sorediate, and only later giving rise to isidia. Eventually, some of the isidia may further develop into elongate spinules — which may apparently disarticulate, and so function as "viviparous" vegetative propagules.

Western North America, lower oroboreal, subcontinental.
LB 9.5 (91-8); LB 14 (88-247).

(+++) (*) *Usnea wasmuthii* Räsänen

HB-LB, rare.

This member of the *U. subfloridana* group may be distinguished chemically by its production of barbatic acid. The specimens tested contained usnic, barbatic and salazinic acids.

Collected over *Pseudotsuga* on dry hillside and on *Picea* and *Salix* adjacent to a marsh.

Possibly western North America–western Eurasia, low (oro)boreal to temperate.
HB 3 (83-773c); HB 9.5 (91-30); LB 9 (77-139); LB 9.5 (91-37).

Vestergrenopsis isidiata (Degel.) E. Dahl

?-LB-?, very rare.

Over inclined rock faces, especially where subject to ephemeral seepage flow. Possibly more common than indicated.

Western North America–eastern North America–western Eurasia (Thomson 1984), essentially (oro)arctic, but with oroboral extensions, and with oceanic tendencies.
LB 17 (38519).

(++) *Xanthoparmelia coloradoënsis* (Gyelnik) Hale

Syn. *Xanthoparmelia taractica* (Kremp.) Hale s. auct. — HB-(LB-)((MB)), scattered.

The specimens tested were found to contain salazinic, norstictic and usnic acids, and an unknown grey. Specimen 84-902 (MB 2) is morphologically very close to *X. wyomingica* (Gyelnik) Hale.

Over acid or base-rich rock, generally in open, somewhat exposed sites. Apparently more xerophytic than the related *X. cumberlandia*.

Western North America (Hale 1990), middle oroboreal to temperate.
HB 7 (78-274); LB 6 (13164); MB 8 (13697).

Xanthoparmelia cumberlandia (Gyelnik) Hale

Syn. *Parmelia cumberlandia* (Gyelnik) Hale — HB-(LB), scattered.

The specimens tested were found to contain norstictic, usnic, stictic, constictic, connorstictic and menegazziaic acids, as well as an unknown grey.

Over base-rich rocks, mostly in south-facing sites subject to early snow-melt. In more arid districts elsewhere, also over acid rocks into the MB.

Western North America–eastern North America, mid (oro)boreal to temperate (see Hale 1955: fig. 1).
HB 2 (78-1289); HB 7 (78-273); HB 5 (79-1205); LB 29 (83-724).

Xanthoparmelia plittii (Gyelnik ex D. Dietr.) Hale

Syn. *Parmelia plittii* Gyelnik — HB, very rare.

Over south-facing, base-rich outcrops, strictly in the semi-arid portions of the study area. In more arid districts elsewhere, extends upward into the UB.

North America, low boreal to tropical (see Hale 1964).
HB 1 (80-546); HB 7 (78-272).

Xanthoria candelaria (L.) Th. Fr. s. lat.

HB-MB, rare to scattered.

Over bark, lignum and vertical rock in well lit sites. Especially abundant in the vicinity of barnyards and mineral springs, where all available substrates are colonized.

Circumpolar, (oro)arctic to temperate (Thomson 1984).
LB 7 (13100); LB 14 (78-851a); MB 4 (79-1055); MB 15 (13458).

Xanthoria elegans (Link) Th. Fr.

HB-(LB-LA), rare.

Over rock. Best developed in rather exposed, calcareous (or calcium-enriched) sites. Apparently sensitive to prolonged snow cover.

Circumpolar, (oro)arctic to temperate (see Thomson 1984).
HB 1 (78-1311); HB 7 (77-174); HA 1 (78-580).

Xanthoria fallax (Hepp) Arnold

HB-LB, rare.

Over rock, bark and lignum in open or somewhat shady sites.

Circumpolar, (oro)boreal to temperate (Thomson 1984).
HB 5 (79-1228); HB 7 (78-303); LB 11 (80-366).

Xanthoria sorediata (Vainio) Poelt

?-LB-?, very rare.

Collected only once: over base-rich basalt on an open cliff face.

Circumpolar, (oro)arctic to (oro)boreal (Thomson 1984).
LB 17 (77-166)

VI DISCUSSION

1. Macrolichen diversity

Inland British Columbia was heavily glaciated until roughly 11 000 years ago (Duford & Osborn 1978). At about 15 000 years ago, the upper surface of the ice rested at about 2 400 m. Thus, with the exception of a few oroarctic lichens and bryophytes which may have persisted on the higher mountain summits, the modern flora of the region will have assumed its present character only rather recently.

Migration into the area by lichens doubtless followed patterns similar to those postulated for the vascular plants and bryophytes, which have derived both from northern glacial refugia and, more generally, from southern areas that escaped glaciation. A few species have also probably entered the area from coastal regions.

Given the youthfulness of the Wells Gray flora, our report of 293 macrolichens from an area 6 000 km^2 is exceptional, and clearly reflects the considerable climatic, topographic and substrate diversity within the study area. Notwithstanding Ahti's statement that the greatest species diversity in the boreal zone occurs in "highly oceanic coastal areas" (Ahti 1977), the Wells Gray region, 500 km from the Pacific Ocean, appears in fact to have the richest reported macrolichen flora of any (oro)boreal area of comparable size, if the halophytic seashore flora is excluded. Macrolichen diversity for other selected regions in the (oro)arctic, (oro)boreal and temperate zones are summarized in Table 4.

It is interesting that only 12 of the taxa reported here are restricted to the oroarctic zone, viz. *Alectoria sarmentosa* subsp. *vexillifera, Allantoparmelia alpicola, Bryoria subdivergens, Dactylina arctica, D. ramulosa, Lecidoma demissum, Pseudephebe minuscula, Solorina bispora, S. octospora, Stereocaulon rivulorum, Umbilicaria lambii,* and *U. virginis.* The rest, i.e. 280 species, may be characterized as having a major portion of their range in the (oro)boreal and/or (oro)hemiboreal, and thus account for approximately 56% of the world's total boreal macrolichen flora of roughly 500 species (Ahti 1977).

A few genera were especially well represented in the study area. The local *Peltigera* flora (23 species), for example, includes all but two of the taxa hitherto reliably reported for North America. The genus *Cladonia* (42 species) is also rather diverse, as are *Hypogymnia* (11 species) and *Cetraria* (18 species).

2. Phytogeographic patterns

The Wells Gray region is situated in the oroboreal and oroarctic subzones, and it is therefore not surprising that a great majority (98%) of the macrolichens present here are primarily boreal and/or arctic species. Species having predominantly temperate distributions include *Gonohymenia nigritella, Normandina pulchella, Melanelia subelegantula, Polychidium dendriscum* and *Sticta limbata.*

2a. *Circumpolar species*

Different from most vascular plants, lichens tend to display broad longitudinal distributions, especially at northern temperate, boreal and arctic latitudes. For example, of the 293 lichens considered in the present study, at least 216 (i.e. 74%), are considered to be more or less circumpolar. It is otherwise, however, for the 97 corticolous macrolichens occurring locally, only about 56 (58%) can be characterized as having circumpolar distributions, as compared with 160 (87%) of the 193 species having other substrate preferences (including lignum).

2b. *Disjuncts*

Roughly 36 (12%) of the local macrolichen flora can be characterized as having disjunct distributions. For the most part the disjunctions are between west-

Table 4. Macrolichen diversity in selected regions of the (oro)arctic, (oro)boreal and temperate zones in the northern hemisphere. Note that the concept "macrolichen" is not fully consistently applied in the calculations.

Species	Area (km^2)	Region and source
405	360 300	Finland (Vitikainen, pers. comm.)
359	36 000	Baden-Württemberg, Germany (Wirth 1987)
293	6 000	Wells Gray Park, B.C. (Goward & Ahti (1992)
260	409 600	Newfoundland, incl. Labrador (Ahti 1978a)
254	6 800	Devonshire, England (Hawksworth 1971)
249	230 000	Yukon; N.W. Territories (Bird et al. 1980)
223	2 000	Southern New Brunswick (Gowan & Brodo 1988)
215	116	Vega, Norway (Degelius 1983)
205	42 000	Southern Ontario (Wong & Brodo 1992)
203	850 000	Northern Ontario (Ahti 1964)
186	13 000	Black Hills, U.S.A. (Wetmore 1967)
181	7 850	Ottawa region, Ontario (Brodo 1988)
180	1 700	Southwestern B.C. (Noble 1982)
178	34 200	Southern Appalachians (Dey 1978)
132	3 650	Long Island, New York (Brodo 1968)

ern North America and western or eastern Eurasia, though other disjunct patterns are also present (cf. Brodo & Gowan 1983). Representative examples are many incompletely circumpolar, more or less oceanic taxa. Such as *Alectoria sarmentosa* subsp. *sarmentosa, Bryoria glabra, Cavernularia hultenii, Cetraria chlorophylla, Evernia prunastri, Cladonia norvegica, C. umbricola, Peltigera collina* and *Sticta limbata*.

2c. *Endemics*

Thirty-one taxa are endemic to western North America. This represents 11% of the total species present — a percentage distinctly higher than in (oro)boreal latitudes elsewhere (see, for example, Ahti 1977). However, not all local substrates are equally rich in endemic species. For example, no North American endemics at all have been found to occur primarily over lignum and only about 2% of terricolous and saxicolous species belong to this category. By far the richest local substrate for endemic macrolichens is tree bark — on which no fewer than 22 species (i.e. 21% of the epiphytic flora, and 71% of the endemic flora) is represented by endemic species. It is interesting to observe that, though a few of these species may occasionally be found on deciduous trees and shrubs, all are primarily restricted to conifers.

Among the epiphytic endemics it is also noteworthy that only four species (*Melanelia subelegantula, Parmelia hygrophila, Parmelia pseudosulcata* and *Pseudocyphellaria anomala*), i.e. 16%, regularly produce specialized asexual reproductive structures — soredia and isidia — as compared with 42 (75%) among the circumpolar epiphytes (see below).

Virtually all of the endemic corticoles may be characterized as essentially temperate to low boreal species. In B.C. only *Cetraria merrillii* (rarely present also in Spain!), *C. subalpina* and, along the coast, *Pseudocyphellaria anomala* are known to occur north of about latitude 55°N. Presumably most, if not all, of these species passed the Pleistocene glaciations south of the main Cordilleran ice sheet.

2d. *Outliers and range extensions*

During the course of field work, we detected a number of lichens far outside their known geographic range. A few of these were typically coastal lichens, e.g. *Cavernularia hultenii, Dendriscocaulon intricatulum, Hypogymnia enteromorpha, Nephroma occultum, Pannaria mediterranea, Parmelia pseudosulcata, Peltigera britannica, P. pacifica, Polychidium dendriscum* and *Sticta limbata* — most of which are here reported for the first time for inland North America. Additionally, we made several collections of the crustose species *Placopsis gelida* (L.) Lindsay, also hitherto known only from highly oceanic localities. All of these lichens are hygrophytic and are doubtless favoured by the relatively humid conditions characteristic of the study area, especially in summer. The presence of a primarily coastal element was also found in the moss flora of Wells Gray Park (Ahti & Fagerstén 1967).

Other species have hitherto been considered to be restricted to eastern North America, e.g. *Cladonia parasitica, Peltigera evansiana* and *Pilophorus cereolus. Baeomyces placophyllus, Collema glebulentum, Evernia mesomorpha, Melanelia septentrionalis, Nephroma isidiosum* and *Lasallia pensylvanica* all represent considerable southward range extensions in western North America (see Thomson 1984), though the last species is now also known from the Jonas rock slide near Jasper, Alberta (John 1989).

3. Substrate preferences

Though some lichens regularly colonize a wide variety of substrates, most tend to reveal a distinct preference for a single substrate type, whether bark, lignum, rock or soil. This tendency is especially well developed among the crustose lichens (Brodo 1974), but even among the macrolichens one substrate type is usually found to dominate. For example, of the 293 lichens recorded in the study area, only 19 (7%) regularly occurred over more than one substrate type. Of these, however, very few were found over more than two substrates.

A breakdown of substrate preferences reveals that 99 species (34% of the total) occur predominantly over bark, 24 species (8%) over lignum, 109 species (37%) over earth, and 77 species (26%) over rock. Here it should be noted that lichens were considered to be saxicolous only when typically growing directly attached to rock; species colonizing thin soil over rock or moss over rock were classified as terricolous, though some of these (e.g. *Lobaria linita, Nephroma arcticum, Psora globifera*, etc.) would probably be termed saxicolous by other authors. At any rate, corticolous, terricolous and saxicolous macrolichens are more or less equally well represented in the study area as a whole, though corticolous species clearly predominate at forested oroboreal elevations, and terricolous and saxicolous species in the oroarctic. The lignicolous element, confined primarily to decaying wood, is considerably less diverse, and is made up mostly of *Cladonia* species.

3a. *Saxicolous species*

Though a few rock-dwelling lichens, e.g. species of *Nephroma, Parmelia, Stereocaulon* and *Xanthoparmelia,* colonize a broad range of rock types having very different chemistries, by far the majority are more specific in their substrate requirements. For example, most species of *Arctoparmelia, Cetraria, Cornicularia, Lasallia, Parmelia, Pseudephebe,* and *Umbilicaria* display a distinct preference for acidic granitic or siliceous rocks, whereas *Phaeophyscia, Physcia,* and *Xanthoria* are restricted to base-rich (or base-enriched) rock types. One species, *Gonohymenia nigritella,* occurs in the study area only on limestone — a substrate otherwise avoided by most local saxicolous macrolichens.

For other taxa, habitat type is probably of equal or greater importance than rock type. This is certainly true for the aquatic *Hydrothyria venosa,* which was found only in cold, fast-running mountain streams. A number of other species occur only in seasonally submerged sites, e.g. *Collema bachmanianum, C. glebulentum, Dermatocarpon luridum, D. miniatum, D. rivulorum* and *Ephebe lanata.* In all of these species the chemical properties of the substrate are doubtless modified by mineral deposits from the water.

3b. *Terricolous species*

Most terricolous (including muscicolous) macrolichens encountered at lower elevations are more or less restricted to forested habitats. A few, however, were found to occur only or primarily in more open sites, usually of southerly aspect, e.g. *Cladonia cariosa, Leptogium minutissimum, L. tenuissimum, Peltigera lepidophora, P. ponojensis, P. rufescens, Psora globifera, P. nipponica* and *P. tuckermanii.* By contrast, *Baeomyces placophyllus* was collected only on a north-facing outcrop.

The soils in the area are largely calcareous, deriving from lime-rich basalt. This seems to be a major reason for the conspicuous abundance and diversity of terricolous *Peltigera* species, many of which are distinctly basiphilous. Acidophytic species, such as *Cladonia merochlorophaea* and *Lecidoma demissum,* have very districted distributions.

3c. *Corticolous species*

As already mentioned in Methods, above, we performed approximately 150 relevés during the course of our studies (see also Ahti 1962), most of them in forested sites. On the basis of these, it may be concluded that *Pseudotsuga menziesii* (a mesophyte) and *Picea engelmannii* x *glauca* (a hygrophyte) have the richest epiphytic macrolichen floras, each with approximately 45 species. Somewhat less diverse floras are associated with *Abies lasiocarpa* (35 species), *Betula papyrifera* (31 species), *Thuja plicata* (31 species) and *Pinus contorta* (30 species). By contrast, *Tsuga heterophylla* was found to be colonized by only 24 species, and *Populus tremuloides* by only eight species.

The meagre epiphyte flora associated with *Populus tremuloides* is especially noteworthy, given this species' comparatively rich lichen diversity in other parts of its range (see Case 1977). Perhaps the depauperate flora in the study area simply reflects the wetter climate, which thus tends to prevent dust from accumulating over this smooth-barked tree. Most of the lichens that do colonize *P. tremuloides* are found on the branch nodes and other roughened portions of the branches and trunk. By contrast, other local tree species have much more roughened bark. In the vicinity of farmsteads, *Populus tremuloides* supports a much richer epiphytic flora, consisting especially of *Physconia enteroxantha, Xanthoria candelaria, X. fallax* and other nitrophiles. Enhanced nitrogen levels are a well known characteristic of such places.

A comparison of the phorophyte preferences of circumpolar lichens with those of lichens endemic to western North America (see Table 5) reveals some interesting patterns. For example, 64% and 45% of the circumpolar epiphytes are found to occur respectively on the hygrophytes *Thuja plicata* and *Tsuga heterophylla,* whereas the percentage is considerably lower for the endemic lichens, i.e. 38% for *Thuja* and 31% for *Tsuga.* By contrast, the xerophytic *Pinus contorta* scores considerably higher for endemic species (56%) than it does for circumpolar species (39%). In a general way this supports the hypothesis that a majority of the endemic species are adapted to rather well-lit, xeric conditions, and have presumably evolved at temperate latitudes.

Even more striking is the observation that reproductive strategies differ widely between the endemic and the circumpolar corticoles. Whereas approximately 70% of the endemic species are often fertile, only about 15% of the circumpolar species regularly produce apothecia. Asexual reproductive propagules (i.e. soredia and isidia) therefore predominate in the latter group; and given that these appear to be much more effective than spores for long-distance dispersal, this perhaps in part accounts for the much broader distribution of the circumpolar species. An alternative, or perhaps complementary, explanation is that the western North American endemics have simply evolved more recently, and have not yet developed widespread asexual morphs.

In general, the circumpolar lichens colonize more species of trees than do the endemics, especially

Table 5. Frequency and phorophytic affinities of circumpolar and Pacific Northwest endemic (*) macrolichens in Wells Gray Park and its vicinity. Based on approx. 100 plots at all forested elevations. +++ = present on 75% of trees of that species; ++ = present on 25–74% of trees; + = present on 5–24% of trees; – = present on less than 4% of trees; ·· = data were not obtained. ABll = *Abies lasiocarpa*; PICe = *Picea engelmannii* + *P. glauca* + their hybrids; PINc = *Pinus contorta*; PSEm = *Pseudotsuga menziesii*; THUp = *Thuja plicata*; TSUh = *Tsuga heterophylla*; BETp = *Betula papyrifera*; POPm = *Populus tremuloides*; POPt = *Populus trichocarpa*.

	ABll	PICe	PINc	PSEm	THUp	TSUh	BETp	POPm	POPt
**Ahtiana sphaerosporella*	–	··	··	–	··	··	··	··	··
**Bryoria abbreviata*	–	–	··	–	··	··	··	··	··
B. capillaris	++	++	++	++	+	+	–	··	··
B. fuscescens	++	++	++	++	+	+	–	··	··
B. lanestris	+	++	+	+	··	··	··	··	··
**B. oregana*	++	++	++	+	··	+	–	··	··
**Cetraria canadensis*	··	··	+++	++	··	··	+	··	··
C. ciliaris	··	+	++	++	+	··	++	··	··
**C. idahoensis*	··	–	++	++	–	··	+	··	··
**C. pallidula*	–	–	–	–	··	··	··	··	··
C. pinastri	+	++	+	++	++	++	++	··	··
C. platyphylla	+	··	++	++	··	··	–	··	··
Hypogymnia austerodes	++	++	··	++	+	··	+	–	··
**H. imshaugii*	–	+	+++	+++	+	··	++	··	··
**H. occidentalis*	+++	+++	++	+++	++	++	+++	··	··
H. physodes	+++	++	+++	+++	++	+++	+++	··	··
**H. rugosa*	++	+	··	++	–	+	+	··	··
H. tubulosa	+	+	–	++	+	–	++	··	··
Imshaugia aleurites	··	··	+	–	··	··	++	··	··
Leptogium burnetiae	··	··	··	··	··	–	–	··	–
Lobaria pulmonaria	++	++	··	–	++	++	+	··	··
L. scrobiculata	–	–	··	··	–	··	–	··	··
Melanelia exasperatula	–	–	··	+	··	··	··	··	··
**M. multispora*	··	··	··	··	··	··	··	··	–
M. subaurifera	··	–	··	+	+	··	+	··	–
**Nephroma occultum*	–	··	··	··	··	··	··	··	··
N. parile	+	+	··	–	+	++	+	··	–
**Parmelia hygrophila*	++	++	+	++	++	+++	++	··	··
P. sulcata	+++	+++	+	+++	++	++	+++	+	+
Parmeliella triptophylla	··	··	··	··	··	–	–	··	–
Parmeliopsis ambigua	+++	+++	+++	+++	++	+++	+++	··	··
P. hyperopta	+++	+++	+++	+++	+++	+++	+++	··	··
Physcia adscendens	··	··	··	··	··	··	··	–	+
P. aipolia	··	–	··	··	··	··	··	+	+
Physconia enteroxantha	··	··	··	··	··	··	··	··	–
Platismatia glauca	+++	+++	+++	+++	+++	+++	+++	··	··
**Pseudocyphellaria anomala*	–	+	··	··	··	–	–	··	··
Ramalina dilacerata	··	–	··	+	··	··	–	··	··
R. farinacea	··	··	··	–	–	··	··	··	–
R. obtusata	··	–	··	–	+	··	··	··	–
R. pollinaria	–	··	··	–	–	··	··	··	··
R. thrausta	++	++	··	++	++	++	–	··	··
Sphaerophorus globosus	··	··	··	··	··	–	–	··	··
Sticta fuliginosa	+	–	··	··	··	+	··	··	··
Xanthoria candelaria	··	–	··	–	··	··	–	··	–
X. fallax	··	··	··	··	··	··	··	–	–

when only acidophilous species are considered. Yet even among endemic lichens, none are strictly limited to a single phorophyte in the study area, though *Ahtiana sphaerosporella* comes close to being so; its relationship with *Pinus albicaulis* has already been discussed by Kalgutkar and Bird (1969), and by Goward (1985). A few other endemic species, e.g. *Cetraria canadensis, C. idahoensis, C. merrillii* (subendemic) and *C. platyphylla*, show a distinct affinity for *Pinus contorta* and *Pseudotsuga menziesii*. By contrast, the most catholic corticole in the study area, as revealed by our relevés, is neither a Pacific Northwest endemic nor a truly circumpolar species, but *Cetraria chlorophylla* — a western North America–eastern North America–western Eurasian disjunct.

Finally, it can be noted that approximately 25% of the corticolous macrolichens are endemic to the Pacific Northwest, compared with only about 6% among noncorticoles. This observation seems to support the hypothesis that the conifer forests of the Pacific Northwest have been evolutionarily isolated during much of their history.

3d. *Epiphyllous species*

A very few macrolichen species, especially *Hypogymnia physodes* and *Parmelia sulcata*, have been observed colonizing the leaves of *Thuja plicata*. This phenomenon, however, which has rarely been reported in western North America (e.g. Daubenmire 1943, Vitt et al. 1973), was restricted locally to LB elevations in the most humid portions of the study area.

4. Lichen zonation

As a rule, ecological behaviour (ecoclimatic distributions, substrate preferences) of a given lichen is more or less uniform throughout its range. This fact is of basic importance for detailed comparisons between separate areas on different continents, since much of the experience from one region can readily be applied in another.

However, many of the circumpolar and even disjunct species do exhibit different zonal amplitudes in different portions of their range. Thus *Cladina rangiferina*, for example, extends into the arctic in many parts of Eurasia and North America, though in the study area it was not detected above the UB subzone, and in fact becomes rare above the LB subzone. Discrepancies of this kind were noted for about 30% of the species discussed in the present study, and in most cases, the upper zonal limits tended to be somewhat depressed locally as compared to those in other parts of the northern hemisphere. It seems likely that these differences reflect environmental factors, especially snow cover (see below), but in some instances they may also reflect subtle genetic differences in the populations.

A particularly striking example of differential zonal distributions can be seen in certain "arctic–alpine" species (e.g. *Alectoria nigricans* and *Thamnolia vermicularis*) which, in coastal regions (and to some extent also in the study area), may descend to oroboreal and even orohemiboreal elevations. A likely explanation, already offered by Gowan Brodo (1988), is that summer temperatures in oceanic sectors, as in oroarctic localities, are not warm enough to be limiting. A similar situation probably exists on north-facing lowland outcrops in arid portions of British Columbia, where other "arctic–alpine" species (e.g. *Cetraria nivalis* and *Pseudephebe pubescens*) may be found. All of these species are more or less chionophobic; doubtless they are further favoured in these lowland sites by the general absence of prolonged snow cover (see below).

By far the richest subzone for macrolichens in the study area is the LB, with approximately 215 species. Doubtless the HB subzone would be nearly or quite as rich, but it is restricted to a small area in the south, and is therefore not well expressed locally. The MB, with 178 species, is also rather diverse, though numbers fall off dramatically above this to about 110 species in the UB and HA subzones, 100 species in the LA, and roughly 50 species in the MA. The UA subzone was sampled too sparsely to permit comparison.

Ahti (1977) presented histograms of the subzonal distributions of macrolichens in Finland, based on 363 species; it is interesting to compare these with distributional patterns in the study area (Fig. 7). Here it may be noted that Finland has a zonal amplitude roughly equivalent to that of the study area (i.e. hemiboreal through southern arctic). Continentality is also similar, as is effective precipitation, at least compared to the semi-arid portions of the study area. It is important to emphasize, however, that effective precipitation in the humid and perhumid sectors, which actually comprise most of the study area, is comparatively rather high, and has no counterpart in Finland.

In Finland, Ahti reported that 40% of the macrolichens were present in all subzones, whereas in the study area the equivalent figure is only about 25%. This, however, includes many species that become very rare in the UB and HA subzones.

A second point of difference is the positioning of primary zonal breakpoints for the macrolichens. In Finland, the most significant zonal boundaries are those between the MB and the UB, and the UB and the HA, where approximately 23% of the species have their upper limits, and 12% have their lower limits. In the Wells Gray area, the primary zonal breakpoint for lowland species is clearly the MB–UB boundary, where some 23% of the macrolichens have their upper limits. At the UB–HA boundary, by contrast, only about 4% of the macrolichens disappear. The most important boundaries for upland species are between the LA and the HA, and the HA and the UB, where approximately 5% of the total mac-

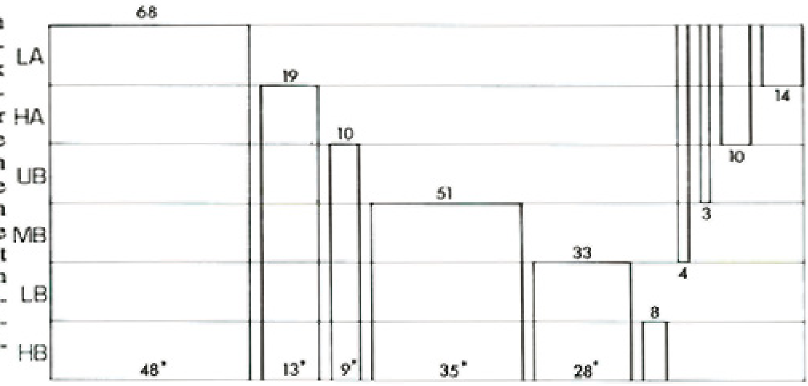

Fig. 7. Schematic subzonal spectrum of the ecoclimatic distribution of macrolichens in Wells Gray Provincial Park and its vicinity. Notes: (1) The histograms are based on 220 species for which clear subzonal limits could be discovered; other species have not been included. Rare extrazonal records have also been excluded. (2) Distribution above the LA subzone and below the LB subzone are in some cases difficult to discern. The figures marked with an asterisk (*) represent the number of species within each category that have actually been observed in the HB subzone.

rolichen flora has its lower limits. These differences are most readily explained by the relatively heavier snowpacks of the study area, especially in the UB and HA subzones, where many terricolous lichens are clearly excluded by prolonged snowcover.

It is probably also significant that whereas in the study area roughly 6% of the macrolichens are restricted to the oroarctic, in Finland there are none that do not also extend into the hemiarctic subzone. Again, heavier snow cover in the study area doubtless plays an important role in restricting many oroarctic chionophobes to exposed ridgetop situations above treeline.

Very few macrolichens are uniformly distributed throughout the study area, even within a given subzone. Putting aside the obvious differences in substrate and habitat requirements, already discussed, some species (e.g. *Peltigera pacifica, Platismatia norvegica, Sphaerophorus globosus*) are entirely or largely restricted to humid portions of the study area, whereas others (e.g. *Gonohymenia nigritella, Psora himalayana, Xanthoparmelia plittii*) are confined to semi-arid portions. These patterns, it must be stressed, are most pronounced at HB and LB elevations; they are less easy to discern above the MB subzone, apparently owing to a more general distribution of specific microsite conditions. In the oroarctic strong winds and a rugged topography ensure that the same mosaic of available microsite conditions is expressed in all parts of the study area.

Other species were detected only in the spray zones of the larger waterfalls, especially in open, well-ventilated sites. Examples include *Leptogium subtile, Pannaria mediterranea, Phaeophyscia kairamoi* and *Polychidium dendriscum. Sticta limbata* also belongs to this group, though it was observed once (as a scrap) in a humid forest near a lake.

Evernia divaricata is restricted to an anomalously humid area in the southwestern portion of the study area. This species was not detected in similar forest types elswewhere. Perhaps its present distribution is relictual — dating to 1926, when fire destroyed much of the lowland forests of the Clearwater Valley. In this connection it may be significant that *E. divaricata* seems to lack effective sexual or asexual reproductive propagules; possibly its rather circumscribed range therefore simply reflects a slowness to reinhabit its full ecological range after having been excluded by fire. Esseen et al. (1981) have reported a similar situation in *Usnea longissima.*

Our observations on the zonal distribution of macrolichens suggest that their macrodistributions are seldom directly determined by thermal factors. To judge from its zonal range, *Cetraria canadensis* might be taken as an example of a species requiring rather warm temperatures during the growing season, though even here other controlling factors, e.g. phorophyte preference, humidity, prolonged snowcover, cannot be ruled out. In contrast, the strict occurrence of *Dactylina arctica* and *D. ramulosa* at oroarctic elevations strongly suggests a sensitivity to high summer temperatures. Very few other examples of these kinds can be cited.

4a. *Corticolous species*

The distribution of epiphytic macrolichens is controlled in part by the distributions of the woody plants they colonize. Many corticoles therefore disappear above the limit of trees, though a few species switch substrates in the oroarctic zone and become terricolous.

Twenty-nine of the 97 corticolous macrolichens studied (i.e. 28%) were detected at essentially all forested elevations, though usually at differing levels of abundance in different subzones. This observation presumably substantiates the claim (e.g. McCune &

Antos 1982, Kershaw 1985) that specific microclimatic conditions, for example those on the trunks of trees, may be similar even under very different macroclimatic regimes. As a rule, most species tend to move from less exposed to more exposed habitats with increase in elevation.

Even so, many corticoles are clearly restricted to the lower subzones. This proved to be especially true of hygricolous species, e.g. *Hypogymnia vittata, Lobaria pulmonaria, Nephroma occultum, Platismatia norvegica, Pseudocyphellaria anomala, Ramalina thrausta, Sphaerophorus globosus, Sticta fuliginosa* and *S. limbata;* most of these lichens are most common in humid portions of the LB subzone, and none are found above the MB subzone. It is interesting that many of these species are known to occur into the UB in wind-blown sites in more oceanic portions of the province.

A few more or less xerophytic species also become rare or disappear above the MB: *Cetraria canadensis, C. pallidula, C. idahoensis,* the Everniae, the Ramalinae and most Usneae. The fact that the last three genera are well represented in the Rocky Mountains at UB and even HA elevations perhaps suggests a preference for less humid climates or more calcium-rich substrates (the Rockies are composed predominantly of limestone), or both.

Several of the corticolous species studied display what may be called a bimodal pattern of zonation, i.e. they are common in the HB and LB subzones and near treeline, but are apparently very rare in the intervening MB and UB subzones. *Bryoria abbreviata, B. fremontii, Cetraria pinastri, C. orbata* and *Letharia vulpina* all show this pattern very clearly, and are doubtless excluded from the MB and UB by the prolonged snow cover and frequent high humidity characteristic of these subzones. In the HA, in contrast, gradient winds are more pronounced, and the effective humidity is therefore more similar to that of lowland elevations. It should be noted that, among corticolous species at least, this distribution type may be more apparent than real: all of the species mentioned are photophilous and, though they may not be common in shady forest types within two or three metres of the ground, they probably do colonize the (more open) treetops at all elevations. At any rate, virtually all species exhibiting this local distribution are more common in less humid districts elsewhere, where their distribution is also more continuous, even within two metres of the ground.

The bimodal type of distribution is even more pronounced among terricolous lichens. For example several species of *Cladonia* disappear above the LB and MB subzones, only to reappear again in the LA.

It is interesting that *Letharia vulpina* is generally considered to be a temperate to hemiboreal lichen, though in the study area it was not infrequent at HA elevations, and even in the LA.

4b. *Saxicolous and terricolous species*

The zonal distribution of most saxicolous lichens was found to be even broader than that of the corticoles, though, again, many species showed a shift to more exposed sites at higher elevations. In this connection it must be stressed that surface temperatures on southerly exposures in the oroarctic may be as high as or higher than equivalent sites at valley elevations. At the same time, snow cover may actually be of shorter duration in many areas on the windswept peaks than in any other portion of the study area. Thus for many saxicolous macrolichens, especially various species of *Umbilicaria*, growing conditions are more favourable in the oroarctic than at shadier, snowier, less exposed MB and UB elevations; it is not surprising that like the terricoles, the saxicoles often also exhibit distinctly bimodal patterns of distribution.

The *Xanthoparmelia* species and, to a lesser extent, the *Arctoparmelia* species provide notable exceptions to this pattern, being much more common at HB, LB and at most MB elevations. In less humid districts elsewhere, *X. coloradoënsis* is not uncommon in exposed sites in the HA.

For many terricoles and some saxicoles, the zonal limits reported here are distinctly narrower than those reported in other parts of their range. For example, many species of *Cladina, Cladonia, Peltigera* and *Stereocaulon* — collectively 30% of all the species under study — virtually disappear locally above the MB subzone, notwithstanding that in less humid portions of their range they are known to occur at least into the HA.

4c. *The effects of snow*

Snow is present in most parts of the study area for at least five months of every year and may therefore be considered a primary environmental factor for many macrolichens, especially terricolous and saxicolous species. In fact, snow cover appears to play a fundamental role locally in controlling the distribution of many lichens. Its effects may be discussed under two headings: 1) thermal considerations; and 2) hydric considerations.

Thermal considerations. — In (oro)boreal and (oro)arctic environments, the primary thermal effect is usually considered to be beneficial for terricolous and some corticolous lichen species, namely to insulate them against extremes of winter cold. Benedict (1990b) has documented the adverse effects of extreme and sudden cold on exposed lichens. Barkman (1958) notes that in subarctic regions the Parmeliopsidetum ambiguae (including *Cetraria pinastri)* is restricted to microsites that are snow-covered during the winter months. The fact that in the Wells Gray area this community regularly extends to above the snow pack suggests that the insulating properties of snow may be less critical here than in more continental regions.

It is tempting, however, to speculate that the regular formation of insulating "qali", or snow clumps, on the branches of trees in some portions of the study area may favour at least some epiphytic species, especially those more commonly found in oceanic regions. In this connection it is interesting that such species as *Cavernularia hultenii, Hypogymnia enteromorpha, H. oceanica, Nephroma occultum, Sticta fuliginosa* and *S. limbata* are all invariably restricted to relatively windless forest types, often in outer spray zones of waterfalls, where qali tend to persist through much of the winter. Here these lichens are usually well developed, though never abundant, perhaps suggesting a greater thermal sensitivity during the establishment phase.

Because the study area is more or less uniformly snow-covered during the coldest winter months, it is difficult to determine what, if any, thermal advantage the snowpack may confer on terricolous and saxicolous lichens. Snowcover is, however, known to be of critical importance to at least some lichen communities under arctic conditions (Kershaw 1985).

Hydric considerations. — Many terricolous lichen species were found to be absent from sites in which the snow cover persists beyond early May. At oroarctic elevations, moreover, terricolous lichen communities were generally observed to be arranged in concentric patterns roughly parallel to the margins of melting snowfields. Similar observations have been published for other areas in western North America, e.g. Brooke et al. (1970), Gough (1975) and Flock (1978). More recently, Benedict (1990a) employed lichen transplant techniques to demonstrate a causal relationship between duration of snow cover and lichen mortality.

The mechanism involved in this relationship has not been elucidated experimentally, and may in fact vary from species to species. Flock (1978) postulated that lichens may simply be unable to endure the short growing season characteristic of snowy sites. Benedict (1990a), reviving Beschel's (1961) hypothesis, provided an alternative explanation: that prolonged snow cover is damaging to lichens primarily owing to prolonged wetting during snow melt. According to this view the critical period is spring and early summer, when meltwater is continuously available at the base of the snow pack, but light intensity is insufficient to allow photosynthesis. Under such conditions lichens may eventually deplete their thallus carbon reserves, and may then (to borrow an expression from Beschel) breathe themselves to death.

Fig. 5 depicts both the average and extreme durations of snow cover for the subzones present in the study area, based on many years of observation. At all forested elevations, snow is general throughout the winter, though above treeline strong winds redistribute the snow, baring the ridges and windward slopes, and creating persistent cornices and snowfields on the leeward slopes and in the depressions. In general, however, snow lingers longest at UB and especially (forested) HA elevations, where in sheltered sites it does not usually disappear until mid June or later. In contrast, the snowpack at most HB sites has melted by early April, or earlier.

Though total macrolichen diversity does not vary greatly within the forested subzones, terricolous species are much more diverse in the HB and LB than in the UB and HA. In the genus *Peltigera*, for example, the numbers are 22 versus 12 species respectively, though a number of species reappear in less snowy oroarctic sites. Near the upper limits of their range in the MB and UB, many *Peltigera* species are more or less restricted to logs, mossy boulders, and other elevated platforms. A similar pattern can be discerned for *Cladonia* (42 species versus 20 species). The saxicolous genera *Dermatocarpon, Rhizoplaca* and *Xanthoparmelia* essentially disappear altogether in the UB and HA in the study area.

Based on these and other observations, it is possible in general terms to classify many terricolous and saxicolous macrolichens according to their sensitivity to prolonged snow cover. Species that do not occur in snowy sites may be called chionophobic, whereas lichens whose distributions are restricted to such sites are chionophilic. In this connection it is convenient to recognize five categories: 1) highly chionophobic (e.g. *Brodoa oroarctica, Cornicularia normoerica, Rhizoplaca chrysoleuca*); 2) moderately chionophobic (e.g. *Cetraria commixta, Cladina rangiferina, Cladonia multiformis, Peltigera elisabethae)*; 3) indifferent (e.g. *Cladonia coniocraea, Parmeliopsis ambigua, Peltigera aphthosa)*; 4) moderately chionophilic (e.g. *Cladonia bellidiflora, Nephroma arcticum, Stereocaulon rivulorum)*; and 5) highly chionophilic (e.g. *Cetraria subalpina, Lobaria linita, Solorina crocea*).

Most of the locally occurring macrolichens judged to be highly chionophobic are restricted to exposed ridges, where snow persists for only short periods. A number of these are known only from oroarctic localities, e.g. *Alectoria nigricans, A. ochroleuca, Dactylina arctica, D. ramulosa, Pseudephebe minuscula, Umbilicaria lambii* and *U. virginis*. Others, however, are known to occur on (north-facing) windblown outcrops at oroboreal or even temperate elevations in arid districts outside the study area: *Coelocaulon aculeatum, Cornicularia normoerica* and *Pseudephebe pubescens*.

In contrast, a number of terricoles (but no saxicoles!) are restricted to or best developed in sites from which the snow does not melt until early to mid June. Examples include *Cetraria subalpina* (also in part corticolous), *Solorina crocea*, and, perhaps to a lesser extent, *Cladonia bellidiflora, Lobaria linita* and *Nephroma arcticum*. The lower distributional limits of all these species tend to be distinctly lower in the study area than in more arid districts elsewhere; the last three, for example, regularly occur downward into the LB in the snowiest portions of study area.

In most cases prolonged snow cover is especially limiting for arboreal macrolichens (see also Gough 1975), especially fruticose species. In areas of heavy snowfall, the lower trimline of the Alectoriae and Bryoriae on the trunks and branches of the trees provide a useful indicator of the average depth of the winter snow pack, which may be as much as two or three metres. It is interesting that these genera are best developed (e.g. to a total biomass of 3 300 kg per hectare; Edwards et al. 1960) in oldgrowth forests at UB and HA elevations in the southern portions of the study area. In comparison, their biomass is considerably reduced in equivalent forest types in the more snowy northern portions.

A very few arboreal macrolichens, however, show a considerable tolerance for prolonged snow cover. Of these the most notable are *Parmeliopsis ambigua* and especially *P. hyperopta* — both of which extend nearly, or quite, to the ground, even in snowy districts.

VII LIST OF TAXA NEW FOR BRITISH COLUMBIA, CANADA OR NORTH AMERICA

The following taxa are reported or documented for the first time for the geographic units indicated:

British Columbia (7 new species, 16 first documentations):

(+) *Baeomyces carneus*
(+) *B. placophyllus*
(+) *Bryoria subdivergens*
(+) *Catapyrenium squamulosum*
(+) *Cladonia parasitica*
(+) *Collema glebulentum*
(+) *Lasallia pensylvanica*
(+) *Nesolechia oxyspora*
(+) *Omphalina hudsoniana*
(+) *Peltigera evansiana*
(+) *P. neckeri*
(+) *Phacopsis huuskonenii*
(+) *Phaeophyscia constipata*
(+) *P. kairamoi*
(+) *Ramalina obtusata*
(+) *Scutula stereocaulorum*
(+) *Solorina bispora*
(+) *S. octospora*
(+) *Umbilicaria lyngei*
(+) *Usnea diplotypus*

Canada (7 first documentations):

(++) *Buellia pulverulenta*
(++) *Nephroma isidiosum*
(++) *N. occultum*
(++) *Phacopsis vulpina*
(++) *Scutula tuberculosa*
(++) *Umbilicaria hyperborea var. radicicula*
(++) *Xanthoparmelia coloradoënsis*

North America (5 new species):

(+++) *Corticifraga fuckelii*
(+++) *Echinothecium reticulatum*
(+++) *Leptogium subtile*
(+++) *Refractohilum peltigerae*
(+++) *Usnea wasmuthii*

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